Integrated Pest Management For Schools:
A Catalog of Resources

Edited by

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Preface

This reference manual was created from documents initially developed for the National School IPM World Wide Web site, which is located at **http://schoolipm.ifas.ufl.edu**. Many School IPM practitioners from around the country have contributed material to the web site to make it the leading resource for School IPM information. Soon after development of the web site it was noted that not everyone interested in School IPM information had internet access. In addition, many Pest Management Professionals (PMP) expressed their interest in a hard copy manual to maintain in the office or shop. This manual is the result of such requests.

The Web site and this manual are intended for a very broad audience. Concerned parents, school officials, PMPs, teachers, School IPM coordinators/practitioners, regulatory officials, and even students, will all find this reference to be a comprehensive resource. For additional detailed information on specific topics, a listing of related WWW links and reference sources is provided in Appendix IV.

The manual is separated into four chapters. The first chapter provides an introduction to School IPM and possible mechanisms to initiate IPM implementation. The second chapter provides tools for the school administrator to help manage a School IPM program. The third chapter of the manual is intended to be used by School IPM practitioners/coordinators when communicating concepts of School IPM to broad audiences. This chapter contains sample news releases (which increase awareness and help create support for IPM programs) and brief slide presentations covering IPM. The fourth chapter is the "meat" of managing pests. This chapter contains detailed information and is designed to be a teaching tool for PMPs, technicians, and School IPM coordinators.

The concept of Integrated Pest Management is relatively new to urban environments. It has been shown that implementation of IPM in schools can reduce risks associated with traditional pest control. With increased awareness/communication and improved teaching/training programs it is hoped that all schools will soon be implementing IPM. Use of this manual should aid in accomplishing this goal.

Dr. Clay Scherer
Dr. Phil Koehler

University of Florida
May 2001

1

What is School IPM?

Clay Scherer

IPM IS A PROCESS FOR ACHIEVING LONG TERM, ENVIRONMENTALLY SOUND pest suppression through the use of a wide variety of technological and management practices. Control strategies in an IPM program extend beyond the application of pesticides to include structural and procedural modifications that reduce the food, water, harborage, and access used by pests.

Four Points of IPM:

- Prevention of pest populations;
- Application of pesticides only "as needed";
- Selecting the least hazardous pesticides effective for control of targeted pests; and
- Precision targeting of pesticides to areas not contacted or accessible to the children, faculty, or staff.

As a parent, how do I get IPM implemented in my child's school? Often parents can provide the most influential voice on issues regarding school policies. Getting Integrated Pest Management (IPM) into your child's school or even the entire district can begin at the grass roots level by organizing concerned parents. If your school or school district is not currently using IPM, the following five-step process can help you initiate IPM:

1. Educate yourself about IPM. It is important to have at least some knowledge of the current pest control program used in your school. A good starting place for this information is the supervisor of pest control. Somewhere, or through someone, you have heard a little about IPM and it sounded good. Now, you need to find out all the details you can and become an educated advocate for the program. It is not important to understand how to control each pest. What is important is to understand the principles of IPM and why it is an improvement over conventional pest control. Only by knowing the facts will you be able to persuade others to join your efforts.

There are several resources available to you. This book contains information on many aspects of IPM. Within this book you will also find information about many other resources. There are also many local resources available to you. Your local county extension agent, county/city environmental resources department personnel, and school health personnel should be able to provide additional information.

2. Get the Parent/Teacher Association (PTA) involved. If you haven't already, get involved with your school's PTA and bring up the issue of IPM at a meeting. The more parents interested in IPM, the higher the chance of success in getting IPM in your school. PTA officers likely are among the decision-makers at the school. The more informed they are about IPM, the better equipped they will be to lobby the local school board. Your school's principal would also be a good person to speak with. At least make the principal aware that a group of parents are concerned about excessive pesticide use in the school and that alternatives such as IPM exist.

3. Get an IPM policy statement adopted. One of the most important steps in getting IPM into your school is to get the local school board to approve an IPM policy statement districtwide. See page 5 for an example of an IPM Policy Statement.

4. Establish a pilot IPM program. Everyone struggles with change. Depending on the type of pest control currently being used in your school district, the switch to IPM can amount to just a few adjustments or a major overhaul including retraining of personnel. In order to make the change as smooth as possible and with as much success as possible, implementing IPM at one specific location in your school district for a trial period may be worth considering. A trial could consist of switching several schools over to IPM, switching just one entire school, or just a few isolated structures (i.e. the media center and administration wing, if combined) at one school. Remember, IPM is a process. In order for an IPM trial to be successful, a period up to one year may be necessary.

5. Establish a School IPM committee. Eventually, it will be important for the school district to have some sort of School IPM committee made up of concerned parents, pest managers, and administrators. Establishment of such a committee will increase sustainability of a School IPM program. The role of this committee is to review the IPM program periodically and incorporate feedback from the schools into possible policy changes.

As a school administrator, how do I get IPM implemented in my school? A school administrator is often forced to make critical decisions about sensitive issues. There are many variables that influence popular opinion, depending on each school's particular situation. Whether your school is large or small, in an urban or a rural setting, the information below should aid in modifying your current pest control program into an Integrated Pest Management (IPM) program.

1. Educate yourself. The first step in the IPM implementation process is to educate yourself as much as possible about the subject. Although you may be familiar with IPM and convinced of its benefits, you must be able to answer various questions about IPM and be able to convince others of its value. This book, as well as other resources it references, is a great starting place for information on School IPM. As an administrator, the faculty, staff, students, and other administrators will expect you to be knowledgeable about IPM.

2. Communicate with pest managers. In-house pest control. If pest control is handled by in-house staff in your school, contact the supervisor of pest control. It is important to convey your deep interest in IPM and that you have completed background research on the topic. Discuss with the pest management supervisor all the benefits of IPM, including the reduced health risks associated with IPM implementation. Be sure to provide some of the School IPM references to the pest management supervisor. Upon completion of the initial contact allow for a short period for the pest management supervisor to review the materials you provided and research it. Offer to meet with the pest management supervisor and even walk through your school discussing IPM strategies while pointing out specific areas of concern.

Contracted pest control. If pest control is handled by a private pest control operator, contact the person listed in the school's pest control contract as the supervisor or contact person. This information can be found by contacting the school district's purchasing agent. Discuss with the supervisor the overall method of pest control currently being used in your school. Let the supervisor know that you are interested in getting IPM implemented into your school. More than likely, the supervisor will possess considerable knowledge about IPM and should be willing to cooperate with your efforts, depending upon certain contractual obligations.

3. Contact neighboring schools. There is no sense in "reinventing the wheel." Contacting school administrators from neighboring schools or neighboring districts can be extremely helpful. Your counterparts may have already gone through the process of converting to an IPM program and be able to offer valuable suggestions. If they haven't, they may become interested in IPM and be willing to combine their efforts with yours.

4. Inform the school board. It will be important for you to make a brief presentation to the local school board and initiate the process of establishing an official School IPM Policy Statement. An example of a School IPM Policy Statement is on page 5. Adoption of an official policy statement is important because it gives school officials the authority to make decisions regarding pest management. In the case of an IPM policy, it provides administrators the foundation from which to implement IPM.

5. Establish contacts with local authorities. There may be many local resources available that you are unaware of. Your local county extension agent should have considerable expertise in insect pest identification and pest management. The extension agent may also be able to provide assistance in developing and supporting an IPM program. Because the Cooperative Extension Service is also a state and federal resource, the extension agent has the ability to contact outside experts on IPM and bring that to the local level. There may also be individuals within the county administration that could provide expertise. Many local resources such as the county health department or environmental services department employ professionals who possess experience in pest-related health risks, pest management, and sanitation. All of these individuals can provide support for an IPM program in schools.

6. Ensure sustainability. It is important to create a mechanism through which the IPM program can be maintained. The best method of accomplishing this is to create a School IPM advisory committee. This committee should have representatives from pest management (whether in-house or contracted), teachers, school administration, sanitation staff, and concerned parents (PTA). Because IPM is a process it will be important for this committee to help make decisions on pest management that may be unique to your school or school district. Additionally, periodic feedback from these individuals will help improve the IPM program.

As a faculty/staff member, how do I get IPM implemented in my school? Faculty and staff work in the classrooms and cafeteria areas just like the students. As a result, teachers and staff are exposed to all the same risks as the students. In addition, faculty and staff should not introduce potentially harmful bug sprays into the classroom. Commonly used over-the-counter products available at local stores often contain the same ingredients as those products available only to licensed pest control operators. When used in the classroom these sprays are potentially dangerous to chemically sensitive children. Also, these products can make some pest problems worse because they may interfere with or even reduce the effectiveness of treatments made previously by the pest management staff. Interested faculty and staff can follow several steps in helping to get Integrated Pest Management to work.

1. Never bring in cans of bug spray. If you have an emergency pest problem, follow the procedure provided by the pest management personnel. Hopefully, a mechanism exists whereby you can notify the pest management technician (by telephone or written report) of any pest problems so they can quickly treat the problem. Don't buy pesticide products at local stores to use in school areas.

2. No food or drink in the classroom. Do not bring food or beverage items into the classroom except in sealed containers (i.e. lunch boxes). It is very important to continually remind school children that food and snacks are to be eaten in the cafeteria, not the classroom. Even the tiniest of crumbs

is a full meal for roaches or ants.

3. Keep the classroom as clean as possible. Sanitation, not pesticides, makes the biggest impact on pest populations. Cleaning up after any pets in the classroom and after parties is an absolute must. Empty soda cans, used paper plates, and food wrappings should be placed in the trash can and then hauled to an outside dumpster before the end of the day. Trash cans full of this type of debris left overnight in the classroom are often sources of pest problems.

4. Get to know the pest management staff. Whether pest control is handled in-house or is contracted out, try and interact with the pest control technicians as often as possible. The more communication that occurs between the faculty/staff and the pest control technician the more effective pest control will be. It is very important for teachers and school staff to communicate with the pest control technicians about the kind of pest problems that exist. Specifics such as where the pests are (i.e., near the sink in the rear of the classroom), what kind of pests exist (i.e., roaches, ants, wasps, rodents), and when they are a problem (i.e., only in the morning or all the time) is valuable information to the pest control technician. The technician will be better prepared to treat the pest problem with this sort of information. A great way to communicate pest problems to the pest control technician is by using a Pest Sighting Log.

5. Begin using a Pest Sighting Log. Pest Sighting Logs are used by school employees to communicate pest problems to the pest control technician. The log is a record of when the pests were seen, by whom, where, and what kind of pests were present. The pest control technician checks the log and then uses the information provided to treat the problem. The pest control technician also records what action was taken to treat the pest problem on the Pest Sighting Log. Information such as what pests were identified, what was the cause of the pest problem, and what was used (pesticides, if any) to obtain control of the pests is important to record. The pest control technician also makes recommendations to building maintenance staff on the Pest Sighting Log about what changes in maintenance might help prevent future pest problems (installation of proper door sweeps, turning off unnecessary lights at night, installing proper window screening). A Pest Sighting Log should be kept in each classroom.

6. Talk to pest control technicians about IPM. Convincing your current pest control technicians to implement IPM may be simpler than you think. Also, speak with your school's principal about IPM and the advantages it furnishes by providing a safer school environment.

7. Learn as much as possible about IPM. Consider bringing up IPM at the next school PTA and/or faculty meeting. Help build support for the idea of switching to a schoolwide IPM program by distributing IPM materials to others. A knowledgable group of people who support an issue is often more effective than a single voice of concern.

As a pest manager, how do I get IPM implemented into schools? As a pest manager you may find Integrated Pest Management a viable option as an alternative to traditional pest control. If you are currently servicing schools, day care centers, or city/county government facilities, and are not using IPM, you should consider the advantages of the IPM concept. If you are well trained in the practice of IPM and wish to begin implementing it into some facilities the following information may be helpful. If the concept of IPM is new to you, the following five-step process is essential to implementing IPM into schools and public buildings.

1. Educate yourself about IPM. (If you feel that you are already properly trained in providing IPM you may want to advance to step 2.) If you are not already trained in the techniques and materials involved with an IPM program, this will be the most crucial step. There are many sources available to you. This book contains lots of good technical information regarding IPM methods and materials. Also, there are educational presentations beginning on page 31 that provide additional descriptions of typical IPM procedures. However, this book should be just a beginning. Your local regulatory agency and the Cooperative Extension Service are also good places to get additional information. In addition to those sources, many manufacturers also supply technical bulletins and documents with their products that describe IPM techniques and application methods. Lastly, several professional texts are available which cover in great detail the ins and outs of IPM. Check the "Other Resources" section of this book for a complete list.

2. Schedule a meeting with school administrators. In most schools the administrators are very busy and have little time to spare for building operations and maintenance. However, administrators are very interested in issues concerning the safety of students and staff. No one wants a student or staff member to be stung, bitten, or otherwise harmed by pests or exposed to more pesticides. Addressed in this manner, the issue of School IPM quickly gets attention and gains endorsement from administrators. (At this point in-house pest management staff can go on to Step 3; private contractors should continue reading.) After discussing IPM with school board members or school principals, you will probably be directed to the individual responsible for outsourcing services for the school district as a whole, the purchasing agent or purchasing officer. This mechanism may vary, however, as some districts allow the individual schools to outsource certain services independently.

When discussing the issue of IPM with the purchasing agent, you should alert the agent that an IPM program is a very different method of controlling pests than traditional pest control and, therefore, requires very different contract language than traditional pest control contracts. On page 11 are guidelines for purchasing agents constructing IPM contracts. While these guidelines are not suitable to every situation, they provide a good outline for a workable IPM contract within a school district. You may even wish to provide the purchasing agent with a copy. An additional source available to purchasing agents is the United States General Services Administration, Building Services Group in Washington DC. Also see Step 3 on the following page.

3. Volunteer to set up an IPM advisory committee. The creation of an IPM advisory committee is an essential step in getting a successful IPM program implemented in a school. Again, depending on the school district, this committee may be districtwide or include just a single school. If you have already established working relationships with the school board or the school principals, you should easily obtain approval for this step. However, don't forget to stress that a School IPM advisory committee should be made up of volunteers from several areas. These include: the PTA, one or two members of the school district's administration, local health department, building services department or facilities department, county extension service, pest control industry, sanitation services, IPM coordinator (if such exists with the school or county administration), and any other interested group.

It is through this committee that many of the details of the IPM program design can be developed. Concerns about which pesticides to be used, when applications are to be conducted, and so on should first be discussed by this committee then relayed to the purchasing agent and/or the IPM coordinator, if the school has established this position. Much of the work for this committee, in the beginning, will be to educate members of the faculty, staff, students, and parents about the concept of IPM and the advantages associated with its implementation.

It may be appropriate at this time to discuss current pest control techniques being used in the school. If pest management is being conducted by in-house personnel, a manager or supervisor of that staff should be included as a member of the IPM advisory committee. As a result, any recommendations made by the School IPM advisory committee can be rapidly communicated to the pest management staff. Also any issues from the pest management staff can be quickly brought before the advisory committee.

If pest control is currently being conducted by a private pest control operator, it is very important that recommendations from the IPM advisory committee are passed on to both the purchasing agent and the pest control operator. If recommendations from the advisory committee are viewed as outside the scope of service provided by the pest control operator, these recommendations should be adequately detailed and given to the purchasing agent to consider incorporating into the next pest control contract to be bid out. However, some of the recommendations may be easily implemented as part of the existing contract.

4. Establish a pilot IPM program. To make the change to IPM as smooth and successful as possible, consider implementing IPM at one specific location in your school district for a trial period. A trial could consist of switching several schools over to IPM, switching just one entire school, or just a few isolated structures (i.e., the media center and administration wing, if combined) at one school. Remember, IPM is a process. In order for an IPM trial to be successful, a period up to one year may be necessary. Any effort to establish a pilot IPM program should first be approved by the IPM advisory committee.

5. Set up communication links. (This step is a follow-up to Step 3.) For IPM to be implemented successfully, a number of individuals will have to put forth some effort. All of the individuals mentioned above have an important role in establishing IPM and they must be involved. However, there are others who can provide valuable assistance to the School IPM advisory committee. Among these are administrators and other staff from districts that are already using IPM. Contacting the principals, school staff, cooperative extension agents, and pest management staff from a neighboring school or district that currently uses IPM can be very helpful. Those individuals may have already solved many of the problems which you will encounter. The more experience you bring into the discussions on IPM within your school district, the greater the chances it will succeed.

2

Information for the Administrator

Those individuals who might be referred to as administrators include school principals, School IPM coordinators, statewide program coordinators (university or state agency), or even pest management directors. These individuals aren't necessarily involved with the day-to-day application of IPM but are more involved with the overall big picture in managing entire programs or initiating area-wide school IPM programs. This section provides materials which many coordinators have found helpful in initiating and managing School IPM programs.

This section includes policy information for school boards, examples of training programs and surveys, and examples from other School IPM manuals. This section also includes forms that might be used for documentation of the program, sample letters that might be used to communicate with parents, contract guidelines and models that might be used to obtain IPM from a private pest management firm, regulatory information regarding pest management in schools, and contact information for Poison Control Centers.

Getting Started

Sample Pest Management Policy Statement

Clay Scherer

The first step in an IPM program is to inform teachers, staff and students about the school's policy. The notice can be printed and posted on bulletin boards to inform everyone.

Policy

It is the policy of this school district to implement Integrated Pest Management procedures to control structural and landscape pests and minimize exposure of children, faculty, and staff to pesticides.

Pests

It is the policy of this school district to control pests in the school environment. Pests such as cockroaches, fleas, fire ants, stinging wasps, termites and rodents are annoying and can disrupt the learning environment in schools. Pests are known to bite, sting, or transmit diseases, and may also cause allergic responses.

Pesticides

It is the policy of this school district to reduce exposure to pesticides in the school environment. When pesticides are used to control pests in schools, there is potential for human exposure. Excessive exposure may result in pesticide poisoning or allergic responses in sensitive individuals. Children may be more susceptible to pesticides than adults due to their smaller size and rapid growth and development. Their playful behavior may expose them to more pesticide residues.

Integrated Pest Management

- Nonchemical prevention of pest populations using such methods as sanitation, exclusion, and cultural practices.
- Application of pesticides only as needed to correct verified problems.
- Selecting the least hazardous methods and materials effective for control of targeted pests.
- Precision targeting of pesticides to areas not contacted or accessible to the children, faculty, and staff.

Success

The success of IPM in schools depends upon:

- Full cooperation of administrators, faculty, maintenance/custodial staff, parents, and students.
- Establishment of a school district-wide IPM coordinator and advisory committee.
- School-based safety committees shall include pest management and pesticide policy as part of their agenda.
- Each school shall designate a staff member to coordinate the IPM program and maintain pest management records.

Integrated Pest Management — What is it?

Edward Crow

Insects and rodents such as cockroaches, ants, mice and rats need food, water and shelter to survive. They become pests when they live in close association with people and may pose serious problems in sensitive areas such as schools, hospitals, research facilities and office buildings. Insect and rodent pests carry disease organisms on or in their bodies; they cause damage by chewing electrical wiring and insulation; and contaminate food and food preparation surfaces. Since most people find insects and rodents repulsive, there are aesthetic considerations that make pest control important. The traditional method of controlling pests has been to apply an insecticide or rodenticide as a general preventive treatment, whether the pest is known to be present or not.

However, relying solely on pesticides to solve pest problems will eventually fail because of pesticide resistance that leads to loss of control and a resurgence in pest numbers. Also, with an improper application of a pesticide there is the potential to contaminate the school or work environment and expose staff and students to pesticide residues. In order to provide safe, effective pest control that is compatible with sensitive areas, Integrated Pest Management (IPM) has been utilized as the preferred method of pest control. IPM has been used in those areas where the control of pests is needed and the general application of pesticides is undesirable.

IPM is an effective and environmentally sound approach to pest management. It relies on the coordinated use of pest and environmental information and the best available pest management methods to prevent unacceptable levels of pest damage by the most economical means and with the least possible hazard to people, property and the environment.

Pest control in schools must protect both the health and safety of the children and staff, minimize pest damage to structures and personal property, and improve the quality of the educational environment by avoiding annoyance and disrupting of work and learning caused by insects, rodents and other pests. To meet these goals, the Maryland Department of Agriculture, University of Maryland Cooperative Extension Service, Maryland Association of Boards of Education, and the Governor's Pesticide Council are working to implement an IPM program to control pests in schools. In order to have a successful IPM program, teachers, parents and students should have an understanding of what an IPM program is and what role they have in helping to ensure that the IPM program will be effective.

Many individuals falsely assume that an IPM program represents a nonchemical approach to pest management. Unlike any single method of pest control, IPM programs balance the costs, benefits, public health, and environmental quality, avoiding unnecessary repeated applications of pesticides. This is accomplished by focusing on correcting conditions that encourage pests by reducing the amount of food, water, and harborage available to pests and eliminating unnecessary pesticide applications. Practices such as sanitation, excluding pests through structural repairs, and education comprise the routine IPM service, as well as the use, where needed, of chemical-based methods of pest control. A combination of these practices achieves an effective long-term pest control program. The basic components of IPM are:

- MONITORING. Monitoring is the regular surveillance of an area for pests using traps, visual inspections, and interviews with staff. Surveys are conducted to determine if a pest problem exists, the location and size of the infestation, and conditions that may contribute to pest problems.
- SANITATION/STRUCTURAL REPAIRS. Pest problems often can be prevented through proper sanitation, reduction of clutter and pest harborage, and performing small repairs that exclude pests from a structure.
- COMMUNICATION. Staff and student cooperation in correcting conditions that contribute to pest problems is essential to the success of an IPM program. Training and educational programs on subjects such as pest identification, biology, and sanitation can be conducted to promote understanding and assistance with the IPM program.
- RECORD KEEPING. Monitoring data on pest numbers and observations on housekeeping and structural deficiencies are recorded in a logbook maintained in each facility. A section of each logbook is reserved for use by staff to alert the pest management technician of pest sightings between scheduled services.
- PEST CONTROL WITHOUT PESTICIDES. IPM practices such as trapping screening, caulking, steam cleaning and power washing, and freezing are effective long-term pest control methods. Nonpesticidal pest control practices can be effective and applied with a high degree of safety.
- PEST CONTROL WITH PESTICIDES. Pesticide use may be necessary in an IPM program to effectively control pest infestations. Pesticide applications should only be done when needed and be applied in a manner, such as baits, that will maximize the effectiveness in controlling the target pest and minimize the exposure to humans and other nontarget species.
- PROGRAM EVALUATION. Monitoring data and observations are periodically summarized and reviewed to evaluate program effectiveness. IPM practices and procedures are continually adopted and modified based on past experience and results, and knowledge, gained over time, of the problems associated with each facility.
- QUALITY ASSURANCE. Technical oversight provides an objective, ongoing evaluation of program activities and effectiveness. Whether provided by in-house or contracted pest control personnel, oversight and review are critical to maintaining an effective IPM program.

Integrated Pest Management is different from a traditional pest control service. IPM programs can significantly reduce the use of pesticides through the use of technical expertise in identifying and encouraging the use of more permanent nonpesticidal control practices that are proactive in preventing pest problems, not reactive to a crisis. IPM programs

discourage unnecessary pesticide use and do not rely on generic prescriptive pesticidal treatments as the only tangible evidence of pest control. Each IPM program is specifically designed to meet the individual needs of the area serviced.

The success of an IPM program depends on the assistance and cooperation of the administration, staff and students in each facility. Improvements in sanitation, housekeeping, and facility structure can be initiated only by the occupants of each facility. IPM does work and is a safe and effective way to control pests. However, unlike traditional pest control programs, IPM cannot be used intermittently to solve a single pest problem and then be discontinued. IPM must be a continuing program in order to manage the environment where pests live and to address future pest management needs.

Getting Started with School IPM

Peggy Powell

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Many states are beginning to adopt Integrated Pest Management (IPM) practices in school facilities. IPM is an approach to pest control that relies on common-sense practices rather than depending exclusively on pesticides. IPM uses information about pests' life cycles to control them, with less hazard to people and to the environment.

The primary goal of IPM is finding the cause of pest problems. Understanding what pests need to survive is the key. Pests live in areas that provide basic needs such as food, water, and shelter. Pests can often be controlled by removing food and water sources or by closing off entry points into buildings. Pesticides can also be part of an IPM program if they are selected carefully and used cautiously.

Good housekeeping practices, structural repairs, and staff training are all part of an IPM program. In many cases, an IPM program can be combined with the pest management plan already in place in a school.

The following are steps to follow when setting up an IPM program:

1. Develop an IPM Policy Statement

The policy statement should explain what is expected, how existing services will be included, and how students and staff can take part in the program.

2. Set Pest Management Objectives

Examples of pest management objectives include (1) controlling pests that are found in the facility to prevent interference with learning, (2) eliminating possible injury to students and staff, and (3) preserving the integrity of buildings.

3. Designate Pest Management Roles

Designation of roles for the pest control contractor, staff, students, and parents is an important part of an IPM program. Cooperation among people is the key to success. The more the students and staff join in, the better the program will work.

Students and staff. The most important job for students and staff is to help in keeping the school clean. Prevention of pests depends on everyone working together to clean up litter and leftover food.

Parents. Parents' first school pest management responsibility is to learn about and follow IPM practices at home. Pests carried from home in notebooks, lunch boxes, or clothing can slow the success of an IPM program.

Pest control contractor. The pest control contractor is the person who inspects the facility, monitors for pests, and decides if control measures are necessary. The pest control contractor also keeps records of the amount, location, and dates of any pesticide use.

The mere presence of one insect does not always require the application of a pesticide. The pest control contractor and school staff should decide in advance how many pests are harmless and how many require control.

5. Inspect Sites and Monitor for Pests

Inspecting for pests is an important part of IPM. The pest control contractor should identify any pests found and try to figure out where they came from. Then, structural changes to the building can be used to reduce pest numbers.

Monitoring traps are placed in areas where pests have been reported. The numbers of pests caught are counted to determine if action thresholds have been reached and if control measures are necessary.

6. Apply IPM Control Strategies

When the number of pests becomes greater than the action threshold, the pest control contractor takes action. He or she may physically remove the pests or suggest changes to the habitat so that pests can't get to food, shelter, and water. Other control strategies used in an IPM program may include building repair, improved sanitation, or careful application of a "less hazardous" pesticide.

7. Evaluate Results and Keep Records

Accurate record keeping allows the pest control contractor to evaluate the success of the IPM program. Records also help in forecasting the appearance of seasonal pests to predict future pest outbreaks.

Whether an IPM program raises or lowers costs depends on housekeeping, maintenance, and pest management policies. The costs of setting up an IPM program can also depend on whether the pest management services are contracted out or provided by in-house staff. Be aware, though, that some states require in-house personnel to become certified before they can apply pesticides.

Maryland Pest Control Association's Integrated Pest Management Training Outline

Jerry Bukovsky

I. Principles of Integrated Pest Management (IPM)

A. Reduction of Pesticide Exposure
1. Application techniques
2. Apply only to active harborages
3. Cease regular insecticide treatments
4. Educate the customer

B. What Is IPM?
1. A system of controlling pests that does not depend on automatic application of pesticides.
2. Aspects of IPM include careful inspections; regular monitoring; identifying conditions contributing to pest problems; priority given to nonchemical techniques; record-keeping to track problems, prevent reoccurrences, and evaluate existing pest management actions.

C. A Typical IPM Visit
1. Review the log book or sighting log to see if any reported pest problems exist since the last service visit.
2. Check in with the staff members in charge of handling the service to discuss special problems or conditions.
3. Conduct walk-through visual inspections. This should include every area both inside and out, checking for pest activity and evidence of problems. Be sure to look at sticky traps and monitoring devices. Communicate with individuals working in these areas by asking questions and discussing pest problems.
4. Identify any pest that is found and decide if its numbers are above the action threshold level which requires some method of control. NOTE: Action thresholds are usually predetermined at the time of sale and are included in the scope of service.
5. For each individual pest problem, a decision must be made as to what control tactics to use given the following:
• Identity of the pest
• Extent of the problem
• Sensitivity of the site
6. Nonchemical recommendations in addition to nonchemical pest management should be implemented whenever possible.
7. If a pesticide application is necessary, then you would choose a product that poses the least hazard to people and environment (minimal risks).
8. Evaluate the work since the previous visit to determine its success or if further action is needed.
9. Lastly, document the service, make entries in the log book, prepare any notices to the customer, and complete any other record keeping requirements.

II. Monitoring Pests

A. Action Thresholds
1. The point at which action (control) must be taken.
2. Site- and pest-dependent
a. Different levels dictate the control actions.
b. Utilize common sense and evaluate the location and severity.
c. These levels can be revised based on continued sightings or lack thereof.

B. Monitoring Devices
1. Sticky traps
2. Pheromone traps
3. Spider webs
4. Light traps
5. Baits (acceptance rates)
6. Actual sightings (log book)
7. Flying insect traps

C. How to Use and Evaluate Monitoring Devices
1. Sticky traps
• Primarily used for crawling insects, but can capture flyers as well (fungus gnats, etc.).
• Fasten them to help indicate direction of travel.
• Observe life stages, i.e., nymphs, adults, and sex (male/female).
• Replace them regularly when they become dirty or contaminated.
• Use in high- and low-risk areas.
• Initial and date traps; map their locations. Record any captures and be sure to include the pest and location.
• Try to check the traps on a regular schedule so that you can use the information for comparison purposes.
• Be consistent — use the same type of trap if at all possible.
• Think like an insect! Act like an insect!

2. Pheromone traps — NOTE: Monitors particular pests; pheromone is host-specific.
• Useful in monitoring cockroaches (German, American, and oriental)
Victor M330 and M331
• Indianmeal moth
• Warehouse/khapra beetle
• Red and confused flour beetle
• Cigarette beetle
• Saw-toothed grain beetle
• Drugstore beetle
• Angoumois grain moth
• Grain borers (larger and lesser)
• Drosophila and house flies

- Webbing clothes moth

3. Spider webs
   Although not always available, they are invaluable because spiders construct webbing where known insect activity occurs. Webs will contain most insects, and various insect carcasses can be observed to detect activity.

4. Light traps
   - Utilize ultraviolet lights to attract flying insects.
   - Placement is critical.
   - Can cause other insect problems, i.e., dermestid beetles.
   - Bulb replacement is crucial to continue effectiveness of the trap.

5. Baits
   - Prebaiting ex. Census (Rodent Monitor)
   - Bait acceptance rates

6. Log book
   - Trends relating to captures and sightings

7. Flying insect traps
   - Yellowjackets (outdoors)
   - Fruit flies (indoors or outdoors)
   - Flies (outdoors)

III. Nonchemical Pest Management

A. Sanitation
   1. Vacuuming
   2. Steam cleaning or power washing
   3. Containers that are insect- and vermin-proof
   4. Proper rotation of stock
   5. Proper storage
      - Off floor
      - Out of boxes
      - Away from walls
      - Inspection stripe
   6. Proper waste disposal
   7. Plantings that discourage insect and rodent harborage

B. Exclusion
   1. Physical or mechanical alterations that prevent pest entry or otherwise reduce the attractiveness of the area.
      - Kick plates
      - Weather-stripping
      - Screening and hardware cloth
      - Caulking
      - Mortar and/or concrete sealing
      - Eliminating moisture sources
      - Changing mulching materials

C. Trapping
   1. Insect
   2. Rodent

IV. Using Pesticide in IPM

A. Pesticide Hazards
   1. Labels
   2. MSDS

B. Choosing the Right Pesticide
   1. Utilize the signal words
   2. Formulations
   3. Volatility

C. Application Tactics
   1. Baits
   2. Gels and pastes
   3. Cracks and crevices
   4. Voids (Insider)
   5. Spot treatment
   6. Perimeter
   7. Space sprays
      Time of treatments
      Sensitive areas
      Out of sight — out of mind
   8. IGRs

V. Record Keeping

A. Floor Plan

B. Log Book
   1. Activity and sightings
   2. Monitoring data
   3. Service tickets

C. Quarterly Reports or Evaluation of the Program

   1. Determine whether or not goals are being achieved, corrections need to be made, or other implementations are necessary.

Sample Letters

Head Lice Letter to All Parents at the Start of the School Year

Clay Scherer

This letter should be sent out to all parents during the beginning of the school year.

Dear Parents:

Head lice have become more and more of a problem over the last few years. The number of children infested with head lice is increasing all across the country. Control of head lice depends on prompt diagnosis and effective treatment. Your help in inspecting your child at least weekly throughout the school year for the presence of head lice would be greatly appreciated.

We suggest the following procedure for inspecting your child for head lice:

1. Under bright light begin looking at the back of the head just above the neck area.
2. Part the hair section by section and look closely for head lice or nits (eggs). Eggs will usually be located near the scalp.
3. Depending on the length and thickness of the hair, it should take between 5 and 15 minutes to properly inspect a child's head.

If you suspect your child is infested with head lice, please notify the school nurse. In addition, the entire family should be inspected for head lice. For information on how to treat your child's head lice infestation, consult your family physician, a local pharmacist, or feel free to contact your child's school nurse for recommendations.

If you have access to the Internet, you can obtain information on controlling head lice from the National School Integrated Pest Management web site at http://schoolipm.ifas.ufl.edu.

Sincerely,

School Principal

Head Lice Letter to Parents of an Infested Child

Clay Scherer

This letter should go to the parent(s) of a child who has been identified as having head lice.

Dear Parent:

During a screening examination your child was found to have head lice. Head lice do not carry any disease, nor does their presence mean that you or your child are dirty. Head lice can infest anyone. To prevent further spread of head lice to other students, this condition should be treated immediately. Your child will not be allowed to return to class until the infestation has been properly treated. You may wish to consult your family physician, a local pharmacist, the school nurse, or you can follow the recommendations below. In addition, you should inspect the entire family for head lice, as your child may have spread it to other members.

Upon return to school your child will be inspected by the school nurse to determine that the head lice infestation no longer exists. This means that your child must be free of all lice and nits (eggs).

Basic Head Louse Control Recommendations

1. Live lice must be removed or killed. Mechanically removing head lice can be accomplished using a special fine-toothed comb which requires no use of pesticides. This method is time consuming but can be made easier after a treatment with ordinary hair conditioner. Various creams and shampoos that contain pesticides are available over the counter for treatment of head lice. These treatments are not always effective and can cause reactions in some children. There are two or three products available by prescription only that are known to be quite effective at killing head lice. The prescription products also contain pesticides. Recently, several new brands of head lice shampoos have become available over the counter that claim to be nontoxic and effective at killing lice. No known scientific reports exist as to their efficacy.
2. Eggs (nits) of head lice must be removed from the child's hair. This step is the most crucial and will require most of your time and effort. There are no known products available over the counter that kill head lice eggs. Eggs must be removed using a fine-toothed comb or tweezers.
3. Your child's bedding, clothes, and towels must be washed in warm soapy water and dried in a dryer on the high heat cycle. This step must be completed on the same day as above steps. Any personal items such as toys or stuffed animals that cannot be laundered must be sealed in a plastic bag for two weeks. Although head lice live only on humans, this step will kill any lice or eggs that may have recently fallen off your child's head. Vacuuming carpets may also help.

For more complete information please feel free to contact the school nurse or, if you have Internet access, you can obtain additional information from the National School Integrated Pest Management Web Site at http://schoolipm.ifas.ufl.edu.

Sincerely,

School Principal

Contracts

School officials may find these guidelines useful when creating bid specifications for pest management proposals. These specifications are provided as a starting place for those schools which outsource pest management. If used as a template for contracts, these guidelines should provide the pest control operator with necessary descriptions and details in order to deliver quality IPM for schools.

Qualities To Look For In A Professional Pest Control Operator (PCO)

Brian Becker

Wisconsin rules require professional pest control businesses to have a business license. In addition, all employees that make pesticide applications must be both licensed and certified by the state. Schools should check to make sure the business has met this legal requirement.

Applicators should be able to identify pests and should know about pest behavior and control methods. Training in Integrated Pest Management practices is also essential. If an applicator is being hired to help maintain school grounds, knowledge of plant health maintenance is beneficial. Experience in school pest control is helpful but not required.

Professional applicators should provide proactive suggestions that identify housekeeping and structural deficiencies that contribute to pest problems. The business should offer an IPM service program that includes:

Development of a pest monitoring program, including:
- regular inspection of potential problem sites;
- identification of pests;
- classification of outdoor areas;
- discussion and establishment of pest thresholds with school staff;
- recommendations for control; and
- evaluation of control measures.

Making pest control recommendations:
- Emphasize maintenance and sanitation;
- Make pesticide applications only when necessary, i.e. when the established pest threshold is exceeded;
- Provide schools with pesticide labels and toxicity information for each pesticide that may be used;
- Use low-risk pesticides when other means of control are not feasible; and
- Schedule applications when school or grounds are not occupied.

Other things to consider when hiring a professional pest control service:

Discussion with the applicator:
- Provide a copy of the school's pest control policy;
- Discuss goals of the IPM program (pest tolerances, limited pesticide use);
- Discuss history of the school's pest problems;
- Discuss pest management actions that school or district will be responsible for; and
- Request that the applicator develop a written pest management plan for the school.

School pest control coordinator:
- Identify a person from the school or district who is knowledgeable about the school's pest problems to meet with the PCO when he visits. This person should be the primary contact for the PCO.
- The school pest control coordinator will collect information on where and when pests are seen in the building and share this with the PCO.
- The coordinator will make sure the PCO complies with the school's IPM program.
- The coordinator will assure that the maintenance and sanitation recommendations made by the PCO are carried out by the school maintenance staff.
- The coordinator may be involved in approving pesticides and pesticide applications carried out by the PCO.
- The coordinator can help the PCO with his knowledge of the school building.
- The coordinator can coordinate notification of parents and staff of pesticide applications according to the school's notification procedure.

Structural and Procedural Recommendations:
- The PCO should inspect building and identify housekeeping or maintenance problems that need to be corrected.
- The PCO should make a list of any recommended changes related to the building or grounds, e.g., location of garbage dumpsters (possibly in check-list form), and present them to the school pest control coordinator.

Have the PCO survey building and grounds before starting service:
- This will allow the PCO to become familiar with the building and your school pest control coordinator.
- Your PCO can use this visit to prepare a pest management plan that will help the PCO work within your school's pest control policy.
- Prepare a drawing of the school building and grounds and indicate potential problem areas

Record Keeping:
- The school's pest control coordinator should coordinate the recording of all pest sightings and present them to the PCO to aid in their routine inspection.
- The school pest control coordinator should also maintain a record of all pesticides used by either the PCO or school staff as a means to track compliance with the school's IPM policy.

Timing of services:

- Normal activities (monitoring, checking housekeeping) can be done while school is in session. Pesticide use should be made when exposure to children and other people will not occur.

- Some possibilities are holiday, weekend and evening pesticide applications. In some cases certain areas of the schools may need to be blocked off before pesticide applications can be made to keep people from entering the treated area.

Integrated Pest Management Program Contract Guide Specification, 1999 Revision

Albert Greene

This Document is Intended for General Guidance Only And Does Not Pertain to Any Actual Contract

1. GENERAL

A. Description of Program: This specification is part of a comprehensive Integrated Pest Management (IPM) program for the premises listed herein. IPM is a process for achieving long-term, environmentally sound pest suppression and prevention through the use of a wide variety of technological and management practices. Control strategies in an IPM program include:

- Structural and procedural modifications to reduce food, water, harborage, and access used by pests.
- Pesticide compounds, formulations, and application methods that present the lowest potential hazard to humans and the environment.
- Non-pesticide technologies such as trapping and monitoring devices.
- Coordination among all facilities management programs that have a bearing on the pest control effort.

B. Contractor Service Requirements: The Contractor shall furnish all supervision, labor, materials, and equipment necessary to accomplish the monitoring, trapping, pesticide application, and pest removal components of the IPM program. The Contractor shall also provide detailed, site-specific recommendations for structural and procedural modifications to aid in pest prevention.

2. PESTS INCLUDED AND EXCLUDED

A. The Contractor Shall Adequately Suppress the Following Pests:

1. Indoor populations of rodents, insects, arachnids, and other arthropods.
2. Outdoor populations of potentially indoor-infesting species that are within the property boundaries of the specified buildings.
3. Nests of stinging insects within the property boundaries of the specified buildings.
4. Individuals of all excluded pest populations that are incidental invaders inside the specified buildings, including winged termite swarmers emerging indoors.

B. Populations of the Following Pests are Excluded From This Contract:

1. Birds, bats, snakes, and all other vertebrates other than commensal rodents.
2. Termites and other wood-destroying organisms.
3. Mosquitoes.
4. Pests that primarily feed on outdoor vegetation.

3. INITIAL BUILDING INSPECTIONS

The Contractor shall complete a thorough, initial inspection of each building or site at least ten (10) working days prior to the starting date of the contract. The purpose of the initial inspections is for the Contractor to evaluate the pest control needs of all locations and to identify problem areas and any equipment, structural features, or management practices that are contributing to pest infestations. Access to building space shall be coordinated with the Contracting Officer's Representative (COR). The COR will inform the Contractor of any restrictions or areas requiring special scheduling.

4. PEST CONTROL PLAN

The Contractor shall submit to the COR a Pest Control Plan at least five (5) working days prior to the starting date of the contract. Upon receipt of the Pest Control Plan, the COR will render a decision regarding its acceptability within two (2) working days. If aspects of the Pest Control Plan are incomplete or disapproved, the Contractor shall have two (2) working days to submit revisions. The Contractor shall be on-site to perform the initial service visit for each building within the first five (5) working days of the contract.

The Pest Control Plan shall consist of five parts as follows:

A. Proposed Materials and Equipment for Service: The Contractor shall provide current labels

and Material Safety Data Sheets for all pesticides to be used, and brand names of pesticide application equipment, rodent bait boxes, insect and rodent trapping devices, pest monitoring devices, pest detection equipment, and any other pest control devices or equipment that may be used to provide service.

B. Proposed Methods for Monitoring and Detection: The Contractor shall describe methods and procedures to be used for identifying sites of pest harborage and access, and for making objective assessments of pest population levels throughout the term of the contract.

C. Service Schedule for Each Building or Site: The Contractor shall provide complete service

schedules that include weekly or monthly frequency of Contractor visits, specific day(s) of the week of Contractor visits, and approximate duration of each visit.

D. Description of any Structural or Operational Changes That Would Facilitate the Pest

Control Effort: The Contractor shall describe site-specific solutions for observed sources of pest food, water, harborage, and access.

E. Commercial Pesticide Applicator Certificates or Licenses: The Contractor shall provide photocopies of State-issued Commercial Pesticide Applicator Certificates or Licenses for every Contractor employee who will be performing on-site service under this contract.

The Contractor shall be responsible for carrying out work according to the approved Pest Control Plan. The Contractor shall receive the concurrence of the COR prior to implementing any subsequent changes to the approved Pest Control Plan, including additional or replacement pesticides and on-site service personnel.

5. RECORD KEEPING

The Contractor shall be responsible for maintaining a pest control logbook or file for each building or site specified in this contract. These records shall be kept on-site and maintained on each visit by the Contractor. Each logbook or file shall contain at least the following items:

A. Pest Control Plan: A copy of the Contractor's approved Pest Control Plan, including labels and MSDS sheets for all pesticides used in the building, brand names of all pest control devices and equipment used in the building, and the Contractor's service schedule for the building.

B. GSA Forms 3638: Field Office copies of GSA Form 3638, Pest Control Work and Inspection Report, or an equivalent. These forms will be used to advise the Contractor of routine service requests and to document the performance of all work, including emergency work. Upon completion of a service visit to the building or site, the Contractor's employee performing the service shall complete, sign, and date the Form 3638, and return it to the logbook or file on the same or succeeding day of the services rendered.

C. Contractor's Service Report Forms: Customer copies of the Contractor's Service Report Form, documenting all information on pesticide application required by statute in the jurisdiction where service is actually performed. These forms shall not be mandatory if all required information on pesticide application is included on the GSA Pest Control Work and Inspection Report.

6. MANNER AND TIME TO CONDUCT SERVICE

A. Time Frame of Service Visits: The Contractor shall perform routine pest control services that do not adversely affect tenant health or productivity during the regular hours of operation in buildings. When it is necessary to perform work outside of the regularly scheduled service time set forth in the Pest Control Plan, the Contractor shall notify the COR at least one (1) day in advance.

B. Safety and Health:

1. The Contractor shall observe all safety precautions throughout the performance of this contract. All work shall be in strict accordance with all applicable Federal, state, and local safety and health requirements. Where there is a conflict between applicable regulations, the most stringent will apply.
2. The Contractor shall assume full responsibility and liability for compliance with all applicable regulations pertaining to the health and safety of personnel during the execution of work.

C. Special Entrance: Certain areas within some buildings may require special instructions for

persons entering them. Any restrictions associated with these special areas will be explained by the COR. The Contractor shall adhere to these restrictions and incorporate them into the Pest Control Plan.

D. Uniforms and Protective Clothing: All Contractor personnel working in or around

buildings specified in this contract shall wear distinctive uniform clothing. The Contractor shall determine the need for and provide any personal protective items required for the safe performance of work. Protective clothing, equipment, and devices shall, as a minimum, conform to U.S. Occupational Safety and Health Administration (OSHA) standards for the products being used.

E. Vehicles: Vehicles used by the Contractor shall be identified in accordance with state and

local regulations.

7. SPECIAL REQUESTS AND EMERGENCY SERVICE

On occasion, the COR may request that the Contractor perform corrective, special, or emergency service(s) that are beyond routine service requests. The Contractor shall respond to these exceptional circumstances and complete the necessary work within three (3) hours after receipt of the request.

8. CONTRACTOR PERSONNEL

Throughout the term of this contract, all Contractor personnel providing on-site pest control service must maintain certification as Commercial Pesticide Applicators in the category of Industrial, Institutional, Structural, and Health Related Pest Control. Uncertified individuals working under the supervision of a Certified Applicator will not be permitted to provide service under this contract.

9. USE OF PESTICIDES

The Contractor shall be responsible for application of pesticides according to the label. All pesticides used by the Contractor must be registered with the U.S. Environmental

Protection Agency (EPA), state and/or local jurisdiction. Transport, handling, and use of all pesticides shall be in strict accordance with the manufacturer's label instructions and all applicable Federal, state, and local laws and regulations.

The Contractor shall adhere to the following rules for pesticide use:

A. Approved Products: The Contractor shall not apply any pesticide product that has not been included in the Pest Control Plan or approved in writing by the COR.

B. Pesticide Storage: The Contractor shall not store any pesticide product in the buildings specified in this contract.

C. Application by Need: Pesticide application shall be according to need and not by schedule. As a general rule, application of pesticides in any inside or outside area shall not occur unless visual inspection or monitoring devices indicate the presence of pests in that specific area. Requests for preventive pesticide treatments in areas where surveillance indicates a potential insect or rodent infestation will be evaluated by the COR on a case-by-case basis. Written approval must be granted by the COR prior to any preventive pesticide application.

D. Minimization of Risk: When pesticide use is necessary, the Contractor shall employ the least hazardous material, most precise application technique, and minimum quantity of pesticide necessary to achieve control.

10. INSECT CONTROL

A. Emphasis on Non-Pesticide Methods: The Contractor shall use non-pesticide methods of control wherever possible. For example:

1. Portable vacuums rather than pesticide sprays shall be the standard method for initial cleanouts of cockroach infestations, for swarming (winged) ants and termites, and for control of spiders in webs.
2. Trapping devices rather than pesticide sprays shall be the standard method for indoor fly control.

B. Application of Insecticides to Cracks and Crevices: As a general rule, the Contractor shall apply all insecticides as "crack and crevice" treatments only, defined in this contract as treatments in which the formulated insecticide is not visible to a bystander during or after the application process.

C. Application of Insecticides to Exposed Surfaces or as Space Sprays: Application of insecticides to exposed surfaces or as space sprays ("fogging") shall be restricted to exceptional circumstances where no alternative measures are practical. The Contractor shall obtain approval of the COR prior to any application of insecticide to an exposed surface or any space spray treatment. No surface application or space spray shall be made while tenant personnel are present. The Contractor shall take all necessary precautions to ensure tenant and employee safety, and all necessary steps to ensure the containment of the pesticide to the site of application.

D. Insecticide Bait Formulations: Bait formulations shall be the standard pesticide technology for cockroach and ant control, with alternate formulations restricted to unique situations where baits are not practical.

E. Monitoring: Sticky traps shall be used to guide and evaluate indoor insect control efforts wherever necessary.

11. RODENT CONTROL

A. Indoor Trapping: As a general rule, rodent control inside buildings shall be accomplished with trapping devices only. All such devices shall be concealed out of the general view and in protected areas so as not to be affected by routine cleaning and other operations. Trapping devices shall be checked on a schedule approved by the COR. The Contractor shall be responsible for disposing of all trapped rodents and all rodent carcasses in an appropriate manner.

B. Use of Rodenticides: In exceptional circumstances, when rodenticides are deemed essential for adequate rodent control inside buildings, the Contractor shall obtain approval of the COR prior to making any interior rodenticide treatment. All rodenticides, regardless of packaging, shall be placed either in locations not accessible to children, pets, wildlife, and domestic animals, or in EPA-approved tamper-resistant bait boxes. As a general rule, rodenticide application outside buildings shall emphasize the direct treatment of rodent burrows wherever feasible.

C. Use of Bait Boxes: All bait boxes shall be maintained in accordance with EPA regulations, with an emphasis on the safety of non-target organisms. The Contractor shall adhere to the following five points:

1. All bait boxes shall be placed out of the general view, in locations where they will not be disturbed by routine operations.
2. The lids of all bait boxes shall be securely locked or fastened shut.
3. All bait boxes shall be securely attached or anchored to floor, ground, wall, or other immovable surface, so that the box cannot be picked up or moved.
4. Bait shall always be secured in the feeding chamber of the box and never placed in the runway or entryways of the box.
5. All bait boxes shall be labelled on the inside with the Contractor's business name and address, and dated by the Contractor's technician at the time of installation and each servicing.

12. STRUCTURAL MODIFICATIONS AND RECOMMENDATIONS

Throughout the term of this contract, the Contractor shall be responsible for advising the COR about any structural, sanitary, or procedural modifications that would reduce pest food, water, harborage, or access. The Contractor shall be responsible for adequately suppressing all pests included in this contract regardless of whether or not the suggested modifications are implemented. The Contractor will not be held responsible for carrying out structural modifications as part of the pest control effort. However, minor applications of caulk and other sealing materials by the Contractor to eliminate pest harborage or access may be approved by the COR on a case by case basis. The Contractor shall obtain the approval of the

COR prior to any application of sealing material or other structural modification.

13. PROGRAM EVALUATION

The COR will continually evaluate the progress of this contract in terms of effectiveness and safety, and will require such changes as are necessary. The Contractor shall take prompt action to correct all identified deficiencies.

14. QUALITY CONTROL PROGRAM

The Contractor shall establish a complete quality control program to assure the requirements of the contract are provided as specified. Within five (5) working days prior to the starting date of the contract, the Contractor shall submit a copy of his program to the Contracting Officer.

The program shall include at least the following items:

A. Inspection System: The Contractor's quality control inspection system shall cover all the services stated in this contract. The purpose of the system is to detect and correct deficiencies in the quality of services before the level of performance becomes unacceptable and/or the COR identifies the deficiencies.

B. Checklist: A quality control checklist shall be used in evaluating contract performance during regularly scheduled and unscheduled inspections. The checklist shall include every building or site serviced by the Contractor as well as every task required to be performed.

C. File: A quality control file shall contain a record of all inspections conducted by the Contractor and any corrective actions taken. The file shall be maintained throughout the term of the contract and made available to the COR upon request.

D. Inspector(s): The Contractor shall state the name(s) of the individual(s) responsible for performing the quality control inspections.

GSA Structural Pest Control Business Practices, 1998 Revision

Albert Greene

Background

Early in the 1960s, concern over widespread pesticide misuse and the publication of Rachel Carson's *Silent Spring* launched the environmental movement. Pesticides are still relatively unique as toxic contaminants in that they are intentionally put into the environment to accomplish their purpose. Therefore, all pest control programs have a special responsibility to fully consider the impact of these chemicals and to prioritize the use of least toxic alternatives.

Integrated Pest Management (IPM)

Modern, responsible pest control is often termed "Integrated Pest Management." IPM can be defined as: a coordinated system of technological and management practices to control pests in a safe and environmentally sound manner. It is a process for minimizing pesticide use and risk while maximizing the control of pests that affect public health, impede operations, or damage property. IPM is mandated on federal property by Section 303 of the Food Quality Protection Act of 1996 (PL 104-170).

An IPM program for buildings emphasizes three fundamental elements:

Prevention. IPM strives for "built-in" control solutions by concentrating on the resources that pests need to enter or live in a particular area. It is a preventive maintenance process that seeks to identify and eliminate potential pest access, shelter, and nourishment. It also continually monitors for pests themselves, so that small infestations don't become large ones.

Least-Toxic Methods. Pesticides are essential to control pests in many situations. However, IPM aims to minimize both pesticide use and risk through alternate control techniques and by favoring compounds, formulations, and application methods that present the lowest potential hazard to humans and the environment.

Systems Approach. IPM is not just a pest control contract. This contract must be effectively coordinated with all other relevant programs that operate in and around a building. Plans and procedures involving design and construction, repairs and alterations, cleaning, waste management, food service, and many other activities, should incorporate a pest control perspective whenever possible.

Pesticide Issues For Public Buildings

Following are the three most important pesticide issues for public buildings. All pertain to pesticide products that are difficult or impossible to apply precisely, or that can readily drift away from the immediate application site. Just because a pesticide product is used legally does not necessarily mean it is appropriate for a public building!

Indoor Air Quality. Pesticide fumes or particles may linger for days or weeks as air or surface pollutants. Therefore, the old-fashioned spraying that once characterized indoor pest control should no longer be permitted on a routine basis inside public buildings. Insecticides approved for normal use should be limited to nonvolatile bait formulations that are either applied to cracks and crevices or concealed inside protective containers. Since baits are generally more effective, spray is becoming obsolete as a standard exterminator's tool.

Health and Safety in Child Care Space. Children are particularly sensitive to pesticide residues, so the elimination of these chemicals from the air they breathe and the surfaces they touch is of critical importance.

Americans With Disabilities Act (ADA) Compliance. Building occupants who claim sensitivity to pesticides and other chemicals may request that employers make "reason-

able accommodations" under the ADA to allow the employees to perform their jobs. In the case of chemical sensitivity, this means the elimination of volatile, sprayed pesticides in the workplace.

Guidance Documents

The following 10 guidelines summarize pest control standards that have been mandatory since 1989 for Federal buildings operated by GSA's National Capital Region (NCR). They have since been widely adopted throughout the public sector.

The NCR Regional Entomologist is GSA's national point of contact on pest control issues, and can provide a wide range of additional guidance documents, including contract specifications, desk guides for building managers, training materials, and information on the latest control technologies. Please contact: (insert contact name here).

GSA Guidelines For Structural Pest Control Operations, 1997 Revision

Albert Greene

(These standards have been mandatory since 1989 for federal buildings operated by the U.S. General Services Administration, National Capital Region.)

1. All on-site pest control contractor personnel should be Certified Pesticide Applicators. Persons "working under the supervision" of a Certified Applicator do not meet this standard. Pesticides should never be applied by government employees.

2. Pesticide application should be according to need, when pests are actually present, rather than by schedule. Pesticides should be used only if adequate control cannot be achieved with nonchemical methods.

3. Pesticide use should always consist of the least hazardous material, most precise application technique, and minimum quantity of material necessary to achieve control.

4. The contractor should provide labels and material safety data sheets for every pesticide used on the premises to the contracting officer or representative.

5. Pesticides should not be stored on the premises.

6. Pesticides applied to the air or to exposed surfaces should never be used for routine treatment inside buildings. If their use is essential for a special circumstance, tenant personnel must not be present during treatment. As a general rule, pesticides should be applied only as containerized or crack and crevice treatments in which the applied material is never visible.

7. As a general rule, insecticides should be applied only as baits formulated as solids, pastes, or gels. Spray or dust formulations should be selected only as a last resort or when solids, pastes, or gels are not practical.

8. Bait formulations, traps, vacuuming, sanitation, and exclusion techniques should be emphasized for insect control inside buildings.

9. Traps, sanitation, and exclusion techniques should be emphasized for rodent control.

10. Exclusion techniques should be emphasized for bird control.

Regulatory

Regulations Regarding Pesticide Use in Schools

Clay Scherer

Anyone applying pesticides in schools as part of a contracted service must possess a license and be certified to do so. Further restrictions may apply beyond this, depending on laws for each state. In recent years many states have passed additional regulations regarding pesticide use in schools. Providing details of school pesticide use laws for each state is beyond the scope of this manual. For information regarding the exact regulation covering this topic in your state, please refer to the state regulatory agency in your state, i.e., state department of agriculture. In addition, several of the sources listed in the appendixes of this manual can provide information regarding pesticide use laws.

Besides any laws which may or may not exist, there are some practices regarding pesticide use in schools that are considered part of an IPM program. Below are some things to consider when pesticides are being applied in schools:

- Only individuals trained in the proper application of pesticides should be applying pesticides in the school. Most of the time this will be the pest management professional.
- Teachers, janitors, office personnel, and other staff members should not apply pesticides in the school unless properly trained, i.e., no use of over-the-counter "bug sprays."
- Proper notification to students and staff should be made prior to all treatments and at the conclusion of all treatments.
- All pesticides have labels providing information on proper use and storage; the label is the law. Any use or storage outside of the label directions is against the law.
- Communication is the key in an IPM program. All pesticide applications should be recorded and communicated to the appropriate personnel.

State and Regional Poison Control Centers
Appendix 1 at the back of this book lists state and regional poison control centers nationwide.

School IPM Organization Directory
Appendix 2 at the back of this book lists key contacts relating to School IPM.

Assessment Tools and Training Materials for School IPM Practitioners

School IPM practitioners use many tools to help implement IPM in schools. The School IPM surveys that follow the sample workshop agenda were produced by School IPM practitioners from various states. These survey instruments were used to evaluate pest management programs in schools within an entire state. Results of surveys can help identify strengths and weaknesses of pest management programs and focus education and training programs. Repeated use of such an instrument over time can help identify trends and determine which principles of IPM are being utilized.

These surveys can be used as a model for others who are interested in evaluating School IPM programs in their area. Each survey was designed uniquely to serve the needs of the individual School IPM practitioner. Depending on what one wants to accomplish, modification of one of these model surveys might be considered. For specific information about the results or design of the surveys please contact the appropriate author.

Sample School IPM Workshop Agenda

Clay Scherer

Integrated Pest Management (IPM)
for Schools and Community Colleges

8:00–8:30
Registration and Introduction
Moderator

8:30–8:45
Why consider modifying
existing pest control programs to use IPM?
Department of Education Representative

8:45–9:00
Video: "Introduction to School IPM"
— Texas A&M *ABCs of School IPM*
Moderator

9:00–9:15
Survey Results:
Pest management practices in Educational Facilities
University Specialist

How To Use IPM For Specific Pests

9:15–9:35
Cockroach Control
University Specialist

9:35–9:55
Ant Control
University Specialist

9:55–10:15
Rodent Control
University Specialist

10:15–10:30
Break

10:30–11:15
Real life experiences
with implementing IPM in educational facilities
(Equipment used will be displayed)
School Board Practitioner

11:15–11:40
Implementing and contracting IPM /
Resources available for IPM
University Specialist

11:40–12:45
Lunch

12:45–2:30
Group Training Stations
(Split into groups. Each session 20 min, then rotate):

A
Grounds Pest Inspection
Cooperative Extension Agent

B
Kitchen Pest Inspection
School Board Practitioner

C
Pest Monitoring
University Specialist

D
Pest Identification (cockroaches and ants)
University Specialist

E
Vertebrate Pest Control
University Specialist

Sample School District IPM Questionaire

Clay Scherer and Karen Vail

School District: _____
Name: _____
Title: _____
Telephone: _____

1. Does your school district have an official policy statement concerning pest management?
Yes _____ No _____ Don't know _____

2. How does your School District perform pest control?

	In-House	Contract	Both
Indoor	_____	_____	_____
Outdoor	_____	_____	_____

If contract, please give us the name of the pest control company(ies) that service the schools in your district.

3. Does your school district currently use Integrated Pest Management to control pests?
Yes _____ No _____ Don't know _____
If no, has your district considered implementing an IPM Program? Yes __ No ___

4. Does your school district do routine scheduled spraying of pesticides?
Yes _____ No _____ Don't know _____

5. How much does your school district spend on pest control/management? _____

6. Who makes the decision when and where pesticides will be applied? (check all that apply)

Principal	_____
IPM coordinator	_____
Designated teacher	_____
Maintenance/custodian	_____
Pest control supervisor	_____
Other (specify)	_____
Pest control technician	_____

7. What materials and methods are used for pest management? (Check all that apply)

Spray or spot-spray classrooms	_____
Vacuum pests	_____
Crack and crevice treatments	_____
Use rodenticides indoors	_____
Dust or bait	_____
Use rodenticides outdoors	_____
Foggers or thermal fog	_____
Capture devices	_____

8. What is the frequency of pesticide application for the following areas?

	as needed	monthly	quarterly	semi-annually	annually	other (explain)
Food service	___	___	___	___	___	___
Classrooms	___	___	___	___	___	___
Admin. offices	___	___	___	___	___	___
Grounds	___	___	___	___	___	___
Other (specify)	___	___	___	___	___	___

Is the frequency of application about the same for all the schools in the district?
Yes _____ No _____

9. Who applies pesticides in your school district? Place a check beside those who apply pesticides routinely, for complaints and in emergencies. Also check if they are state certified applicators.

Applicators	_____
Teachers	_____
Vo-Ag teachers	_____
Custodians	_____
Maintenance	_____
In-house pest control technicians	_____
Contracted pest control tech.	_____
School volunteers	_____
Other (specify)	_____

10. Estimate the percentages of the following methods of pesticide treatments used in your pest control program.

	Some of the time	Most of the time	All the time	Not used
Surface sprays	_____	_____	_____	_____
Crack/crevice	_____	_____	_____	_____
Dusts	_____	_____	_____	_____
Baits	_____	_____	_____	_____
Granules	_____	_____	_____	_____
Aerosols/fogging	_____	_____	_____	_____

11. Rank the following pests from the most (10) to the least (1) important in your school district.

	Rank 1–10
Cockroaches	_____
Ants/fire ants	_____
Rodents	_____
Spiders	_____
Wasps	_____
Head lice	_____
Snakes	_____
Landscape insects and diseases	_____
Weeds	_____
Other: _____	_____

12. How are most pesticides stored in your school district?
_____ Districtwide designated storage facility
_____ School-site designated storage
_____ Districtwide warehouse
(stored with other items)

13. Where do you obtain information on Pest Management?
_____ Cooperative Extension Service
_____ Pest control contractor
_____ Vendors/manufacturers
_____ Other (please specify)
_____

Do you want additional information on IPM?
Yes _____ No _____

Sample School IPM Survey

Paul Guillebeau

1. How large is your school district, in terms of pest management?
Number of acres requiring outdoor pest control _____
Number of indoor square feet _____

2. Does your school District have a written policy concerning pest control?
YES __ NO __
If YES, please attach a copy (your District name deleted).

3. Are principals, teachers, or other employees authorized to purchase or bring their own pesticides for use in the school system?
YES __ NO __

4. How much of the pest control for your district is done by an outside company? An answer of 0% means that district staff do all pest control tasks.

Structural Pests (termites or other wood-infesting pests)
0% ___ 25% ___ 50% ___ 75% ___ 100% ___

Indoor Pests (roaches, indoor ants, flies, stored product pests)
0% ___ 25% ___ 50% ___ 75% ___ 100% ___

Landscape Pests (fire ants or other outdoor ants, weeds, other outdoor pests)
0% ___ 25% ___ 50% ___ 75% ___ 100%____

5. How much did your District spend on structural pest control last year, including both pesticide and labor costs?
Less than $5,000 ___
$5,000 - $19,999 ___
$20,000 - $49,999 ___
$50,000 - $74,999 ___
$75,000 - $100,000 ___
More than $100,000 ___

6. How much did your District spend on landscape pest control last year (all outdoor and athletic field pest control), including both pesticide and labor costs?
Less than $5,000 ___
$5,000 - $19,999 ___
$20,000 - $49,999 ___
$50,000 - $74,999 ___
$75,000 - $100,000 ___
More than $100,000 ___

7. Who decides which pesticides to use?
Local school maintenance supervisor ___
Local school maintenance staff ___
Local school principal ___
County/District maintenance office ___
School superintendent=s office ___
Pest Control Company ___
Other (please explain)_____

8. Who decides when and where pesticides will be applied?

Local school maintenance supervisor ___
Local school maintenance staff ___
Local school principal ___
County/District maintenance office ___
School superintendent's office ___
Pest Control Company ___
Other (please explain)_____

9. What are your primary sources for pesticides? Check all that apply.
Local Retail Outlets ___
Pest Control Companies ___
Pesticide Distributor ___
Bring From Home ___
Other (please specify) _____

10. Please check any notification policies used when pesticides are applied.
Written notification of students/staff ___
Oral notification of students/staff ___
Post notification near treated areas ___
Maintain list of pesticide-sensitive individuals ___

11. Are there Material Data Safety Sheets maintained for every pesticide that is used?
YES ___ NO ___

12. Are there records of pesticide applications?
YES ___ NO ___
If YES, which of these items is recorded for pesticide applications. Check all that apply.
Date of application ___

Time of application ___
Applicator name ___
Name of pesticide ___
Target pest(s) ___
Where applied ___
Type of application ___
Amount of pesticide used ___
Other (please list) _____

13. When are pesticides applied?
After school hours only ___
During school hours ___
Both during school and after hours ___
Weekends only ___
After school hours or only to unoccupied areas during school hours ___
Other (please explain) _____

14. Do your pesticide applicators have variable work schedules?
YES ___ NO ___

15. How are pesticides stored? Check all that apply.
District storage facility ___
Locked school storage facility ___
Unlocked school storage facility ___
Other (please list) _____

16. Does pesticide storage room have power ventilation?
YES ___ NO ___

17. Describe your security system for the pesticide storage area.
No Special Entry Restriction ___
Key Control ___
Security Code ___
Sign-In ___
Other (please describe) _____

18. Which of the following nonchemical methods are used to control pest? Check all that apply.
Cleaning up clutter (removing empty boxes from food storage, etc) ___
Inspection of incoming merchandise for pest infestation ___
Regular inspections of kitchens, bathrooms, class rooms, etc., for pest infestation ___
Light traps ___
Glue boards for rodent control ___
Removing or securely storing all available food ___
Pressure washing kitchen floors ___
Caulking holes below baseboards, around chalkboards, around pipes, etc. ___
Plastic liners in garbage cans ___
Using glue boards to monitor pests ___
Exclusion (screens, air doors, etc.) ___
Vacuuming pests ___
Using capture traps ___
Baits ___
Using biological controls (*Bacillus thuringiensis*, beneficial nematodes, etc.) ___
Using least toxic control agents (boric acid, diatomaceous earth, insect growth regulators [IGR], etc.) ___
Other (please list) _____

19. Please check the pest(s) that you need to control, along with the pesticides you use for that pest. If you do not have a particular pest, skip to the next section.

ANTS ___

When are pesticides applied to control ants?

Daily ___ Weekly ___ Monthly ___ As Needed ___
Other (explain) _____

What pesticides are used to control ants?

Insecticide	Rate	#Applications/Year
Acephate (Orthene)	_____	_____
Bendiocarb (Ficam)	_____	_____
Chlorpyrifos (Dursban)	_____	_____
Cyfluthrin (Tempo)	_____	_____
Cypermethrin (Cynoff, Demon)	_____	_____
Deltamethrin (Suspend)	_____	_____
Diazinon	_____	_____
Fenoxycarb (Logic, Award)	_____	_____
Fipronil (MaxForce)	_____	_____
Hydramethylnon (Amdro)	_____	_____
Malathion	_____	_____
Methoprene (Pharorid)	_____	_____
Orthoboric acid (Tarro)	_____	_____
Propetamphos (Safrotin)	_____	_____
Propoxur (Baygon)	_____	_____
Sulfluramid (Raid)	_____	_____
Tetramethrin + Sumithrin	_____	_____
Tralomethrin (Saga)	_____	_____
Other (please list)		
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

COCKROACHES ___

When are pesticides applied to control cockroaches?

Daily ___ Weekly ___ Monthly ___ As Needed ___
Other (explain)_____

What pesticides are used to control cockroaches?

Insecticide	Rate	#Applications/Year
Abamectin (Avert)	_____	_____
Acephate (Orthene)	_____	_____
Amindinohydrazone	_____	_____
Fipronil (Maxforce) (Combat)	_____	_____
Bendiocarb (Ficam)	_____	_____
Boric Acid	_____	_____
Chlorpyrifos (Dursban)	_____	_____
Cyfluthrin	_____	_____
Cypermethrin (Cynoff, Demon)	_____	_____
Deltamethrin (Suspend)	_____	_____
Diazinon	_____	_____
Hydramethylnon	_____	_____
Hydroprene (Gencor)	_____	_____
Malathion	_____	_____
Orthoboric acid	_____	_____
Propetamphos (Safrotin)	_____	_____
Propoxur (Baygon)	_____	_____
Tetramethrin + Sumithrin	_____	_____
Tralomethrin (Saga)	_____	_____
Other (please list)		
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

FLIES ___

When are pesticides applied to control flies?

Daily ___ Weekly ___ Monthly ___ As Needed ___
Other (explain) _____

What pesticides are used to control flies?

Insecticide	Rate	#Applications/Year
Chlorpyrifos	_____	_____
Cyfluthrin	_____	_____
Cypermethrin (Cynoff, Demon)	_____	_____
Deltamethrin (Suspend)	_____	_____
Dichlorvos (Vapona)	_____	_____
Methomyl (Flytek)	_____	_____
Nithiazine (Quick Strike)	_____	_____
Pyrethrins + piperonyl butoxide	_____	_____
Tetramethrin + Sumithrin	_____	_____
Tralomethrin (Saga)	_____	_____
Trichlorfon (Dipterex)	_____	_____
Other (please list)		
_____	_____	_____
_____	_____	_____
_____	_____	_____

STORED PRODUCT PESTS ___

When are pesticides applied to control stored product pests?

Daily ___ Weekly ___ Monthly ___ As Needed ___
Other (explain)_____

What pesticides are used to control stored product pests?

Insecticide	Rate	#Applications/Year
Acephate (Orthene)	_____	_____
Bendiocarb (Ficam)	_____	_____
Chlorpyrifos (Dursban)	_____	_____
Cyfluthrin (Tempo)	_____	_____
Deltamethrin (Suspend)	_____	_____
Diazinon	_____	_____
Malathion	_____	_____
Pyrethrins* + piperonyl butoxide	_____	_____
Tetramethrin + Sumithrin	_____	_____
Tralomethrin (Saga)	_____	_____
Other (please list)		
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

TERMITES ___

When are pesticides applied to control termites?

Daily ___ Weekly ___ Monthly ___ As Needed ___
Other (explain) _____

What pesticides are used to control termites?

Insecticide	Rate	#Applications/Year
Chlorpyrifos (Dursban TC)	_____	_____
Cypermethrin (Demon TC)	_____	_____
Deltamethrin (Suspend)	_____	_____
Disodium octaborate tetrahydrate	_____	_____
Bora-care	_____	_____
Fenvalerate (Tribute)	_____	_____
Imidocloprid (Premise)	_____	_____
Hexaflumuron (Sentricon System)	_____	_____
Permethrin (Dragnet FT)	_____	_____
Sulfluramid (First Line)	_____	_____
Tralomethrin (Saga)	_____	_____
Other (please list)		
_____	_____	_____
_____	_____	_____
_____	_____	_____

WEEDS ___

When are pesticides applied to control weeds?

Daily ___ Weekly ___ Monthly ___ As Needed ___
Other (explain) _____

What pesticides are used to control weeds?

Herbicide	Rate	#Applications/Year
benefin (Balan)	_____	_____
bensulide (Bensumec/Pre-San)	_____	_____
oryzalin (Surflan)	_____	_____
trufluralin	_____	_____
atrazine (Aatrex)	_____	_____
simazine (Princep)	_____	_____
Wynstar	_____	_____
oxadiazon (Ronstar)	_____	_____
Goosegrass/Crabgrass control		
pendimethalin		
(Lesco PRE-M/Turf &		
Ornamental Weed Grass Control)	_____	_____
napropamide (Devrinol)	_____	_____
isoxaben (Gallery)	_____	_____
dithiopyr (Dimension)	_____	_____
prodiamine (Barricade/RegalKade)	_____	_____
ethofumesate (Prograss)	_____	_____
metribuzin (Sencor)	_____	_____
2,4-D (Weedar 64)	_____	_____
dicamba (Vanquish)	_____	_____
bromoxynil (Buctril)	_____	_____
bentazon (Basagran)	_____	_____
pronamide (Kerb T/O)	_____	_____
MSMA (Bueno 6/Daconate 6)	_____	_____
DSMA (Weed-E-Rad)	_____	_____
mecoprop	_____	_____
Lescopar	_____	_____
Turf Kleen	_____	_____
2 Plus 2	_____	_____
Three-Way	_____	_____
Trex-San	_____	_____
Triplet	_____	_____
Trimec Southern	_____	_____
Trimec Bentgrass	_____	_____
MCPP	_____	_____
Triamine	_____	_____
Tri-Ester	_____	_____
Dissolve	_____	_____
MCPA	_____	_____
Trimec Encore	_____	_____
Weedone DPC	_____	_____
triclopyr	_____	_____
Turflon II Amine	_____	_____
clopyralid	_____	_____
Confront	_____	_____
glyphosate (Roundup Pro)	_____	_____
sethoxydim (Vantage)	_____	_____
fenoxaprop (Acclaim Extra)	_____	_____
diclofop-methyl (Illoxan)	_____	_____
imazaquin (Image)	_____	_____
halosulfuron (Manage)	_____	_____
fluazifop-butyl (Fusilade II)	_____	_____
diquat (Reward)	_____	_____
fenarimol (Rubigan)	_____	_____
mecoprop (Mecomec 4/MCPP/	_____	_____
Lescopex)	_____	_____
diclofop-methyl (Illoxan)	_____	_____
Other (please list)		
_____	_____	_____
_____	_____	_____
_____	_____	_____

List other insects _____

When are pesticides applied to control other insects?
Daily ___ Weekly ___ Monthly ___ As Needed ___
Other (explain) _____

What pesticides are used to control other insects?

Insecticide	Rate	#Applications/Year
Acephate (Orthene)	_____	_____
Amindinohydrazone	_____	_____
(Maxforce) (Combat)	_____	_____
Bendiocarb (Ficam)	_____	_____
Boric Acid	_____	_____
Chlorpyrifos (Dursban)	_____	_____
Cyfluthrin Tempo)	_____	_____
Cypermethrin (Cynoff, Demon)	_____	_____
Deltamethrin (Suspend)	_____	_____
Diazinon	_____	_____
Hydramethylnon	_____	_____
Hydroprene (Gencor)	_____	_____
Malathion	_____	_____
Orthoboric acid	_____	_____
Propetamphos (Safrotin)	_____	_____
Propoxur (Baygon)	_____	_____
Silica Gel (Dri-Die)	_____	_____
Tetramethrin + Sumithrin	_____	_____
Tralomethrin (Saga)	_____	_____
Other (please list)		
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

RODENTS ___

When are pesticides applied to control rodents?

Daily ___ Weekly ___ Monthly ___ As Needed ___
Other (explain) _____

What pesticides are used to control rodents?

Rodenticide	Rate	#Applications/Year
Bromadiolone (Contrac)	_____	_____
Chlorophacinone (tracking powder)	_____	_____
Diphacinone (Ditrac)	_____	_____
Warfarin (Final)	_____	_____
Zinc phosphide (tracking powder)	_____	_____

North Carolina Public Schools Pest Management Survey 1998

Mike Linker and Patti Pritchard

Purpose
This survey is being conducted by the North Carolina Cooperative Extension Service at North Carolina State University as part of an educational program. The way in which pests are managed at schools is an important issue for children, parents, and school faculty and staff. The results of this survey will be used to assist school staff manage pests that occur IN AND AROUND school buildings (excluding landscape grounds and maintenance pests).

1. Who makes decisions regarding pest control practices in your school unit? (PLEASE CHECK ALL THAT APPLY)
   ___ I make them personally
   ___ Decisions are shared with others on my staff
   ___ School administrators (Please select most appropriate response below)
   ___ School board ___Principal ___Superintendent
   ___ A pest control company (PCO) makes decisions
   ___ Decisions jointly made between school and pest control company (PCO)
   ___ Others (PLEASE EXPLAIN)
   _____

2. To deal with pest problems in and around buildings, such as ants, roaches, bees, crickets, and spiders, does your school unit . . . (PLEASE CHECK ALL THAT APPLY)
   _____ Maintain a regular, year-round contract with licensed pest control company?
   _____ Contract with a pest control company on a one-time, as-needed basis, when pest problems occur?
   _____ Use school employees whose primary duties include pest control?
   _____ Use school employees, such as custodians, whose primary duties are not pest control?
   _____ Use a combination of school employees and contracted services with a licensed pest control company?
   _____ We do not use pesticides in school buildings.

3. Has your school unit experienced problems with head lice?
   _____ Yes _____No (IF NO, PLEASE GO TO QUESTION 5)

4. How does your school unit respond to head lice problems? (PLEASE CHECK ALL THAT APPLY)
   _____ Children encouraged not to share personal items with classmates
   _____ Note sent home with children
   _____ Education programs on proper sanitation
   _____ Exclusion of infested persons from school
   _____ Apply pesticides to school buildings
   _____ Other (PLEASE EXPLAIN)
   _____

WE ARE INTERESTED IN SPECIFIC WAYS IN WHICH PEST CONTROL IS PERFORMED IN YOUR SCHOOL UNIT.

5. Do any school employees perform any pest control procedures in your school unit?
   _____ Yes _____ No (IF NO, PLEASE GO TO QUESTION 10)

6. How many employees perform pest control procedures in buildings in your school unit?
   Please record the number of employees_____

7. How many of these persons are licensed structural pesticide applicators?
   Please record the number of employees: _____
   (LICENSED STRUCTURAL PEST CONTROL APPLICATORS ARE PERSONS WHO ARE IN CHARGE OF A BUSINESS THAT PERFORMS PEST CONTROL FOR THE GENERAL PUBLIC)

8. How many of these persons are certified structural pesticide applicators?
   Please record the number of employees: _____
   (CERTIFIED APPLICATORS CAN USE RESTRICTED USE PESTICIDES IN OR AROUND BUILDINGS CONTROLLED BY THEM OR THEIR EMPLOYERS)

9. What is highest educational level of the persons performing pest control in buildings in your school unit? (PLEASE CHECK ONE RESPONSE ONLY)
   _____ Some grade school (1–8)
   _____ Some high school (9–12)
   _____ High school graduate
   _____ Some college or technical school
   _____ College graduate and beyond

10. Do any contract pest control companies perform any pest control procedures in your school unit? (PLEASE CHECK ONE RESPONSE ONLY)
_____Yes _____No (IF NO, PLEASE GO TO QUESTION 14)

11. How important is each of the following factors when selecting a pest control company? (PLEASE RANK, WHERE 1 = MOST IMPORTANT FACTOR, 2 = NEXT MOST IMPORTANT FACTOR, ETC.)
_____ Cost
_____ Performance
_____ Liability
_____ Use of least toxic pest control methods
_____ Other (PLEASE SPECIFY)
_____

12. What pest control company(ies) do you currently contract with? (PLEASE GIVE THE NAME OF THE COMPANY[IES] AND CITY WHERE LOCATED. YOU MAY RECORD AS MANY AS THREE COMPANIES)

Company
_____
_____

Company
_____
_____

Company
_____
_____

City _____

City _____

City _____

13. For each of the companies you listed above, how many hours each month does the pest control company spend at your school unit performing pest control practices? (DO NOT INCLUDE TIME SPENT ANSWERING "ON-DEMAND" CALLS. INCLUDE REGULAR VISITS ONLY)
Comments:
_____

Company: _____
Hours: _____

Company: _____
Hours: _____

Company: _____
Hours: _____

14. Please rank each of these pests by the frequency of the infestation in and around the buildings in your school unit. (PLEASE RANK EACH OF THE ITEMS WHERE 1 = MOST FREQUENT, 2 = NEXT FREQUENT, ETC.)
_____ Ants
_____ Bees/wasps
_____ Birds
_____ Cockroaches
_____ Flies
_____ Head lice
_____ Rodents
_____ Other (PLEASE SPECIFY)
_____

15. How would you rate the effectiveness of your current pest control program?
_____ Extremely effective
_____ Somewhat effective
_____ Somewhat ineffective
_____ Completely ineffective

Comments:
_____

16. Does your school unit use integrated pest management (IPM) programs to control pests in school buildings? (PLEASE CHECK ONE RESPONSE ONLY)
_____Yes ____No

Comments:
_____

17.Does your school unit use any of these pest control measures to control pests school buildings? (PLEASE CHECK ALL THAT APPLY)
_____ Sanitation and housekeeping
_____ Vacuuming (pests, cobwebs, etc.)
_____ Structural modifications (caulking, screening,etc)
_____ Trapping/monitoring

18. Does your school unit use pesticides to control pests in school buildings? (PLEASE CHECK ONE RESPONSE ONLY)
_____Yes _____No (IF NO, PLEASE GO TO QUESTION 25)

19. How are the types of pesticide that will be applied in school buildings selected? (PLEASE CHECK ALL THAT APPLY)
_____ Formulation
_____ Product toxicity
_____ Price
_____ Method of application
_____ Products approved by administration
_____ Recommendations (BY:)
_____
_____ Other (PLEASE SPECIFY)
_____

20. How frequently are pesticide applications made in school buildings? (PLEASE CHECK ALL THAT APPLY)
___ Weekly
___ Bi-monthly
___ Monthly
___ Quarterly
___ Annually
___ As needed (EXPLAIN)
_____

21. When are applications made in school buildings? (PLEASE CHECK ALL THAT APPLY)
_____ After all the students and teachers vacate the building in the evening
_____ Early in the morning before school hours
_____ On weekends and/or holidays
_____ Anytime during the day when school is in session

22. What types of pesticide application techniques are used inside buildings? (PLEASE CHECK ALL THAT APPLY)
_____ Baseboard
_____ Insect bait products
_____ Crack and crevice
_____ Spot treatment
_____ Aerosol (bug bombs)

23. Do you provide notice when pesticides will be/have been applied in schools? (PLEASE CHECK ONE RESPONSE ONLY)
_____Yes _____No (IF NO, PLEASE GO TO QUESTION 25)

24. What type of notification do you provide: (PLEASE CHECK ALL THAT APPLY)
_____ Notify school administration
_____ Post sign in school after pesticide application
_____ Send notice home with students before pesticides are applied
_____ Other (PLEASE EXPLAIN)
_____

25. Approximately how much money was expended in the 1997–98 school year in your school unit for the following pest control programs? (PLEASE ROUND DOLLAR VALUES TO THE NEAREST WHOLE DOLLAR)
$_____ Chemical purchases
$_____ Pesticide application equipment purchases
$_____ Structural/physical modification
$_____ Contracted services
$_____ Employee pest control training

26. What is your school unit's average annual expenditure over the last five years for pest control? (PLEASE ROUND AVERAGE ANNUAL EXPENDITURES TO THE NEAREST WHOLE DOLLAR)
$_____

27. Does your school unit currently maintain records or reports on pest control activities? (PLEASE CHECK ONE RESPONSE ONLY)
_____ Yes _____ No (IF NO, PLEASE GO TO QUESTION 29)

28. Which of these records or reports does your school unit currently maintain on pest control activities? (PLEASE CHECK ALL THAT APPLY)
_____ Pest sightings (i.e., type of pest and location)
_____ Monitoring results
_____ Inspections
_____ Pesticide applications (i.e., type of product and rate used)
_____ Diagram of where pest monitoring traps are placed
_____ Other (PLEASE EXPLAIN)
_____

29. Do you currently have an established program in your school unit for addressing issues or concerns of students, teachers or parents about your school's pest control program? (PLEASE CHECK ONE RESPONSE ONLY)
_____Yes _____No

30. Has your school received any complaints related to the use of pesticides from students, parents, faculty or staff? (PLEASE CHECK ONE RESPONSE ONLY)
_____ Yes _____No (IF NO, PLEASE GO TO QUESTION 32)

31. Please indicate the frequency of problems reported, using the scale "Never, Infrequently, Occasionally, Frequently." (PLEASE CHECK ONE RESPONSE ONLY FOR EACH ITEM BELOW)
Never___ Infrequently___ Occasionally___ Frequently___

Burning of eyes, nose and throat
Never___ Infrequently___ Occasionally___ Frequently___

Dizziness
Never___ Infrequently___ Occasionally___ Frequently___

Shortness of breath/asthma
Never___ Infrequently___ Occasionally___ Frequently___

General dislike of pesticides
Never___ Infrequently___ Occasionally___ Frequently___

Symptoms due to assumed exposure
Never___ Infrequently___ Occasionally___ Frequently___

Other (PLEASE SPECIFY)
_____

32. Does your school have written procedures for conducting pest control procedures in school buildings? (PLEASE CHECK ONE RESPONSE ONLY)
___Yes ___No (IF NO, PLEASE GO TO QUESTION 34)

33. Does your school have an advisory committee that reviews pest management issues and makes recommendations on policies? (PLEASE CHECK ONE RESPONSE ONLY)
___Yes ___No

Comments:
_____

34. If you would like to provide any additional information or comments regarding your school's pest management program, please use the space below. If you need additional space, please attach additional sheets.

Comments:
_____

Forms

Clay Scherer

The following documents should be used as part of an IPM plan.

Integrated Pest Management Pest Sighting Log. A pest sighting log should be kept for each facility, building, floor, or room, whichever is most practical with your specific IPM plan. An individual (possibly the IPM Manager) should be identified to maintain and be responsible for this document. All employees in the given area should know who this person is and report any pest sightings accordingly. The pest manager reviews this document at the beginning of each visit and responds appropriately. Any treatments made should be recorded on this document by the pest manager. Review of this form should be included as part of the pest manager's periodic inspection process.

Integrated Pest Management Cafeteria Inspection Checklist. Because food-handling areas tend to be the source of many pest infestations, a separate inspection form is provided for cafeterias. This document can be used by the pest manager to ensure that a thorough inspection is completed. One of these checklists should be completed during each inspection. The pest manager should not limit the inspection solely to what is indicated on the checklist. Comments on the checklist provided by the pest manager should be reviewed by the IPM coordinator or maintenance personnel and appropriate action taken.

Integrated Pest Management Intent to Apply Pesticides. Applying pesticides in a school environment results in a potential hazard. It is important for teachers and staff to be aware when a potentially dangerous situation exists. The "Intent to Apply Pesticides" form should be completed by the pest manager prior to treatment and submitted to an IPM coordinator.

Integrated Pest Management
Pest Sighting Log

Facility: _____

To Be Filled Out By
School Official

To Be Filled Out By
Pest manager

Location of Sighting Bldg. # / Specific Location	Type of Pest(s) Sighted	Date	Action Taken	Technician Name	Date

Integrated Pest Management-Cafeteria Inspection Checklist

School Name: _____ Date/Time of Inspection: _____ Inspector: _____

Building Exterior:	Satisfactory	Unsatisfactory	Comments for Facilities/Maintenance
1. Garbage storage area	_____	_____	_____
2. Garbage handling system	_____	_____	
3. Perimeter walls	_____	_____	_____
4. Perimeter windows/openings	_____	_____	
5. Roof areas	_____	_____	_____
6. Parking lot and/or drainage areas	_____	_____	
7. Weeds and surrounding landscape	_____	_____	_____
8. Rodent-proofing	_____	_____	
9. Other _____	_____	_____	_____

Building Interior:			
1. Walls	_____	_____	_____
2. Floors	_____	_____	
3. Ceilings	_____	_____	_____
4. Floor drains	_____	_____	
5. Lighting	_____	_____	_____
6. Ventilation/air handling equip.	_____	_____	
7. Other _____	_____	_____	_____

Food Storage:			
1. Dry food storage area	_____	_____	_____
2. Damaged/spoiled dry food	_____	_____	
3. Empty container storage	_____	_____	_____
4. Refrigerated areas	_____	_____	
5. Overall sanitation	_____	_____	_____
6. Other _____	_____	_____	
			_____

Food Preparation/Distribution Areas:	Satisfactory	Unsatisfactory	Comments for Facilities/Maintenance
1. Counter and surface areas	_____	_____	_____
2. Food serving lines	_____	_____	
3. Spaces around appliances/equip.	_____	_____	_____
4. Other _____	_____	_____	
Other Kitchen Areas:			
1. Dishwashing areas	_____	_____	_____
2. Garbage/trash areas	_____	_____	
3. Tray return area	_____	_____	_____
4. Storage area for pots/pans/plates	_____	_____	
5. Lighting	_____	_____	_____
6. Other _____	_____	_____	
Utility Areas and Bathroom:			
1. Sinks and waterclosets	_____	_____	_____
2. Custodian's closet/work area	_____	_____	
3. Other _____	_____	_____	_____
Lunchroom area:			
1. Tables/chairs	_____	_____	_____
2. Office areas	_____	_____	
3. Vending machine area	_____	_____	_____
4. Other _____	_____	_____	

Recommendation to cafeteria employees to aid in pest prevention: _____

_____

This report reviewed by (name): _____ Title: _____

This report reviewed on (date): _____

Action taken: _____

Intent to Apply Pesticides

Date:

Facility:

Specific Location in/near Facility:

Type of Pesticide (circle): Insecticide Rodenticide Herbicide

Other:

Name of Chemical and Manufacturer:

Day/Date of Pesticide Application: Time of Day:

Length of Time to Stay off/out of Treated Area:

Name of Licensed Applicator:

COMPLETED FORM SHOULD BE SENT TO IPM COORD. PRIOR TO TREATMENT

Intent to Apply Pesticides

Date:

Facility:

Specific Location in/near Facility:

Type of Pesticide (circle): Insecticide Rodenticide Herbicide

Other:

Name of Chemical and Manufacturer:

Day/Date of Pesticide Application: Time of Day:

Length of Time to Stay off/out of Treated Area:

Name of Licensed Applicator:

COMPLETED FORM SHOULD BE SENT TO IPM COORD. PRIOR TO TREATMENT

3

Educational Presentations for School IPM

THE FIRST SECTION OF THIS CHAPTER PROVIDES EXAMPLES OF NEWS releases that may be used to increase awareness of School IPM in the community. These short stories may be submitted to local media, school newsletters, PTAs, or any group spreading the word about school-related issues. Many School IPM coordinators have found this mechanism to be very critical in supporting School IPM programs.

This chapter also includes several slide presentations printed out as handouts. These are intended to be used by a School IPM practitioner (or similar person) to educate staff, faculty, or parents about various components of IPM. These essentially are teaching materials. These pages can simply be photocopied and distributed to participants during an educational session. There are three presentations covering IPM design and four presentations covering some of the major pests in schools. The presentations are designed to appeal to the broadest of audiences, so an IPM practitioner may use them many times targeting various groups.

Entire presentations, including the ones in this section of the manual, are available free over the Internet as downloadable files at the National School IPM World Wide Web site. In addition, there are VHS training videos available from the Texas Agriculture Extension Service. Please see Appendix 3 for more information.

Informational and News Releases

This section contains short articles on subjects related to School IPM. These articles are contributed to this book by professionals who work in the area of School IPM.

These articles are copyrighted by the individuals or organizations that produced them and as such are not allowed to be used in materials sold for profit by private individuals or organizations, except where permission is given by the individual authors or agencies. An exception is granted to editors of magazines, newsletters or other media that publish on a regular basis and who wish to reproduce these articles to educate the public or industry professionals. However, articles submitted by agencies of the United States federal government are in the public domain, for example: EPA; USDA.

As a matter of professional courtesy, please credit the author and/or agency that provided the article. In most cases, a contact person (telephone number or e-mail address) is listed for each article. Please let this individual know if you are using the article.

Modification of the article is allowed, especially if a specific state or state regulation is referred to. For example, the phrase "Don't forget that West Virginia law ..." would not be relevant for use in other states and could be deleted from the article.

Pesticides In and Around Schools — Time for a Change

S.E. Simmons, T.E. Tidwell, and T.A. Barry.

When schools and pesticides are mentioned in the same news item, it is doubtful that the story will focus on cockroaches in the cafeteria or mold in the gym. More likely, students or teachers have complained about odor and illness, classrooms have been evacuated, or parents are calling for an investigation. In today's environment, the idea that pest control decisions can be left to a custodian or commercial exterminator seems as quaint as the one-room schoolhouse.

School board members and administrators face tough questions from students, parents, teachers, and activist groups on pesticides in and around the classroom. Administrators themselves often need an education on their district's approach to pest control and an understanding of pesticide terminology. Where can educators learn the ABCs of pest control and their options to reduce pesticide risks?

DPR Promotes Proactive Pest Control

Since 1980, various projects at the California Environmental Protection Agency's (CaUEPA) Department of Pesticide Regulation (DPR) have focused on reducing risks associated with

pesticide use in the urban community, including parks and schools. Much of this effort is aimed at facilitating Integrated Pest Management (IPM) training for government staff and providing specialized information about pests and pesticides to workers and the general public. More recently, projects have been oriented to funding reduced-risk pest management research and forming alliances with agriculture and nonagriculture groups, including schools. The purpose of these recent efforts is to facilitate the adoption of IPM strategies.

IPM policies have been established in several California school districts, including Cloverdale, Fremont Unified, Fontana Unified, Los Angeles Unified, PaJaro Valley Unified, Placer Hills Union, San Diego Unified, and Templeton. A number of these districts have been recognized by DPR with "IPM Innovator" awards. Innovators have worked hard to reduce risks associated with pesticide use and have done so in creative ways.

DPR surveyed all school districts in 1994 to learn about IPM policies and programs in schools. About 10 percent of the respondents (52) had a pest management policy and program, whereas 124 districts had a pest management program. Besides official policies to establish an IPM program, numerous schools have IPM programs. It is likely that the number of IPM programs has increased since 1994.

Resources

When school staff are called upon to answer questions about pesticide use on their campus, specific information is frequently lacking. Furthermore, for those school districts without a clear policy dealing with pesticides, a typical first response might be to ban pesticides from the school campus. Later, after decision-makers have a better understanding about pesticides and IPM, a ban will likely have to be rewritten. Before taking drastic actions and enacting policy that will be difficult to follow, it is a good idea to look to those school districts that have already adopted an IPM program.

Information can also be obtained from the local county agricultural commissioner and Cooperative Extension University of California. (Check the local telephone book under government listings.)

Finally, some structural pest control companies promote IPM by providing services including pest identification, pest monitoring, and the use of reduced-risk pest control practices. To ensure that they obtain quality IPM services, school districts should solicit companies based on a

Request for Qualifications, select the best companies in the first group to bid on a Request for Proposals, and conduct an oral interview. For example, the Inland Empire Schools Insurance Authority in San Bernardino completed this task for 34 school districts. At their discretion, each district may choose one of two companies to conduct their IPM program. This process saved each district considerable time.

A quality assurance process that focuses on communication is also a key component of the contract with the service provider. Communication of all pest control activities by the company to someone at the site or facility is absolutely necessary. Information is retained at the facility and a copy is forwarded to the IPM program supervisor for review. The review focuses on two key questions: Was information properly communicated, and did the company follow school policy and its intent? Clearly, administrators of any school that adopts an IPM program must have staff properly trained to review reports relating to pest control activities.

Successful IPM Programs

To set up a successful IPM program, most school districts have a policy approved by top management that establishes the following elements:

- The designation of someone in the role of IPM coordinator.
- A commitment by management to involve all staff, students, and parents in the program.
- An information and training program provided to everyone based on need.
- A record of all pest management activities, particularly pesticide use, kept at each school site and district headquarters.
- An annual evaluation of program results.

Administrators often ask about the costs associated with an IPM program. This is not easily answered, because there is no baseline data for costs associated with a current program. However, if the pest control program is typical, then there may be a savings in costs for contracted services and an increase in costs associated with staff training. By establishing a baseline of costs for the categories listed below, an assessment can be completed and the IPM program tracked.

Costs for any pest management program are associated with five general categories:

1. Contracts for pest control services (typically monthly service) and for emergency or special services (the cost to respond to unusual pest problems such as skunks under a building, a swarm of bees, a black widow spider in a classroom, or bird mites biting students).
2. Cost for training staff to handle pesticides, including disinfectants (can be reported as number of people trained, their job classification, title of training course, and number of hours per year per employee).
3. Pesticide purchases per year (includes chemicals and devices such as disposable traps).
4. Special or periodic IPM projects, including annual or biennial inspections, purchase and/or installation of special pest control equipment (such as certain vacuum cleaners or air curtains), building fumigation, unusual pest problems (such as birds, or skunks), and construction for pest prevention.
5. Management costs as related to committee and management meetings, contract procedures, record keeping, liability insurance, development of training guides and materials, and conflict resolution.

The adoption of an IPM program can reduce costs and improve pest control. The IPM coordinator needs the support of management, staff, and the community. Providing information to constituents is critical to the success of the IPM program, which will hopefully lead to improved credibility and reduced-risk associated with pesticide use.

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Definitions

Integrated Pest Management (IPM)
IPM is a common-sense approach to pest control. IPM programs start with pest prevention, involve improved sanitation, and, before using a pesticide, making sure that pest problems are properly identified.

Integrated Control
In 1967, the United Nations Food and Agriculture Organization panel of experts defined integrated control as "a pest management system that in the context of the associated environment and the population dynamics of the pest species, utilizes all suitable techniques and methods in as compatible a manner as possible and maintains the pest populations at levels below those causing economic injury."

Common terms, some that have legal definitions, include:

Pesticide: a chemical that kills or repels pests. Pesticides include herbicides (weeds), insecticides (insect), fungicides (plant diseases), and germicides, sterilants, and disinfectants (germ killers). All pesticides sold in California must be registered by the U.S. Environmental Protection Agency and the Department of Pesticide Regulation (Cal/EPA). Each product is given an EPA registration number.

Pest: an unwanted organism.

Pest control: the use of any substance, method, or device to prevent, destroy, repel, mitigate, or correct a pest infestation or inhibit, regulate, stimulate, or alter growth of plants (desirable or undesirable).

Understanding Pest Control Terms and Jargon

Principals, school administrators, and school boards often are unfamiliar with pests, pest control, and pesticides. The terminology may be strange, and there are numerous federal and state laws that regulate how pesticides are registered and used. Reading and understanding a pesticide label, which is also considered to be part of the law, is usually a task viewed with fear by those not familiar pesticide technology and law. The potential for misinformation being given to a concerned parent or teacher is significant and may lead to confrontation.

There are numerous resources to help in the understanding of terminology associated with pesticides and pest control. The Internet provides access to several sites. Even manuals for pest control are available and can be downloaded. Frequently these manuals contain a glossary of pest management terms. An important term "Integrated Pest Management," or IPM, was introduced to agriculture (in concept) in the late 1950s and has relevance today to reduce risks associated with pesticides. Integrated control, as IPM was called, focused on improving decision making about pest control through "supervised control" and scouting or monitoring pest activity. Equally important was the integrating of biological control (use of parasites and predators of pests) with chemical control (pesticides) with the least effect of the pesticide to nontarget organisms. The IPM concept, with numerous definitions, has become the innovative standard with which to compare conventional pest control.

Pesticides include herbicides, insecticides, rodenticides, fungicides, disinfectants, sterilants, and numerous other words with the suffix of -icide. Legally, any substance that is sold which claims that it kills, repels, destroys, or mitigates a pest must be registered as a pesticide. This even includes single-cell organisms that are labeled for pest control.

Finally, another set of common terms surround meaning associated with toxic, nontoxic, and least toxic. Suffice it to say that all pesticides are toxic; it depends on the dose and the response by the intended or unintended organism. Chemicals can be defined in terms of relative toxicity, again depending on the response by different organisms and the type of exposure. For example, dermal or skin exposure toxicity is different from inhalation, eye or ingestion exposure. Toxicity can also be expressed in terms of short-term or long-term exposure. "Hazard" is used to describe the toxicity under a set of circumstances based on protection of the workers and those entering the treated environment.

The Six Steps Of The IPM Process In Public and Commercial Buildings

Albert Greene

The IPM process is mostly common sense. The challenge to making it work is using patience and skill to gradually replace the system's old attitudes and habits with that common sense. Each pest problem, great or small, usually presents the pest controller with six basic tasks:

1. Understanding and Educating the Client. Most pest

control in and around buildings is a service to the occupants and is performed at their request. The IPM process therefore typically begins with people rather than pests. Client relations is always a two-way street. Educating the customer about pest biology and control is essential, but it is much more effective if the pest controller first understands customer concerns as well as expectations. Education then begins by explaining whether or not these concerns are warranted and the expectations attainable. As in any service occupation, the ability to listen and communicate is an absolute necessity.

2. Analyzing the Pest Problem. Despite the fact that volumes have been written about pest biology and management, it is fairly simple to figure out the identity of most structural pests and why they are present. Exactly where they are coming from can be more difficult to discover, and may require a thorough understanding of structural engineering and design.

3. Taking Short-Term, Corrective Action. Although IPM emphasizes a preventive maintenance approach to pests, the real world often demands immediate corrective action for preexisting problems. In many cases, the use of pesticides for this purpose is unavoidable. However, all parties must understand that each corrective action will be the least toxic of all feasible alternatives. Reluctant clients who feel more comfortable with older (but now less appropriate) technologies should be reminded that minimization of liability has become an overriding pest control imperative.

4. Implementing Long-Term, Preventive Action. Ongoing, "built-in" control actions that indirectly reduce pests by minimizing their food, harborage, and access are the heart of the IPM process and a fundamental measure of its success. These actions are often technically simple sanitation or exclusion procedures that are administratively difficult to plan, coordinate, and execute. Structural pest prevention is the "applied facilities management" aspect of IPM, and requires that the pest controller have as thorough a knowledge of building operations as of pest biology. It also frequently requires the understanding and cooperation of program areas that traditionally have not interacted closely with pest management.

5. Inspecting, Documenting, and Evaluating Results. Skilled inspection is the backbone of IPM. The evaluation of corrective action should strive to be as efficient as possible, with documentation no more elaborate than necessary. Even the simplest records can usually indicate whether control measures have succeeded or that a new approach is needed. However, the greatest IPM inspection challenge is to establish a routine proactive surveillance program. Tenants and building managers serve as a vast pool of "inspectors" for pest infestations, but they cannot be relied on to detect and report conditions conducive to infestation.

6. Getting Back to the Client. "Closing the loop" by following up on whether client satisfaction has been achieved is the step easiest to ignore, but one of the most critical to an IPM program's continued support and viability. To put it simply, the IPM program has not been a success unless the client considers it a success.

Less Toxic Pesticides For Use in Schools and Day Care Centers

Peggy K. Powell

If nonchemical pest management methods alone are ineffective or impractical, you may wish to consider incorporating a pesticide into your Integrated Pest Management program. Although all pesticides are inherently toxic, there are now a number of "less toxic" pesticide options.

Less toxic pesticides are considered so because of several different factors. Many possess lower inherent danger to human health or the environment. Some of the botanical pesticides, which come from plants, as well as such inorganic pesticides as boric acid, silica gel, and diatomaceous earth, fall into this category. Others, the microbial or biological control agents like bacteria, fungi, and nematodes, are more specific to a particular pest. Still others, such as bait stations, are packaged for delivery in such a way as to greatly minimize human exposure.

Some states now require less toxic products to be used in school settings. Check with your state regulatory agency about the requirements in your state.

Botanicals

Pyrethrum is a botanical insecticide extracted from chrysanthemum flowers. Pyrethrin is the active ingredient. Advantages of pyrethrin are that it provides a quick knockdown of insects and breaks down very quickly in the environment. Pyrethroids are synthetic compounds similar to pyrethrin. Pyrethroids are more toxic to insects and usually more stable in the environment than pyrethrin. Some pyrethroids used for indoor pest management include permethrin, resmethrin, tetramethrin, and allethrin. They are useful in controlling a wide range of pests.

Another botanical insecticide is d-limonene. This citrus peel extract kills insects on contact. As of now, it is only available in the form of flea control sprays and shampoos.

Inorganics

Inorganic insecticides include boric acid and the desiccating dusts silica gel and diatomaceous earth. The term "desiccating" refers to the fact that they cause the insects to die from dehydration.

Boric acid is derived from boron, a naturally occurring mineral. It acts as a stomach poison and causes insects to die from starvation. Boric acid is available in powder, paste, aerosol, tablet, and liquid forms for use against cockroaches, ants, and other insects. Most boric acid products are available as ready-to-use products. Pest control professionals can use boric acid products to control wood-infesting beetles and to spot treat wood to protect it from termites.

Silica gel is an inert, nonabrasive material that is very effective in absorbing moisture. It absorbs the waxy coating on the insect's body and causes death by dehydration. Silica

gel products are often used by professional pest control operators to control cockroaches, silverfish, and other pests.

Diatomaceous earth is the fossilized remains of tiny, one-celled organisms called diatoms. It kills insects by scratching their waxy outer covering and causing them to dehydrate. If you decide to use this product, be sure to purchase the correct grade, usually labeled "natural grade." The diatomaceous earth sold for use in swimming pool filters is not suitable for pest control. Diatomaceous earth is used to control cockroaches, ants, silverfish, and fleas.

Other Types of Less Toxic Insecticides

Other types of less toxic insecticides include insecticidal soaps and insect growth regulators.

Insecticidal soaps are available in concentrated or ready-to-use liquid form. Soaps penetrate the waxy covering on the insect's body and cause death by dehydration. Insecticidal soaps are primarily useful against soft-bodied, plant-feeding insect pests on ornamental plants and in vegetable gardens. They can be used indoors against such indoor plant pests as whiteflies and mealybugs.

Insect growth regulators, or IGRs, are compounds that mimic insect hormones. They disrupt the insect's reproductive ability, but have no effect on humans. Insect growth regulators available for cockroach and flea control are hydroprene and methoprene. Insect growth regulators are available in combination with one of the pyrethroid insecticides and in cockroach bait stations.

Biological Control Agents

Biological control is the use of one organism to control another. Everyone is familiar with preying mantids and lady beetles in the garden, but indoors, most people don't like even "good" insects. Therefore, the search for biological control agents for indoor insect pests has taken a different approach. Fungi, bacteria and nematodes — microscopic organisms that aren't so offensive to people — have been analyzed for insect control properties. Several of these "microbial" control agents are now commercially available.

Nematodes are microscopic worms that live in soil. Some nematode species are parasitic on insects and can be used to control insect pests. Several nematode-containing products are available for outdoor flea control. The nematodes carry bacteria that kill the fleas but don't harm people or pets.

Fungi that kill insects but don't hurt people are also used as biological control agents in indoor settings. One of the newest types of cockroach bait station contains a species of fungus normally found in soil. When a cockroach enters the chamber, the fungus adheres to its body and eventually kills it plus any other cockroach that the diseased cockroach contacts.

Bacteria are yet another type of microbial control agent. One of the most commonly employed is *Bacillus thuringiensis,* or Bt. Bt is widely used in agriculture to control a variety of pests. A strain of Bt that is effective in killing ants is now being developed and should be available soon.

Bait Stations

Bait stations offer several advantages over other forms of insecticide. Bait stations deliver an insecticide through a sealed plastic or metal chamber that insects enter. This gives bait stations the advantage of decreasing both the amount of insecticide used and the likelihood of exposure to it. Bait stations are particularly suitable for use in situations where the safety of children is a concern.

If you decide to use any of these less toxic materials for control, be careful not to confuse less toxic with nontoxic. All pesticides are designed to kill something. Don't assume that just because a pesticide is "natural," it is completely safe and can be used with complete abandon. Boric acid, for example, can be poisonous if ingested in large amounts. Be careful to keep it away from children and pets. Pyrethrin can cause skin irritation or an allergic reaction if inhaled. Likewise, you should not inhale silica gel, diatomaceous earth, or boric acid dust. Be certain to wear a dust mask when applying any of these products. As with any pesticide, always read and follow the directions on the label.

Selecting a Pest Management Method for Schools and Day Care Centers

Peggy K. Powell

Nonchemical or Chemical Control?

Decisions, decisions, decisions. You've identified the pest and obtained a list of control options. But just how do you decide which one to use? First, should you use nonchemical pest management methods or rely on pesticides? If nonchemical methods seem feasible, will they be effective used alone, or will they need to be supplemented with a pesticide? If a pesticide is required, how do you decide which one? With so many choices, just how do you go about deciding which pesticide to use?

Nonchemical Control Methods

If you decide to start with nonchemical control methods, you need to consider feasibility, difficulty, and cost. Sanitation measures, exclusion techniques, and structural repairs vary in their complexity, cost, and permanence. Consider the amount of skill required, the amount of time required, the cost of repairs, and the permanence of results.

Take skill, for example. Caulking cracks in a kitchen or bathroom is a job almost anyone can do, while installing screen over roof eaves requires a bit more expertise. In considering structural repairs, think about their permanence. The effects of a particular structural modification, such as basement waterproofing, are long lasting. Thus, the cost may be offset over the long term by savings resulting from not having to use other pest control methods.

Chemical Control Methods

If nonchemical methods don't seem to do the job or if the pest in question can't be controlled with such tactics, you may need to use a pesticide. A number of factors must be considered when you select a pesticide for use in a school. These are the product's (1) safety, (2) effectiveness, (3) specificity, (4) speed, (5) persistence, (6) repellency, and (7) cost.

Safety. Perhaps the most important factor is the product's safety to the applicator, the students and staff, and the environment. All pesticides are designed to kill something and thus are inherently toxic. However, there are now a number of "less toxic" pesticide options, considered so because of several factors, most notably less danger to human health or to the environment. The natural pyrethrins and some of their synthetic derivatives — the pyrethroids — and the inorganic pesticides boric acid, silica gel, and diatomaceous earth, fall into this category.

The safety of a pesticide, its ease of application, and the likelihood of human exposure are closely related to its so-called "delivery method" — how the product is packaged for application. Delivery methods for pesticides include sprays, foggers, dusts, and bait stations. A bait station is a delivery method in which the pesticide is sealed inside a plastic or metal chamber. It has the advantage of decreasing both the amount of insecticide used and the likelihood of exposure to it.

Total release aerosols, also known as foggers or "bombs," on the other hand, are designed to disperse pesticide throughout a room. Unlike spot treatments, which place the pesticide where the pests are, this type of delivery method applies pesticide to everything in the room, resulting in a greater possibility of human exposure.

Effectiveness. A product obviously must be effective in controlling the pest. Otherwise, it is a waste of both time and money, and the risk factors associated with its use will vastly outweigh its benefits. However, a product's effectiveness sometimes can be determined by application method. If an insecticide is placed where the insect will never come into contact with it, it will have no effect, even though the particular chemical might be toxic to the insect.

Specificity. This refers to the degree to which a particular pesticide is toxic to only the pest you are trying to control. A specific, or selective, pesticide will have little or no effect on the applicator, the staff or students, and other harmless creatures who might happen to wander by. A high degree of specificity is desirable, so there is less worry over a product's toxic effects on beneficial or nontarget organisms. Many of the newer, less toxic pesticides, such as insect growth regulators, are highly specific.

Speed. The speed at which the control method works is also an important consideration. Many less toxic insecticides, boric acid dust for example, take longer to kill insects than many traditional, and often more toxic, products. It is important to be aware of this, so that seeing live insects soon after treatment will not result in overapplication or a switch to a more toxic product for a second treatment.

Persistence. You also should consider the persistence of the compound in the school environment and the desirability of such persistence. For example, a high degree of persistence is desirable for a pesticide injected into soil to control termites. On the other hand, a pesticide used indoors may be more desirable if it does not persist on surfaces or in the air once it has done its job. The natural pyrethrins and some of the pyrethroids are examples of pesticides that are not highly persistent.

Repellency. Some cockroach control products, like pyrethrins, possess a high degree of repellency to insects. Therefore, application of these products to cracks and crevices may not be very effective, as they only force the cockroaches to look for new hiding places where they don't come in contact with the insecticide.

Cost. Some products that cost a bit more than others may be well worth a few extra dollars. For example, flea control products containing insect growth regulators tend to cost more than those without. But the benefits of insect growth regulators in preventing flea maturation more than compensate for the additional cost.

Nonchemical Pest Management Methods In Schools and Day Care Centers

Peggy K. Powell

If you dislike the idea of using pesticides in your school or just want to try something else first, you may wish to explore nonchemical pest management.

There are three keys to successfully implementing nonchemical pest management. You must determine the pest's (1) entry method, or how it gets into the building; (2) food, or what it eats; and (3) preferred climate, or what kind of environmental conditions it prefers. Once you know these three things, you can set about to reduce, eliminate, or change them, and your work toward controlling the pest will be much easier.

Restrict ENTRY: There are a number of ways to restrict pest entry into buildings. One familiar example is the use of screens on windows and doors. Another method is to inspect all incoming products to make sure you're not bringing insects in along with food and supplies. Other entry restriction methods include caulking openings around cable and pipe access points, installing weather stripping around doors and windows, and placing screen covers over floor drains.

Reduce the availability of FOOD: The best way to reduce the availability of food is by sanitation. Good housekeeping can go a long way toward making a building less attractive to many insects. Important steps include a good overall cleaning, regular vacuuming, daily emptying of the trash, leaving no dirty dishes in the sinks, and storing pet food in pest-proof containers.

Modify CLIMATE: Climate control methods make your school a less hospitable environment for many pests. Silverfish, booklice, and springtails are known as "moisture-loving

Nonchemical Pest Management Methods Table

	METHOD	Cockroaches	Ants	Fleas	Flies	Wood Infesting	Stinging/Biting	Fabric & Food Pests	Moisture Loving
ENTRY	Pestproof building	✔	✔		✔				✔
	Screen floor drains	✔							
	Install weather stripping	✔	✔		✔				
	Seal wall openings	✔	✔				✔		
	Inspect incoming products	✔						✔	
	Patch cracks in walls	✔	✔						
	Screen areas under porches			✔					
FOOD	Keep buildings clean	✔	✔	✔	✔				
	Vacuum regularly			✔				✔	
	Seal or refrigerate food	✔	✔		✔			✔	
	Launder or dry-clean fabrics							✔	
	Dispose of garbage regularly	✔	✔		✔		✔		
	Replace decaying wood				✔				
CLIMATE	Control indoor moisture	✔						✔	✔
	Avoid using shelf paper	✔						✔	
	Eliminate clutter	✔							✔
	Heat or cold treatment							✔	
	Install vapor barrier					✔			
	Insulate cold water pipes					✔			✔
	Repair plumbing leaks					✔			✔
	Ensure adequate ventilation					✔			✔
	Trim vegetation near buildings								✔
	Replace bark mulch	✔				✔		✔	

Prepared by Peggy K. Powell, Compliance Assistance Program, Pesticide Regulatory Programs, West Virginia Department of Agriculture, Gus R. Douglass, Commissioner

pests" because they have definite preferences for damp areas. Your school will be less attractive to them if you repair plumbing leaks, insulate cold water pipes, and use dehumidifiers.

Climate control methods can reduce your school's chance of being attacked by wood-infesting insects. If the school was built on a crawl space, installing a vapor barrier should help to dry the wood and lower its attractiveness to insects. Carpenter ants often infest wood that has gotten wet when plumbing fixtures have leaked.

Climate control techniques can be used outdoors as well. Trimming vegetation away from the building, removing clutter, and replacing bark mulch with gravel or stone will help to deter millipedes, crickets, and earwigs.

To successfully implement nonchemical pest management in your school, remember the three keys: ENTRY, FOOD, and CLIMATE. Take a look around and ask yourself some questions. How are pests able to get in, what can they find to eat, and how have you provided an agreeable climate for them? Think of ways to control these factors. Some methods are effective for controlling one group of pests and some for others. Use the table to help you decide which nonchemical methods might work in your situation.

Integrated Pest Management in Schools and Day Care Centers: Tips on Monitoring

Jason Rulen and Peggy Powell

West Virginia rules for Integrated Pest Management in schools and day care centers requires monthly monitoring for pests before pesticides can be applied. The initial inspection of the facility will give the pest manager a good idea of pest-prone locations where monitoring traps should be placed.

A knowledge of the habits of the pest in question is helpful in knowing where to place monitoring traps. For example, German cockroaches stay in narrow crevices and travel along edges where horizontal and vertical surfaces meet (for example, where the floor joins the wall).

Here are some tips on setting up a monitoring program:

- Place traps as close to likely insect harborage sites as possible.
- Try to place traps along likely insect runways. Note that horizontal placement is often more effective than vertical placement.
- Traps placed inside cabinets or behind appliances are more likely to be effective and less likely to be destroyed or discarded.
- Place enough traps in an area to cover all possible harborage sites. For small kitchens and storage areas, six to eight traps should be sufficient. For large commercial or school kitchens, 10 to 20+ traps may be required.
- The complexity of an area may dictate whether you need to place relatively few or many traps. For example, a storage area that contains a lot of shelves, boxes, and other items will require more traps than an empty room of the same square footage.
- When you first begin monitoring in an area, you should place enough traps to locate all of the pests' harborage sites. Pay special attention to food storage areas, damp areas, and kitchen areas. Avoid placing traps in areas where they are likely to get wet or to pick up dust and dirt.
- After you have pinpointed harborage areas, your control efforts can be directed toward these spots. You should require fewer traps for follow-up monitoring after treatment.
- Use data gathered from traps to assess the problem. If only adults are captured, the population is probably breeding elsewhere. If nymphs are captured, the trap is likely close to a harborage site.
- If insects are found at only one end of a trap, the harborage is likely on that side as well. If insects are on both sides, harborages are possible on either or both sides of the trap.
- Number and date each trap you put out. Record on a monitoring diagram where traps are placed, and indicate on it where new traps are placed or delete traps that have been moved.
- Don't forget that West Virginia law requires a copy of the monitoring diagram to be placed in the IPM file in each school or day care center.

Pest Control and Sanitation: What Can I Do?

Edward Crow

An effective Integrated Pest Management (IPM) program must have the cooperation of the entire school staff including teachers, nurses, food service workers, custodial staff, and administration. All of these people need to know basic concepts of Integrated Pest Management and how they are utilized to control pest problems within schools.

Students And Staff

The most important assistance that staff and students can give to an effective IPM program is through the use of sanitation. Many of the pest problems in schools can be reduced, or even prevented from occurring, if students and staff ensure that proper sanitation practices are followed. The more cooperation that is received from these parties the better the results achieved by the IPM program.

Some areas that receive special attention due to their susceptibility for pest problems include coffee and snack areas, staff lounges, refrigerators and microwaves, vending machines, mop closets, trash cans, desks, and lockers.

Students can help prevent pest problems by:

- Cleaning up leftover food;
- Not leaving food in lockers;

- Not placing gum under desks;
- Removing paper clutter;
- Keeping food and beverages in designated areas; and
- Reporting pests, when noticed, to teachers.

Staff can help in the prevention of pest problems by:

- Leaving pest control and pest management to trained professionals;
- Not moving sticky traps or other pest monitoring devices;
- Not propping open windows or screens;
- Removing trash, especially trash that contains food;
- Keeping areas dry by removing standing water and items that are wet or have been damaged by water;
- Storing animal feed in tightly sealed containers, cleaning up spills immediately and cleaning cages on a regular basis;
- Keeping instructional food items, such as dried beans used for math exercises, in tightly sealed containers;
- Keeping refrigerators, vending machines and microwaves clean and free of spills at all times;
- Avoiding the use of shelf paper; and
- Discarding any infested materials or food items.

Parents

It is just as important to receive the same commitment from parents, since they also play an important role in the effectiveness of the pest management program in schools. IPM programs and the people providing these services need the support of parents. Parents should be aware of the pest management programs being utilized at their children's school.

Parents can help in the prevention of pest problems by:

- Encouraging children to lend a hand in cleaning up; and
- Discouraging children from keeping food in their lockers and desks.

IPM is a way to help insure a clean and safe school building for students. Additional information on pest management programs within the school system can be obtained by contacting school administrators.

Summary

The foundation of an effective pest management program is good sanitation. Trash disposal and sound structural maintenance also play important roles in an IPM program. Staff and students must understand how their actions can increase or decrease pest problems pest problems in the school. With a combined effort by school administrators, staff, students, parents, and the pest control specialist to incorporate the following practices, many pest problems can be avoided within the school.

- Clean up spills immediately;
- Store all food items in tightly sealed containers;
- Wrap or bag food waste before disposal;
- Remove trash; and
- Not keep food items in lockers and desks.

Through the use of these practices, pest problems can often be eliminated before they ever occur. An inhospitable environment is created for the pest by depriving it of food, water and harborage needed for its survival. Further information on Integrated Pest Management in schools can be obtained from the Maryland Department of Agriculture's IPM Leaflet No. 1, "Integrated Pest Management — What Is It?"

IPM Design

What is School Integrated Pest Management (IPM)?

Clay Scherer

A Tour of Pest Problem Areas in Schools

Clay Scherer

Staff Training

Jerry Jochim

On pages 40 through 84 are several slide presentations printed out as handouts. These are intended to be used by a School IPM practitioner (or similar person) to educate staff, faculty, or parents about various components of IPM. These essentially are teaching materials. These pages can simply be photocopied and distributed to participants during an educational session. There are three presentations covering IPM design and four presentations covering some of the major pests in schools. The presentations are designed to appeal to the broadest of audiences, so an IPM practitioner may use them many times targeting various groups.

Entire presentations, including the ones in this section of the manual, are available free over the Internet as downloadable files at the National School IPM World Wide Web site. In addition, there are VHS training videos available from the Texas Agriculture Extension Service. Please see Appendix 3 for more information.

What is

School Integrated Pest Management (IPM)?

SCHOOL IPM

A tutorial for school officials and concerned parents

IPM Definitions

SCHOOL IPM

Technically: IPM is a process for achieving long term, environmentally sound pest suppression through the use of a wide variety of technological and management practices.

Simply: IPM controls pests while reducing the hazards of pests and pesticide exposure to humans.

Significance of Common Pests in Schools

- **Cockroaches:** Skin fragments and feces are the most common cause of asthma in urban youth.
- **Ants:** Fire ant stings cause several human deaths per year.
- **Rodents:** Deadly hantavirus is transmitted by rodent urine and feces.

Harmful Effects of Pesticides Caused by Excess Exposure

- **Acute Effects:** Harmful or fatal if swallowed or inhaled.
- **Delayed Effects:** Tumors, cancer, birth defects, blood and nervous system disorders.
- **Allergic Effects:** Asthma and skin, eye and nose irritation.

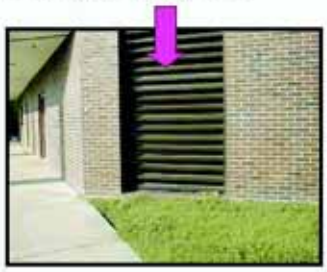
Four Points of IPM

1. Prevent pest populations.
2. Apply pesticides only as needed.
3. Select the least hazardous pesticides.
4. Target pesticides to areas not contacted by or accessible to the students, faculty or staff.

1) Prevent Pest Populations

All plumbing should be in good repair.

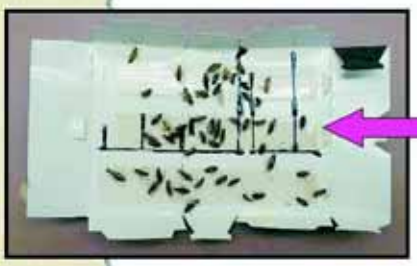
Proper screening or other devices should be in place around air vents, windows, doors, etc.



Any cracks in walls or around plumbing and electrical conduit should be well sealed.

2) Apply Pesticides As Needed

Treatment is necessary only when pests are present. Proper inspection procedures result in early detection of pest problems.



Sticky traps are great for monitoring pest infestations. Also, specimens can be collected and properly identified.

3) Select the Least Hazardous Material

Sprays create significant risks to children in schools. When it is necessary to treat, use the safest products that will solve the problem.

Many newly developed products are very effective in controlling pests, but are virtually harmless to humans.

4) Target Pesticides Properly

Crack and crevice treatments, such as puffing dusts into wall voids or treating cracks with gel baits drastically reduces exposure potential.

Targeting surfaces with residual sprays places pesticides where children and staff may contact them.

Benefits of IPM

- Reduced pesticide use.
- Healthier learning environment for our children.
- Better long-term control of pests.
- Reduced liability of school districts.


Acknowledgements
SCHOOL IPM
Author and Photos:
Clay W. Scherer, University of Florida
Design:
Matthew B. Downey, University of Florida
This is one of several presentations available at the School IPM World Wide Web Site
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School Integrated Pest Management (IPM)

SCHOOL IPM

A Tour of Pest Problem Areas in Schools

Landscape

SCHOOL IPM

- Trim trees and shrubbery away from exterior walls and roof lines.
- Landscape plantings offer pests access to buildings.

Playgrounds

- Thoroughly inspect grounds on a routine basis for evidence of pests such as fire ants, yellowjackets, etc.
- Limit the use of pesticides in playgrounds.

Front Office/Media Center

- Administrative areas are much less likely to have pest problems, but periodic inspections are still necessary.

Kitchen 1

- Pest problems can be very severe in the school cafeteria.
- Sanitation is essential. Close, careful inspection of the dining hall is very important.

Kitchen 2

- The tube framing of cafeteria tables provides excellent refuge for cockroaches.
- Closely inspect these areas and keep them clean. Gel baits can be safely placed here.

Kitchen 3

- The serving line can create pest problems as a result of uncleaned spills and droppings.
- Clean these areas on a daily basis.

Kitchen 4

- Store trays only after they are properly cleaned and fully dried.
- Even small amounts of water left behind can sustain a pest population.

Kitchen 5

- Food debris is often spilled or left behind at the tray and silverware return areas. Thoroughly clean these areas on a daily basis.

Kitchen 6

- Keep areas under kitchen equipment clean and dry.
- These are preferred hiding places for many pests.

Kitchen 7

- Store dish washing racks only after they are cleaned and dried.
- Inspect floor drains often.

Dry Storage Area

- Do not store items within cardboard boxes.
- Discard leaky or damaged goods.

Garbage Storage/Removal

- Remove garbage from the cafeteria on a daily basis.
- Close lids on all garbage containers.

Classrooms 1

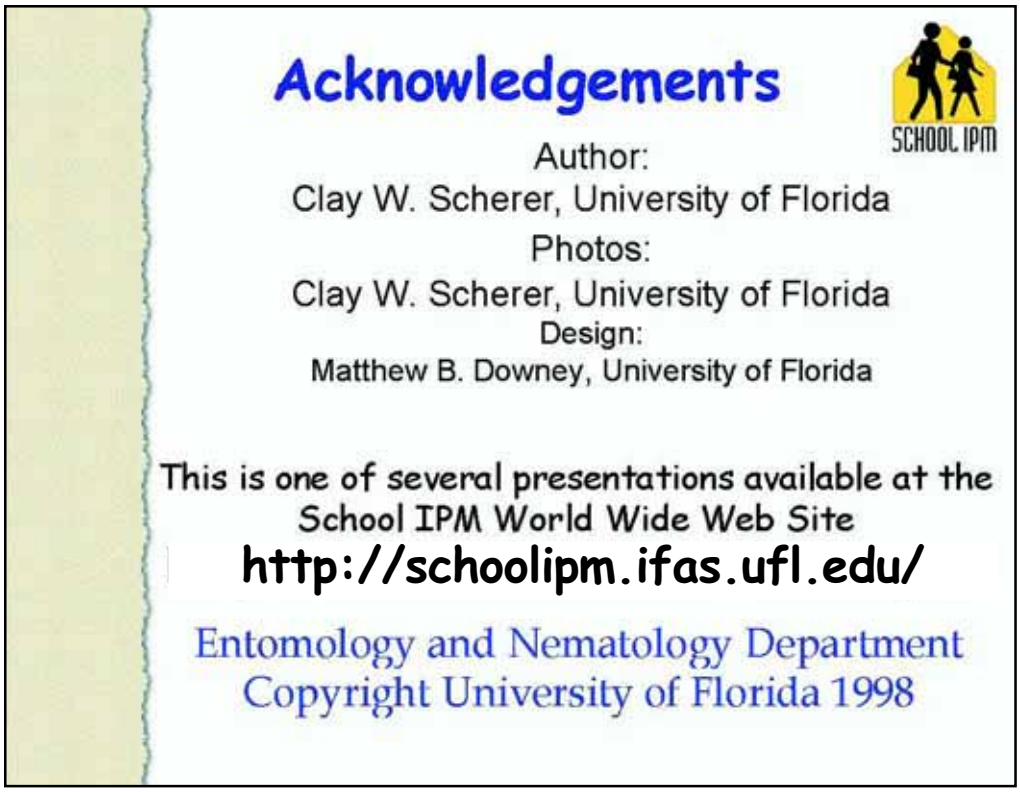
- Store classroom items in a well kept manner to facilitate pest inspections.
- Keep areas near windows and doors clear.

Classrooms 2

- Many pest species use classroom sinks as a water source.
- Cleanliness in this area is a must.

Remember the Four Steps of IPM

1. Prevent pest populations through sanitation and exclusion practices.
2. Apply pesticides only as needed.
3. Select the least hazardous pesticide to control the pests.
4. Target pesticides to areas not contacted by or accessible to the students, faculty or staff.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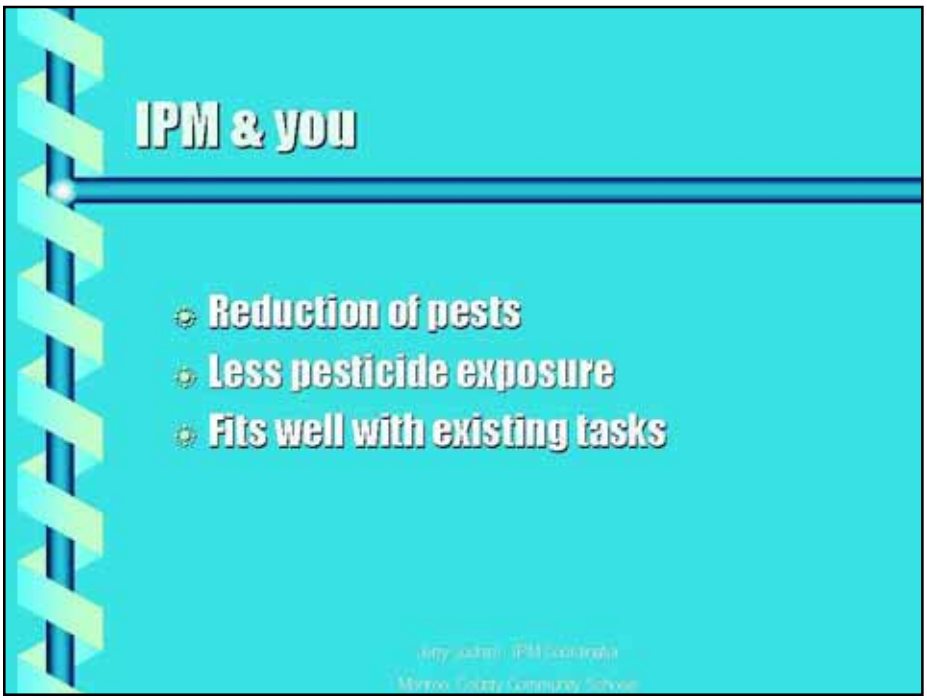
IPM in our schools
Staff Training
Custodians
Teachers
Cooks
PTO
Monroe County Community School Corp


IPM & you
Reduction of pests
Less pesticide exposure
Fits well with existing tasks

Advantages of IPM

- Cleaner building
- Tighter building
- Fewer pests
- Pesticide exposure is all but eliminated

Sanitation

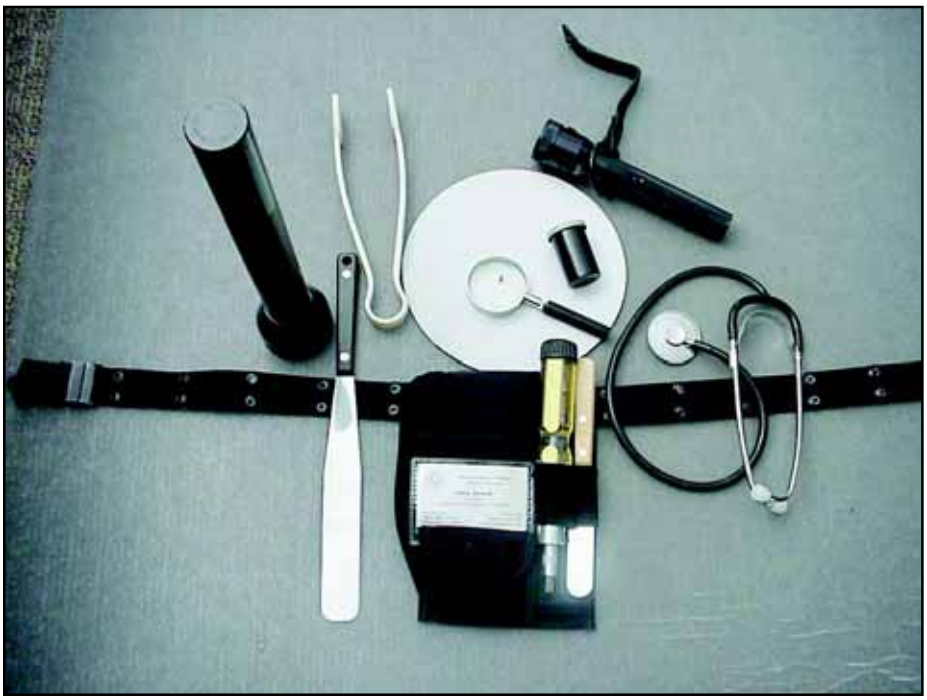
- Don't give insects & mice reasons to be pests.
- Keep food in pest proof containers.


Keep closets clean


Don't let pests live here


wausau papers
2650


Pests commonly found in our schools
Ants
Bats
Cockroaches
Flies
Rodents
Stinging Insects
Stored Grain Pests
Termites




Poison-free
YELLOW JACKET
ALLURE
ALLURE
ADVANCE
DUAL CHOICE
CAUTION


Poison free
Poison free
EcoPCO'D
DUST INSECTICIDE
ADVANCE
DUAL CHOICE
Victor
MOUSE
GLUE TRAPS

Pests

How to Control Ants Using IPM
Thomas Weissling

How to Control Cockroaches Using IPM
Thomas Weissling

How to Control Red Imported Fire Ants Using IPM
Clay Scherer

How to Control Head Lice
Clay Scherer

How to Control
Ants
Using
Integrated Pest Management (IPM)

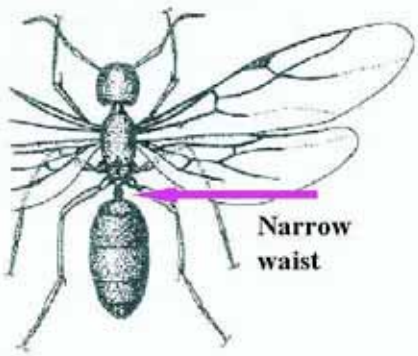
SCHOOL IPM

A tutorial for school officials and concerned parents

Description of Ants

SCHOOL IPM

- Have a narrow "waist."
- Antennae are "elbowed."
- Winged adults have two pairs of wings.
- New queens lose their wings after mating, and start a new colony.



Biology of Ants

- Eggs hatch into white, soft, legless larvae.
- Larvae molt several times then pupate, eventually emerging as adult ants.
- Complete development ranges from six weeks to two months depending on the species.
- Ants are social insects, that is, the queen lays eggs and workers find food, defend and maintain the nest.

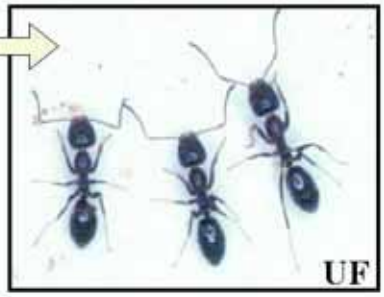
Common Pest Ants - 1

acrobat ant

- black, 3 mm long
- nests outdoors
- feeds on sweets
- does not bite or sting
- heart-shaped abdomen

Argentine ant

- dark brown, 2-3 mm long
- nests outdoors
- feeds on many things
- does not bite or sting



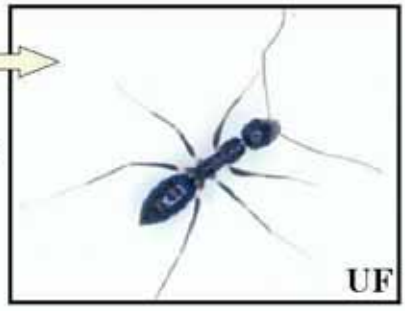
Common Pest Ants - 2

bigheaded ant

- brown, 2-3 mm long
- nests in/around structures
- feeds on many things
- does not bite or sting
- some workers have large heads

crazy ant

- black, 3 mm long
- nests in/around structures
- feeds on many things
- does not bite or sting
- very long antennae



Common Pest Ants - 3

Florida carpenter ant

- reddish-brown, 5-10 mm long
- nests in/around structures
- feeds on many things
- will bite when handled
- infests damaged wood

ghost ant

- white/tan, 1 mm long
- nests in/around structures
- feeds on sweets
- does not bite or sting
- needs a lot of moisture

Common Pest Ants - 4

Pharaoh ant

- rust colored, 2 mm long
- usually nests in structures
- feeds on many things
- does not bite or sting

white-footed ant

- black, 3 mm long
- nests in/around structures
- feeds on sweets
- do not bite or sting
- exists in very large colonies
- presently only in south Florida

Control of Pest Ants - 1

- Prevention
  - Store food in air tight containers.
  - Empty trash cans daily.
  - Food containers and soda cans should be taken from classroom trash cans to dumpsters immediately.
  - Remove infested, indoor potted plants and treat.
  - Trim trees and shrubs so that branches do not contact walls or roof lines.
  - Repair leaky sinks and water fountains.

Control of Pest Ants - 2

SCHOOL IPM

- Inspection
  - Locating the nest is the key in ant management.
  - Follow worker ants back to nesting area.
  - Look for places within the structure where ants gain entry:
    - Along electrical wires, outlets, and light switches.
    - Around doors, windows, plumbing, and vents.
    - Along cracks and crevices.

Control of Pest Ants - 3

SCHOOL IPM

- Non-Chemical Treatment
  - Crawling worker ants can be mopped up with soapy water or vacuumed. This provides short term relief.
  - Non-chemical nest treatment can provide long term control.
    - Vacuum nest to remove the queen, workers, and brood.
    - Boiling water can kill ants.

Control of Pest Ants - 4

- Chemical Treatment
  - Bait Treatment containing a slow-acting poison:
    - Bait is fed to queen by worker ants.
    - Requires several days to kill entire colony.
    - Baits are available as containerized stations, granules, and gels.

Control of Pest Ants - 5

- Chemical Treatment Continued
  - Nest Treatments - In areas not contacted by people
    - Apply insecticide directly to the ant nest.
    - Use dust or liquid formulations.
  - Barrier Treatments - Prevent ants from coming indoors.
    - Apply insecticide to exterior surfaces of walls where ants are known to enter.
    - Used as a last resort.

Control of Pest Ants - 6

SCHOOL IPM

- Chemical Treatment Continued
  - Surface sprays only kill ants that crawl on treated surfaces. They do not kill the colony.
  - Pesticides should not be applied to areas that students or staff contact.
  - Appropriate school personnel should be notified when pesticides are applied in the school.

Acknowledgements

SCHOOL IPM

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Japanese Ant Database Group
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http://schoolipm.ifas.ufl.edu/

How to Control Cockroaches

Using

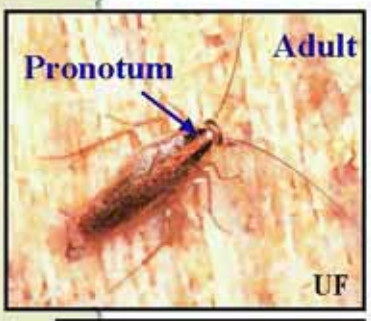
Integrated Pest Management (IPM)

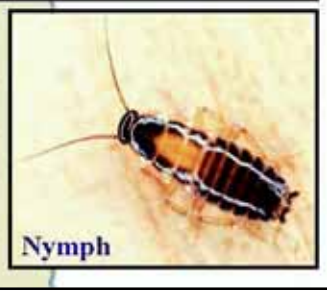
SCHOOL IPM

A tutorial for school officials and concerned parents

Description of Nymphs and Adults

SCHOOL IPM





- Enlarged plate behind head (pronotum).
- Color usually brown.
- Body flattened.
- Legs long and slender, adapted for running.
- There are 70 different species of cockroaches in the United States, but only a few species may be found in schools.
- The predominant indoor species is the German cockroach. (pictured)

Description of Ootheca

- Eggs covered by a special case called the ootheca.
- Ootheca protects eggs from drying out and from being eaten.
- Female, depending on the species, may glue ootheca onto a protected surface, drop it somewhere, or may carry it around until the eggs hatch.

Cockroach Biology

Cockroach life stages
(University of Nebraska-Lincoln)

- Cockroaches have three life stages: egg, nymph and adult.
- They hide during the day in warm, moist, dark crevices and come out at night to eat.
- They eat many different products, but are fond of starches.

5 Steps to Cockroach Management

- **Identify** - some species live indoors; others live outdoors. Identification helps you decide where to apply management strategies.
- **Prevent** cockroaches from entering and maintaining populations in the school.
- **Monitor** cockroach populations.
- **Treat** cockroaches when found.
- **Post-treatment Evaluation**

Prevent Cockroach Infestations

- Inspect materials (especially packages containing food) brought into school for all stages of cockroaches. Destroy immediately if found.
- Block entry points from outside, such as openings around pipes, doors and windows.
- Eliminate areas where roaches may hide during the day.
- Sanitation helps reduce the amount of food available to cockroaches. Do not leave uncovered food items indoors overnight.
- Eliminate sources of excess water, such as around leaky plumbing.

Monitor Cockroach Populations

SCHOOL IPM

- Sticky traps or visual inspection can be used in the school to help identify areas of infestation.
- Place sticky traps in areas likely to be infested, such as in the kitchen or lunch room. Inspect the traps after a week or so.
- Sticky traps can help determine if the school is actually infested, help locate "hotspots", be used to monitor population changes, and be used to help reduce infestations.

Treat with Baits + IGR's

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- Baits consist of a small amount of toxic material combined with a food source, and sometimes an attractant.
- Many baits are packaged within childproof plastic cases. Others are pastes or gels that are applied in hard-to-reach areas where cockroaches may be found.
- Baits are also available as granules to control cockroaches found outdoors.
- Insect growth regulators (IGRs) are also useful for cockroach management. These compounds are generally nontoxic to humans.

Do Not Spray Classrooms

SCHOOL IPM

- Treatment of classrooms with insecticidal sprays is usually unnecessary and may be hazardous.
- Baits, especially when combined with preventative measures, are very effective at managing cockroach infestations while greatly reducing pesticide exposure potential.

Acknowledgements

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How to Control Red Imported Fire Ants Using Integrated Pest Management

SCHOOL IPM

A training tutorial for pest management in public schools

Description of Fire Ants

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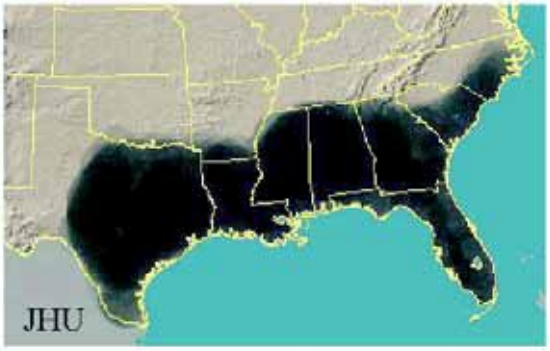
- Reddish-brown, 1/8-1/4 inch long
- Feeds on plant oils, some sweets
- Inflicts painful sting
- Can cause death in allergic people
- Constructs dome-shaped nest using soil

Distribution of Imported Fire Ants



To limit the spread of imported fire ants, a federal quarantine restricts the movement of soil, potted plants, sod, etc. to uninfested areas of the U.S. Any shipments outside the quarantine area requires inspection and certification by proper authorities.

How to Control Fire Ants

Immediate solution in sensitive area outdoors. Example: playground.

- Treat fire ant mound with liquid drench:
  - hot boiling water (190-212°F), or
  - pyrethroid insecticide
- If pesticide drench is used, be sure to restrict access until risk of exposure is removed from treated area.

How to Control Fire Ants - 2

Immediate solution in sensitive area indoors.

Example: electrical boxes, carpet.

- Use vacuum cleaner to remove existing ants and notify pest manager.
- Note specifics of fire ant entrance and provide this information to pest manager.
- Treatment of infested area should be conducted after hours.
- Follow up treatment with appropriate crack sealers or caulking.

How to Control Fire Ants - 3

Long Term Suppression

- Mound treatment using granular bait.
  - Always use dry/fresh material.
  - Follow label and sprinkle bait granules around mound.
  - Apply granules when temperatures are between 70° and 90° F.
  - Avoid application during mid-day sun.

How to Control Fire Ants - 4

SCHOOL IPM

Long Term Suppression (continued)

– Broadcast Bait Application

- Granular bait is applied to large areas such as ball fields following label rate.
- Locating and identifying individual mounds is not necessary.
- Helps prevent fire ants from establishing and can provide up to one year of control.

Example of Fire Ant Treatment

SCHOOL IPM

- Fire ants have infested a hallway.
- These ants and their debris can be removed using a vacuum.
- Then, an appropriate treatment can be applied such as a containerized bait station.
- Ant entry should be inspected and sealed.

Example of Fire Ant Treatment

- Fire ant nest located outside on a ball field.
- Any nest located here should be treated immediately.
- Use of a granular bait is appropriate here.
- This area should be inspected periodically throughout the year.

Acknowledgements

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Photos: University of Florida

U.S. Map: Ray Sterner
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How to Control

Head Lice

SCHOOL IPM

A tutorial for school officials and concerned parents

Description of Adult Lice

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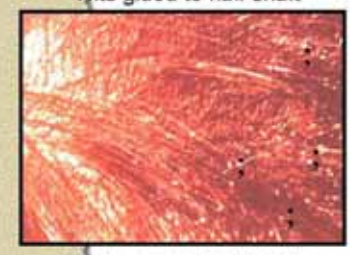
Beginning to feed

Full of blood

- Adult lice are about 1/8 inch long.
- Lice are wingless, bloodsucking insects.
- Lice have claws and move by crawling. Lice cannot jump.

Description of Lice Eggs

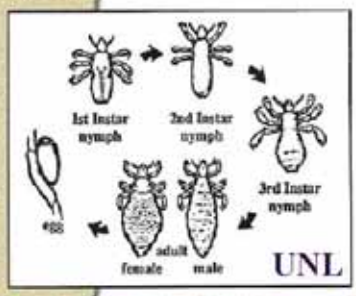
Nits glued to hair shaft



White eggs glued to hair

- Lice eggs are called nits.
- Nits are oval, white-gray-tan-dark brown cylinders about 1/16 inch long.
- Nits are glued to hairs very near the scalp.
- Older nits are found far from the scalp due to hair growth.

Lice Biology



Baby lice (nymph)

- Lice eggs hatch within seven to 10 days.
- Baby lice, also called nymphs, become adults in two weeks.
- Only adults can lay eggs.

4 Steps to Lice Eradication

SCHOOL IPM

- Prevention: Inspect frequently.
- Treatment: May include use of lice shampoo.
- Treatment of Belongings: Wash bedding and clothing in hot soapy water. Dry using "high heat" cycle. Bag other items.
- Post-treatment Inspection: Inspect individuals up to 10 days following treatment.

Prevention of Head Lice

SCHOOL IPM

- Head lice are spread by infested people.
  - Pets cannot get or spread head lice.
  - Only people get head lice.
- Children should not share combs, hats and personal belongings.
- Frequent inspections are a must.
  - Search entire head, especially back of head and neck.
  - Part hair section by section.
  - Remove lice with tweezers or lice comb.
  - Be careful not to spread lice to others while inspecting.

Option #1
Non-chemical Control

1. Remove lice and nits using lice comb.
2. Place lice and nits in soapy water or freeze.
3. Wash all bedding and personal belongings in hot soapy water. Dry on "high heat" cycle.

As a Last Resort

- Shave child's head.
- Even a very short haircut can aid in detection and removal of lice.

Option #2
Treatment with Lice Shampoo

1. Wash hair with household shampoo.
2. Completely wet hair with lice shampoo.
3. Add warm water, leave product on head for recommended time - usually 10 minutes.
4. Rinse thoroughly with warm water while removing any dead lice and nits.
5. Retreatment may be necessary in seven to 10 days as this kills hatching eggs.

Do Not Treat Classrooms

- Lice live their entire life cycle on the human body.
- Lice die within 24 hours after falling off the host.
- Treatment of classrooms with insecticidal sprays is unnecessary and may be hazardous.

Acknowledgements

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4

Technical Information on School IPM: School IPM Resource Guide

THIS CHAPTER OF THE GUIDE TARGETS PEST MANAGEMENT PROFESSIONALS (PMP). This chapter is split into three overall subsections: IPM Design, Pests, and Pesticides. The IPM Design section provides details on overall design of an IPM program. Concepts such as monitoring and utilizing hard-copy documentation might be new to some PMPs. The section on pests provides detailed "how-to" information on controlling the most common pests in schools using IPM strategies. The section on pesticides covers all aspects of pesticide safety, including handling, mixing, spills, proper application, and relative toxicity of pesticides.

IPM Design

Pests and Pesticides in Schools

Jonathan Morehouse, Clay Scherer, and Philip Koehler

Introduction

Our children spend six hours a day for 12 years in school. Parents have a responsibility to work with educators to provide the safest environment in which children can attain an education. Numerous species of insects are present in and around schools. A number of these insects are pests that are harmful to children and disrupt the learning environment in classrooms. As a result, most schools apply pesticides to control pest infestations.

Pests in Schools

Children react poorly to pests. If a classroom is infested with pests, teachers cannot maintain discipline, and learning is disrupted. Pests have been found to cause allergic reactions in sensitive individuals. They also can transmit life-threatening diseases to humans. Children are especially susceptible to these diseases. Cockroaches, ants, wasps, head lice and rodents are the main pests found in many schools.

Cockroaches, especially the German cockroach, can live and breed by the thousands in classrooms and cafeterias. They can carry germs from filthy surfaces to cafeteria tables and classroom desks. Cockroaches are the leading cause of asthma in urban youth. The more often children are exposed to cockroaches the more allergic they become.

Pest ants, like the pharaoh ant, build nests in classrooms and cafeterias. Thousands of ants can forage for food in places like dumpsters, cafeteria food disposal areas, and on cafeteria tables and classroom desks. Ants have been shown to be capable of transmitting staph and strep in these kinds of environments.

Fire ants build their nests on school grounds. These nests often contain more than 100,000 ants. During recess and physical education classes, children often are stung when they step into the nests while playing. Fierce defenders of their nests, fire ants can inflict hundreds of painful stings to children. Fire ants cause one to two deaths a year in Florida.

Many kinds of wasps often build nests under eaves and in playground equipment. Wasps savagely defend their nests, often stinging children who play nearby. Wasps and bees are the leading cause of death by venomous animals in the United States.

Rodents are often found living in and under school buildings. Rats and mice contaminate stored food with their droppings and urine. Rodent droppings and urine may contain hantavirus, a disease linked to more than 27 recent deaths in the United States, including one in Florida. Rodents can also gnaw through electrical insulation and cause electrical fires.

Parental Concerns

Decreasing educational dollars often result in limited funding for pest management. Therefore, pests often cause disruptions and dangerous situations.

Parents should be concerned about pests in their children's school. Do they know if there are pest infestations that may disrupt class activities? Do they know if the school is free of pests that cause allergies and transmit disease? It is important not to have pests in the school environment.

Traditional Pest Control

Pesticides are used in schools to kill pests. Pesticides are often sprayed on exposed surfaces, like walls, baseboards, and floors of classrooms, offices, and food service areas to kill pests. Also, playgrounds and athletic fields are often sprayed with pesticides.

The compressed air sprayer has been the main tool of the pest control industry for the past 50 years. It is well designed for covering large surfaces with pesticides. These are often exposed surfaces that children may touch.

Pesticides are often applied in schools on a routine, scheduled basis. These applications are made even though no insects may be causing a problem.

Pesticides are often applied by untrained staff. They have little knowledge of the poisons they are applying or safe application techniques.

Effects of Pesticides

We are all concerned about the effects of pesticides on wildlife and endangered species. These concerns about our environment have led to strict regulations on the manufacture and the use of pesticides. We are also worried about pesticide contamination of water, soil, and air.

Pesticides can harm school-aged children. In fact, there is little information about the effects pesticides may have on them. But we do know children are generally more susceptible to pesticides than adults. Pesticides often have greater effects on children because of their lower body weight. Their skin may be more permeable to pesticides, and their playful behavior puts them in greater contact with pesticide residues. It is our responsibility to protect children from excessive pesticide exposure in school.

Integrated Pest Management (IPM)

How do we as parents and educators provide an environment where pests are managed and the use of pesticides minimized? The dilemma is a desire for a pest-free school environment and for no risk of pesticide exposure.

The solution is Integrated Pest Management. IPM is a process that relies on prevention, inspection, and communication. With IPM, pesticides are used only to manage pests, after all other nonchemical methods of control have failed.

IPM reduces the use of pesticides by first preventing pest infestations through sanitation and exclusion. Pest populations are monitored to determine where, when, and what kind of controls should be applied. When pests are found, nonchemical methods for pest management are used first. Pesticides are only used as they are needed rather than according to a treatment schedule. Least toxic pesticides are selected to minimize hazard. Results are evaluated so that pesticides are not continuously applied in schools.

IPM begins with prevention. We can modify and repair structures to eliminate the resources pest need for survival, such as food, water and shelter. This will eliminate conditions that allow pests to thrive. Prevention offers long-term solutions for problems that in the past required continuous pesticide use.

The success of IPM depends on the cooperation of many individuals. Pest management is not the sole responsibility of a pest control operator. Proper maintenance, housekeeping and sanitation of buildings is important for successful long-term management.

To reduce pesticide use in schools, it is important to know when pests invade the school and where they are located. Inspections are an important component of IPM, and allow the pest manager to detect infestations early.

Sticky traps are the main tool for monitoring pest populations. The traps show the pest control operator what and how many pests are present. If no pests are found, no pesticides should be applied.

When pests are found, nonchemical methods of managing them are used. These methods can include restricting where food is eaten, moving the dumpster away from the school, repairing and maintaining leaking pipes, and pressure cleaning food service areas, just to name a few.

After all nonchemical methods of managing pests have failed, pesticides should be applied only to the area(s) of infestation. Most pests, like cockroaches, live in cracks and crevices. Pesticides applied to these areas effectively control the pests and minimize exposure to children. These targeted applications precisely deliver pesticides to the pests. Pesticides should be applied by trained and state certified personnel knowledgeable in school-based functions, pesticide safety, modern application techniques, and Integrated Pest Management procedures. To protect children, select the least hazardous pesticides. Pesticides should be applied to pest harborages so surfaces are not contaminated and chemicals do not come in contact with exposed surfaces.

The main tools for pest management minimize children's exposure to pesticides. Applications should be baits that are applied to pest harborages or contained in child-proof bait trays, dusts that are applied in wall voids or attics, or crack-and-crevice injections that target the pests where they live. These formulations reduce exposure, yet provide superior control of many pests.

School-Based IPM Advisory Committee

What can parents do to protect their children from pests and pesticides in the school? First, talk with the principal and the children's teacher about what is being done to control pests in the school. Second, find other parents who share concerns about pests and pesticide exposure. Third, form a school IPM advisory committee with the school's administration. Parents must work with educators to change the way pest management is performed.

The issues associated with pests and pesticide use in schools are quite complex. Both pests and pesticides can harm children. Parents can help protect the health of children by working to establish Integrated Pest Management in their schools.

Successful Pest Management Programs in Schools

Jonathan Morehouse, Clay Scherer, and Philip Koehler

Introduction

The goal of successful pest management programs in schools is to protect students, faculty, and staff from noxious pests and toxic pesticides. We can reduce pesticide use and still manage pest populations by preventing pest infestations, using nonchemical methods to manage pests, applying least toxic pesticides only as needed, and targeting pesticide applications to locations where pests occur.

Traditional Pest Control

Traditional pest control in schools has usually meant regularly scheduled pesticide applications. Broad spectrum nerve poisons such as organophosphates, carbamates, and pyrethroids often are sprayed on exposed surfaces throughout the school whether pests are present or not. These exposed surfaces are not only areas that pests contact, but also are areas that children may touch.

Parents are becoming more concerned about the effects pesticides have on their children. Many people consider themselves sensitive to the chemicals used in pesticide formulations and feel their children have a right to attend school without being exposed to these harmful chemicals. Concerned parents and environmental organizations are very upset about pesticide use in schools and are filing lawsuits to protect children from excessive pesticide exposure. Because some schools use untrained or minimally trained personnel for pest control, there is significant liability for most schools.

Covering exposed surfaces with pesticides may increase the risk of children contacting surface residues and inhaling contaminated airborne dust particles. The National Academy of Science reported in 1995 that children may be more susceptible to pesticides than adults because of their small size.

Pesticides do not solve the problems that cause pest infestations. For instance, poor sanitation creates food and water resources that pests exploit. Pesticides may kill some of the pests that thrive in conditions of poor sanitation. However, the continual use of pesticides leads to insecticide resistance in pest populations, resulting in the need to apply more at higher doses.

According to a 1995 telephone survey of Florida school districts, 88 percent of the districts that contract for and 55 percent of the districts that perform in-house service apply broad-spectrum nerve poisons throughout the school. Schools that use pest control service contracts usually specify regularly scheduled treatments whether insects are present or not. Consequently, these contracts do not allow for the use of pest management. Whether pest control is done in-house or by contract, it is important to manage pests such as wasps, fire ants, and cockroaches.

Pests

The most dangerous venomous arthropods to humans are wasps. They cause more than 200 deaths a year nationally. However, measures can be taken to reduce the threat from wasps. Frequent inspections of the school grounds and removal of nests will insure that wasps will not endanger children.

Fire ants are very common. They can inflict scores of painful stings and cause one to two deaths a year in Florida. Children are stung during recess and physical education class when they step into fire ant mounds because fire ants build their nests on school grounds. It is important for schools to inspect and treat mounds to reduce the risk of fire ant stings.

Some children and adults are allergic to venomous arthropods. These victims may suffer a mild reaction such as itching. However, allergic reactions of some may include cyanosis and death. Many deaths across the United States are attributed to venomous insects each year.

The health and safety of children is the school's responsibility while they are at school. If a child reacts badly to a sting received while at school, is the school negligent? What is the liability of the school district if a child is stung, triggering a severe reaction?

German cockroaches can live and breed by the thousands in areas where humans live and work. Classrooms and kitchens are exploited by cockroaches because there is an abundance of food, water, and shelter, and sanitation often is poor. German cockroaches can carry germs like staph and strep. They are the No. 1 cause of asthma in urban youth.

Cockroach body parts and droppings may cause asthmatic reactions in sensitive children. The more often children are exposed to cockroaches the more sensitive they become. What is the liability of the school district if an asthmatic child is exposed to cockroaches and that exposure triggers an attack?

Pesticides

It is important to manage pests, but equally important to protect children from excessive pesticide exposure. Many pesticides are usually broad-spectrum poisons that may harm humans and kill pests.

Chemical sensitivity may be a reaction to pesticides. Even though pesticides are applied carefully, they can travel on air currents to affect chemically sensitive people. Liquid pesticides are volatile and have been shown to move from the application site to areas where no pesticides have been applied.

Surface treatments from a hand-held, compressed-air pump sprayer increases the risk of exposure to pesticides by sensitive individuals from airborne particles. This exposure may trigger reactions that could be life threatening. Schools have the responsibility to provide a safe environment without the risk of exposure to pesticides. What is the liability of the school district if a child is exposed to pesticides in school?

Each school must decide if pesticides will be stored on campus. If the school decides to store pesticides on campus, control measures must be strictly followed to limit and document

the access and use of the pesticides in order to reduce any risk of accidental poisoning.

Many schools do not store pesticides properly. It is common to find improperly stored pesticides that are accessible to children in the classroom, such as in sink-based cabinets, on shelves, or on the teacher's desk. The improper storage of pesticides is an accident waiting to happen. One of the primary responsibilities of the school-based IPM committees is to decide on the proper storage and handling procedures for pesticides at the school site. What is the liability of the school district if a child is poisoned due to improper pesticide storage?

Integrated Pest Management (IPM)

Schools are faced with the dilemma of managing pests and minimizing the use of pesticides. Integrated Pest Management is designed to provide a safe and healthy environment for children while managing pests that may harm children or disrupt the learning environment.

Integrated Pest Management offers an alternative to traditional pest control methods. IPM emphasizes pesticide reduction through long-term solutions to pest populations. IPM prevents pests by decreasing the resources pests need to survive. Then if pests become a problem, nonchemical alternatives are employed to reduce pest populations. Pesticides are used only as the last resort, selecting the least hazardous material and precisely applying it to maximize efficacy and to minimize exposure.

IPM Policy Statement

As with any important issue addressed by the school board, it is important to establish a general policy so that all schools in the district know the rules and can comply. A districtwide IPM policy statement is necessary and functions as a road map. It guides the transition from a regularly scheduled chemical-based program to a program that relies on the prevention of pest populations. The policy statement puts into writing the general policy of the school board for Integrated Pest Management.

The goal of IPM can be summarized simply by the following: reduced pesticide use while providing long-term solutions for pest management. Any policy statement should include a commitment to implement IPM procedures, the pests to be managed, a commitment to reduce pests and pesticides, and list the goals and concepts of IPM as it relates to pest management and pesticide reduction.

A policy statement should be short, simple, and generally state what the goals of IPM are for your school district. Individual schools in the district will specifically address what procedures will be adopted to achieve the stated goals of reduced pesticide use and long-term pest management solutions. The policy statement should affirm the school district's responsibility to manage pests and provide a safe environment. For instance "It is the policy of this school district to implement IPM procedures and manage pests while reducing the use of pesticides. These pests include but are not limited to cockroaches, fire ants, wasps, and rodents, to name a few."

The next item addressed by the policy statement should recognize the risks of traditional pest control to children and the school board's commitment to reduce excessive exposure to harmful pesticides. The policy statement should explicitly state its commitment to the reduction of traditional pesticide use. The risk of exposure to pesticides can result in poisoning or allergic responses in sensitive individuals. This section of the policy statement acknowledges the fact that traditional pest control raises the question of safety for the children.

Finally, the school board should state the concepts and goals of IPM. Also stated should be the procedures to establish an IPM program. As you can see by the model policy statement, these concepts are listed. If there any questions regarding which concepts or goals should be included, the extension agent and many PCOs have the knowledge to help you.

IPM Advisory Committee

Each school in the district establishes its own IPM advisory committee to develop its individual pest management policies. These policies reflect the priorities of each school. The advisory committee should include concerned parents, school administrators, faculty and staff, and pest control operators. This committee could be part of the PTA, SAC or the safety committee already functioning at the school.

Once the IPM committee is established, its function will be to coordinate preventive pest management practices and pesticide reduction at the school level. The committee also develops ways to track and evaluate the progress of the IPM program in meeting the districtwide goals of reducing pests and pesticide use. It is the responsibility of the school IPM committee to coordinate the implementation of IPM practices in the school. The committee acts as a clearinghouse for information about IPM procedure and facilitates compliance with the policy statement within the school.

The committee, with the help of an IPM expert, designs the necessary forms, reports, and procedures to properly document pest management activities such as repairs, maintenance, pesticide use, and storage. These reports are critical to the success of the IPM program. The data necessary to evaluate the effectiveness of IPM will be analyzed from these reports.

Regularly scheduled IPM committee meetings are necessary to monitor and evaluate progress, correct inefficient procedures that hinder meeting the stated goals of the school IPM policy statement, and educate concerned individuals involved with the program.

Forms and Records

One of the reports necessary for the success of the IPM program is an inspection report. The pest control operator inspects the property on a regular basis as agreed upon in the service agreement. The PCO documents problem areas that are conducive for pest infestations, such as unsanitary conditions in the food service area, discovery of any infestations,

and offers recommendations to correct any deficiencies. Once recommendations are made it is the responsibility of the principal to facilitate corrections. The advisory committee monitors the progress made in meeting the above recommendations.

The sighting log is another tool that helps the PCO monitor and locate pest populations. Insects documented on the report show the pest control operator where there may be the beginnings of an infestation. These logs should be placed at critical areas, such as food service and storage, teacher's lounge, and classrooms where pests have been seen. The log should include the location(s) of the pest sighted, date discovered, the pest, and who sighted the pest. A section for the PCO's signature and date the PCO investigated the sighting should also be included. This log would also serve as a service record for treatment.

After all nonchemical methods of pest management have been employed, it may be necessary to use pesticides. The Pesticide Usage Report is the most important document used to monitor the use of pesticides at the school. It documents if treatment is needed, the areas treated, target pests, chemicals used, at what rates, and the amount of pesticide used.

If and when pesticide treatments are necessary to manage pests, it is important to notify everyone at the site. The pesticide application warning sign should include the date and time of treatment, materials used, and re-entry time. The sign should be placed in a conspicuous area where treatments are being made. The advisory committee is responsible for pesticide notification.

Some of the issues the IPM committee also will address are certification of the individuals applying pesticides, will there be any exceptions to the certification in the cases of ants or wasps, and should pesticides be stored on site. What forms will be used for pesticide notification, pesticide use, and how to document where pesticides are applied? Other concerns that will be addressed is how to develop lines of communication with the parties involved with the IPM program, and facilitate changes at the school to help eliminate pest populations.

Implementation of IPM

To be effective, a pest management program has to establish clear lines of communication and designated roles of responsibilities. The school board sets the overall pest management policy, provides funding, and monitors the results from the individual schools. The schools design a program that satisfies its priorities within the parameters set by the school board. The school principal ensures that recommendations from the PCO are carried out and completed. The pest control operator is no longer solely responsible for pest prevention. Everyone at the school shares in the responsibility for pest management. The IPM committee develops and coordinates procedures, facilitates communication, and evaluates the procedures and progress of the pest management program. The PCO inspects, monitors, and recommends changes to factors contributing to any infestations. The remaining staff upgrades procedures to prevent pest populations.

Selecting Treatment Strategies

Edited by Clay Scherer; originally written by S. Darr, T. Drlik, H. Olkowski, and W. Olkowski

IPM is not simply a matter of substituting "good" pesticides for "bad" pesticides. Too often we want an easy solution, a "magic bullet" that will solve all our problems in one shot. Unfortunately, pest management is complicated, and we cannot always expect a simple solution to pest problems. IPM is based on the fact that combined strategies for pest management are more effective in the long run than a single strategy. A good pest manager considers as many options as possible and tries to combine them into an effective program. The best pest managers have ideas for new and creative ways to solve pest problems. Wherever possible, IPM takes a preventive approach by identifying and removing, to the degree feasible, the basic causes of the problem rather than merely attacking the symptoms (the pests). This prevention-oriented approach is also best achieved by integrating a number of treatment strategies.

Criteria for Selecting Treatment Strategies

Once the IPM decision-making process is in place and monitoring indicates a pest treatment is needed, the choice of specific strategies can be made. Choose strategies that:

- Minimize risk to humans and the environment;
- Are least disruptive of natural controls in landscape situations;
- Are least toxic to nontarget organisms;
- Prevent recurrence of the pest problem;
- Are easiest to carry out safely and effectively;
- Are most cost-effective in the short and long term; and
- Are appropriate to the site and maintenance system.

Least hazardous to human health

It is particularly important around children to take the health hazards of various strategies into consideration. For example, aerosol sprays can kill cockroaches. However, they can also pose potential hazards to humans because the pesticide volatilizes in the air, increasing the likelihood of respiratory or lung exposure of students and staff. In addition, aerosol sprays may leave residues on surfaces handled by students and teachers. When cockroach baits are used instead, the pesticide is confined to a much smaller area, and if applied correctly, the bait will be out of reach of students and staff. Baits volatilize very little, so lung exposure is not a problem.

Least disruptive of natural controls

In landscape settings, you want to try to avoid killing off the natural enemies that aid in controlling pest organisms. Unfortunately, and for a number of reasons, natural enemies often are more easily killed by pesticides than are the pests. When choosing treatment strategies, always consider how the strategy might affect natural enemies. When choosing a pesticide, try to use one that has less effect on natural enemies.

Least toxic to nontarget organisms

The more selective the control, the less harm there will be to nontarget organisms.

Example: Aphid populations in trees often grow to high numbers because ants harvest the honeydew (sweet exudate) produced by the aphids, and protect them from their natural enemies. The ants that protect these aphid pests are often beneficial in other circumstances, aerating the sod and helping to decompose plant and animal debris. By excluding the ants from the tree with sticky bands around the trunk, it is often possible to achieve adequate suppression of the aphids without harming the ant populations.

Most likely to be permanent and prevent recurrence of the problem

Finding treatments that meet this criteria is at the heart of a successful IPM program because these controls work without extra human effort, costs, or continual inputs of other resources. These treatments often include changing the design of the landscape, the structure, or the system to avoid pest problems. The following are examples of preventive treatments:

- Educating students and staff about how their actions affect pest management.
- Caulking cracks and crevices to reduce cockroach (and other insect) harborage and entry points.
- Instituting sanitation measures to reduce the amount of food available to ants, cockroaches, flies, rats, and mice.
- Cleaning gutters and directing their flow away from the building to prevent moisture damage.
- Using an insect growth regulator to prevent fleas from developing in an area with chronic problems.

Easiest to carry out safely and effectively

While the application of pesticides may seem comparatively simple, in practice it may not be the easiest tactic to carry out safely or effectively. Use of conventional pesticides often involves wearing protective clothing such as mask, and goggles. In hot weather, people often are reluctant to wear protective gear because of the discomfort this extra clothing causes. By choosing not to wear the protective clothing, applicators not only violate the law, but also risk exposure to toxic materials.

Most cost-effective in the short and long term

In the short term, use of a pesticide often appears less expensive than a multi-tactic IPM approach. However, closer examination of the true costs of pesticide applications over the long term may alter this perception. In addition to labor and materials, these costs include mandatory licensing, maintaining approved pesticide storage facilities, disposing of unused pesticides, liability insurance, and environmental hazards.

Other factors to consider are whether a particular tactic carries a one-time cost, a yearly recurring cost, or a cost likely to recur a number of times during the season. When adopting any new technology (whether it be computers or IPM), there will be some start-up costs. Once the program is in place, IPM generally costs less than or about the same as conventional chemically based programs.

In addition, parental and community concern about the use of conventional pesticides may make any use of pesticide in and around schools problematic. A public relations headache can develop over comparatively innocuous incidents, and require substantial amounts of time from the highest paid employees of the school district to attend meetings and prepare policy statements. These costs should also be factored into the pest control equation.

Appropriate to the weather, soils, water, and the energy resources of the site and the maintenance system

Skillfully designed landscapes can reduce pest problems as well as use of water and other resources. We cannot stress enough the importance of choosing the right plant for the right spot. Plants that are forced to grow in unsuitable sites where they are unable to thrive will be a continual source of problems. When plants die on the school site, take the time to find a replacement that is suited to the landscape.

Timing Treatments

Treatments must be timed to coincide with a susceptible stage of the pest and, if at all possible, a resistant stage of any natural enemies that are present. Sometimes the social system (i.e., the people involved or affected) will impinge on the timing of treatments. Only monitoring can provide the critical information needed for timing treatments and thereby make them more effective.

Example: To control scales on plants using a low-toxic material such as insecticidal soap or horticultural oil, it is necessary to time treatments for the period (often brief) when immature scales (crawlers) are moving out from under the mother scales, seeking new places to settle down. It is at this stage that scales are susceptible to soaps and oils.

Spot Treatments

Treatments, whether pesticides or nontoxic materials, should be applied only when and where needed. It is rarely necessary to treat an entire building or landscape area to solve a pest problem. By using monitoring to pinpoint where pest numbers are beginning to reach the action level and confining treatments to those areas, costs and exposure to toxic materials can be kept to a minimum.

Summary of Available Treatment Options

The following is a list of general categories of treatment strategies. We have included some examples to help illustrate each strategy. The list is not intended to be exhaustive, since products change, new ones are discovered or invented, and inge-

nious pest managers develop new solutions to old problems every day.

Education

Education is a cost-effective pest management strategy. Information that will help change people's behaviors — particularly how they dispose of wastes and store food — plays an invaluable part in managing pests like cockroaches, ants, flies, yellowjackets, and rodents. Education can also increase people's willingness to share their environment with other organisms so that people are less likely to insist on toxic treatments for innocuous organisms. Teaching children about IPM will have a long-term effect on the direction of pest management in this country as these students grow up to become consumers, educators, policy makers, and researchers.

Habitat Modification

Pests need food, water, and shelter to survive. If the pest manager can eliminate or reduce even one of these requirements, the environment will support fewer pests.

Design or Redesign of the Structure

Design changes can incorporate pest-resistant structural materials, fixtures and furnishings. Sometimes these changes can entirely eliminate pest habitat. For example, buildings designed without exterior horizontal ledges will reduce pigeon problems. Inside, industrial stainless steel wire shelving mounted on rolling casters helps reduce roach habitat and facilitates cleanup of spilled food.

Sanitation

Sanitation can reduce or eliminate food for pests such as rodents, ants, cockroaches, flies, and yellowjackets.

Eliminating Sources of Water for Pests

This involves fixing leaks, keeping surfaces dry overnight, and eliminating standing water.

Eliminating Pest Habitat

How this can be done will vary depending on the pest, but some examples are caulking cracks and crevices to eliminate cockroach and flea harborage, removing clutter that provides roach habitat, and removing dense vegetation near buildings to eliminate rodent harborage.

Modification of Horticultural Activities

Planting techniques, irrigation, fertilization, pruning, and mowing can all affect how well plants grow. A great many of the problems encountered in school landscapes are attributable to using the wrong plants and/or failing to give them proper care. Healthy plants often are likely to have fewer insect, mite, and disease problems. It is very important that the person responsible for the school landscaping have a good foundation of knowledge about the care required by the particular plants at the school or be willing to learn.

Design or Redesign of Landscape Plantings

- Choose the right plant for the right spot and choosing plants that are resistant to or suffer little damage from local pests. This will take some research. Ask advice of landscape maintenance personnel, local nurseries, local pest management professionals, and County Extension agents or the master gardeners on their staffs.
- Include in the landscape flowering plants that attract and feed beneficial insects with their nectar and pollen, e.g., sweet alyssum, *Lobularia* spp., and flowering buckwheat, *Eriogonum* spp., species from the parsley family (Apiacae) such as yarrow and fennel, and the sunflower family (Asteraceae) such as sunflowers, asters, daisies, marigolds, zinnias, etc.
- Diversify landscape plantings. When large areas are planted with a single species of plant, a pest can devastate the entire area.

Physical Controls

Vacuuming

A heavy duty vacuum with a special filter fine enough to screen out insect effluvia (one that filters out particles down to 0.3 microns) is a worthwhile investment for a school. Some vacuums have special attachments for pest control. The vacuum can be used not only for cleaning, but also for directly controlling pests. A vacuum can pull cockroaches out of their hiding places; it can capture adult fleas, their eggs, and pupae; and a vacuum can be used to collect spiders, boxelder bugs, and cluster flies.

Trapping

Traps play an important role in nontoxic pest control. However, in and around schools, traps may be disturbed or destroyed by students who discover them. To prevent this, place them in areas out of reach of the students in closets or locked cupboards. Another strategy is to involve students in the trapping procedures as an educational activity so they have a stake in guarding against trap misuse or vandalism.

Today a wide variety of traps is available to the pest manager. Some traps are used mainly for monitoring pest presence. These include cockroach traps and various pheromone (insect hormone) traps, although if the infestation is small, these traps can sometimes be used to control the pest. Other traps include the familiar snap traps for mice and rats, electric light traps for flies, and flypaper. There are also sticky traps for whiteflies and thrips, cone traps for yellowjackets, and box traps for skunks, raccoons, and opossums.

Removing Pests by Hand

In some situations removing pests by hand may be the safest and most economical strategy. Tent caterpillars can be clipped out of trees, and scorpions can be picked up with kitchen tongs and killed in soapy water or in alcohol.

Biological Controls

Conserving biological controls means protecting those already present in the school landscape. To conserve natural enemies you should do the following:

- Treat only if injury levels will be exceeded.
- Spot treat to reduce impact on nontarget organisms.
- Time treatments to be least disruptive in the life cycles of the natural enemies.
- Select the most species-specific, least-damaging pesticide materials such as *Bacillus thuringiensis*, insect growth regulators that are specific to the pest insect, and baits formulated to be attractive primarily to the target pest.

Microbial controls

Microbial controls are naturally occurring bacteria, fungi, and viruses that attack insects and weeds. A growing number of these organisms are being sold commercially as microbial pesticides. Because each of these microbial pesticides attacks a narrow range of pests, nontarget organisms are much less likely to be affected.

The most well-known microbial insecticide is *Bacillus thuringiensis*, or Bt. The most widely sold strain of Bt kills caterpillars. Another strain kills only the larvae of black flies and mosquitoes, and a third strain kills only certain pest beetles.

Microbial herbicides made from pathogens that attack weeds are commercially available for use in agricultural crops. In the near future, there may be commercial products for use in urban horticultural settings.

Least-Toxic Chemical Controls

The health of school residents and long-term suppression of pests must be the primary objectives that guide pest control in school settings. To accomplish these objectives, an IPM program must always look for alternatives first and use pesticides only as a last resort.

Many people are familiar with insecticides such as malathion, fungicides such as benomyl (Benlate), and herbicides such as 2,4-D. These and similar materials have engendered controversy over possible hazards they pose to human health and the environment. There are many other chemical products to choose from that are relatively benign to the larger environment and at the same time effective against target pests.

Least-toxic pesticides are those with all or most of the following characteristics: They are effective against the target pest, have a low acute and chronic toxicity to mammals, biodegrade rapidly, kill a narrow range of target pests, and have little or no impact on nontarget organisms. More and more such products are reaching the market. These include materials such as the following:

- Insect growth regulators (IGRs);
- Desiccating dusts;
- Pesticidal soaps and oils; and
- Some botanical pesticides.

Insect Growth Regulators (IGRs)

Immature insects produce juvenile hormones that prevent them from metamorphosing into adults. When they have grown and matured sufficiently, their bodies stop making the juvenile hormones so they can turn into adults. Researchers have isolated and synthesized some of these chemicals, and when they are sprayed on or around certain insects, these insect growth regulators prevent the pests from maturing into adults. Immature insects cannot mate and reproduce, so eventually the pest population is eliminated. The IGRs methoprene and fenoxycarb are used to suppress fleas, and hydroprene is used against cockroaches.

Since humans and other mammals don't metamorphose as insects do, our bodies do not recognize juvenile hormones.

Desiccating Dusts

Insecticidal dusts such as diatomaceous earth and silica aerogel, made from natural materials, kill insects by absorbing the outer waxy coating that keeps water inside their bodies. With this coating gone the insects die of dehydration.

Silica aerogel dust can be blown into wall voids and attics to kill drywood termites, ants, roaches, silverfish, and other crawling insects.

Pesticidal Soaps and Oils

Pesticidal soaps are made from refined coconut oil and have a very low toxicity to mammals. (They can be toxic to fish, so they should not be used around fish ponds.) Researchers have found that certain fatty acids in soaps are toxic to insects but decompose rapidly, leaving no toxic residue. Soap does little damage to lady beetles and other hard-bodied insects, but could be harmful to some soft-bodied beneficials. A soap-based herbicide is available for controlling seedling stage weeds; the soap kills the weeds by penetrating and disrupting plant tissue. Soap combined with sulfur is used to control common leaf diseases such as powdery mildew.

Insecticidal oils (sometimes called dormant oils or horticultural oils) also kill insects and are gentle on the environment. Modern insecticidal oils are very highly refined. Unlike the harsh oils of years ago that burned leaves and could only be used on deciduous trees during the months they were leafless, the new oils are so light they can be used to control a wide variety of insects even on many bedding plants.

Note that it is always wise to test a material on a small portion of the plant first to check for damage before spraying the entire plant.

Botanical Pesticides

Botanical pesticides, although they are derived from plants, are not necessarily better than synthetic pesticides. Botanicals can be easily degraded by organisms in the environment. However, plant-derived pesticides tend to kill a broad spectrum of insects, including beneficials, so they should be used with caution. The most common botanical is pyrethrum, made from crushed petals of the pyrethrum chrysanthemum flower. Pyrethrins are the active ingredient in pyrethrum, but pyrethroids, such as resmethrin and permethrin, have been synthesized in the laboratory and are much more powerful and long-lasting than the pyrethrins. Neem, another botanical pesticide, is discussed above under "Repellents." Some botanicals, such as nicotine or sabadilla, can be acutely toxic to humans if misused, and rotenone is very toxic to fish. The same care must be used with these materials as with conventional insecticides.

How to Select a Pesticide for an IPM Program

When contemplating the use of a pesticide, it is prudent to acquire a Material Safety Data Sheet (MSDS) for the compound. MSDS forms are available from pesticide suppliers and contain some information on potential hazards and safety precautions.

The following criteria should be used when selecting pesticide: safety, species specificity, effectiveness, endurance, speed, repellency, and cost.

Safety

This means safety for humans (especially children), pets, livestock, and wildlife, as well as safety for the overall environment. Questions to ask are as follows:

- What is the acute (immediate) and chronic (long-term) toxicity of the pesticide? Acute toxicity is measured by the "LD-50," which is the lethal dose of the pesticide required to kill 50 percent of the test animals (measured in milligrams of pesticide per kilogram of body weight of the test animal). The higher the LD-50 value, the more poison it takes to kill the target animals and the less toxic the pesticide. In other words, high LD-50 equals low toxicity. Chronic toxicity refers to potential health effects from exposure to low doses of the pesticide for long periods of time. Chronic effects can be carcinogenic (cancer-causing), mutagenic (causing genetic changes), or teratogenic (causing birth defects).
- How mobile is the pesticide? Is the compound volatile, so that it moves into the air breathed by people in the building? Can it move through the soil into the groundwater? Does it run off in rainwater to contaminate creeks and rivers?
- What is the residual life of the pesticide? How long does the compound remain toxic in the environment?
- What are the environmental hazards listed on the label? What are the potential effects on wildlife, beneficial insects, fish, or other animals?

Species Specificity

The best pesticides are species specific; that is, they affect just the group of animals or plants you are trying to suppress. Avoid broad-spectrum materials that kill many different organisms because they can kill beneficial organisms that keep pests in check. When broad-spectrum materials must be used, apply them in as selective a way as possible by spot-treating.

Speed

A quick-acting, short-lived, more acutely toxic material might be necessary in emergencies; a slow-acting, longer-lasting, less-toxic material might be preferable for a chronic pest problem. An example of the latter is using slower-acting boric acid for cockroach control rather than a quicker-acting but more toxic organophosphate.

Cost

This is usually measured as cost per volume of active ingredient used. Some of the newer, less-toxic microbial and botanical insecticides and insect growth regulators may appear to be more expensive than some older, more toxic pesticides. But the newer materials tend to be effective in far smaller doses than the older materials — one container goes a long way. This factor, together with their lower impact on the environment, often makes these newer materials more cost effective.

Pesticide Use Guidelines

In addition to becoming informed about the characteristics of the material itself, it is important to develop guidelines to be followed each time a pesticide is used. Prepare a checklist to be used each time an application is made. The following are important items to include on the checklist:

- Make sure the pesticide is registered for use in the state. (Pesticides can be registered in some states and not in others.) What are the laws regarding its use?
- Read the pesticide label. Follow its restrictions and directions for use, labeling, and storage exactly.
- If required, secure a written recommendation from a licensed pest control adviser for using the pesticide.
- Make sure that all safety equipment and clothing (e.g., neoprene gloves, goggles, respirator, hat, and other protective coverings as necessary) is available and worn when the pesticide is used.
- Verify that the person doing the application is certified and/or qualified to handle the equipment and material chosen and has been adequately trained.
- Make sure application equipment is appropriate for the job and properly calibrated.
- Confine use of the material to the area requiring treatment (spot-treat).
- Keep records of all applications and copies of MSDS sheets for all pesticides used.

- Monitor the pest population after the application to see if the treatment was effective and record results.
- Be prepared for all emergencies and compile a list of whom to call for help and the kinds of first aid to be administered before help arrives. Place the list in an accessible area near a phone.
- Dispose of pesticides properly. Do not pour pesticides down the drain, into the toilet, into the gutter, or into storm drains! If you are unsure about how to dispose of the pesticide, call the manufacturer or your local utility company that handles sewage and storm drains.

Notification and Posting

School systems have the responsibility to inform occupants when they may be exposed to pesticides. Unless it is in emergency situation, the applications should be performed when only maintenance staff are present and the building is otherwise unoccupied.

Schools should direct concerned parents to the school pest manager for more specific information. Post all areas to be treated or that have been treated. If posting is a new practice at the school, the new policy should be explained in the context of the IPM program so that all affected parties will understand that the posting is part of a new overall effort to reduce pesticide use and not the result of new or heavier pesticide use.

Introduction to IPM Principles and Practices

Edward Crow

What You Need to Know About IPM

IPM, or Integrated Pest Management, is different from traditional pest control. It is a system of controlling pests that does not depend on automatic application of pesticides. Instead, pests are monitored by regular and careful inspections. The inspections also identify conditions contributing to pest problems. The IPM technician then decides what actions are necessary, if any, based on the biology and habits of the pests involved. Priority is given to nonchemical pest management techniques, particularly those that can prevent a recurrence of the problem. Pesticides are used when necessary, but only in a way that minimizes potential exposure to people and the environment. Records are kept to track problems, prevent recurrences, and evaluate the results of pest management actions.

Whether you are a technician whose job it is to do IPM, or you are someone who must evaluate the success, failure, and safety of IPM programs, there is a body of knowledge you must learn in order to become proficient:

- IPM theory
- Working definition of IPM
- Benefits and goals of IPM
- How IPM differs from traditional pest control
- Components of IPM
- Action thresholds
- How to evaluate success or failure

IPM Tactics for Major Pest Groups in Your Area

Cockroaches • Ants • Rodents • Spiders • Fleas • Flies • Bees and wasps • Fabric pests • Stored product pests • Birds • Occasional pests • Urban wildlife • Moisture pests • Wood-infesting pests

Monitoring

- Purpose—pest ID, location, population size, sanitation, entry, etc.
- Visual inspections—goals, methods, inspection equipment Sticky traps—types, placement, interpretation
- Pheromone traps—types, placement, interpretation
- Flying insect traps—types (jars, ILTs, etc.), placement, interpretation
- Rodents (visuals, tracking patches, etc.)
- Termites and other wood destroyers (monitoring stations, moisture meter, visual)

Communications

- Notification and posting—when required, procedures, etc.
- How to talk with staff—giving and getting information
- IPM service reports—what to include, how to fill out, etc.
- How to report special sanitation, structural, or operational problems
- How to use an IPM logbook
- How to use floor plans/maps for reporting and reviewing IPM data

Nonchemical Pest Management

- Pestproofing—caulking, screening, weather-stripping, etc. and who is responsible
- Sanitation/housekeeping—reducing pest food, water, harborage
- Vacuums—role (direct control, sanitation, inspection) and operation
- Power washing—role and proper operation (if applicable)
- Rodent traps—snap traps, multicatch, glue boards
- Wildlife traps—raccoons, squirrel, skunk, moles, as applicable
- Light management—manipulating light to keep insects away from buildings
- Insect light traps—as a flying insect control tool
- Biologicals—nematodes for fleas, fungus for termites, etc. as applicable
- Moisture control—importance, techniques (ventilation, plastic soil covers, etc.)
- Repellents—insects, wildlife, domestic animals

Pesticides and IPM

- Guidelines on when and how to use pesticides in IPM
- Safety issues and how to choose products and application method
- Insect baits—uses, techniques, precautions, limitations, etc.
- Crack and crevice/void treatments—uses, techniques, precautions, etc.
- Other insecticide tactics—as applicable
- IGRs and biorationals—as applicable
- Rodenticides—safety issues, techniques, guidelines

Monitoring in IPM Programs

The key difference between integrated pest management (IPM) and traditional pest control is that in IPM pesticides are not automatically applied. In most cases, IPM technicians only use pesticides when they absolutely must. How do they know? Through monitoring, which is simply a 10-dollar word for inspections at regular intervals. Monitoring determines if pests are present, how many, where they are located, and often why the problem occurred. IPM is, at its most basic, a cycle of monitoring, control actions, and evaluation.

The monitoring component of an IPM program is essential to its success. It keeps everyone informed about all aspects of the pest situation and conditions at the site. Monitoring includes the following:

- Identifying and locating pests
- Identifying areas of critical sensitivity (classrooms, infirmary, etc.)
- Estimating size of pest populations
- Identifying the factors that are contributing to the pest problem (poor sanitation, improper storage, holes in walls, etc.)
- Reporting management practices that could affect pest populations or pest management activities (trash pickup, lighting, construction, etc.)
- Identifying nontarget species that could be killed or injured
- Assessing natural enemies and potential secondary pests
- Assessing environmental conditions (temperature, humidity, weather or seasonal changes)

There are three basic components to a monitoring program:

1) walk-through visual inspections of all areas of the building including outside;
2) use of various types of monitoring traps; and
3) information from personnel working on site, including review of the logbook. All occupants of a building should be encouraged to report pest activity.

Visual Inspection

In large facilities, IPM technicians should use blueprints or create a floor plan showing all rooms, sensitive areas, points of entry, etc. They need to become familiar with the entire structure. Certain areas are more prone to pests than others and will require more intensive inspections. Examples include cafeterias and snack rooms, food storage areas, staff lounges, sites with live animals, locker rooms, recycling collection points, and loading docks. Here are some inspection guidelines:

Use a bright flashlight and a magnifying glass (hand lens) during the inspection. Do not look just for the pests themselves, look for other evidence of pests such as droppings (especially from cockroaches and rodents) and frass (from wood borers), gnawing, tracks, and grease marks (from rodents), damage (such as powderpost beetle exit holes), and shed insect skins. The presence of feeding debris or frass is an indication of infestation.

Examine window sills regularly as many pests fly or crawl towards light. Also check inside ceiling light fixtures. Pests may be found behind baseboards, under furniture, behind moldings, in cracks in floors, behind radiators, or in air ducts. Check around door jambs for cockroaches and spider webs. Spiders often spin their webs across gaps around doors to capture insects trying to enter.

Look, too, for conditions that might lead to pest problems. Check for moisture problems, both indoors and out, which may lead to moisture-related pests such as carpenter ants, termites, or mold. Look out for damaged screens, doors, and walls, which could allow pest entry. Note any sanitation problems. Be aware that fresh flowers and potted plants may be infested with insect pests.

Inspect outdoors, also. Heavy landscaping near the foundation and plants such as ivy growing on walls increases the risk of outdoor pests moving inside. Moisture problems around the foundation, gutters, or air conditioning units can favor moisture-related pests. Bright exterior lights may be attracting insects to the outside of the building, and these insects may be finding their way indoors. Poor management of trash may be attracting rodents, which could find their way inside through utility lines or other openings.

Monitoring Traps

While the best inspection tools are our eyes, sometimes pests are hidden from view. Other tools can help find these hidden pests, and sometimes estimate their numbers. There are currently three major types of monitoring traps: sticky traps, which use an adhesive to capture insects; pheromone traps, which use chemical attractants to draw certain species of pests into the trap; and insect light traps (ILTs), which use ultraviolet light to lure and capture certain flying insects.

Sticky Traps in IPM

Sticky traps are simply paper, cardboard, or other materials with one or more surfaces covered with glue. They can be flat, triangular, boxlike, or hanging tapes (for flying insects). They are a simple and inexpensive way to capture cockroaches, ants, and other pests. Sticky traps can tell you a number of things:

1. What pests are present. Obviously, when you capture cockroaches or other pests in a sticky trap, you know that you

have pests, and you know the species. But the opposite is not necessarily true. If sticky traps are empty, the area may be pest-free. On the other hand, the traps could be in the wrong place, or the infestation could be in an unusual place. Perhaps there is an isolated heavy infestation 15 feet away behind the refrigerator, but there is no sticky trap there. Sticky traps are good positive indicators of an infestation, but are not accurate in proving that the area is pest-free (unless the area has been saturated with traps, which might be done in a suspected case of delusory parasitosis, for example).

2. Where pests are located. By placing traps in various locations, an IPM technician can locate focus areas or pest entry points. The distribution of pests on the trap can help determine a site of infestation. With cockroaches, for example:

- A bunch of cockroaches on one side of the trap pretty much tells you they are coming from that direction.
- If all stages of the cockroach are captured, you are probably dealing with a large, long-standing population.
- If only adults or large nymphs are captured, you may have a new infestation that has moved in from a cockroach focus nearby.
- If mostly small nymphs have been captured, there will be a pocket of infestation within a few feet.

3. The trend of pest problems. Sticky traps are good tools to evaluate the success or failure of your IPM program. Are the trap catches decreasing? This suggests control actions are successful. Are they increasing or remaining the same? Someone needs to make some changes. To be sure that the trapping trends are reflecting actual pest populations, technicians need to use the same brand of trap in the same places over the same time periods. Otherwise, trap catches may be affected more by differences between traps than by changes in pest populations.

4. Determining when to take control action. Some IPM programs include "action thresholds," pest levels that must be reached before a particular control action is taken. Sticky traps are a good measuring tool for action thresholds. For example, insecticide treatment in an IPM program might only be triggered if five or more cockroaches were captured in a sticky trap. Less, and control would be limited to nonchemical tactics.

5. Controlling pests. Sticky traps have generally been considered poor control tools. However they are an option in very sensitive situations where no pesticides are permitted. Cockroach sticky traps are now available with various lures. One type has a pheromone attractant for German cockroaches. In certain situations, placing large numbers of these traps can knock down populations of these pests by as much as two-thirds.

Placing Sticky Traps

Where you place sticky traps will naturally depend on the type of pest. Cockroaches are the most common pest. For them, it is not efficient to place sticky traps evenly throughout an area. Since cockroaches only travel a few feet from hiding places looking for food, you would need large numbers of traps to be effective. Instead, place sticky traps only in the most likely areas of infestation, and in travelways, and in locations where the building can least afford to have pests. In other words, prioritize sticky trap locations based on knowledge of the pest and the site. Here are some other tips:

- Avoid placing sticky traps in the open when you can. Cockroaches and certain other crawling pests do not travel in the open if they do not have to. Further, it keeps the traps out of the view and grasp of your customers.
- For cockroaches, think about where you normally find them, and place the sticky traps nearby. Put them inside cabinets, under sinks and stoves, under kitchen equipment, in kitchen drawers, on the floor behind the toilet, and next to trash cans. Whenever possible, place them horizontally against the edges of a wall or other vertical surface, near corners and sites where there has been cockroach spotting. Although it is in the open, one of the best sticky trap sites in a residential kitchen is on the kitchen counter back against the splash board.
- In food storage areas, place sticky traps on or under shelves and approximately ten feet apart. Place them on different levels. Try to create a matrix in the storage area that will pinpoint a new infestation and help you identify the infested goods.
- In large facilities, consider numbering and dating the traps.

In an IPM monitoring program, technicians should replace any traps that have already captured a pest, and record the capture information. They should also replace any trap whose glue has become dusty or dirty, and follow the manufacturer's recommendations on a regular replacement schedule. Three months is probably as long as you can stretch a sticky trap's useful life. Even though it can appear sound, the glue may have lost its holding power.

IPM technicians should be using sticky traps. However, they should not be the only monitoring tool used. If sticky traps are not placed near the primary site of infestation, or if the pests are foraging in another direction, the traps may capture nothing, while there may be a serious pest problem just a few feet away. Sticky traps are a good tool, yes, but no substitute for a hands and knees "eyeball" inspection.

Pheromone Traps

Much of what insects do is directed by odors. Various smells tell them where to find food, or a mate, or others of their own kind. Pheromones are the natural scents that insects produce to communicate with each other. Scientists have isolated some of these scents and they can be used in traps to attract certain insect pests. Some are sex attractant pheromones that draw only the male insect. Other pheromone traps use aggregation pheromones that attract both males and females of the same species. Pheromone traps are valuable tools for monitoring certain pests, particularly "stored product pests" such as cigarette beetles and Indianmeal moths, and outdoor pests such as gypsy moths, Japanese beetles, fungus gnats, and many pests of field crops and fruit trees. Pests are strongly attracted to the lures.

There are many different styles of traps, the most common being hanging traps. These have a sticky surface and a small

lure that contains the pheromone to attract certain flying insect pests. Another common type of trap is the pitfall, which lures crawling insects into a container filled with oil. Pheromone lures are available for the following stored product and indoor pests:

- Angoumois grain moth
- Cigarette beetle
- Clothes moth (webbing)
- Confused flour beetle
- Drugstore beetle
- Indianmeal moth
- Larger grain borer
- Lesser grain borer
- Powderpost beetle (Anobiid)
- Red flour beetle
- Warehouse beetle

Indoors, pheromone traps are used most commonly to detect stored product pests in places like grocery stores, granaries, food warehouses, and seed companies, but they can be used anywhere.

Pheromone traps are most useful as an early warning system. When you find the first insect in a trap, it's time to consider control measures. They also help pinpoint a problem, and the number of insects trapped can help gauge how severe the infestation is. Use of pheromone traps after treatment can help evaluate the effectiveness of an application. Mass trapping using pheromone traps is sometimes even effective as a control measure.

Where pheromone traps are placed depends on the insect, the style of trap, and the type of facility. For instance, while you can easily place traps every 50 feet in a storage facility, a grocery store manager would likely object to that level of visibility. Below are some general guidelines. For specifics, follow the manufacturer's directions.

- In general, pheromone traps are placed in a grid pattern, 20 to 60 feet apart.
- Place traps in areas where there have been pest problems and in hard-to-clean areas where there could be product spillage. Place traps around machinery, in corners, and next to beams. Place traps to avoid air currents and moisture.
- Consider the insects' habits. Traps will catch more moths near the ceiling and more beetles near the ground.
- Don't place traps near doors, windows, vents, or loading docks where they could attract insects from outside.
- If trapped insects might be entering from outdoors, place traps around the outside of the building (but not near doors or windows) to check outdoor populations. This will also intercept migrating insects before they enter the facility.
- Once insects have been captured in a trap, tighten the grid to pinpoint the source of the infestation. For example, place traps every five feet around the one with the catch.
- Number each trap and mark on a map of the facility where you have placed the traps.
- Keep a monitoring record of each trap's location in the grid, the date it was placed, and its catch at each inspection. Some technicians record this information right on the trap itself.
- Check traps on a regular basis, usually weekly, more often if you suspect an infestation. Never let a trap go unchecked longer than a month.
- Replace pheromone lures according to the manufacturer's directions. Replace traps when they become dusty, dirty, or overloaded with insects. Remove used traps from the facility.

Insect Light Traps

Insect light traps (also called ILTs, insect electrocutors, and electronic insect traps) are useful for detecting and controlling occasional flying insects. The traps emit ultraviolet light ("black light") that is very attractive to certain insects, particularly to flies and moths. The insects are drawn into the trap and are either "zapped" (electrocuted on a grid) or fall onto a glue board. Flies can see lights from about 25 feet away, moths up to 100 feet away, depending, of course, on the ambient light present in a room. Only industrial grade traps should be used, not the backyard "bug-zappers" sold in retail stores.

There are many types of traps including ceiling-hung, two-sided models, wall mounts, corner mounts, and decorative glue trap ILTs for use in restaurants, cafeterias, and other public areas.

ILT Use as a Monitoring Tool

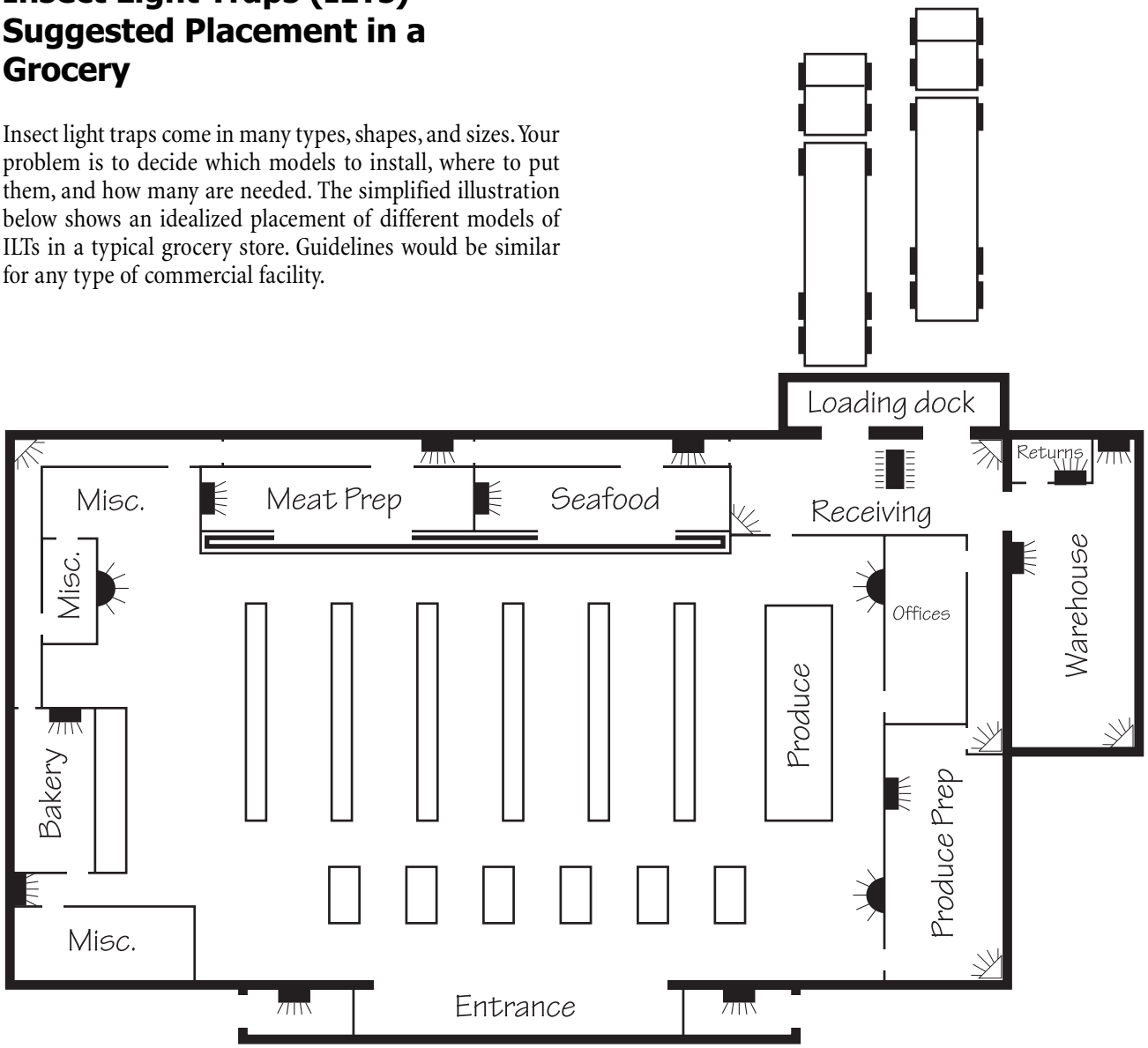
An ILT not only kills flies and other insects, it is an effective pest monitoring tool and "early warning system" to identify a breakdown in sanitation or control procedures before a pest problem gets out of control. Glue trap ILTs, which capture insects whole, tend to be better monitoring tools than electrocuting ILTs, which often shatter the insects when they are "zapped," but either type of trap can be used. Collecting trays and glue boards should be checked often, usually once a week. Not only does this conform to good monitoring practice, but it avoids the risk that dead and rotting insects will themselves attract dermestid beetles and other scavengers into the area. As technicians empty the tray or remove the glue board (power disconnected, of course), they should also brush out the dead insects from behind the tray/board and from cracks and crevices.

Here are a few examples to show how much information can be obtained from using ILT catches as a monitoring tool:

- If large numbers of house flies suddenly are found in the trap, you can be fairly sure that there is a nearby breeding source either inside, or if outside, then a window or door is being left open.
- If the trap contains dermestid beetles in the winter, there must be an infested site inside the facility. At this point you would try to pinpoint the infested location by using pheromone traps.
- If the trap contains winged ants, there is a nearby nest.
- If the trap suddenly captures mosquitoes, someone is probably leaving a door open at twilight.

Insect Light Traps (ILTs) Suggested Placement in a Grocery

Insect light traps come in many types, shapes, and sizes. Your problem is to decide which models to install, where to put them, and how many are needed. The simplified illustration below shows an idealized placement of different models of ILTs in a typical grocery store. Guidelines would be similar for any type of commercial facility.



Ceiling-hung, two-sided ILTs should be installed in the receiving area 8–10 feet above the floor, and about 15 feet inside the loading dock doors. Place it perpendicular to the doors so that the light does not draw insects in from outside. This installation is primarily designed to capture high-flying moths and other night fliers that enter through the loading dock doors.

Wall-mount ILTs and **corner-mount ILTs** should usually be installed 3–5 feet from the floor (waist high). House flies primarily fly close to the ground. Install ILTs to capture insects *before* they enter processing rooms and sales areas. ILTs are most effective when installed where insects are funneled into narrow spaces such as hallways and small rooms. Install corner-mount ILTs in the outside corner of intersecting corridors to attract insects from both sides. *Do not install ILTs directly over exposed food or food prep surfaces.* Electrocuting ILTs (in contrast to ILTs using glueboards) cannot be within five feet of these surfaces.

Decorative glue trap ILTs are the best choice for public areas.

Bulb Replacement

The heart of an insect light trap is the ultraviolet fluorescent bulb that attracts flying insects. But you can't tell by looking at a glowing bulb whether it's working at full strength. The phosphor inside loses 50% of its effectiveness after a year of continuous use; the effective life of the average bulb is 7,000 hours, only about nine months. Bulbs should be changed at least once a year, or even twice a year if in continuous use, even if they appear to be burning strongly. When the bulbs are changed, the technician should also--

- With the unit unplugged, check for loose electrical connectors, damaged wire, cracked lamp sockets or insulators, scorched ballast unit or transformer (if visible), and other indicators of electrical problems requiring professional servicing.
- Clean the outside grid with a stiff brush. Wash the reflector and exterior with warm soapy water, then rinse and wipe dry.
- Add a strip of tape or a tag to the bottom of the trap with the date that the bulbs were changed.

ILT Installation

How do you determine how many traps will be needed for a particular facility? Unfortunately, there are no hard and fast rules and so the answer will vary for each job. Most flying insects won't respond to lights more than 100 feet away, and flies rarely respond if the light is beyond 25 feet.

Far more important than numbers is trap placement. A single trap in the right location will outperform a half dozen installed in the wrong locations. In schools, for example, insect light traps are most effective in narrow hallways or 15-25 feet inside main entry points. In facilities with loading docks, a good first line of defense is a large ceiling-hung trap mounted 15-25 feet inside loading dock doors.

Traps that are low to the ground usually capture more *flies* than do ceiling-hung traps. Ceiling hung traps capture more *moths*. The illustration reproduced on the next page (Suggested Placement in a Grocery) shows some typical types of ILT installations.

Use insect light traps *indoors only*. When placed outdoors, they mostly capture nonpest insects.

Communications in IPM Programs

Probably the simplest and least expensive, as well as one of the most effective, ways to manage pest problems in IPM is through communication. Many pest problems can be traced to shortcomings in sanitation, operational procedures, and structural deficiencies. Correcting such problems is the best way to control pests for the long-term. Many people do not understand the connection between pests and sanitation, clutter, cracks and holes in walls, etc. Building maintenance and grounds personnel need to understand pestproofing and other steps they can take to keep pests from entering buildings. Housekeeping staff can learn to find and give special attention to areas with sanitation problems. Food service workers should understand the connection between inadequate sanitation and pests. Students in schools can help by regularly cleaning leftover food out of their lockers and picking up trash paper. All of this requires good communications. Furthermore, simply having informed individuals who will spot and report pest problems can go a long way toward managing pests.

Communication can take place in many ways: informational handouts, service reports, sanitation reports, an IPM logbook, conversations between technicians and staff, and for schools, features in the school newspaper, notes sent home to parents, presentations at school assemblies, PTA and staff meetings. Science teachers may even be persuaded to teach students about IPM, perhaps including hands-on experience. The idea is not simply to teach people about pests, but to involve them in the pest management program. They should understand that they play a part in IPM, and that the success of the IPM program is in their own best interest.

Another communication tool is notification of pesticide application. This can take place either before application, such as notification of parents of certain school children before a pesticide is applied in their school. For the specifics of the notification requirements in Maryland schools, consult the appropriate Maryland Department of Agriculture regulations on school IPM and notification.

Various reports, handouts, and forms can be used to educate people about IPM and to communicate with them about the specifics of an IPM program. Some materials are provided in Appendix B of MDA's *Integrated Pest Management in Schools IPM Training Manual*. On the next few pages are additional materials adapted for schools; specifically, samples of informational handouts and inspection reports, which were reprinted with permission from other publications.

Problems with Outdoor Mice? Act Now to Keep Them From Becoming *Indoor* Mice.

How We Can Help

The first cold spell of fall can trigger mice into invading schools, particularly schools located in rural areas or on wooded lots in the suburbs. Once inside, they cause the typical kinds of mouse problems:

- chewing furniture, clothing etc. to get nest material,
- feeding on packaged bird seed, pet food, grass seed, and even people food,
- scratching and scrambling in walls and ceilings,
- frightening people by running across the floor.

Call us today so we can control your outdoor mice and prevent them from coming inside. Our pest control expert will determine the extent of your mouse problem, and recommend a control method or methods suited to your particular case:

Whichever control methods we recommend, you can bet that we will be around until the problem is solved. Give us a call today. Let us help keep your school free of mice.

What *You* Can Do to Reduce Mice Outdoors and Stop Them from Coming In

- Move bird feeders away from your school. Bird seed, and especially sunflower seed, is a favorite food of mice. Use catch trays under feeders.
- Move wood piles, firewood, or debris away from the foundation of the school.
- Do not allow garbage to overflow from trash containers; haul away tires and abandoned vehicles.
- Do not leave pet food outside.
- Trim weeds and grass short near the school.
- Avoid planting heavy seed-bearing plants near the foundation.
- Trim tree branches that are touching outside walls or the roof, since mice can use them to find their way into an upper floor or the attic.
- Seal cracks around the foundation, and around windows and doors, and openings around pipes and utility lines. If you can fit a pencil in a crack, a mouse can squeeze through it!
- Install door sweeps under doors if necessary.
- Call us for professional mouse control.

Beware of Hantavirus

In some areas of the country, hantavirus has become a threat to people where large numbers of field mice, especially deer mice, are living in and around buildings. The disease can be transmitted by breathing dust contaminated with rodent droppings and urine, or by direct contact with infected mice. The disease is rare but deadly. If you have large numbers of mice infesting a shed or a cabin or a basement, please have us check it out. Do not disturb the mice or kick up dust or allow anyone in the structure or room until we can inspect it. If there is a risk of hantavirus, the area can be sprayed with detergents and water or diluted bleach, ventilated, wet-mopped, and the mice eliminated.

Don't Make Life Easy for Roaches ... Roaches Need Food, Water, and Hiding Places to Survive

Wildlife Survey

- Put garbage in a container with a tight-fitting lid or in a sealed plastic bag.
- Take garbage to the dumpster or the trash chute every evening.
- Do not collect old newspapers, magazines, boxes, or paper bags.
- Store foods in refrigerator or keep them covered or wrapped.
- Clean up food scraps.
- Keep kitchen counters and shelves clean.
- Clean grease from the stove, range hood, and walls.
- Mop floors regularly.
- Keep pots, pans, and dishes clean.
- Don't leave dirty dishes out overnight.

Clean Up Kills Roaches!

Don't Feed the Rats!!

Rats love the same foods that you do. A kitchen trash bag is loaded with good things for a rat to eat. If trash is tossed on the ground instead of in a trash can or dumpster, the rats will find it. They will also find every french fry or hamburger wrapper tossed on the ground. A basic law of rats is this: the more food, the more rats.

Help us get rid of rats—

- Put trash *inside* the dumpsters.
- Don't let your children take the trash to the dumpster unless they are big enough to open the doors and put the trash inside.
- Don't throw food or food wrappers on the ground. Put them in the trash can.
- If you see a rat, or see trash on the ground, tell the appropriate school personnel.

We need to work together!

Tips to Prevent Pests Around Your School

Minimize food sources for pests such as rats, mice, and cockroaches. Don't store garbage outside in plastic bags; put garbage in a container with a tight-fitting lid. Don't allow bird seed to accumulate on the ground, or leave pet food out overnight. Don't leave ripe fruit and vegetables under trees or in the garden to decay. Avoid putting food scraps into unscreened compost piles.

Eliminate pest hiding places and breeding sites. Remove nearby stumps, dead trees and wood and debris piles. Store firewood away from the house. Trim weeds, especially along the foundation, deck, and patio. Eliminate potential mosquito breeding sites by turning over cans and buckets, boats, and wheelbarrows, by removing old tires, by cleaning gutters and bird baths, and by eliminating standing water.

Help Us Reduce Pests Outside Your Food Service Area

Dumpsters and Trash Receptacles

- Keep dumpsters closed, with drain plugs in place, and steam clean or pressure wash dumpsters regularly.
- Have dumpsters on concrete pad with no shrubbery nearby.
- Clean under and around dumpsters and compactors daily.
- Use wildlife-proof trash cans and clean daily.
- Clean recycling bins once a week.

Vegetation

- Trim grass and eliminate high weeds.
- Establish a vegetation-free strip two feet out from foundation wall (gravel, stone, blacktop, concrete, etc., *not* bark or other organic mulch).
- Do not allow shrubs or tree branches to touch building.
- Avoid flowering plants around outdoor eating areas or doorways.
- Choose landscape plants that are pest resistant.
- Avoid dense groundcovers near building.

Loading Dock/Delivery Area
- Remove all food debris from under and around loading dock.
- Hose down area daily.
- Minimize bright lights shining onto loading docks, doorways, and white walls, particularly just after sunset. Substitute less powerful bulbs, install light shields, refractors, or filters, or use high-pressure sodium vapor lights and dichrom yellow lights to reduce the lights' attractiveness to flying insects.
- Don't store boxes, pallets, etc. near foundation, loading dock, or dumpster.

Moisture Control
- Adjust grade to eliminate standing water.
- Clean gutters and outside drains; make sure water flows away from foundation.
- Repair leaks.

School Pest Control Inspection Report

During regular pest control service, our technicians also inspect for problems that might contribute to pests, cause moisture damage, or otherwise cause you concern. We noticed the following potential problems at your home, which you may want to address. If you need more information, please contact our office at the telephone number above, or talk with your technician at the next service visit.

Outdoors
- o Clogged/damaged gutters
- o Clogged/damaged downspouts
- o Missing splashblocks
- o Water at foundation
- o Wet stucco/siding
- o "Weepy" or water-stained walls
- o Carpenter ants
- o Termites
- o Misc. moisture pests
- o Wood rot
- o Wood-soil contact
- o Missing/damaged door sweeps
- o Damaged weather stripping
- o Spilled trash
- o Missing/damaged chimney cap
- o Deteriorated chimney
- o Fascia/soffit damage
- o Planter against foundation
- o Branches touch roof
- o Dense shrubbery against house
- o Damaged siding
- o Mulch against foundation
- o Inadequate caulking
- o Holes & other pest entryways
- o Torn screen
- o Firewood along foundation
- o Poison ivy
- o Mosquito breeding
- o Spilled bird seed attracting pests
- o Pet food attracting pests
- o Poison ivy
- o Deck damage/rot
- o Wild animal nests
- o Other _____
- o Other _____
- o Other _____

Comments:

Indoors
- o Plumbing leaks
- o Excessive condensation
- o Leaky windows
- o Leaky skylights
- o Poor ventilation in crawl
- o Damaged tub grout
- o Wet basement
- o Cracks in slab
- o Deteriorated mortar
- o Leaky dishwasher
- o Decay on window/door
- o Insulation improperly installed
- o Firewood stored inside
- o Trash containers inadequate
- o Food debris/grease
- o Fruit fly breeding
- o Pests in paper/plastic bags
- o Unvented attic
- o Other _____
- o Other _____
- o Other _____

Comments:

Technician:
Date:
Customer name:
Location address:

Date of survey

Findings:
- o Spilled trash
- o Open/inadequate trash cans
- o Open dumpster
- o Construction in area
- o Storm sewer nearby
- o Overgrown plants/weeds
- o Tree branches touching roof
- o Shrubbery against building
- o Stacked building materials
- o Spilled bird seed
- o Branch piles/debris
- o Compost piles
- o Fruit trees

o Berries
o Pet food outside
o Wild animal nests
o Burrows
o Access under building
o Missing/damaged door sweeps
o Damaged weather stripping
o Open chimney
o Fascia/soffit damage
o Damaged siding
o Inadequate caulking
o Holes & other pest entryways
o Torn screen
o Tree holes (squirrels)
o Nut trees
o Outdoor eating areas
o Sighting _____
o Tracks _____
o Other _____

Attractiveness of site to wildlife

o Low o Moderate o High

Comments:

Inspector:

Insecticide Baits

In IPM programs, cockroach baits may be the only pesticides allowed on a regular basis, or the only ones allowed without special notification. Hospitals, schools, and office buildings increasingly specify them. They see baits as reducing chemical exposure. Even people who are strongly against the use of pesticides may accept baits, perceiving them as somehow different from "pesticides." But, of course, they too are pesticides.

Compared to many other insecticide formulations, baits have relatively low toxicities to people. Many baits are designed to be placed in voids, cracks and crevices, further reducing hazard. Bait stations provide their own voids, cracks and crevices. Also, baits do not easily vaporize. They have low volatility. (Volatility is a measure of how fast a pesticide vaporizes, or turns into a gas, when exposed to the air.) The lower the volatility, the less insecticide vapor in the air, the lower the hazard from airborne residues.

Baits are especially well-suited for sensitive accounts and IPM programs. Since baits pose less hazard, they are ideally suited for use in sensitive sites such as hospitals, schools, public areas, or around children and the elderly. In addition, while some baits have a slight odor up close, bait treatments do not leave behind an odor. Baits are typically not considered a risk by people who are otherwise nervous about pesticides. They come in many forms: bait stations, injectable gels, pastes, granules, and liquids.

Baits are especially effective against German cockroaches, traditionally the number one pest indoors. German cockroaches are not repelled by the insecticides present in baits. They feed on all of the baits used today, sometimes with enthusiasm. German cockroaches are not flushed into the open as happens with many insecticides. And baits are useful in locations where control of German cockroaches has been compromised by resistance. While there have been occasional reports of resistance in German cockroaches to certain cockroach baits, significant field resistance has not been documented.

Baits are also available for ants, termites, crickets, and other pests, with more variable success. With ants, in particular, one bait may work very well against a few species, variably well with some species, and not at all against others. Often, an ant bait's effectiveness changes from season to season.

Baits are also long lasting. The residual varies with the bait, but can be up to three to six months if not depleted by feeding. Because of the various characteristics of baits, they are ideally suited for use in the following situations:

- Any facility with an IPM program
- Any place where people are concerned about pesticides
- Schools (but not containerized baits, because children like to play with them)
- Hospitals, nursing homes, and other medical facilities
- Office buildings with light infestations

Insecticide Bait Stations

Insect bait stations are available to control both cockroaches and ants. Their advantages are that the insecticide is enclosed inside a plastic station, the bait remains effective for long periods, and they are very easy to apply. A disadvantage is that they are often visible and unattractive. Also, children may collect and play with them. When used in schools or around children, they should be hidden inside cabinets, equipment, and other infested sites.

When used against ants, bait stations should be placed along ant travelways, particularly at the intersection of the wall and floor, or countertop and splashboard. Another placement site would be near feeding areas.

Placement is much different for cockroach baits. Cockroaches are cautious and nervous. They prefer dark corners and stay out of sight. Because cockroaches like to have a crack to quickly dart into, they travel along edges whenever possible. For example, given a choice of routes to get from a shelf corner to the opposite corner, a cockroach will take the long way around the perimeter, hugging the edges, rather than striking out across an open space.

Does it make sense to place cockroach bait stations smack dab in the middle of a shelf or cabinet side wall? No. Bait stations should be in corners and along edges where traveling cockroaches are more likely to come in contact with the bait.

Whether the bait station is horizontally on a shelf or stuck it up vertically on a cabinet wall, it should be flush against the edges. In fact, the more edges the bait station touches, the better. That's why a corner placement that touches three edges is better than one just against the side. And a dark back corner of a cabinet is best of all.

Pastes, Gels, and Other Injectable Baits

There are now a variety of bait formulations for use inside cracks and crevices, and in small "spots." Insecticide bait may be packaged inside tubes or syringes that you squeeze to apply, or designed to be applied by various types of bait "guns" or with a small spatula or putty knife. The main benefits of *injectable* baits are (1) the placements are hidden, and (2) the baits are more easily placed inside cracks, crevices, and voids.

Gel baits come in a cartridge, syringe, or special applicator gun and are applied as either a bead or a spot, depending on the site you're treating. Listed below are some typical application sites:

Application Sites in Kitchens:
- along the back bottom edge of cabinets
- on the inside plate of cabinet hinges
- along the runners or in corners behind drawers
- along the back edge of the exhaust hood
- along the underside flange of the sink
- behind refrigerators
- the undersurface of tables

Application Sites in Bathrooms:
- behind the cover plate around pipes and shower heads
- inside the shelf slots or razor blade slots in medicine cabinets
- along the top edge of bathroom mirrors
- in the overflow drain of sinks or tubs

Cockroach Control With Baits

Cockroach baits are used most often against German cockroaches. There are certain characteristics of this pest that relate to controlling them with baits. First, German cockroaches are not attracted to food beyond a short distance. They must come within a few inches of a bait, sometimes literally bumping into it, before they realize they have found food. German cockroaches usually do not travel far for food. Instead, they learn and remember (yes, they do remember) where food is likely to be found. They travel between nearby daytime hiding places and their regular feeding sites, usually at night.

When German cockroaches travel, they prefer to do so along edges and inside darkened voids. Even if they bump into your bait, they may not feed on it. They may prefer their regular food. If they detect an insecticide deposit, they will be repelled from the area, and change their foraging patterns. If they feed on a bait, but not enough for a lethal dose, they may develop behavioral resistance, and avoid the bait in the future.

Based on these biological and behavioral characteristics, there are certain techniques that technicians should follow to improve the effectiveness of baiting for German cockroach control.
- The more bait placements, the more effective the control.
- Put a small amount of bait at each placement site.
- Place baits in cracks and crevices and voids wherever possible.
- Place bait stations in corners or flush against edges, horizontally whenever possible.
- Areas with cockroach spotting are prime baiting sites.
- Replace bait as needed, following the manufacturer's directions.
- In heavy infestations, replace bait more often or first knock down the population with a traditional insecticide treatment.
- Avoid using other insecticides near bait (except for IGRs-insect growth regulators), and avoid contaminating baits with any chemicals. Look out for chemical residues on your hands.
- Carry baits separately from other insecticides, perhaps in a small tool box or fishing tackle box containing only baits, sticky traps, and other nonchemical tools.
- Enforce sanitation near baiting sites. Baits work much better when roaches are hungry.
- Carefully inspect account at each service visit and change baiting sites to reflect recent cockroach activity.
- Remove old bait stations when replacing new ones or cockroaches may live inside them after the bait is gone.

Cockroach Baits in Commercial Kitchens

In most cases, cockroach bait gels and bait stations can be used interchangeably in food handling establishments. Each has certain advantages. Bait stations protect the bait from cleaning products, other pesticides, grease, and dust. But bait stations don't stick well to surfaces that are already greasy or dirty. Bait stations serve as monitoring devices as well since they can be dated and numbered and checked to see how much bait has been consumed.

Bait gel is placed directly into tiny cracks and crevices where roaches hide and where there would not be room for a bait station. Gels are less noticeable to customers than bait stations. Both gels and bait stations can be used in cold storage areas (as long as the temperature is above -10° F). However, neither gels nor bait stations should be applied to any surface where the temperature may be hotter than 130° F since the gel may melt and drip.

Bait stations are useful in these sites:
- on the floor in corners, where shelves meet walls
- on the floor under storage racks
- behind appliances
- on the bottom surface of stainless steel shelves
- under and behind wash stations
- on the underside or inside edges of food and beverage carts
- undersides of storage pallets

Gel bait is useful in these sites *but in cracks and crevices only* :
- around the flange where equipment legs meet the floor
- around drip trays under refrigeration units
- behind stoves where splashback meets the wall
- along inside corners of stainless steel hanging pot racks
- where hanging shelf rods meet the ceiling

- around flange where exhaust duct enters ceiling
- on the undersides of shelves, pot and pan racks, and bakers' racks
- around wall-mounted fixtures such as soap dispensers or signs
- behind sink faucets
- around flanges where pipes enter walls, floor, or ceiling
- under table tops
- behind countertop splash guards
- where electrical conduits enter walls or ceiling
- in cracks or missing grout in ceramic tile

Ant Control With Baits

Indoor ant baits come in prepackaged plastic bait stations, gel tubes, squeeze bottle, liquids, or as a concentrate to be mixed with a food bait. No matter which bait formulation chosen, placement determines success. In addition to baiting travelways and wherever ants have been seen, technicians should bait near these locations as well:

- Water sources, such as around sinks, tubs, toilets, water fountains, air conditioners, dishwashers, potted plants, aquariums, and in laundry rooms.
- Food sources, such as near pet food, kitchen counters, stoves, pantry shelves, microwaves, vending areas, break areas, and on windowsills where ants feed on dead insects.
- Heat sources, such as near light fixtures, electrical boxes, heat ducts, hot water heaters, radiators, and near appliances such as refrigerators.

Baits should be checked and replaced often. Baits that have no activity should be moved. With an extensive infestation, surveying and prebaiting with a nontoxic bait will save time and the unnecessary use of bait. Once the technician is satisfied that there are a number of active baiting sites, the nontoxic food baits are replaced by the toxic bait formulation.

Frequently Asked Questions About Ant Baits

How long will it take to get rid of these ants?
Don't expect immediate results when baiting ants. We want the ants to feed on the bait and then take it back to the rest of the colony. The bait is then shared with the larvae, queen, and other workers, eventually eliminating the colony. If the worker ants died before returning to the colony, the colony wouldn't be destroyed. You should start seeing fewer ants in about one week.

Why don't we just spray instead?
Spraying only temporarily solves the problem. Sprays kill some of the foraging worker ants but will not affect developing ants back in the colony. Baits can eliminate the entire colony. Also, ants are extremely sensitive to pesticides and will avoid areas where they have been sprayed. Don't spray anywhere near the baits because the spray will repel the ants away from the baits. The presence of pesticide sprays will even cause some ants to break up their colony into several smaller colonies, making control more difficult. With bait, there is no odor and no pesticide in the air or on surfaces for people to come in contact with.

I still have plenty of ants around, but they don't seem to be interested in the bait. What gives?
There are a few reasons why that could happen. There may be competing food sources. If the ants are already feeding on an available food, like pet food for example, they may not be interested in foraging for other foods. If you've sprayed any insecticide or used any strong cleaning products around the bait, that could repel the ants. At certain times of the year, ants switch their feeding preferences from sweets to proteins or vice versa. We may need to try a different type of food bait and see if we get better results.

Structural Pest Control Using the IPM Approach

Edward Crow

The manner in which structural pest control is performed has changed drastically within the past few years. Pesticide applications once considered a common or acceptable practice are no longer considered an acceptable practice by many people. Another method of pest control known as integrated pest management (IPM) has evolved. IPM reduces risks from pesticides and improves the quality of pest control. The public is asking, that IPM be used instead of traditional pest control services, particularly in sensitive sites.

IPM is a system of controlling pests that does not depend on the automatic application of pesticides. Instead, pests are monitored by regular and careful inspections. The inspections also identify conditions contributing to pest problems. A decision is made on what type of action is necessary, if any, based on the biology and habits of the pest involved and the information obtained from monitoring. Priority is given to nonchemical pest management techniques, particularly those that can prevent a recurrence of the problem. Pesticides are used when necessary, but only in a way that minimizes potential exposure to people and the environment.

IPM is really just good common sense. Institutions that have adopted IPM programs not only report a reduction in their use of pesticides, but a significant improvement in their level of pest control. IPM looks at the big picture and analyzes the factors that caused pest populations to grow in the first place. When a pest problem requires action, nonchemical methods are considered first. Methods that work over the long term, or that prevent pests, such as pest proofing (exclusion) or operational changes that improve sanitation, are utilized when possible. Pest control practices such as trapping, caulking, power washing, and vacuuming are control measures that can be used with a high degree of safety. Often, nonchemical measures are combined for the most effective results, and sometimes used together with limited pesticide application.

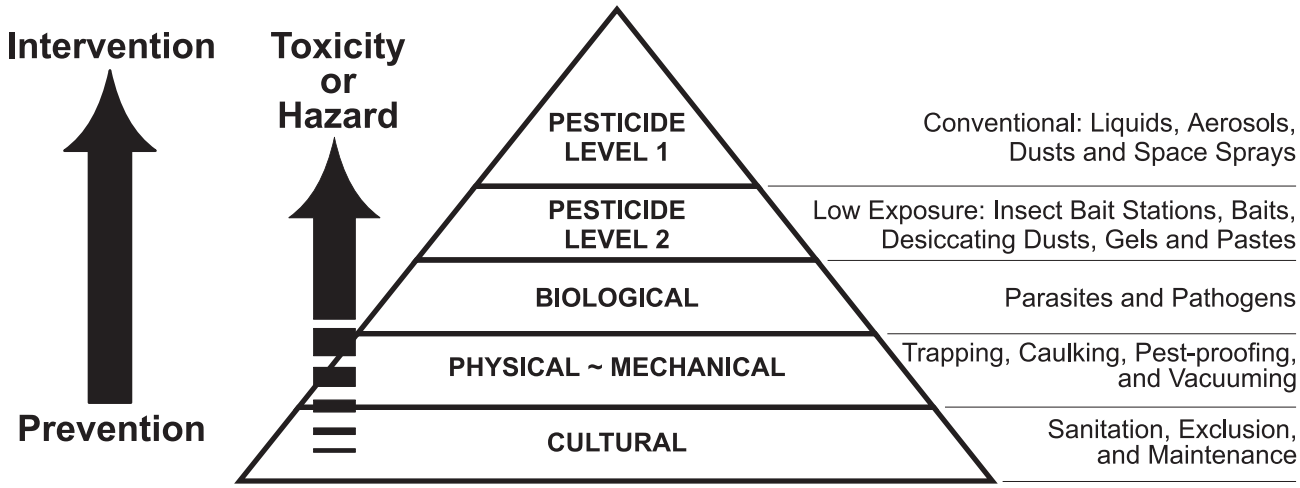
However, if a pesticide must be used, it should not be applied automatically or on a schedule, but only when justified against identified pests. Pesticides that pose the least hazard to people should be selected and applied using low-exposure techniques.

The diagram below depicts the tiers of pest control in a structural IPM program.

Pest Control Procedures Using IPM

The following hierarchy can be used as a guide to provide effective pest control and to minimize the potential for exposure of occupants to pesticides.

- Sticky traps, pheromone traps, and insect light traps should be used to guide pest management services and evaluate pest control actions wherever necessary. Pheromone traps are valuable tools for monitoring certain pests, particularly stored product pests.
- The use of good sanitation practices is critical for an effective pest control program. Proper sanitation can prevent infestations from occuring by denying the pest food and water that it needs to survive. Proper storage of supplies and food in conjunction with the elimination of clutter is also important.
- Portable vacuums rather than pesticides should be used for control of cockroach infestations, swarming ants and termites, and spiders. The use of steam cleaning equipment for cleaning kitchen areas is also effective and should be considered.
- Pestproofing through physical or mechanical changes to the structure eliminates harborage and denies the pest access to the structure. This is accomplished, in part, by caulking and sealing cracks and openings around pipes, use of screens and door sweeps.
- Trapping plays an important part in an IPM program. Insect traps are used mainly for monitoring pest activity. However, if the pest infestation is small, these traps can sometimes be used to control the problem. Jar traps are effective for certain insects, particularly yellow jackets and flies. The use of snap traps is the most effective control measure available for controlling rodent infestations, particularly mice.
- ***The feasibility of exclusion, prevention, trapping, and removal of infested products or pests needs to be considered prior to treatment of any pest problem.***
- Containerized and other types of bait, paste and gel formulations, rather than sprays, should be used for cockroach and ant control when appropriate. These formulations are used at low rates, have a low volatility and are placed into cracks and crevices reducing the chance of human exposure to pesticides. Baits are considered the standard choice for non-food preparatory spaces. The use of these formulations greatly reduces the potential of exposure to the pesticide. Baits for other insects should also be considered as they are introduced into the marketplace and their efficacy established.
- As a general rule, liquid, aerosol, or dust (i.e., desiccating insecticidal dust) formulations should be applied only as crack and crevice treatments with injection devices or tips specifically designed or modified for this purpose. *"Crack and crevice treatment"* is defined as a pesticide application in which the stream of pesticide is visible and is only released within the crack or crevice without leaving a deposit on exposed surfaces.
- Applications of pesticide liquids, aerosols, or dusts to exposed surfaces, and pesticide space sprays (including fogs, mists, and ultra-low volume applications), should be restricted to unique situations where no alternative measures are practical. Granular formulations and compressed air sprayers should only be used for treatment of utility areas or areas outside the building, when necessary, to correct active pest problems.
- In the event that the application of a pesticide spray is necessary, a formulation with the least potential for human exposure will be chosen. As a general rule, wettable powders and micro-encapsulated formulations should be considered as first choices. Such applications should be made only to areas unoccupied at the time of application and the area should remain unoccupied until the treated surfaces have dried, or longer if specified by the product label. It should be determined, on a case-by-case basis, if additional ventilation and prenotification of the application are required.



Pests: General

Action Thresholds in School IPM Programs

Lawrence Pinto and Sandra Kraft

Maryland Department of Agriculture (MDA) regulations require a school system to have an approved Integrated Pest Management (IPM) plan. The plan must include standards to determine the severity of pest infestation and the need for corrective action. One way to meet this requirement is through action thresholds. This document was developed to help schools develop their own action thresholds. **The specific action thresholds mentioned in the document are offered as examples only.** They are not required by the regulations. Each school using action thresholds should develop thresholds of their own, suited to specific conditions at the school.

Integrated pest management, or IPM, is a system of controlling pests that does not depend on automatic application of pesticides. A school IPM program consists of a cycle of monitoring, control, and evaluation. Pest levels and other factors are monitored through documented, systematic inspections conducted at regular intervals.

A key difference between IPM and traditional pest control is that IPM often uses "action thresholds." An action threshold is the point at which an IPM technician takes action to reduce a pest's numbers. Sometimes an action threshold is a number: five yellowjackets at a trash can, 10 percent feeding damage to a plant, three flies in a classroom. Sometimes it is qualitative: light or no infestation versus heavy infestation. Below the threshold level, the IPM technician does not apply pesticides or set traps or take any other direct control action. (Although the technician should continue to monitor and do sanitation inspections, pestproofing, and take other steps to prevent pest problems.) But if a pest is at or above the action threshold, the technician acts to control the pest.

The idea behind the action threshold is that most pests can be tolerated at some low level. An occasional ground beetle in a school hallway, for example, would bother few people. The costs and risks of taking action because of that one beetle — replacing door sweeps, caulking cracks in walls, or applying pesticide — would far outweigh any benefits. Besides, a lone beetle is likely a temporary guest rather than a serious pest. But thirty ground beetles in a hallway would be a different story, and an IPM technician would need to take some kind of pest management action.

Action thresholds are easy to understand. Establishing them is more difficult. Action thresholds vary by pest (hornet versus ant), by site (storage room versus infirmary), and sometimes by geographic location (western Maryland versus southern Maryland), or by season (fourlined plant bugs stop feeding in June, so the action threshold might be much higher in July than May). For some landscape pests, action thresholds will also vary depending on whether natural enemies are present.

Establishing Thresholds

Five factors should be considered in setting action thresholds: economics, health and safety concerns, aesthetic concerns, public opinion, and legal concerns.

Economics

In high numbers, carpenter bees can seriously damage naturally aged, unfinished wood decking and trim. It can be expensive to protect this wood from carpenter bee attack by treating and sealing it. But it can be far more expensive to have to replace that wood after carpenter bees have damaged it. At some level of carpenter bee activity, the risk of damage justifies action. The action threshold might, for example, be set at an average of one carpenter bee per five linear feet. Then, if eight or more carpenter bees were seen along a 40-foot stretch of building (which equals one bee per five linear feet), the IPM technician would schedule the unfinished wood for treatment or sealing.

Health and Safety Concerns

Action thresholds are set low when health or safety are at stake. The action threshold for ticks by a school athletic field would be set much lower if Lyme disease was common in the area. (Blacklegged ticks transmit Lyme disease.) Bee or wasp action thresholds indoors might be set as low as one (take action if you see a single bee or wasp), if a school child is known to have a severe allergy to stings. The threshold for poisonous black widow spiders would be much lower than for garden spiders.

Aesthetic Concerns

Aesthetic damage occurs when the appearance of something is degraded. Examples include bird droppings on sidewalks, defoliation or flower damage to landscape plants, and disease spots in lawns. People often disagree over what level of aesthetic damage should trigger action. What is acceptable to one person may not be to another. Aesthetic thresholds are fairly consistent, however, for pests that damage landscape plants. The average person begins to feel that some control action is necessary when a pest has damaged roughly 10 percent of the plant.

Public Opinion

Certain pests are seen as more disgusting, scarier, or otherwise worse than other pests. The reasons are complex, based on social, cultural, or psychological factors. Most people are less willing to tolerate a cockroach than a cricket, a tick than a beetle, a mouse than a pigeon.

Unfortunately, people often disagree on what level of a particular pest is tolerable. Some people, for example, are frightened of spiders. Seeing a spider is seeing one spider too many. Others view spiders as beneficial, and are willing to tolerate a

few spiders, even in an occupied room. Those who equate pests with social status are often unwilling to accept any level of any pest. In contrast, cultural factors or fear of pesticides will often force people to tolerate an unusually high level of pests before they feel pest control action is necessary.

A person's tolerance of a particular pest can sometimes be modified by providing information about pests and beneficial organisms, and the risks and benefits of control.

Legal Concerns

Pests in commercial and institutional kitchens are regulated under state and county health codes. There is little tolerance for cockroaches, ants, mice, and other pests anywhere food is stored, prepared, or served, so action thresholds are typically low. Safety and building standards, rather than IPM considerations, may determine when action is necessary to control termites, rats, flies, and other pests in commercial and public areas, including public buildings such as schools. During public health emergencies, government agencies may legally mandate control of certain pests, such as raccoons or skunks during rabies outbreaks, or mosquitoes during encephalitis outbreaks.

Setting Action Thresholds

Schools need to set action thresholds that are suited for their facilities. The specific action thresholds may be developed by a contractor, school pest control staff, consultants, or by committee. Someone may already have developed action thresholds for some of your key pests. The information may be published in research or extension publications. Schools can sometimes obtain action threshold numbers from other schools that have IPM programs already in operation. Such action thresholds can be used as a reasonable starting point, and then modified to suit the conditions at a particular site.

Most action thresholds will be developed from scratch. The school first determines which pests to include and which locations need separate action thresholds. Then the school decides site by site and pest by pest what pest level is tolerable, and sets an action threshold for each pest at each site. For example, the school might decide that field ant colonies outdoors were of little concern, that an occasional ant or two in a basement storage room was tolerable, but that a single ant in the infirmary would require immediate action. On that basis, the school might set the action levels to be 2 colonies of field ants per square yard outdoors, 5 ants per 100 square feet for storage areas, and 1 ant in the infirmary.

Different levels of a pest may generate different control actions. If an IPM technician found three cockroaches in a storage room, he or she might simply place a couple of cockroach bait stations. But 30 cockroaches might require that the storeroom be extensively cleaned, treated with additional insecticides, and all cracks and crevices carefully caulked.

The school should review the action thresholds regularly, preferably quarterly. Action thresholds may need to be raised or lowered, particularly in the first year or two of an IPM program. Perhaps the level for house flies needs to be lowered because students are being bothered by flies in classrooms. Or perhaps the action threshold for pests on landscape plants needs to raised because the plants are being sprayed too often. IPM is a dynamic process.

Examples of Action Thresholds

Listed below are a few examples of action thresholds for pests and sites in a school. The list of action thresholds is not complete, and the thresholds, while reasonable, are offered as examples only. Action thresholds at a particular school could be very different, depending on conditions at the school, pest tolerance levels, and other variable factors.

Please note that when action thresholds are exceeded, some pest management action would be necessary, but not necessarily pesticide application. And even though pests may be below action thresholds, the technician would still be responsible for identifying and reporting or correcting sanitation problems, pest entry points, etc. in order to prevent future pest infestations.

Ants (common house-infesting)
Classrooms and other public areas: 5 ants/room; infirmary: 1 ant/room; kitchen: 3 ant/room; maintenance and storage areas: 5 ants/100 square feet in two successive monitoring periods; outside grounds: 2 field ants mounds/square yard.

Ants (carpenter)
Classrooms, public areas, maintenance areas: 3 ants/room; infirmary: 1 ant/room; kitchen: 2 ant/room; immediate action if ant colony suspected inside or within 25 feet of any building.

Bagworms
Control on conifers when 2 or more large bags/tree or bush. In light infestations, hand pick and destroy; in heavy infestations, spray with *B.t.* between June 15 and July 15, or spray residual insecticides after July 15.

Bees (honey)
Classrooms, infirmary, kitchen and public areas: 1 bee; maintenance areas: 3 bees; outdoors: no action unless children are threatened.

Bees (bumble)
Classrooms, infirmary, kitchen and public areas: 1 bee; maintenance areas: 3 bees; outdoors: action necessary if communal nests are present in student activity area. Also action whenever children are threatened.

Bees (carpenter)
Classrooms, infirmary, kitchen and public areas: 1 bee; maintenance areas: 3 bees; outdoors: 1 carpenter bee/5 linear feet if susceptible, unfinished wood. Also action whenever children are threatened.

Cockroaches
Classrooms and other public areas: 2 cockroaches/room. If 2-10 cockroaches per room, apply cockroach bait. If 10 or more, track down infestations, review sanitation, trash handling, clutter, etc.; open equipment, check inaccessible areas; vacuum and otherwise clean room, and apply baits or other insecticides as necessary. Infirmary: 1 cockroach/room; kitchen: 1 cockroach/room; maintenance areas: 5 cockroaches/room; outside grounds: no action unless noticeable infestation.

Crickets
Classrooms and other public areas: 3 crickets/room; infirmary: 1 cricket/room; kitchen: 2 crickets/room; maintenance areas: 10 crickets/room; outside grounds: no action unless causing problems.

Grain and flour pests
Found in food for human consumption: 1/package or container; pet food: 1 if escaping from packaging; if found in pheromone traps: 2 of any one species (total of all traps)

House flies
Classrooms and other public areas: 3 flies/room; infirmary: 1 fly/room; kitchen: 1 fly/room; maintenance areas: 5 flies/room; outside grounds: 5 flies around any one trash can or 10 flies around a dumpster.

Landscape plants (general)
Whenever pest damage approaches 10 percent/plant.

Lawn pests (insects, nematodes, disease)
Whenever visible damage approaches 10 percent in any 100 square foot area.

Lice (head or body)
Take no action: refer to nurse.

Mice
Indoors: any mouse sighting or evidence of mice (such as new mouse droppings, tracks, etc.) triggers pest management action; outdoors: any noticeable burrows or activity in student areas.

Pigeons
Roof ledges: 10/building for 3 consecutive inspections; public area or roof: whenever droppings accumulate more than 1-inch or nests obstruct gutters or equipment.

Poison ivy
Student activity areas: 1 plant; wooded areas: no control necessary unless near path or student activity area.

Rats
Indoors: any rat sighting or evidence of rats (such as new droppings, tracks, etc.) triggers pest management action; outdoors: any active burrows or activity.

Silverfish
Library and wherever books, paper, files are stored: 1/room; other indoor areas: 2/room

Spiders
Take immediate action if a black widow or brown recluse is suspected in any area; other spiders—classrooms: 1 spider/room; infirmary: 1 spider/room; kitchen/cafeteria: 1 spider/room; hallways: 2 spiders/hallway; maintenance and unoccupied areas: 3 spiders/room; outdoors: only if in large numbers or causing problems.

Tent caterpillars
Desirable ornamental plants: 1 tent or egg mass/tree; woodland trees, nonornamental trees: if potentially damaging or aesthetically intolerable, or after two complaints in two weeks (to prevent repeated infestations, remove wild cherry hosts).

Ticks
Outdoor student activity areas: 3 tick, any species; outdoor wooded and other areas of low student activity: keep grass and weeds trimmed; if any blacklegged ticks found, treat wood edges; for other species, take action if moderate to heavy populations.

Weeds
Lawns: whenever weeds approach 15 percent in any 100 square foot area; ornamental plantings: whenever competing with ornamental plants or whenever aesthetically displeasing.

Yellowjackets/hornets
Classrooms and other public areas: 1 yellowjacket or hornet; outdoors: action necessary if nests are present in or near student activity area; 10/10 minutes at trash can or dumpster; 1 yellowjacket or hornet anywhere if children are threatened.

An Example of Setting Action Thresholds for Yellowjackets

Count the number of yellowjackets foraging at a trash can in a given 10-minute period. If that number averages around five, and you are getting no complaints about yellowjackets, and no one is getting stung, then no action is necessary. That particular level of yellowjacket activity is acceptable. You might, therefore, set the action threshold at ten. Any time you counted ten or more yellowjackets at the trash can in a ten minute period, you would take further action, perhaps increasing trash pickups, powerwashing trash cans, setting additional yellowjacket traps, or spending an hour or two searching for nests.
— from *Yellowjackets and IPM*, available from the Maryland Department of Agriculture

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Pests: Ants

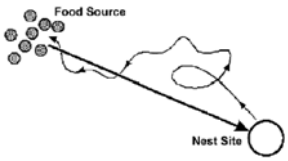
Ant Trails — A Key to Control With Baits

John Klotz, David Williams, Byron Reid, Karen Vail, and Philip Koehler

Introduction

Communication in the ants is based on chemical signals. These chemicals are called pheromones, and they vary from alarm and nestmate recognition to the one we will focus on here, recruitment. All of the pest ants use odor trails for orientation, but these trails differ from one species to another. Where the pheromones originate in the ant's body, their chemical composition, as well as how long they last, all vary from one ant species to the next. In fire ants, the trail chemical is produced by the Dufour's gland, which is named after its discoverer and is laid down by the stinger. This pheromone is made up of molecules that evaporate very quickly. Thus, the odor trails of fire ants are very short-lived. In comparison, the trail pheromones of some carpenter ant species, which are produced by the hind gut, will last for days. However, in both cases, these odor trails have the same purpose of communication, namely recruitment to a resource.

Trailing



A scout ant in search of food leaves the nest and, in the random search pattern that follows, takes a somewhat meandering path outward, until she finds food. She then feeds on the food source and heads straight back to the nest. Somehow on the outgoing trip she can keep track of her position with respect to her nest, and, on the return trip, uses this information to take the shorter, more direct route home. On the way back to the nest, she lays down an odor trail. Once back in the nest, this scout ant then alerts her nestmates of the food find, which encourages them to leave the nest. These recruited ants follow the odor trail directly to the food source. In turn, each ant will reinforce the odor trail until the food is gone. This behavior is a highly efficient means of exploiting a temporary food resource.

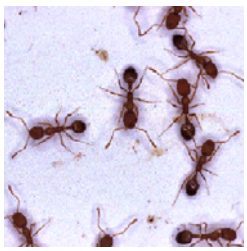
In some instances, these odor trails can become more or less permanent, as in the case of ants that are visiting permanent food sources such as an aphid colony, garbage area, and other sites in structures with permanent food and water. The trail can even be physically cut into the turf, as with carpenter ants that chew their way through the thatch layer.

Structural guidelines are another type of trail that ants use to orient themselves in their natural environment. These may include twigs and branches, which ants use to travel to and from the nest on foraging trips. Traveling along a branch ly-

ing on the forest floor is much quicker than negotiating a path through grass or leaf litter. In the man-made structural environment, guidelines consist of pipes, conduits, wires and other utility lines. Ants follow these guidelines to enter structures as well as to travel within them. These structural guidelines serve as natural highways for ants.

Trailing along these chemical or structural guidelines is an important behavior of ants that, if better understood, can be exploited for control purposes. In inspections, trailing ants should be observed carefully to determine where they are getting into structures. Through close observation, the source of the infestation can be located. Following trailing ants is the best way to locate the actual nest site. One can feed wandering ants a little honey or pieces of insects and then follow them directly back to their nest site.

In the two examples that follow, this behavioral knowledge will be applied to the control of Pharaoh ants in an apartment complex and carpenter ants in a home.



Pharaoh Ants

Perhaps never is it more critical to consider trailing behavior than in baiting programs for Pharaoh ants. Baits cannot be placed in just any location and be expected to work. Pharaoh ant trails and their resources (both food and water) must be located for proper placement of baits and effective control.

An interview with each apartment dweller is a good way to begin to locate areas of ant activity, and to educate the resident on the control program. It is important for the resident to understand that it will take time for the bait to eliminate the ant problem. The resident should understand that delayed-action baits take time to accumulate a toxic dose in the ant colony, so that the entire colony can be eliminated. Sprays may be used several days later after baits are applied to kill off any stragglers. However, sprays should be avoided initially as they will only cause satelliting (formation of new nests), will kill only a few foragers, and might contaminate bait stations.

A pretreatment survey should be conducted first using dabs of peanut butter on a white index cards. Then place the cards in food and water locations throughout the apartment complex as well as outside. Inside, survey cards should be placed in the apartments, and other areas such as the lobby, kitchens, laundries, lounge areas and offices. At least eight to sixteen cards should be placed in each apartment (usually two to four each in the kitchen, living room, bathroom, and bedroom). Survey cards should be placed in any areas where the resident has seen ant activity.

Window sills should be used for card locations in the living room and bedroom of each apartment. Dead insects on window sills attract foraging ants, and the numerous cracks and crevices around window casings are ideal nest sites. In the kitchen and bathroom, cards should be placed near sources of water, such as pipes and drains, sinks, counter tops, and toilets. Outside, survey cards should be placed near windows, around entrances and exits, and incoming and outgoing plumbing lines. It's important to position the cards along edges or other structural guidelines, where the ants are likely to travel. These cards should be left undisturbed for several hours, and then the number of worker ants on each card should then be estimated and recorded on an inspection diagram.

This pretreatment survey locates areas where ant activity is concentrated, so that baits are placed in areas of greatest ant activity. Monitoring will find small isolated colonies that otherwise might be overlooked and could cause reinfestation in the future. Where feeding occurs at survey cards, the trailing ants should be traced back to where they are entering from a crack or crevice, switch plate, pipe flange, etc. These entrance sites should be noted on the diagram, and the toxic baits placed here in the treatment program.

A good floor plan of an infested apartment complex can be used as the inspection diagram to document survey data and locate bait treatments. Not only is this an invaluable tool, but it can also be used to educate the resident about the ants and discuss treatment strategy. A floor plan will help in estimating how much bait or how many bait stations to use. For an average-size room, four to six bait stations, depending on the level of infestation, should be sufficient. A large apartment complex with a heavy infestation of Pharaoh ants will require more bait and application time, as well as the potential for a higher frequency of reinfestation compared to a small apartment complex with a light, localized infestation.

Carpenter Ants

Many of the techniques used for baiting Pharaoh ants will come in handy when baits become available for carpenter ants. Until that time, however, carpenter ant control will rely on spot and barrier treatments with residual insecticides. How can knowledge of trailing behavior be applied to these methods of control?

In carpenter ant control, probably more so than with most other ant problems, the pretreatment inspection survey is the single most important component of a successful control program. This is because the nest site is very often extremely difficult to find. Here, again, the use of structural guidelines by carpenter ants should be emphasized for inspections. In cases where control measures have failed it may be helpful to conduct a night inspection, since carpenter ants are nocturnal. Just as in Pharaoh ants, a pretreatment survey (using insects or honey instead of peanut butter) may also help in determining areas of ant activity.

The treatment should be focused on areas where ants travel, such as behind pipe flanges and switch boxes, where the ants travel along pipes or wires in wall voids. For treatment inside structures use dusts applied lightly to avoid repellency, which

occurs when too much dust is present. The ants must walk through the dust and pick it up, not walk around it.

On the outside perimeter, liquid sprays are applied in a band that is thoroughly and judiciously placed to prevent ants from trailing into a structure. If this is not carefully done to provide a continuous barrier, ants will find a break or bridge to cross over and infest our structures.

Besides these important chemical control procedures, there are several nonchemical techniques that can be used to help out. Trim back vegetation that may provide runways for the ants onto the structure, and seal or caulk entryways into a structure.

In dealing with ants always keep one step ahead of their trails, whether during inspections to determine how they are getting into the structure and where they are traveling within a structure, or during treatment, focusing on those areas where ants are likely to travel. Incorporating these ideas on trailing behavior into ant control programs will insure more effective inspections and more successful treatments, and allows for better control while minimizing the use of chemical pesticides.

Baiting

Like all living organisms, ants have certain nutritional requirements: carbohydrates, proteins, and fats. In nature they obtain these essential nutrients from a varied diet of insect prey (proteins and fats), nectar, aphid honeydew and other plant products (carbohydrates). These nutrients are found in either liquid or solid form. Ants naturally strive for a balanced diet to optimize the growth of the colony. However, the amount of each of these three dietary requirements necessary for optimal growth may vary seasonally. For example, "bait switching" is well documented in Pharaoh ants that have satisfied their appetite for one food and consequently choose another. Carpenter ants eat a diet rich in proteins (for example, mealworms) during brood development, usually in the spring and summer, but the colony will change to carbohydrate (for example, honey), foraging in late summer and fall to meet the adult workers' increased energy requirements (for example, mealworms).

As structural pests, the opportunity for ants to achieve a balanced diet is limited only by sanitation practices and the baits used to control them. Ideally, sanitation problems can be corrected so that baits don't have to compete with other food items, thus forcing the ants to feed on whichever bait is provided.

Although ant baits have a long history in pest control, there is renewed interest in their formulation and development. This new popularity of baits is most likely due to several factors, including public pressure to reduce pesticide use, current availability of insecticides ideal for baiting ants, and numerous advantages that baits offer the pest control industry. Baits are more target-specific than traditional techniques of ant control, which have relied on broadcast applications of insecticides in spot and perimeter treatments, placing heavy loads of broad-spectrum insecticides into the environment. Baits are more cost-effective compared to more labor-intensive inspections to locate nests (attempts which are often unsuccessful) and to treatment strategies that often involve invasive techniques like drilling and dusting. And, if baits are used properly they are highly effective. For example, they exploit the natural foraging behavior of ants to recruit and share resources, thereby spreading the bait toxicant throughout the entire colony and eventually destroying it.

On the negative side, baits tend to be slower acting than sprays or dusts, requiring patience by a distraught resident, for example, who needs to be educated on how baits work and the length of time required to gain control. Also, their shelf-life is limited due to susceptibility of the attractive part of the bait to spoilage. However, the many advantages of baits far outweigh these two disadvantages, which can be alleviated through education of the resident and new and improved bait formulation.

A bait consists of four components: (1) an attractant, usually a food or pheromone that makes the bait acceptable and readily picked up, (2) a palatable carrier, which gives the physical structure or matrix to the bait, (3) a toxicant, which should be nonrepellent and delayed in action, effective over at least a 10-fold dosage range, and (4) other materials added for reasons of formulation, such as emulsifiers, preservatives, waterproofing or antimicrobial agents. Each of these components must be developed and tested for efficacy. Currently, a variety of baits can be selected whose efficacy ranges from marginal to excellent in control.

So, how does one deal with this bewildering array of baits? The best test of a bait is how it works in the field. If the ants are attracted to the bait and are feeding, there's a good chance of eliminating the problem. However, this holds true only if the bait contains a toxicant that is slow-acting. Fast-acting insecticides are only going to kill foraging ants, allowing the queen, nest workers, and brood to survive and soon replace those few that are killed before sharing the poison with their nest mates. Slow-acting insecticides allow time for the foragers to exchange food, eventually eliminating the entire nest when the toxicants reach lethal levels.

If the ants are not visiting the bait, then change to another brand. This is usually sufficient to initiate feeding again. Of course, none of these techniques will succeed without thorough pre-baiting surveys, and the sufficient number and proper placement of bait stations.

IPM for Ants in Schools

Edited by Jerry Gahlhoff; originally written by S. Darr, T. Drlik, H. Olkowski, and W. Olkowski

Introduction

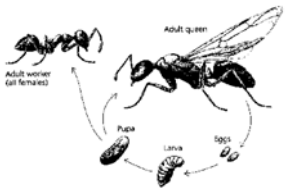
Ants become pests when they invade buildings in search of food or shelter. It is often very difficult and laborious to eliminate most ants from their outside habitat. Therefore, management should be targeted at preventing ants from invading

structures. Unfortunately, prevention is not always successful, and control actions must be implemented.

Although ants often are regarded as pestiferous, it should be noted that ants are beneficial in several ways. First, ants are predators of numerous pest insects, including fly larvae and termites. Second, ants aerate soil and recycle dead animal and vegetable material thus aiding in the formation of topsoil. Additionally, ants are responsible for pollinating plants in some areas. Ants provide a great service to the environment, and management efforts that prevent or control ants are preferred over practices that aim to eliminate ants.

Note that it is not within the scope of this project to address either carpenter ants or fire ants.

Identification and Biology



Ants are social insects that live in colonies whose members are divided into three castes: workers, queens, and males. The responsibilities of the worker caste are to enlarge and repair the nest, forage for food, care for the young and queen, and defend the colony. The queen's primary duties are egg laying and directing the activities of the colony, while males serve only to mate with the queens.

Ants pass through four stages of development: egg, larva, pupa, and adult. After mating with males, queens lay eggs that hatch into blind, legless larvae. The larvae are fed and cared for by worker ants. At the end of the larval stage they turn into pupae, which do not feed. After a short period of time, adult ants emerge from their pupal stage and become worker ants.

The first step in management of pest ants is proper identification. Since there are many types of ants that may invade a structure it is important to identify the type of ant because most ants differ in their habits and food preferences. See Identifying Ants and Common House-Invading Ant Species.

The University of Florida offers a poster that combines line drawings and color and scanning electron microscope photographs in an identification key to help individuals identify the most common structure-invading ants.

Damage

Some species of ants, such as thief, Pharaoh, and Argentine ants, are particularly prone to infesting food. Inside buildings, these ants are primarily a nuisance since they almost never sting or bite. Since ants walk over many different kinds of surfaces and sometimes feed on dead animals and insects, it is possible that they can carry disease-causing organisms to human food. It should always be assumed that ant-infested foodstuffs have been exposed to organisms that can cause spoilage, and the food should be thrown away.

Detection and Monitoring

Visual inspection is the most useful monitoring technique for detecting ants and can be very useful in preventing a developing infestation. A thorough inspection and prevention program is required to locate the ant source.

- Construct a map of the school on which you can note problem areas and areas needing repair.
- A bright flashlight is mandatory. Kneepads and a mirror are helpful.
- A sealant such as outdoor caulk can be used to seal holes and cracks that ants could use to gain entry to the structure.
- Keep accurate records during the monitoring program to help formulate an IPM plan and evaluate its effectiveness.
- Careful attention should be paid to indoor areas such as kitchens and food preparation areas.
- An ant infestation may indicate that there has been a change in the methods of storing food or food waste that allows increased food sources for ants. Note how food and food wastes are stored in the area, and whether refuse containers are emptied and cleaned regularly.
- Inspect recycling bins to ensure that recyclables have been cleaned before storage.
- Interact with kitchen staff and custodians to learn more about the problem from their perspective.
- Ants can be attracted to snacks kept in classrooms or teachers' break rooms, as well as to sweet drinks accidentally spilled on the floor.

Management Options

Habitat Modification

The environment should be modified to reduce ant entryways and access to food. With quality materials and careful work, the alteration will be permanent and make a long-term impact on the number of ant invasions.

Caulking

- Caulk all potential entryways with a silicone caulking compound.
- Use mildew-resistant caulk in moist areas.
- It is not necessary or practical to seal all cracks, but begin with the access point that the current trail of ants is using.
- Always carry caulk when making inspections and seal as many cracks as time allows, especially those around baseboards, cupboards, pipes, sinks, toilets, and electrical outlets. Silicone caulks are flexible, easy to apply, and long-lasting.
- Weather-strip around doors and windows where ants may enter.

Sanitation

Sanitation eliminates food for ants. Thorough daily cleaning of school kitchens and food preparation areas is essential.

- Sweep and mop floors.

- Drain all sinks and remove any food debris.
- If children regularly receive snacks in classrooms, these floors should be vacuumed and/or mopped daily.
- Periodically give all food preparation areas a complete cleaning, focusing on areas where grease and food debris accumulate. These include drains, vents, deep-fat fryers, ovens, stoves, and hard-to-reach areas behind or between appliances. Thoroughly clean the area with a powerful vacuum.
- At the end of each day, remove all garbage containing food from the building.
- Use soapy water to wash any bottles, cans, wrappings, and other items that have food residues clinging to them before storing them for recycling.
- If dishes cannot be washed right away, it is very important that they at least be rinsed to remove all food debris.
- Place garbage in sealed plastic bags before it is placed into a rodent-proof dumpster or other storage receptacle.
- Keep garbage cans and dumpsters as clean as possible to deny food to ants, roaches, flies, mice, and rats.

Proper Food Storage

- Food not kept in the refrigerator should be kept in containers that close tightly. Cardboard boxes can be penetrated by ants.
- Keep particularly attractive substances, like sugar and honey, in a refrigerator.
- Although refrigerator storage is usually safe, ants sometimes get into refrigerators and freezers even when the seals appear intact. When this occurs, a light, temporary coating of petroleum jelly on the edge of the refrigerator seal will exclude the ants.
- Screw-top jars are ant-proof only if the lid has a rubber seal, since the ants can follow the spiral ridges to get into the jar.
- Glass containers with rubber gaskets or plastic containers with tight-fitting, snap-top lids are also ant-proof.
- Upon arrival to the building, transfer packaged food into plastic or glass containers. To prevent roach problems, do not bring shipping boxes into the food preparation area. Instead, boxes should be broken down and stored away from the kitchen in a cool area until removed for recycling.
- Advise students and teachers not to leave unsealed food items in their desks or lockers.
- Any food kept in offices or classrooms should be stored in ant-proof containers.

Physical Controls

At times when only a few ants are noticed foraging in an area, squashing or crushing the ants may be effective.

Vacuuming

- Use a strong vacuum to vacuum up trails of ants effortlessly and quickly.
- Vacuum a tablespoon of corn starch to kill ants in the vacuum bag.

Detergent Barrier

Temporary "moats" of detergent and water may be useful during heavy ant invasions. Containers of food or food waste that must remain open during working hours can be placed in large, shallow pans filled with water mixed with a small amount of detergent. Use this technique to protect potted plants from ants that may be attracted to nectar produced by the plant or to honeydew produced by plant-feeding insects. Elevate the pot above the detergent-and-water mixture by placing it on an overturned saucer. Make sure the limbs and leaves of the plant are not in contact with surfaces that ants could use as bridges.

Chemical Controls

At times, nonchemical methods alone prove insufficient to solve the problem. Integrating a pesticide into your management program may be necessary to gain control of the ant problem.

Pesticides must be used in accordance with their EPA-approved label directions. Applicators must be certified to apply pesticides and should always wear protective equipment during applications. All labels and Material Safety Data Sheets (MSDS) for the pesticide products authorized for use in the IPM program should be maintained on file. Do not apply these materials when buildings are occupied, and never apply them where they might wash into drains or sewers.

When treating ants, all baits and dusts should be placed in cracks, crevices, and in precise areas where ants are active. See Tips For Controlling Specific Ants.

Detergent and Water

When ants invade a classroom or food preparation area, use a mixture of soap and water in a spray bottle. This mixture will quickly kill the ants, which can then be wiped up with a sponge and washed down the drain. Each classroom, cafeteria, and food preparation area should be equipped with such a spray bottle so teachers and staff can safely deal with emergencies.

Boric Acid

Boric acid is one of the most valuable chemical control tools in an integrated ant management program. It is formulated as a dust, gel bait, and aerosol. It acts as a stomach poison and is relatively nontoxic to mammals. If kept dry, boric acid dust remains effective for long periods of time.

- When applying boric acid dust, wear a dust mask to avoid breathing the material.
- Use a bulb duster to apply a light dusting in cracks and crevices. This is recommended over dusting large, open areas.
- Boric acid is approved for crack and crevice treatment in kitchen and food preparation areas.
- Boric acid can be dusted into wall voids and spaces behind and under cabinets.

Diatomaceous Earth and Silica Aerogel

These are insecticidal dusts that can be used for ant control.

Diatomaceous earth is made from fossilized diatoms, and silica gel is produced from sand. Both kill insects by desiccation; they absorb the waxy layer from the insect's outer covering, which causes dehydration and death. Although these materials are not poisonous to humans directly, the fine dust travels freely through the air and can be irritating to the eyes and lungs. Therefore, use a dust mask and goggles during application.

Diatomaceous earth and silica aerogel are especially useful in wall voids and similar closed spaces. During construction and remodeling these dusts can be blown into such spaces, and in finished buildings they can be applied by drilling tiny holes in the walls. These dusts are also useful in crack-and-crevice treatments.

Some products combine diatomaceous earth or silica gel with pyrethrins. The pyrethrins provide a quick knockdown of the ants, and the dusts provide long-term control.

Ant Baits

Baits greatly reduce the amount of pesticide that must be used to kill ants. Foraging ants take the bait back to the nest to feed to other members of the colony, resulting in colony death. Even if the queen is not killed, baits usually will stop an ant invasion. If a colony has been starved by effective sanitation measures, baits will be more readily accepted.

Always place baits out of sight and reach of children, or if this is not possible, use baits at night or on weekends and remove when children are in school.

Some ants are very susceptible to baits, some are less so. There are many reasons for these differences, only some of which we understand. If you are having difficulty in controlling ants with a bait, the following points may be helpful:

- It is important to correctly identify the species of ant that is invading the school, since each species differs in its food preferences. Some baits contain a sweet attractant and others use a protein or oily attractant. Therefore, the attractant in the bait must be preferred by the type of ant identified. If you cannot determine the type of attractant by looking at the label, call the manufacturer for more information. You should also ask if the company has data to support the efficacy of their product against the ant species you are dealing with.
- After setting out bait, observe to see if the target ant is taking the bait.
- Ant colonies have changing nutritional requirements that can pose problems in baiting. A colony that accepted a protein bait one week may be more interested in a sugar bait the next.
- The nesting and foraging environment can also affect bait acceptance. Ants nesting and foraging in dry areas will be more interested in baits with a high water content than will ants nesting in moist environments.
- When there are several competing ant species in one area, nontarget ants may accept your bait more readily than the pest ant and, in some cases, prevent the pest ant from getting to the bait.
- Do not spray pesticides when using baits. Bait stations contaminated with pesticide are repellent to ants, and sprays disperse the ant infestation, making it more difficult to place baits effectively.
- Place bait stations along foraging trails, but do not disturb ant trails between the nest and the bait. Killing the ants or disturbing the trails prevents the ants from taking the bait back to the colony to kill nest mates.
- Do not apply bait until an ant problem is noticed. If you use baits preventively you may attract ants into the building.
- Some baits come packaged in plastic disc "bait stations" that come with double-sided tape so they can be attached to various surfaces out of view. It is important to remove bait stations once control is attained because the stations may serve as harborage for cockroaches.
- Some baits are formulated as granules or gels that can be injected into wall voids through small holes. Gel baits can also be placed near ant trails in inconspicuous places where they will not be disturbed.

Ant IPM Checklist

Lyndon Hawkins

This checklist was developed in California, where Argentine ants are a major problem. However, this checklist may be used to help determine the controls needed for any species of ant.

Is the ant Argentine ant or another ant species? (Argentine ants are the common dark-brown ants you see on sidewalks and kitchen counters. Others pest ants include pharaoh ant, carpenter ant, pavement ant, corn field ant, little black ant, crazy ant, pyramid ant, odorous house ant, and thief ant)
YES NO UNSURE

Is there a trail of ants?
YES NO UNSURE

Do you notice food or water attracting ants?
FOOD WATER

Are the ants entering the building from the outside?
YES NO UNSURE

Has the building been sealed (cracks and crevices caulked) against pests?
YES NO UNSURE

Has the food source inside the building or classroom been eliminated? (Place lunches in a tight container or refrigerator and pet food in containers with tight lids.)
YES NO UNSURE

Have the sinks, counters, and other areas where ants are found been cleaned? (Clean up with hot water, soap, or vinegar.)
YES NO UNSURE

Is the area cleaned daily?
YES NO UNSURE

Has the area been thoroughly vacuumed, including cracks and crevices where food may have accumulated?
YES NO UNSURE

If ants are in a kitchen, has the area where grease may have accumulated, including kitchen equipment, drains, and vents, been cleaned?
YES NO UNSURE

Can a sticky barrier or very smooth barrier (such as sprayed-on Teflon) be used to prevent ants from climbing up the surface?
YES NO UNSURE

Is there a source of food outdoors?
YES NO UNSURE

Is the food source still readily available? (Ants feed on honeydew produced by aphids and other plant sucking insects. If this source disappears the ants will go forage for food elsewhere and may enter buildings.)
YES NO UNSURE

Have baits been used to control ants?
YES NO UNSURE

Argentine ants are more of a problem in the fall and winter because outdoor food sources have disappeared. A good IPM program prevents ants by improving sanitation practices (keeping food in tight containers, picking up food outside and emptying trash containers daily), and baiting early in the season, especially in areas frequented by ants. Do not wait until ants become a major nuisance before beginning a control program.

When ants are entering structures, follow their trails to determine nest sites. Seal cracks and crevices in walls where ants are entering the building. If ants are living in nests inside the building, determine source of moisture that contributes to the favorable habitat. Also, dry rot in the wood may be present.

Pests: Bees, Hornets and Wasps

IPM for Yellowjackets and Hornets in Schools

Edited by Timothy C. McCoy; originally written by S. Darr, T. Drlik, H. Olkowski, and W. Olkowski

Introduction

Yellowjackets and hornets are both beneficial and problematic wasps. They are important predators and scavengers, helping to control pests and recycle organic materials. Although often grouped together with bees, yellowjackets pose a more serious threat to people. Yellowjackets can sting repeatedly, whereas a bee can sting only once. Multiple stings from yellowjackets are common because they aggressively defend their nest when it is disturbed.

Identification and Biology


Yellowjacket


Paper wasp


Yellowjacket nest

"Yellowjacket" and "hornet" are the common names given to wasps in the genera Dolichovespula, Vespula, and Vespa, but for the sake of simplicity we will use the term "yellowjacket" in the following discussion. Note that these common names are not reliable indicators of whether or not they are pests. Yellowjackets are relatively short and stout and hold their legs close to their body, compared with other wasps. Paper wasps, for example, are more slender and have long dangling legs. All yellowjackets are striped either black and white or black and yellow. They are rapid fliers, and are more aggressive than other types of wasps. Their nests are always enclosed with a papery envelope and can be found in the ground, hanging from eaves or tree branches, and occasionally in wall voids.

The queen yellowjacket begins her nest by building a small comb of chewed wood. She lays eggs in the cells and, after the eggs hatch, tends the larvae herself. Once the larvae develop into adult workers, they expand the nest into tiers, built one on top of the other. Yellowjacket colonies seldom exceed 15,000 workers with a single queen, although they can become larger and can include multiple queens in perennial colonies. In the late summer or early fall, new queens and males are produced.

After mating, the queens seek a sheltered place to spend the winter and, except in perennial colonies, all the worker wasps die. The nest is not reused and eventually disintegrates. Early in the warm season colonies are small, and yellowjackets are usually not a problem. Later in the season when colonies are at their peak, these insects become pestiferous. In their search for protein and carbohydrate sources, they are attracted to garbage cans, dumpsters, lunch counters, and playgrounds, where they scavenge for food.

Stings

Insect stings are the leading cause of fatalities from venomous animals, and most of these stings are inflicted by honeybees. The people who die from yellowjacket or bee stings are people who experience large numbers of stings at once or who suffer severe allergic reactions to the inflammatory substances in the insect venom. These allergic reactions include soreness and swelling, not only at the site of the sting, but also on other parts of the body that may be distant from the site. Other symptoms include fever, chills, hives, joint and muscle pain, and swelling of the lymph glands and small air passageways. In severe cases, the individual may suffer a sudden drop in blood pressure and lose consciousness. While many individuals who experience allergic reactions have become sensitized over time by previous stings, half of all fatalities occur in individuals stung for the first time.

Nonallergic reactions to stings include localized pain, itching, redness, and swelling for hours to a day or two after the event.

Nest Disturbance

Yellowjackets that are foraging for food will usually not sting unless physically threatened, such as being struck or caught in a tight place. But if they feel their nest is in danger, they will vigorously defend it. All wasps defend their colonies, but some yellowjackets are more sensitive to nest disturbance and more aggressive in their defense. Disturbing a yellowjacket nest can result in multiple stings. This can occur when someone accidentally steps on an underground nest opening or disturbs a nest in a shrub or building. Sometimes merely coming near a nest, especially if it has been disturbed previously, can provoke an attack.

Wasps in underground nests can be disturbed simply by vibrations. Thus mowing lawns or athletic fields can be hazardous, and operators may need to wear protective clothing when mowing during the late summer season, when colonies are large. It can be very frightening to be the victim of multiple wasp stings. The first response may be to run away. However, the best strategy is to back slowly away from the colony until the wasps stop attacking you. It is important to educate children about the beneficial role of these wasps (they feed on pest insects, particularly caterpillars) and to remind them repeatedly of ways to avoid stings. Since problems with yellowjackets are most common in late summer and fall, teachers can be provided with this information at the beginning of the fall term. See tips on avoiding and treating stings.

Detection and Monitoring

If there is a chronic problem with yellowjackets around outdoor lunch areas or school athletic fields, inspect the area methodically to locate the nests. Nests can be found in the ground, under eaves, and in wall voids of buildings. Ground nests are frequently (but not always) located under shrubs, logs, piles of rocks, and other protected sites. Entrance holes sometimes have bare earth around them. Nest openings in the ground or in buildings can be recognized by observing the wasps entering and leaving.

Management Options

The objective of a yellowjacket management program should be to reduce human encounters with the wasps, but not to eliminate them from the entire area since they are beneficial predators of insects. The two most productive and least environmentally destructive ways to do this are to modify the habitat to reduce yellowjackets' access to food in the vicinity of human activities, and to use physical controls such as trapping and nest removal. Area-wide poison-baiting should be used only as a last resort when other methods have failed and stings are frequent.

Physical Controls

Habitat Modification

Since garbage is a prime foraging/predation site for yellowjackets, garbage containers on school grounds should have tight-fitting lids. The receptacles should be emptied frequently enough to prevent the contents from impeding the closure of the lid. The lids and containers should be periodically cleaned of food wastes. Disposable liners can be used and replaced when soiled or damaged.

When these practices are not followed, school garbage (and the flies around it) becomes a food source for yellowjackets in the area. With a large number of wasps around garbage containers, students may become afraid to get close enough to place garbage all the way inside, and spilled food attracts more wasps.

Dumpsters should be cleaned frequently by washing them with a strong stream of water. If the dumpster service company has a cleaning clause in their contract, make sure it is enforced. To limit yellowjacket infestations inside the school buildings, repair windows and screens and caulk holes in siding. Building inspections for yellowjackets can be done at the same time as inspections for other pests such as rats, mice, and termites. Inspections should be conducted monthly to ensure that developing nests are found before they get large enough to be problematic.

Trapping

Trapping with a sturdy trap and an attractive bait can significantly reduce yellowjacket numbers if a sufficient num-

ber of traps are used. There are a variety of traps on the market. In general, cone-type traps are more useful for long-term (many weeks) trapping. In some schools, unbaited yellow sticky traps (like those used to catch whiteflies) affixed to fences near underground nests have provided sufficient control to protect children from stings.

A homemade, cone-type fly trap can be used to catch yellowjackets simply by using the captured flies inside the trap as bait. The yellowjackets enter the trap to get the flies and become trapped themselves (see tips on this kind of trapping). You can also try using baits such as dog food, ham, fish, and other meat scraps, or, toward the end of the warm weather, sugar syrups, fermenting fruit, and jelly.

Take care to place traps out of the children's reach as much as possible. However, the traps should be placed near the nest if it can be found, and/or near the area where the yellowjackets are troublesome. Teachers can be instructed to make a short presentation on the purpose of the traps to satisfy the curiosity that students will undoubtedly have. Show students the traps, explain how they work, and try to impress upon them the importance of the traps in maintaining the safety of the playground.

When traps are full they can either be placed in a freezer for a day to kill the wasps or enclosed in a heavy-duty plastic garbage bag and placed in the direct sun for several hours. A third way of killing the wasps is by submerging the traps in a bucket of soapy water until the wasps drown.

The traps should be out only during the period that yellowjackets are a problem, usually late summer and early fall. When the traps are taken down for the year, they should be cleaned with soap and water and stored.

Nest Removal

A nest can be destroyed through physical removal (vacuuming) or by using a pesticide (see Chemical Controls). Either way, great care must be exercised because any disturbance around a nest can cause multiple stings. It is best to have a professional pest control operator (PCO) or other experienced person remove the nest. Nest removal should take place at night when the children are out of school and the yellowjackets are inside the nest. When illumination is needed, use a flashlight covered with red acetate film so it will not disturb the wasps.

Adequate protective clothing and proper procedure can minimize problems and stings. It is important to wear protective clothing when removing wasp nests. Complete body coverage is essential because yellowjackets and other wasps can find even the smallest exposed area. Use clothing made for beekeepers. This includes:

- A bee veil or hood that either contains its own hat or can be fitted over a lightweight pith helmet or other brimmed hat that holds the veil away from the head. A metal-screen face plate that extends around the head is a desirable feature. Check the veil carefully for tears before each use.
- A bee suit or loose-fitting, heavy-fabric coverall with long sleeves. This is worn over regular pants and a long-sleeved shirt to provide extra protection from stings.
- Sturdy high-topped boots with pant legs secured over the boots with duct tape to prevent wasps from getting into trousers.
- Gloves with extra-long arm coverings so sleeves can be taped over them to protect the wrists.

Vacuuming

Vacuuming is particularly effective:

- When nests occur in wall voids;
- In environmentally sensitive areas where nests should not be treated with insecticides; or
- In emergencies where nests have already been disturbed.

Vacuuming out entire nests is not recommended unless it is done by a PCO experienced in handling stinging insects.

In some cities there are pest control companies that will perform this service for free so they can collect the wasps to sell to pharmaceutical companies for their venom. If the school is interested in this, take time to find a reputable company.

Chemical Controls

If nonchemical methods alone prove insufficient to solve the problem, then integrating a pesticide into your management program may be warranted.

Pesticides must be used in accordance with their EPA-approved label directions. Applicators must be certified to apply pesticides and should always wear protective gear during applications. All labels and Material Safety Data Sheets (MSDS) for the pesticide products authorized for use in the IPM program should be maintained on file.

When an insecticide is considered necessary for the control of yellowjackets, the best approach is to confine it to the nest itself. Anyone applying insecticides should use special clothing that protects against the chemical as well as against wasp stings. Insecticides should be applied in the evening or very early morning when children are absent, the wasps are inside the nest, and cooler temperatures reduce insect activity.

A number of insecticides are registered for use against yellowjackets. The following are most appropriate for use in schools:

Dusts

Residual dusts can be very effective at controlling nests found in wall voids and underground nests. The extent of wall void nests should be determined by listening for activity behind the wall surface. Once the boundaries of the nest have been determined, holes can be drilled into the wall and an appropriately labeled residual dust can be applied. The subsequent holes can be plugged with steel wool to prevent the wasps' escape. Outdoor ground nests can be similarly controlled by approaching the nest at night and dusting the entrance; this procedure should be followed by plugging the entrance with dusted steel wool.

Silica Aerogel and Pyrethrins

Silica aerogel combined with pyrethrins is an effective insec-

ticidal dust that can be used to destroy an underground nest or a nest in a wall void. Silica aerogel is made from sand and works by absorbing the outer waxy coating on insect bodies. Once this coating is gone, the insects cannot retain water and die of dehydration.

Products with Components That "Freeze" Wasps
Pyrethrins can be used to quickly knock down guard wasps at the nest entrance and to kill yellowjackets in aerial nests when they must be destroyed in the daytime. These aerosol products are designed to project a stream of spray 10 to 20 feet and contain highly evaporative substances that "freeze" or stun the yellowjackets.

Do Not Use Gasoline
Gasoline should never be poured into underground nest holes. This dangerous practice creates a fire hazard, contaminates the soil, and prevents the growth of vegetation for some time. A ground application of gasoline poses greater harm to children and the environment than a yellowjacket nest.

Avoid Area-Wide Poisoning
Mass poisoning is seldom, if ever, necessary and is expensive due to the labor involved in the frequent mixing and replacement of bait. The effectiveness of bait mixtures is also questionable, since the baits face considerable competition from other food sources that are more attractive to scavenging yellowjackets.

Yellowjackets and IPM

Lawrence Pinto and Sandra Kraft

Yellowjackets are social wasps that build enclosed paper nests underground, in trees, and in buildings. The name "yellowjacket" refers to the yellow and black bands of color present on most species. Although their stinging behavior gives them a bad reputation, yellowjackets also play a beneficial role in the environment because they feed their young on enormous quantities of flies, caterpillars, and other insect prey.

Often confused with bees, yellowjackets pose a greater threat to students. Yellowjacket stings are painful and pose health threats to those allergic to their venom. A single yellowjacket can give multiple stings, and if someone disturbs a nest, he or she can be attacked by dozens or even hundreds of aggressive yellowjackets. When one is crushed, it gives off an alarm pheromone that attracts others within a 15-foot radius. A nest can contain hundreds or even thousands of workers, and there can be multiple nests on a school's grounds. Yellowjackets often occur in such numbers that they become a major nuisance, limiting outdoor school activities.

Because of their numbers, the distance they can fly, and how difficult it can be to find their nests, yellowjacket control can be a major challenge. *General insecticide spraying of an area will not control yellowjackets.* Integrated pest management, or IPM, is the only effective way to manage yellowjacket problems and minimize contact between yellowjackets and students. IPM emphasizes nonchemical tactics such as improved sanitation and operational procedures, spring-to-fall monitoring of yellowjackets, and, if necessary, targeted insecticide application.

This IPM bulletin provides background information on how to use IPM to manage yellowjacket problems around schools. For more information, refer to the additional resources on yellowjackets following this article.

Monitoring

The wrong way to deal with yellowjackets is to wait until someone gets stung or until clouds of yellowjackets are buzzing around trash cans and students. IPM needs to be proactive. From spring through the first frost, the IPM technician should be checking school grounds regularly for yellowjacket activity and for conditions attractive to yellowjackets. Yellowjacket activity can be gauged by (1) inspecting trash cans, dumpsters, flowering plants, and outdoor food areas and (2) installing a few yellowjacket traps and checking them weekly. Conditions attractive to yellowjackets include open trash cans, poor trash handling, food spills, flowering plants, soft drinks, recycling bins, and fruit trees.

The Importance of Early Season Monitoring and Intervention

Early intervention can greatly reduce the late season problem with yellowjackets. In late spring and early summer, yellowjacket nests are small with fewer workers. Try to find and eliminate nests before they become large and troublesome.

If yellowjackets are foraging to a specific site, such as a dumpster, you can often track them back to their nest. They tend to leave and enter the nest on the same flight path. They are easiest to see if you stand in the shade and look across an area in full sun. If you see something fly by, continue looking at the same spot. If you see more zip by on the same path, you have probably located the yellowjackets' flight path. Follow them until you find their nest opening. There is often more than one nest, so don't give up when you find the first. Keep checking. Remember that yellowjackets causing a problem on the school grounds could be coming from nests that are not even on school property.

Action Thresholds

The presence of yellowjackets outdoors is natural. Tolerance to yellowjackets will vary, however, depending on their numbers and the location. One yellowjacket at a trash can requires no action; 10 at a picnic table is a different story. IPM programs use the concept of the *action threshold* to trigger a response from the IPM technician. An action threshold is simply the point at which some action must be taken, and it will depend on the site and the pest. For example, you might se-

lect a specific garbage can and count the number of yellowjackets foraging there in a given 10-minute period. If that number averages around five, and you are getting no complaints about yellowjackets, and no one is getting stung, then no action is necessary. That particular level of yellowjacket activity is acceptable. You might, therefore, set the action threshold at 10. Anytime you counted 10 or more yellowjackets at the trash can in a 10-minute period, you would take further action, perhaps increasing trash pickups, powerwashing trash cans, setting additional yellowjacket traps, or spending an hour or two searching for nests. Hopefully, the activity level at the selected trash can would then drop below the threshold level. Action thresholds require constant fine tuning, and may vary from site to site and month to month.

Sanitation and Prevention

The best way to reduce the threat from foraging yellowjackets is to minimize or eliminate their access to food in high-risk areas. School maintenance and janitorial staff, kitchen workers, even playground monitors can all help implement the following measures:

- Keep garbage cans and dumpsters well away from doorways and other high traffic areas used by students.
- Make sure dumpsters and garbage cans have wasp-proof, tight-fitting lids to keep yellowjackets out. If necessary, install cans with self-closing lids. Wire mesh and similar trash cans are unacceptable. Use heavier (at least 3-mil) plastic bags inside garbage cans to reduce punctures and leakage.
- Empty schoolyard trash cans frequently, before containers are completely full. They should be emptied at least daily and ideally just after lunch break. The liner bag should be removed and tied off tightly. If necessary, schedule more frequent commercial trash pickup for dumpsters.
- Surfaces where drinks and food are often spilled (picnic tables, benches, playground equipment) should be washed down frequently. A solution of household ammonia diluted with water can be sprayed on surfaces and inside garbage cans to repel yellowjackets. Use ammonia and water only. *Never add bleach to this mix or you'll create a toxic gas.*
- Garbage cans and dumpsters should be powerwashed frequently. Consider treating them with a boric acid-based cleaner or the household ammonia dilution described above. Clean the wash-down area or dumpster pad, as well.
- Outside soda machines and the surrounding area should be hosed off regularly. Empty soda cans should be collected regularly.
- Recycling bins require special attention because sugar residues in soft drink cans and bottles are extremely attractive to yellowjackets. Locate the bins away from public areas, empty and wash them frequently. Make sure they have lids.
- Have teachers and food service staff serve sweet drinks in covered cups with drinking straws through the lid. This keeps drinks from spilling and yellowjackets can't get inside the cup and sting students in the mouth.
- If there are fruit trees or vegetable gardens on the grounds, see that fallen and rotting fruits and vegetables are picked up routinely.
- Fall-blooming bushes and flowers should not be planted in play or activity areas or near doorways.
- A simple way to keep yellowjackets (and other flying insects) away from a limited outdoor site is to use a powerful electric fan. The air turbulence will blow them away from a picnic table or similar-sized site.

Yellowjacket Troubles Peak in September

Just as students are returning to school in late summer, yellowjackets are at their worst. At this time of year, the yellowjacket colony is at its largest, but its social structure is breaking down. There are no more developing larvae to feed, so workers are foraging randomly for themselves. In the fall, their food interests switch from mainly proteins to mainly sweets. And they become increasingly aggressive in gathering food. They can be a major pest around schools and playgrounds where there are plenty of soft drink cans, drippy ice cream cones, half-eaten bag lunches, and fruit drink boxes.

Yellowjacket Highlights

- Yellowjackets build papery, comb nests usually in the ground, also in trees or shrubs, under eaves, or in building voids
- A single queen starts a new nest in early spring. ***Nests in Maryland are not reused from year to year.***
- As more workers are produced, they enlarge the nest and collect food to feed the young
- A mature nest can contain as many as 5,000 yellowjackets.
- A single yellowjacket can sting repeatedly. Between 1/2 percent and 1 percent of the human population is allergic to yellowjacket venom
- In fall, worker yellowjackets die and next year's queens look for a place to spend the winter

Stings and Allergic Reactions

A normal, nonallergic reaction to a sting is intense, immediate pain at the site of the sting, followed by localized swelling, warmth, and redness. These symptoms usually subside after a few hours but itching at the sting site may continue for days.

Some people have a more intense and dangerous allergic reaction. An allergic reaction can be delayed or immediate. It can include fever, hives, swelling at the site, headache, pain in the joints, and tender lymph glands. Sometimes an allergic reaction starts within minutes of exposure; the skin flushes, hives may appear and the face swells. It becomes hard to breathe, and the victim may feel faint and anxious, with a sense of impending doom. The victim is experiencing "anaphylactic shock," an acute, life-threatening allergic reaction. Any student stung by a yellowjacket should be evaluated by a school nurse or other medical professional.

Pests: Cockroaches

Least Toxic Methods of Cockroach Control

Dini Miller and Philip Koehler

Introduction

Controlling a cockroach infestation is not simply a matter of aesthetics. Large indoor cockroach populations are one of the leading causes of allergies, asthma and other bronchial disorders in humans. Additionally, cockroaches can carry disease organisms and bacteria on their bodies and in their fecal material. The presence of cockroach populations in and around urban structures is an indication that cockroach food, moisture and harborage resources are present. These conditions allow pests to proliferate and lead to cockroach population explosions.

Until recently, efforts to suppress cockroach populations in the urban environment have relied almost exclusively on repeated applications of synthetic pesticides. Surveys have shown that more than one third of all the pesticides used in the United States are applied in urban environments and most of these pesticides are applied in the home. However, the chemical approach to cockroach control has become increasingly less popular. This is primarily due to the development of multi-chemical resistance among German cockroach populations and increased public concern about pesticide exposure in their living environment. These two issues have greatly emphasized the need for a more holistic and less toxic approach to cockroach management.

The Principal Cockroach Species


German cockroach

In order to deal with any particular infestation it is important that the cockroach pest be properly identified so that most appropriate and least toxic control methods can be applied. There are 41 cockroach species present in the state of Florida. Of these only about six are considered pests. These pest species can have very distinct behavior and habitat preferences.

The predominant pest cockroach species in Florida (and the world) is the German cockroach, *Blattella germanica*. German cockroaches are small, with adults less than .75 of an inch (1.5 cm) in length. They are gold in color and have two dark longitudinal bands on their pronotum near the head. Immature German cockroaches, or nymphs, are smaller than adults, wingless and dark brown in color.

German cockroaches are primarily indoor pests and do not have "wild" populations. They have strict moisture requirements so they are usually found in kitchen and bathroom areas. Adults live about six months, and during this time the female produces from four to eight egg cases (oothecae). The female carries the egg case throughout embryonic development (three to four weeks), often releasing it from her body only hours before the nymphs hatch. Each female produces an average of 28 nymphs from each egg case. German cockroaches are the most prolific pest species and, therefore, the most difficult to control.


American cockroach


Australian cockroach


Brown cockroach


Smokybrown cockroach


Oriental cockroach


Florida woods cockroach

The remaining five pest species of cockroaches are more closely related to each other than they are to the German cockroach. These species include the American cockroach, *Periplaneta americana*; Australian cockroach, *P. australasiae*; brown cockroach, *P. brunnea*; smokybrown cockroach, *P. fuliginosa*; oriental cockroach, *Blatta orientalis*; and the Florida woods cockroach, *Eurycotis floridana*. Collectively, this group of cockroaches is known to pest control operators as the peridomestic (outdoor) cockroaches. However, the homeowner would most commonly refer to these cockroaches as "palmetto bugs."

In general, peridomestic cockroaches are much larger and heavier than German cockroaches. Adults range in size from 1.5 to 1.75 inches (3 to 4 cm) in length and are reddish brown to black. Some of these large cockroaches can live up to two years in the adult stage. Adult females can produce an egg case about every one to two weeks. A typical female will produce about 20 to 80 oothecae during her lifetime, each containing 15 to 20 nymphs. Peridomestic females release the egg case from their body soon after it has developed. They then "glue" the egg case to a surface, usually in a hidden, moist area. In contrast, German cockroach females continue to carry the egg case throughout embryonic development.

Peridomestic cockroaches normally breed outdoors in sewers, palm trees, tree holes, fire wood, water meters, well pumps, mulch, and flower beds. These cockroaches usually enter homes only occasionally when foraging for food, water, or warmth. In some situations, however, they will establish breeding populations in attics, crawl spaces, wall voids, and other indoor areas.

Cockroach Prevention: Exclusion and Sanitation

Long-term prevention of cockroach infestation is the best means of ensuring a cockroach-free environment. This is most easily accomplished by means of exclusion (preventing cockroach entry) and sanitation (elimination of cockroach resources). Not only will these measures prevent a future infestation, they will also help to reduce an existing cockroach problem.

Exclusion

Prevent Cockroach Entry

- Cockroaches migrate easily through multi-unit dwellings via plumbing and electrical connections. Sealing gaps around plumbing, wall outlets, and switch plates will prevent cockroaches from migrating from infested units to others.
- Keep doors and windows closed and screened. Also, caulk cracks and gaps that may allow peridomestic cockroaches to invade from outdoors.
- Peridomestic cockroaches frequently enter homes by coming up through dry drain traps. Periodically run the water in spare bathrooms, utility tubs and toilets to keep the drain trap filled and off limits to cockroaches.
- Fiberglass window screen over vent pipes on the roof will prevent cockroaches from migrating up from sewer connections and gaining access to attics and windows.
- Groceries, produce and other packaged food products may have been stored in infested locations before they were purchased. Make an effort to visibly scan all grocery items for cockroach evidence before putting them away.
- Children can transport cockroaches from school to home in book bags and lunch pails. Inspect these items on a regular basis.
- Guests (adults and children) can often transport cockroaches from their infested home to yours either on themselves or in packages. Limit guest access to specific areas of your home and inspect these areas after they depart.

Sanitation

Elimination of Food Resources

German cockroaches can remain alive for approximately two weeks with no food or water and for 42 days if only water is available. Therefore it is important to realize that cockroaches can survive on tiny amounts of food such as crumbs, grease or food residue.

- Indoor trash containers should be emptied frequently, kept clean both inside and out. Plastic bags lining trash containers can be kept closed with twist ties. This will prevent cockroaches from being attracted to the garbage area.
- Filled indoor garbage containers should be removed from the dwelling immediately and placed in outdoor containers with tight-fitting lids or dumpsters.
- Keeping the area around dumpsters or other outdoor garbage storage areas clean and free of debris also will prevent peridomestic cockroach infestations in the area.
- Frequent emptying of sink strainers and running of the garbage disposal will prevent food build-up in the sink drain.
- Washing dishes immediately after a meal will prevent cockroaches from consuming food residue on dishes. Unwashed dishes are a major source of food for German cockroaches.
- Kitchen appliances (toasters, toaster ovens, microwaves, ovens, stoves, and refrigerators) should be kept clean and free of food particles and grease. Additionally, the areas underneath and behind these appliances should be kept grease- and crumb-free.
- If pets are present, dry food should be kept in resealable containers. Do not leave food and water out all the time.
- Feed your pet at particular times and clean up after every meal.
- All foods products should be resealed after opening, stored in plastic snap-lid containers or kept in the refrigerator.
- Regular sweeping/vacuuming of floors and furniture where people eat (i.e., kitchen table or in the living room in front of TV) help to eliminate cockroach food sources.
- Regular cleaning of food storage areas and shelves not only eliminates spilled or scattered food but disrupts cockroach populations that may be using the area as a harborage.

Elimination of Water Resources

The single most important factor in determining cockroach survival is availability of water. German cockroaches live less than two weeks when there is no supply of free water even if food is abundant. During periods of drought the incidence of peridomestic cockroaches indoors will often increase as the large cockroaches invade structures in search of moisture. It is therefore important to eliminate all sources of moisture that contribute to cockroach survival.

- Tighten loose pipes, patch plumbing leaks and replace used washers in the kitchen sink and bathroom areas. Outdoor water spigots and sprinklers should also be checked for drips and leaks.
- Water left in the sink or bathtub after dish washing or bathing also provides moisture for cockroaches. These sources are eliminated by drying out sinks and bathtubs after use.
- A common source of moisture is condensation under the refrigerator. This area should be frequently wiped dry or, if possible, a pan should be placed under the appliance to collect water. The collection pan should be emptied frequently. Condensation on pipes (under the sink or in wall voids) is also a problem. Insulate these pipes if possible.
- Pet water dishes and aquariums are also sources of moisture. Empty pet water dishes at night when cockroaches are foraging but the pet is indoors or asleep. Aquariums should have tight-fitting lids or screens to prevent cockroach entry.
- Be careful not to overwater indoor plants, because excess water is available to cockroaches.
- Glasses, cups and soda cans containing water or liquid resi-

due are common sources of moisture for cockroaches. Be sure not to leave these containers in bedrooms, sinks, on countertops or other areas. Rinse and invert cups and glasses to dry immediately after use and dispose of soda cans in trash containers.
- Steps should be taken to eliminate places where water collects outdoors, such as tires, cans, and tree holes. This will not only eliminate cockroach moisture sources but also mosquito breeding habitat.

Elimination of Harborage Resources

The third critical element for cockroach survival is harborage. By nature, cockroaches avoid open, well lit areas with frequent air movement. They prefer dark, warm cracks and crevices. Excess clutter provides numerous locations suitable for cockroach habitation. The elimination of these harborages (clutter) is important in controlling infestations.
- Adult cockroaches can fit into cracks only 1.6 mm wide (about 1/16 of an inch). Any small gap or hole that leads to a void is a prime cockroach harboring area. Cracks and crevices of this kind should be sealed with a tube of caulking.
- Removing clutter such as boxes, bags, clothing, toys, food, books, and papers eliminates cockroach harborages and breeding areas. It is essential to keep all areas of the home, especially the kitchen and bathroom, uncluttered and free of useless debris.
- Outside, remove debris and trash from around the house.
- Stack firewood far away from the house, as this is a prime harborage area for peridomestic cockroaches.
- Filling in tree holes with cement also eliminates peridomestic cockroach harborage.
- Keep shrubbery and ornamentals well trimmed.
- Keep palm trees free of loose and dead palm branches and remove all palm debris.

Least Toxic Cockroach Management Strategies

After exclusion and sanitation measures have been taken, the next step is to decide on a treatment strategy. The most effective cockroach management strategies rarely eliminate the use of pesticides altogether but try to reduce the need for pesticide treatments by employing other less toxic methods. Many of these methods are currently being used in structures across the country. The following is a discussion of some of the nonchemical and reduced chemical control methods currently available for indoor and outdoor cockroach control.

The most recent technological advances in reduced toxic and nontoxic cockroach control have been in bait formulations and insect growth regulators. Other currently used nontoxic measures include desiccating dusts, traps and biological controls. Each of these treatment methods will be discussed in detail, including how they may be incorporated into a complete urban cockroach management program.

Note: Ultrasonic devices are frequently advertised as a nontoxic method of cockroach control. However, extensive research has shown that these devices neither kill nor repel cockroaches, so they are not included in the following discussion.

Cockroach Baiting

Cockroach baits consist of a toxicant mixed with a food source. Some baits also contain attractants or feeding stimulants that are supposed to make the bait more attractive to cockroaches than the other food sources that may be available in the immediate area.

Current indoor bait formulations are applied as dusts, pastes, gels, or bait stations. The bait station is one of the more popular application methods for cockroach baits. This is because the stations are easy to put out, safe around children and pets, and have residual activity.

Gel and dust-bait formulations are also very safe. They are formulated for injection into cracks and crevices that are harborages for cockroaches but not accessible to people.

Until recently, paste baits were very messy and required application with a putty knife. However, manufactures have improved these products by repackaging the bait material in easy-application syringes that are also suitable for bait-gun application. This greatly improves bait placement, allowing paste baits to be applied into cockroach harborages like the gel and dust formulations.

Almost all baiting products available for indoor use are formulated using one of the following active ingredients: hydramethylnon (Combat, Maxforce), chlorpyrifos (Raid Max), or abamectin (Avert). Combat and Maxforce are bait products using injectable gel formulations and the bait-station delivery system. Raid Max also is available as a bait station. Avert is available as a bait station, a gel aerosol, and a flowable bait dust that can be injected into cracks and crevices.

Outdoor baiting products are used primarily for the control of peridomestic cockroaches. Spreadable granular baits containing chlorpyrifos or bait stations with hydramethylnon bait are the most common formulations used for peridomestic cockroach control.

Spreadable baits usually are applied as a perimeter band around a structure. It is difficult to determine the residual longevity of these products, particularly in areas where precipitation is frequent. Even "weatherized" baits have difficulty retaining their residual properties where there is heavy rainfall. This is particularly true in the southeastern United States, where precipitation can ruin bait effectiveness within a single day.

Bait stations for peridomestic cockroaches are simply larger versions of those used for German cockroach baiting. The problem with this baiting system is that peridomestic species live and breed in outdoors in palm trees, woodpiles, tree holes, and other areas where bait stations are not suitable. The homeowner often wants the large bait stations placed inside the structure in order to kill peridomestic cockroaches that are caught foraging inside. This, however, does nothing about the population of cockroaches that continues to breed outdoors.

Insect Growth Regulators

Insect Growth Regulators (IGRs) are a group of compounds that disrupt the normal growth and development of insects. The IGRs are very safe compounds. They generally have very little toxicity to mammals because they act by disrupting the hormonal processes that are specific to insects.

IGRs that mimic the juvenile hormones of insects are called juvenile hormone analogues (JHAs). JHAs are chemical compounds whose structural chemistry is very similar to the hormones that the immature cockroach produces naturally. These hormones function in cockroaches roughly the same way as they do in humans. They send chemical messages throughout the body that regulate physiological changes. These changes facilitate the development of a juvenile into a reproductive adult. Juvenile hormone analogues disrupt this natural process. Specifically, JHAs interfere with the proper development of last-instar cockroach nymphs. Instead of the nymphs molting into reproductive adults they molt into "adultoids," which often have twisted wings and are sterile. The JHAs effect on the cockroach population is that as more and more cockroaches are exposed to the JHA, the adultoids begin to predominate. Because the adultoids are unable to reproduce, over time the cockroach populations begins to decline. JHAs are a very effective method of long-term German cockroach control. However, because JHAs eliminate reproduction but do not kill existing cockroaches, they are very slow acting (from four to nine months to achieve control). It is for this reason that JHAs often are combined with residual insecticides. In this manner most of the population can be eliminated quickly by the insecticide. Cockroaches that survive the insecticide treatment are then sterilized by the JHA.

Insect growth regulators are available in spray formulations or point source dispensers (where the IGR is released on a filter paper contained in a permeable plastic station, then transmigrates throughout the infested area). Hydroprene (Gentrol Point Source) is a JHA that is currently available for indoor cockroach control. Pyriproxifen (Nylar, spray formulation) recently joined the market and has shown good control in laboratory and field tests against German cockroaches. At this time there are no IGRs available for peridomestic cockroach control.

Chitin synthesis inhibitors (CSI) are another type of insect growth regulator that is being developed for use in management programs targeting a variety of insect pests. These compounds are faster acting than JHAs and can target a much larger range of sensitive stages in the cockroach life cycle. Exposure to CSIs results in the abnormal molting of nymphs, causing them to die during the molting process. CSIs also cause adult cockroaches to form abnormal egg cases and interfere with the hatching process. However, chitin synthesis inhibitors are not yet available commercially for cockroach control.

Inorganic Dusts

Inorganic dusts, such as silica gel and boric acid, have been used frequently for indoor cockroach control. The dusts are applied with a squeeze-bulb duster into cracks and crevices under sinks and stoves, behind refrigerators, along baseboards, and in electrical outlets, cabinets, and wall voids. Silica gel is simply finely ground sand or glass that adheres to and absorbs the protective waxes on the cockroach cuticle, resulting in cockroach death from dehydration. Boric acid is a stomach poison that is picked up by cockroaches walking across dusted areas. The boric acid adheres to the cockroach cuticle, so when the cockroach grooms itself it ingests the boric acid and soon dies.

Traps

One of the nonchemical tactics available for reducing a cockroach infestation involves the use of traps. Sticky traps (i.e., Roach Motel–type) can be purchased and placed indoors near the garbage, under the sink, in the cabinets, under and behind the refrigerator, and in the bathroom. Outdoors, sticky traps are not recommended because they tend to capture many nontarget animals (snakes, lizards etc.) and are not resistant to weathering.

A second trapping method is the use of baited jars. Any empty jar, such as pickle, mayonnaise, or peanut butter, with a rounded inside lip will suffice. Coat the inner lip of the jar with a thin film of Vaseline to keep trapped cockroaches from escaping. The jar should then be baited with a quarter slice of bread soaked in beer (a cockroach favorite). If beer and bread are unavailable try other foods like cookies, dog food or apples. The outside of the jar should be wrapped in paper towel so cockroaches have a surface to grasp as they climb up the sides of the jar. To kill trapped cockroaches simply pour dishwashing detergent into the jar and add hot water. The cockroaches can then be dumped outside or in the garbage. Wash out the jar and repeat the process every two to three days. Indoor jar traps should be placed in the same locations as those listed for sticky traps.

When trapping outdoors, jars should be placed in trees, tree holes, mulched areas, firewood, near garbage cans, compost piles, air conditioning units, and storage sheds. Covering the jars with a dome-shaped piece of aluminum foil taped to the sides will prevent rain from filling the traps. Jar traps are very suitable for outdoor use because they present no danger to nontarget organisms and are not easily damaged by weather.

Biological Controls

Almost all animals have natural enemies. Cockroaches are no exception. However, biological control is not always considered when we think of controlling a cockroach infestation. However, natural controls do play an important role in managing cockroach populations. Natural cockroach enemies include wasps, nematodes, spiders, toads and frogs, centipedes, birds, lizards, geckos, beetles, mantids, ants, and small mammals (mice). It is very important that these populations of natural enemies be maintained to help keep cockroach populations in check.

Oothecal Parasitoids

Parasitic wasps are the most important natural enemy of cockroaches. The wasps are parasitoids of the cockroach egg case (ootheca) and can have a severe effect on the cockroach reproductive potential. Most species of parasitoid wasps are associated with peridomestic cockroaches. The majority of these wasps are very tiny (1 to 5 mm) and do not sting humans. Peridomestic cockroaches like the American and smokybrown live in outdoor harborages such as palm trees, tree holes, and woodpiles. The parasitoids live with the cockroaches in the harborage, parasitizing their egg cases. When the adult male and female wasps emerge (from previously parasitized cockroach oothecae) they mate immediately. The female then begins to sting other oothecae, laying her eggs inside them. The wasp offspring hatch quickly and eat the cockroach embryos inside the ootheca. So when the ootheca hatches, adult wasps emerge instead of cockroach nymphs. This natural system results in 60 to 70 percent of all cockroach egg cases being parasitized without any human interference.

Oothecal wasp parasitoids have been tested for potential indoor use. Domestic populations of brownbanded cockroaches were successfully controlled in a California animal rearing facility by these wasps. However, it is doubtful that parasitoid wasps will ever be reared for commercial use. Very few individuals would welcome a population of 200,000 wasps in their home even if they promised to eliminate a severe cockroach infestation.

Note: Wasp parasitoids are extremely susceptible to pyrethroid insecticides. When attempting to eliminate an outdoor cockroach infestation it is important to realize the insecticide applications in peridomestic cockroach harborages may not kill all of the cockroaches, but it certainly will eliminate the parasitoids. This can result in future cockroach problems as surviving cockroaches can reproduce unchecked the following year. The application of bait around an infested area is the best way to treat a population of peridomestic cockroaches and preserve the wasp parasitoids.

Summary

German cockroaches are the most important pest in the indoor environment. Peridomestic cockroaches live primarily outdoors but often invade structures looking for food, warmth, or moisture. The treatment measures for indoor versus outdoor cockroaches is very different, so it is extremely important that a problem cockroach population be correctly identified. Once the cockroach and its habitat have been determined, the magnitude and location of the population needs to be evaluated. This can be done by performing a thorough inspection in and around the structure and monitoring with traps. The population information should then be used to choose treatment strategies. A combination of treatments is recommended for a complete approach to cockroach management. Several least toxic treatment choices are available for cockroach control. They include bait products (available for indoor and outdoor use), insect growth regulators (IGRs), inorganic dusts and traps. Oothecal parasitoids occur as a biological control for peridomestic cockroaches. However, these wasps are very sensitive to insecticides and should be protected from outdoor applications, particularly those involving pyrethroids.

IPM for Cockroaches in Schools

Edited by Dini Miller; originally written by S. Darr, T. Drlik, H. Olkowski, and W. Olkowski.

Introduction

Cockroaches are the most important pest in schools, homes, restaurants, and other indoor spaces. They consume human foods and contaminate them with saliva and excrement. Infested buildings are easily detected by a characteristic fetid odor that is produced by the cockroach bodies and fecal material. Additionally, cockroach feces and cast skins contain allergens. The allergens can become airborne and cause allergic reactions, asthma and other bronchial problems in persons inhabiting infested buildings.

Cockroach and Biology

German cockroach

Brownbanded cockroach

Except for size and markings, all cockroaches are similar in overall appearance: flattened, oval insects with long legs and antennae. The most common pest cockroaches in the United States can be divided into two groups: domestic — small cockroaches that live only in human structures — and peridomestic — larger cockroaches that generally live outdoors but occasionally invade structures. The most common domestic cockroach pests are the German and brownbanded cockroaches. The most common peridomestic cockroaches in the United States are the American, brown, smokybrown and oriental cockroaches.

The Asian cockroach, *Blattella asahinai*, has recently become established in Florida. This species looks identical to the German cockroach but lives exclusively outdoors and flies readily. Because of its great reproductive potential it has already become a significant pest in gardens, lawns, landscaping, groves, and agricultural areas.

In general, cockroaches like to squeeze into warm cracks and crevices, but the specifics of their habitat differ with the species of cockroach. The German cockroaches prefer moist kitchen and bathroom areas, while brownbanded cockroaches are most often found in the dryer living and bedroom areas. Additionally, American and oriental cockroaches are generally found in very high-moisture habitats like sewers, base-

ments, and mulch. However, smoky-brown cockroaches are more often found in dryer areas like treeholes and attics.

The life cycle of the cockroach begins with the egg case, or ootheca. In German and Asian cockroaches the female carries the egg case around with her until just before the eggs hatch. The brownbanded and peridomestic cockroaches deposit the egg case in a sheltered place. Cockroaches undergo a gradual metamorphosis in their life cycle. An immature cockroach, or nymph, looks very much like an adult but is smaller and wingless. As the nymph grows, it sheds its skin (molts) a number of times. The time it takes a cockroach to develop is influenced to some degree by temperature. The nymphal cockroaches develop more rapidly when it is warm. Thus populations of cockroaches can become extremely large during the summer months.


American cockroach


Brown cockroach


Smokybrown cockroach


Oriental cockroach


Egg case


Cockroach nymph

Cockroaches prefer carbohydrates to protein and fat. They will discriminate among foods if given a choice, but when hungry they eat almost anything. Some products not normally considered food — starch-based paints, wallpaper paste, envelope glue, and bar soaps — contain carbohydrates, and hence are food for cockroaches.

Cockroaches are generally active at night and remain hidden during daylight. Daylight sightings usually indicate a large population that has overrun available harborage, or a recent emigrant cockroach seeking shelter.

Damage

Cockroaches have not yet been proven to be involved in the natural transmission of any particular human pathogen (this means that they are not a necessary part of the life cycle of a disease organism or documented as the cause of any disease outbreak). However, evidence has been collected that clearly indicates that cockroaches can mechanically transmit a long list of disease-causing organisms. Because cockroaches wander at will through all types of organic wastes, then travel over kitchen counters, cooking utensils, food, plates, and silverware, their presence indicates potential contamination of foods and utensils. However, the most important health issue associated with cockroaches is the production of allergens, which can cause severe bronchial problems in sensitive adults and children.

Inspection and Monitoring

Efforts to control cockroaches should begin with a thorough visual inspection and a continuous monitoring program. Cockroaches are rarely dispersed everywhere throughout the building. Once they have located a suitable harborage they tend to concentrate there, leaving periodically to forage for food and water, then returning to the same place. Thus, the first step in the visual inspection is to locate potential cockroach harborage sites. This should be followed by monitoring the area to locate specific cockroach concentrations. Monitoring of infestation sites must continue after treatment to determine whether control efforts have satisfactorily reduced the cockroach population.

Visual Inspection

- Construct a map of the premises.
- Mark all the locations where cockroaches are sighted, or where you see signs of their presence, such as fecal matter, shed skins, and egg cases.
- Mark any places that are likely harborage or food sources.
- Note any sanitation problems such as food or grease spills, food or grease buildup behind or under kitchen equipment, or improper garbage disposal procedures.
- Note any leaks or condensation.
- Look for cockroach entry points, such as holes in walls or floors or around pipes where they enter a wall, around electrical conduits, or in vents.
- See Tools Used to Inspect and Monitor for Cockroaches.

Tools Used to Inspect and Monitor for Cockroaches

- **Flashlight.** Use a heavy-duty, corrosion-resistant model with a bright-colored body, shatter-proof lens, and halogen bulb. A smaller halogen flashlight with a flexible neck is useful in tight, confined locations. Flashlight holders that can be attached to a belt are available.
- **Telescoping Mirror.** Use a furnace inspector's or mechanic's metal mirror with a telescoping handle and rotating head. To illuminate areas inside equipment, fixtures, etc., reflect the flashlight beam off the mirror.
- **Clipboard and Pen.** Use the clipboard to carry monitoring forms and floorplans during inspections.
- **Floorplan Maps and Building Plans.** Carry a floorplan with the major equipment and fixtures marked. In large buildings, construction drawings that show utility lines, heating/cooling ducts, shaft connections, and pipe chases are very useful for locating entry points, harborages, and runways.
- **Sticky Traps.** These are used to locate harborage areas and estimate populations.
- **Flushing Agent.** A pocket-sized can of pressurized air is

useful for spot-flushing roaches out of inaccessible areas where trapping is not sufficient.

- **Utility Tools.** A pocketknife equipped with various blades, screwdrivers, and forceps allows you to open grills, electrical boxes, and other equipment for inspections. Carry small vials and adhesive labels to collect cockroach specimens. A 10-power (10x) hand lens (small magnifying glass) will help you identify roach species. Colored adhesive labels can be used to mark hotspots and locations of traps and bait stations. These tools can be stored in a tool pouch worn on a belt.
- **Knee Pads and Bump Cap.** These are useful when crawling around for floor-level inspections.
- **Camera.** A Polaroid or digital camera is useful for communicating specific conditions (e.g., unsanitary conditions; areas needing pest-proofing) in reports to decision-makers or sub-contractors not on the premises.

How and Where to Inspect

When inspecting for cockroaches, define the specific area on your map that is to be inspected. Inspect the entire area in a systematic and logical fashion from floor to ceiling to make sure no potential harborage areas will be overlooked. Be sure to inspect:

- Under, behind, and around sinks, toilets, showers, bathtubs, drinking fountains, ice machines, dishwashers, beverage dispensers, and floor drains;
- The engine compartments of refrigerators, beverage dispensers, toasters, air conditioners, and other equipment;
- In and under stoves, hot plates, heaters, and near hot water pipes and radiators;
- In and around stove vents, hoods, and grease traps;
- Between equipment and walls and between adjacent appliances;
- Behind picture frames, mirrors, bulletin boards, and wall-mounted shelving;
- In false ceilings, vents, light fixtures, ceiling-mounted fixtures, and railings;
- In cupboards, linen closets, drawers, filing cabinets, lockers, and cluttered areas;
- In and under cash registers, computers, telephones, electric clocks, televisions, switchboxes, and fuse boxes;
- In and around check-out stands, vegetable bins, and meat counters;
- Cracks and crevices in walls and baseboards;
- Under edges and in corners of equipment, tables, desks, counters, and other furnishings and equipment;
- Indoor and outdoor trash containers, dumpsters, and recycling containers; and
- Loading docks and storage areas where incoming food, supplies, equipment, and other potential sources of migrating cockroaches are received and stored.

When to Inspect

Most inspections are conducted during daylight hours for the convenience of the inspector. However, since cockroaches tend to remain hidden during the day it is difficult to access the size and location of the population until after dark. Therefore, be sure to schedule at least one inspection after dark, when the majority of the population is active. This will give you more information about where the cockroaches are and the level of sanitation at a time when the building is supposed to be clean. Begin your inspection with the lights off if possible. A flashlight covered with a yellow filter (Roscoe #12) will prevent the cockroaches from being disturbed while you look for their harborages and sources of food and water. Then turn on the lights and examine areas where cockroaches were observed. Note this information on your map.

Flushing

Flushing is a method of locating cockroach harborages that are difficult to see or reach. Usually a repellent pyrethroid insecticide is sprayed into a suspicious crack or crevice to drive out cockroaches. There are several disadvantages to flushing. First, it displaces the cockroaches, causing them to scatter and possibly disturb employees in the area. Also, it makes the harborage repellent so that cockroaches will not return to it before treatment.

Flushing should not be necessary, especially if you conduct thorough inspections and include at least one night inspection. However, if you do encounter situations where flushing is necessary you can use pressurized air (available in an aerosol can) or a hair dryer. In this way scattered cockroaches will soon return to the harborage where they can be monitored and treated.

Monitoring with Sticky Traps

A visual inspection may not provide all the information you need about where cockroaches are harboring or how many cockroaches there are; you may need to use sticky traps as well. Many brands of sticky traps are available, but most are of a similar design — a rectangular or triangular cardboard box with bands of sticky glue inside and, in some models, a dark strip of cockroach attractant.

The best sites for traps are near harborages and along cockroach travel routes. Cockroaches may not find traps in open locations or outside their normal routes of travel. Initially, it is best to put out traps at all suspected harborages, water resources and travel routes. However, avoid placing traps in extremely dusty or moist areas because they will quickly lose their stickiness.

The more traps used, the sooner the concentrations of cockroaches can be located. Later, you can use fewer traps for ongoing monitoring. Try to "think like a cockroach" as you decide where to place the traps. Your monitoring map and the following examples will help you to determine the best spots.

Trap Locations

Keeping in mind the habitats preferred by cockroaches (refer to table), place the traps in the following types of locations:

- Near and under sinks and stoves;
- In or near motors of refrigerators and other appliances or vending machines;
- In or near electric clocks, switch plates, and conduits;

- Next to computer equipment (where possible);
- Near leaky plumbing fixtures;
- Near steam pipes or hot water pipes with insulating jackets;
- Near drains;
- In drawers and cupboards;
- In closets, on their floors and upper shelves;
- In false ceilings or subfloor areas; and
- In areas where packaged goods and equipment are delivered and stored.

Trap Placement
Cockroaches are thigmotropic which means they like to travel along edges where vertical and horizontal surfaces intersect (i.e.: where the floor and wall come together). So it is important that traps be placed flush against the vertical surface or the cockroaches may continue to travel behind the trap without ever entering it. Examples of edge intersections include:
- Floors and wall junctions;
- Floors and cabinets or other solid furnishings;
- Floors and appliances (stoves, refrigerators, vending machines);
- Sink counters and walls; and
- Hanging cabinets or shelves and walls.

Number and date each trap before you put it out. At the time of placement, mark trap location on your monitoring map. After 24 to 48 hours, pick up the traps, then count and record the number of cockroaches in each trap. Record the date and the number of cockroaches on the monitoring form.

Evaluating Trap Counts
Use the trap counts located on your map to pinpoint sites of infestation. Traps with high numbers of cockroaches indicate nearby harborages, and this is where management efforts should be concentrated. Large numbers of adult cockroaches in the traps can indicate a potential population explosion.

Post Treatment Monitoring to Evaluate Efficacy
After the initial monitoring to pinpoint sites of infestation, treatment efforts can be concentrated at these locations. A week or two after treatment, monitors should again be placed at the infestation sites to see how well the treatment efforts are working. Place fresh traps at the locations indicated on your map and count the number of cockroaches in the traps after 24 hours. If the trap catch has dropped considerably, the cockroach population has declined and progress has been made. If not, another treatment strategy should be considered and greater efforts must be made to eliminate food, water, and harborage resources. In order to assess the continued success of treatments and detect any new infestations, continue to monitor after the IPM program is under way. Vigilance is important and good record keeping will save time and energy.

Continuous Monitoring
To avoid future infestations monitoring should be continued on a monthly or quarterly basis. This will alert pest control personnel to a new invasion before a population can become established. Cafeterias and other food-handling locations should be monitored at least once a month because of the constant transport of food and packaging (that may contain cockroaches) in and out of these areas.

Establishing a Communication System
A successful monitoring program depends on clear and frequent communication with principals, teachers, custodians, and food service personnel. These people have first-hand knowledge of pest sightings, sanitation problems and other contributing factors, as well as the history of control measures in their buildings. With a small investment in time, school personnel can be trained to serve as additional sources of valuable information for the monitoring program.

Make sure personnel understand the following:
- The goals of the cockroach IPM program and the role monitoring plays.
- Their role in the IPM program (what they can do to help reduce the number of cockroaches and the kind of information they can provide).
- How they can communicate with the pest management technicians (you may want to post log sheets in various locations where people can write down pest sightings and other information).

Management Options

Education
Food service and custodial staff play an essential part of any successful cockroach management program. Provide them with information on how to maintain cockroach-free kitchens, dining rooms, and waste disposal areas by applying the methods described below. Teachers, students, and other staff also play a significant role in maintaining a high level of sanitation in other areas of the school, so they must be informed of their responsibilities in that regard.

Habitat Modification
Cockroaches need food, water, and harborage to survive. By modifying the environment of an infested building, you can reduce cockroach access to these resources. A few well-placed alterations will produce a long-term reduction in the capacity of the structure to support cockroaches. It is important to note that the simple act of limiting food, water, and harborage resources will dramatically reduce the number of cockroaches an environment can support.

Limiting Areas for Eating
If you expect to contain and limit pest problems (ants and rodents as well as cockroaches), it is very important to designate appropriate areas for eating and to enforce these rules. The fewer designated areas, the easier it will be to limit the pests.

Proper Food Storage
- Food not kept in the refrigerator should be kept in sealed containers. Cardboard boxes and paper are not cockroach-proof.

- Screw-top jars are cockroach-proof only if the lid has a rubber seal, since young cockroaches may be able to follow the spiral ridges to get into the jar.
- Glass containers with rubber gaskets or plastic containers with tight-fitting, snap-top lids are cockroach-proof.
- Remove food products from cardboard shipping containers before moving them into kitchens or storage areas. Transfer food packaged in cardboard or paper to plastic or glass containers as soon as the food arrives in the building. Do not bring shipping boxes into the food preparation area.
- Advise students and teachers not to leave unsealed food items in their desks or lockers. Any food kept in offices or classrooms should be stored in ant- and cockroach-proof containers.

Eliminating Water Sources

German cockroaches can survive for a couple of weeks without food, but they must have regular access to moisture or they will die within a few days. Cockroaches find drinking water in:

- Sink traps;
- Appliance drip pans;
- Drain pipes;
- Wash basins and tubs;
- Toilet bowls and flush tanks;
- Spills;
- Condensation on cold-water pipes and windows;
- Leaky pipes and faucets;
- Pet dishes and aquariums;
- Vases;
- Beverage bottles; and
- Various high-moisture foods.

Much can be done to limit this supply by increasing sanitation and making repairs. Clean up spills and dispose of drink containers immediately after use. Keep aquariums and terrariums sealed with tight-fitting screened lids. Repair leaks and dripping faucets, then drain or ventilate moist areas. Kitchen surfaces should be kept dry when they are not in use, especially overnight.

Eliminating Cracks and Crevices

- Start by caulking where cockroach populations are highest. If cockroaches remain a problem, caulk additional areas.
- Use silicon caulk or mildew-resistant caulk around sinks, toilets, and drains.
- Before beginning the sealing process, vacuum and wash the area to eliminate egg cases, fecal material, and other debris.
- Caulk or paint over cracks around baseboards, wall shelves, cupboards, pipes, sinks, toilets, and similar furnishings in the locations indicated by monitoring trap catch.
- Repair holes in window screens.
- Weather-strip around doors and windows where cockroaches may enter.
- Where gaps can't be sealed, they can be widened to make them less attractive to cockroaches. For example, the crack between free-standing shelving and adjacent walls can be widened by simply moving the shelving one inch away from the wall.

Eliminating Clutter

Clutter creates a complex environment that provides a multitude of harborages in which cockroaches can live and breed. The removal of clutter is one of the most important components of cockroach management. All useless, idle or outdated items should be removed from the premises. Also, the need for in-house storage of food products and paper goods should be kept to a minimum.

Installing Cockroach-proof Fixtures and Appliances

Whenever food preparation areas are scheduled for remodeling, the school district can take the opportunity to install cockroach-proof kitchen appliances and fixtures, such as stainless-steel open shelving units. The round shape of the metal and the general openness of the design offer few hiding places for cockroaches. Free-standing storage units and appliances on castors enable them to be rolled away from walls to facilitate thorough cleaning.

Removing Vegetation

Peridomestic cockroaches live primarily outdoors in tree holes, mulch, or vegetation. In cases where these cockroaches periodically invade the school buildings, it may be necessary to remove planter boxes, mulch, vegetation, or other landscaping in the adjacent area.

Sanitation

Sanitation disrupts and eliminates cockroach resources. This disruption of the environment can play a significant role in slowing cockroach population growth. Sanitation creates an additional advantage by making the cockroach environment so barren that they have a much greater chance of contacting toxic baits or insecticidal dusts (see Chemical Controls below).

Thorough daily cleaning is essential:

- Sweep and mop the floors.
- Drain all sinks and remove any food debris.
- If children regularly receive snacks in classrooms, vacuum and/or mop these floors daily.
- Periodically give food preparation areas an all-inclusive cleaning, focusing on areas where grease accumulates: drains, vents, deep fat fryers, ovens, and stoves. Steam-clean drains and infested appliances. Thoroughly vacuum the area with a powerful vacuum cleaner (see the section below on vacuuming).
- At the end of each day, remove from the building all garbage containing food to prevent cockroaches from feeding at night.
- Use soapy water to wash any bottles, cans, wrappings, and other items that have food residues clinging to them before storing them for recycling.
- If dishes cannot be washed right away, it is very important

that they at least be rinsed to remove all food debris.
- Place garbage in sealed plastic bags before it is placed into a rodent-proof dumpster or other storage receptacle.
- Keep garbage cans and dumpsters as clean as possible to deny food to cockroaches as well as ants, flies, mice, and rats.

Although sanitation does much to prevent and curb cockroach infestation, an existing population cannot be controlled by sanitation alone.

Physical Controls

Mechanical Barriers

Peridomestic cockroaches can travel up the outside of buildings and enter through open windows, weep holes, or ventilation ducts. Screening these openings will prevent cockroaches from using these entry points. Screens can also be placed behind grill covers, and over vents and floor drains to prevent cockroach entry. Use caulk around the edges of the screen material to make a complete seal.

Domestic and peridomestic cockroaches can travel within and between buildings on runways formed by electrical conduits, heating ducts and plumbing pipes. Seal openings around these runways with caulk, steel wool, or screening material.

Vacuuming

A strong vacuum can be used to pick up live cockroaches as well as their egg cases and droppings. If the vacuum is capable of filtering out very small particles (0.3 microns), it will greatly reduce the amount of cockroach debris that can become airborne during cleaning. Airborne cockroach debris (fecal material, body parts, and cast skins) can cause allergic reactions in sensitive people.

If the cockroach population is large, vacuuming is a quick way of reducing the population immediately. Once a large portion of the population has been eliminated it is much easier to effect the remaining cockroaches with your treatment measures.

Trapping

In certain limited situations traps can be used to reduce cockroach numbers. Traps should be placed near suspected harborages and water sources but removed after a few days or they may begin to smell. Although traps often capture a number of cockroaches they rarely, if ever, achieve a significant degree of control.

Chemical Controls

If nonchemical methods alone prove insufficient to solve the problem, then integrating a pesticide into your management program may be warranted.

Pesticides must be used in accordance with their EPA-approved label directions. Applicators must be certified to apply pesticides and should always wear protective gear during applications. All labels and Material Safety Data Sheets (MSDS) for the pesticide products authorized for use in the IPM program should be maintained on file. Do not apply these materials when buildings are occupied, and never apply them where they might wash into the sewer, storm drains, or any body of water.

When insecticides are needed, they should be applied as crack-and-crevice treatments or in a bait formulation. Broadcast spraying of insecticides greatly increases exposure risk and can lead to cockroach resistance when the pesticide residual activity begins to decline and cockroaches are exposed to sublethal doses. Note: Do not use spray formulation insecticides around computers, where they may short-circuit the equipment. Plastic bait stations can be placed in and around computer equipment if cockroaches establish a harborage inside.

Control Strategies

The most recent technological advances in cockroach control have been in bait formulations and insect growth regulators. Other currently used products include desiccating dusts. Each of these treatment methods will be discussed in detail, including how they may be incorporated into a complete integrated cockroach management program.

Cockroach Baiting

Cockroach baits consist of a toxicant mixed with a food source. Some baits also contain attractants or feeding stimulants that are supposed to make the bait more attractive to cockroaches than the other food sources that may be available in the immediate area.

Current indoor bait formulations are applied as bait stations, gels, dusts, or pastes. The bait station is one of the more popular application methods for educational facilities. This is because the stations are easy to put out, they are safe around children and animals, and have residual activity. Gel and dust bait formulations are also very safe and are packaged for injection into cracks and crevices that are not easily accessible. Until recently, paste baits were very messy and required application with a putty knife. However, manufactures have improved these products by repackaging the bait material into plastic syringes that are also suitable for bait-gun application. This greatly improves bait placement, allowing paste baits to be applied into cockroach harborages like the gel and dust formulations.

Almost all baiting products available for indoor use are formulated using one of the following active ingredients: fipronil (Maxforce/Combat), hydramethylnon (Siege), chlorpyrifos (Raid Max, Ortho), or abamectin (Avert). Combat/ Maxforce are bait products using injectable gel formulations and the bait-station delivery system. Siege bait is available as an injectable gel in a syringe and bait gun. Raid Max is available as a bait station. Ortho is a granular formulation for use outdoors. Avert is available as a bait station, a gel aerosol, and a flowable bait dust that can be injected into cracks and crevices.

Domestic Cockroach Baiting

- Small amounts of bait placed in numerous locations work far better than large blobs of baits placed in central areas.
- Put bait near harborages and between harborages and water sources. Review the Monitoring section for examples of cockroach harborage, and use the information collected from your monitoring traps.
- Once you have pinpointed harborage areas, place the baits along edges or in places where cockroaches are most likely to travel or congregate.
- Sometimes an inch one way or the other can make all the difference in bait placement. If air currents are moving the bait odors away from the cockroach harborage, they may never find the bait.
- Do not place gel or paste baits in areas where they may get covered with grease, flour, or dust. In areas where this might be a problem, bait stations should be used.
- Avoid harsh environmental conditions when baiting. In excessively warm areas baits can melt and run. In cold environments the cockroaches do not move far and may miss the bait. In very wet environments the baits may grow mold and become unattractive to cockroaches.
- Check baits frequently to make sure that they have not been completely consumed or inadvertently removed by cleaning.

Peridomestic Cockroach Baiting

Outdoor baiting products are used primarily for the control of peridomestic cockroaches. Spreadable granular baits containing chlorpyrifos or bait stations with hydramethylnon bait are the most common formulations used for peridomestic cockroach control. Spreadable baits are usually applied as a perimeter band around a structure. It is difficult to determine the residual longevity of these products, particularly in areas where precipitation is frequent. Even "weatherized" baits have difficulty retaining their residual properties where there is heavy rainfall. This is particularly true in the southeastern United States, where precipitation can ruin bait effectiveness within a single day. Bait stations for peridomestic cockroaches are simply larger versions of those used for German cockroach baiting. The problem with this baiting system is that peridomestic species live and breed outdoors in palm trees, tree holes, and other areas where bait stations are not suitable. The large bait stations can be used to capture peridomestic cockroaches caught foraging inside, but this does nothing about the population of cockroaches that continues to breed outdoors.

Insect Growth Regulators (IGRs)

Insect growth regulators (IGRs) are a group of compounds that disrupt the normal growth and development of insects. The IGRs are very safe compounds. They generally have very little toxicity to mammals because they act by disrupting the hormonal processes specific to insects.

IGRs that mimic the juvenile hormones of cockroaches (and other insects) are called juvenile hormone analogues (JHAs). JHAs are chemical compounds whose structure is very similar to the hormones that immature cockroach produces naturally. These hormones function in cockroaches roughly the same way as they do in humans. They send chemical messages throughout the body that regulate physiological changes. These changes facilitate the development of a juvenile into a reproductive adult.

Juvenile hormone analogues disrupt this natural process. Specifically, JHAs interfere with the proper development of last instar cockroach nymphs. Instead of the nymphs molting into reproductive adults they molt into "adultoids", which often have twisted wings and are sterile. As more and more cockroaches are exposed to the JHA, the adultoids begin to predominate. Because the adultoids are unable to reproduce, over time, the cockroach population begins to decline. JHAs are a very effective method of long-term German cockroach control. However, because JHAs eliminate reproduction but do not kill existing cockroaches, they are very slow acting, taking from four to nine months to achieve control. It is for this reason that JHAs often are combined with residual insecticides. In this way most of the population is eliminated by the insecticide, yet immature cockroaches that survive are sterilized by the JHA.

Insect growth regulators are available in spray formulations or point-source dispensers (where the IGR is released on a filter paper contained in a permeable plastic station, then transmigrates throughout the infested area). Hydroprene (Gentrol Point Source) is a JHA that is currently available for indoor cockroach control and is labeled for use in kitchens and food preparation areas. Pyriproxifen (Nylar, spray formulation) recently joined the market, but is not labeled for use in kitchens. At this time there are no IGRs available for peridomestic cockroach control.

Inorganic Dusts

Inorganic dusts, such as silica gel and boric acid, have been used frequently for indoor cockroach control. These dusts can be applied with a squeeze-bulb duster into cracks and crevices under sinks and stoves, behind refrigerators, along baseboards, and in electrical outlets, cabinets and wall voids. Silica gel is simply finely ground sand or glass that adheres to and absorbs the protective waxes on the cockroach cuticle, resulting in cockroach death from dehydration. Boric acid is a stomach poison that is picked up by cockroaches walking across dusted areas. The boric acid adheres to the cockroach cuticle so when the cockroach grooms itself it ingests the boric acid and soon dies.

Summary

German cockroaches are the most important pest in the indoor environment. Peridomestic cockroaches live primarily outdoors but often invade structures looking for food, warmth, or moisture. The treatment measures for indoor versus outdoor cockroaches is very different, so it is extremely important that a problem cockroach population be correctly identified. Once the cockroach and its habitat have been determined, the magnitude and location of the population needs to be evaluated. This can be done by performing a thorough in-

spection in and around the structure and monitoring with traps. The population information should then be used to choose treatment strategies. A combination of treatments is recommended for a complete approach to cockroach management. Several least toxic treatment choices are available for cockroach control.They include bait products (available for indoor and outdoor use), insect growth regulators (IGRs), inorganic dusts and traps.

Sample IPM Programs

Sample IPM Program for a Cockroach Infestation in a Kitchen

- Use sticky traps to locate cockroach habitat and prioritize areas to be treated.
- Knock down the cockroach population by vacuuming areas where traps indicate cockroaches are harboring; steam-clean infested kitchen equipment and appliances if possible.
- Initiate an education program for students, staff, custodians, and building maintenance personnel to gain cooperation for the next steps.
- Improve sanitation and waste management procedures to reduce cockroach food sources.
- Reduce cockroach access to water and habitat by repairing water leaks, caulking cracks, and scheduling other building repairs.
- If the previous activities have failed to reduce cockroach numbers sufficiently, apply insecticidal dusts, baits, or gels in cracks and crevices in hard-to-clean areas. Blow boric acid or silica aerogel into wall or ceiling voids, underneath appliances, or in other inaccessible areas where roaches harbor.
- After the cockroach population has been reduced, apply an insect growth regulator to help prevent future cockroach problems.
- Monitor weekly and fine-tune management methods as needed until the problem has been solved. Continue monitoring monthly or quarterly to insure sanitation measures are maintained and to detect any incipient buildup of cockroach numbers.

Sample IPM Program for a Cockoach Population in an Office or Classroom

- Initiate an education program for students, staff, custodians, and building maintenance personnel to gain cooperation with the program.
- Since monitoring and management activities will probably involve desks, computers, lighting fixtures, and other equipment in use by staff, it is essential that they be given prior warning of work to be done and that the problem cannot be solved without their cooperation.
- Vacuum areas where traps indicate cockroaches are harboring.
- Improve sanitation and waste management in office, snack, and lunch areas to reduce cockroach food sources.
- Caulk cracks and schedule other building repairs to reduce cockroach habitat.
- Place sticky traps to locate cockroach habitat and prioritize areas to be treated.
- If traps indicate cockroaches have infested computers or other electrical equipment, place insecticidal bait stations next to infested machines. Never put baits directly on or inside computers or electrical equipment. Never use aerosol insecticides around computers because of the danger of shorting out the equipment. Give office and custodial staff a map showing where bait stations have been placed, and request that the stations not be moved.
- If traps indicate that cockroaches have infested electrical conduit and are moving into the room through lighting switch plates, spot-treat the switch box with insecticidal bait, gel, or dust.
- If traps indicate storage boxes containing paper files are infested with cockroaches, treat with bait station or tiny gel-bait placements.
- Apply insecticidal bait, gel, or dust in cracks and crevices, and blow insecticidal dusts into wall or ceiling voids, underneath counters, or in other inaccessible areas where roaches harbor.
- After the cockroach population has been reduced, apply an insect growth regulator to help prevent future roach problems.
- Be sure to monitor after treatment to make sure that the treatment efforts are reducing the population.
- Continue monitoring on a monthly or quarterly basis to ensure that new infestations are detected before they get out of control.

Pests: Fleas

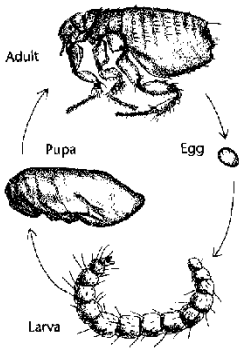
IPM for Fleas in Schools

Edited by D.L. Richman; originally written by S. Darr, T. Drlik, H. Olkowski, and W. Olkowski

Introduction

Fleas can be a problem in all parts of the country except in very dry areas. The most common species in school buildings is the cat flea, *Ctenocephalides felis*. This flea feeds on cats, dogs, and humans, as well as rodents, chickens, opossums, raccoons, and other animals. The dog flea, *C. canis*, and the human flea, *Pulex irritans*, are less commonly encountered.

Identification and Biology



Adult cat fleas are small (1/16 inch long), wingless insects possessing powerful hind legs that are adapted for jumping and running through hair. The adult body is reddish-brown to black, oval, and compressed laterally. Unlike many other flea species, adult cat fleas remain on their host. After mating and feeding, adult female fleas lay oval, white eggs. These smooth eggs easily fall from the host into cracks, crevices, carpet, bedding, or lawn covering. A mature female flea can lay up to 25 eggs per day for three weeks.

Small, wormlike larvae (1/16 to 3/16 of an inch long) hatch from the eggs within 48 hours. They are eyeless, legless, and sparsely covered with hairs. The larval body is translucent white with a dark-colored gut that can be seen through their skin. They feed on adult flea feces, consisting of relatively undigested blood, which dries and falls from the host's fur. They will also eat dandruff, skin flakes, and grain particles. Larvae develop on the ground in areas protected from rainfall, irrigation, and sunlight, where the relative humidity is at least 70 percent and the temperature is 70 F to 90 F. This stage lasts eight to 24 days, depending on the temperature and humidity.

These immature fleas will eventually spin silken cocoons in which they will develop (pupate) into adult fleas. Cocoons are sticky, attracting dirt and debris, which will easily camouflage them. Under optimal conditions, new adults are ready to emerge from their pupal cocoons within two weeks. They can, however, remain in their cocoons up to 12 months in the absence of a host or favorable climatic conditions. Vibrations and/or elevated temperature stimulate adults to emerge. This ability of flea pupae to wait until a host arrives can result in a sudden increase of adult fleas, when they emerge simultaneously from many accumulated flea pupae.

As soon as the adult fleas emerge from the pupal case, they look for a host for their first blood meal. Adults can live one to two months without a meal and can survive up to six months with one. They are the only stage that lives on the host and feeds on fresh blood.

These variations in flea development time account for the sudden appearance of large numbers of adult fleas in "flea season," usually in the late summer and early fall. The flea population has been building up all year long in the form of eggs, larvae, and pupae, but rapid development into biting adults cannot be completed until the temperature and humidity are optimal and host cues signal for adult emergence from the pupal cocoon.

Associated Problems

Flea bites cause irritation, but also serious allergies in animals and humans. Other more serious and less common problems are associated with the cat flea. Cat fleas can carry or transmit various organisms, such as *Yersinia pestis*, which causes bubonic plague; *Rickettsia typhi*, which causes murine typhus; and *Dipylidium caninum*, the double-pored dog tapeworm, which can live in dogs, cats, or humans. Tapeworms are transmitted to a vertebrate host via ingestion of an adult flea carrying a tapeworm cyst.

Detection and Monitoring

Fleas can be a problem in schools even when no pets are kept in the buildings. Adult fleas can be brought in on the clothing of staff, students, or visitors. Other possible sources include urban wildlife such as rats, feral cats, raccoons, opossums, chipmunks, squirrels, or birds that may live in unused parts of the buildings. Detection is as simple as seeing fleas or noticing bites around the ankles of people in the building. Flea dirt, the adult flea feces that dries and falls off the host to serve as food for larvae, may be visible. Tapeworms, transmitted to a human via ingestion of an infected flea, would also signal a flea infestation.

Areas to Monitor

- In and around the cages of pets kept in classrooms (also check the pets themselves for signs of fleas);
- Places where animals might find harborage, such as basements, crawl spaces, attics, eaves, rooftop structures, and secluded shrubbery; and
- Near buildings.

Monitoring Traps

Flea Sock Traps

These are homemade, knee-high, white flannel booties that fit over the shoes and lower pant legs. When you walk through a flea-infested area, fleas will jump onto the flannel and become temporarily entangled in the nap, where you can easily see and count them. Long, white athletic socks worn over the shoes and trouser legs will also work, as well as wide strips of sticky-backed paper wrapped around the lower legs (sticky

side out). Socks can also provide protection from bites if a person must enter a severely flea-infested area for a short time.

Light Traps
These compact (roughly 4 x 6 inch) traps are composed of a small electric light and a sheet of sticky paper. Adult cat fleas looking for a host may be attracted to the warmth and light of the trap. Research has shown that fleas are most sensitive to green light and are more attracted to light traps if the light is turned off for 10 seconds every five to 10 minutes. Therefore, it is important to choose a trap with a green light that can flicker on and off.

Light traps are especially useful for monitoring in office situations where no animals are present and the flea population is likely to be small. Check the traps once a week. If no fleas are caught by the second week, move the trap to another location or remove it. If the traps catch only a few fleas, the infestation is very small and can probably be controlled by the traps alone. In this case, leave the traps in place until no additional fleas have been caught for a week. If 20 or more fleas are caught per trap in a week, this probably indicates a more serious infestation, and time must be devoted to finding the source of the infestation (such as an animal living in or under the building).

Persistent Flea Problems

Persistent flea problems in buildings where there are no pets may indicate the presence of rodents or other wildlife. In this case it can be useful to have the fleas identified by a professional. When the flea species is not the cat flea, its identity can help determine the host animal and where to search to find the animal or its nest.

Management Options

An integrated management program for fleas can be designed by selecting from the following strategies and tactics.

Nonchemical Controls

Wild Animal Removal
Wild animals can be removed with traps by trained animal control technicians. Consult your Yellow Pages or talk to your county Cooperative Extension Service agent for a recommendation. Make appropriate repairs to the building to exclude animals.

Vacuuming
- Vacuuming on a regular basis throughout the year will keep developing flea populations low by picking up adult and egg-stage fleas.
- Vibrations caused by vacuum cleaners stimulate new adult fleas to emerge from their pupal sacs. These new adults will either be exposed to any residual insecticide on the floor or captured in the next vacuuming.
- Vacuuming is not very effective at capturing flea larvae in carpeting because they coil themselves around the fibers. Vacuuming does, however, pick up the dried blood that larvae feed on.
- Use vacuum attachments to clean cracks and crevices. Caulk or seal these openings permanently.
- Most fleas will be killed when dust in the vacuum bag blocks their breathing apparatus, but to be sure, you can vacuum up a tablespoon of cornstarch. The used vacuum bag should be disposed of immediately.
- Vacuum badly infested areas thoroughly every day until the infestation is controlled.
- When infestations are severe, you may need to supplement vacuuming with steam-cleaning or other controls.

Steam-Cleaning
The services of a steam-cleaning firm may be warranted when flea populations are severe. This process kills adult and larval fleas and probably some eggs as well. However, since the warmth and humidity from the steam also stimulates the remaining flea eggs to hatch a day or two after the cleaning, some fleas may reappear. If the other steps recommended in this chapter are followed, the few fleas that hatch after steam-cleaning should represent the last of the flea population.

Flea Combs
Classroom pets in a flea-infested room should be combed regularly with a special flea comb that can be purchased at a pet store. Fleas and eggs removed from the animal should be dropped into soapy water.

Laundry
Wash removable floor coverings, such as rugs, located in areas where there are known infestations. Any bedding for classroom pets should be washed regularly.

Ultrasonic Devices
Ultrasonic flea collars have been proposed for use to keep fleas off pets, but are completely ineffective.

Heat
Tests have indicated that cat flea larvae die after exposure to 103 F for one hour, and researchers have developed techniques to raise the temperature in a room enough to provide this exposure. The heating process uses a common heating unit modified to include special blowers and flexible ducts. Companies have been using heat to kill termites and woodboring beetles for a number of years, and now some companies are experimenting with heat to control fleas. One potential problem with this technique is that fleas can burrow down into carpets and upholstery, and perhaps escape lethal temperatures.

Drying or Flooding Infested Areas Outdoors
Outdoors, organic matter can temporarily harbor flea larvae. Either drying out these areas or saturating them with water will kill the eggs and larvae. You can also treat these areas with insect-attacking nematodes (see Biological Controls, below) or with an insecticide labeled for outdoor use (see

Chemical Controls, below).

Biological Control — Beneficial Nematodes
Insect-destroying nematodes, *Steinernema carpocapsae*, are applied to the lawn as a spray and do not affect people, pets, or plants. These microscopic, wormlike organisms live in the soil and kill insects by entering their bodies, feeding on tissue, and releasing harmful bacteria. When they have eaten all they can of the insect, the nematodes leave to search for other prey. They cannot move far (only an inch or two) and die if they find no other insects. The nematodes sold for flea control are native to the United States and are found naturally in the soil all over the country. They will not adversely affect beneficial soil organisms, including earthworms.

Tips for Using Nematodes
- Use the number of nematodes recommended by the manufacturer.
- Treat areas outside where you have found evidence of animals sleeping or areas that you know are regular travel routes for animals.
- Moisture is critical to the effective use of nematodes, so water the area before and after the application.

Chemical Controls

If nonchemical methods alone prove insufficient to solve the problem, then integrating a pesticide into your management program may be warranted.

Pesticides must be used in accordance with their EPA-approved label directions. Applicators must be certified to apply pesticides and should always wear protective gear during applications. All labels and Material Safety Data Sheets (MSDS) for the pesticide products authorized for use in the IPM program should be maintained on file. Do not apply these materials when buildings are occupied, and never apply them where they might wash into the sanitary sewer or into outside storm drains.

Diatomaceous Earth and Silica Aerogel
These are insecticidal dusts that can be used for flea control. Diatomaceous earth is made from fossilized diatoms, and silica gel is produced essentially from sand. Both these products kill insects by desiccation; they absorb the wax and oil from the insect's outer covering, which causes dehydration and death. Although these materials are not poisonous to humans directly, the fine dust travels freely through the air and can be irritating to the eyes and lungs. Therefore, use a dust mask and goggles during application. Silica gel and diatomaceous earth are also formulated with pyrethrins (discussed below).

How to Use Diatomaceous Earth and Silica Aerogel
- Apply a light dusting to upholstered furniture that is suspected of harboring fleas. Be sure to get into the cracks and crevices.
- Apply a light dusting to rugs or pet bedding.
- Apply to infested carpeting, leave for a couple of days, and then vacuum up.
- Dust into crawl spaces, wall voids, attics, and other similar spaces where you suspect animals of nesting or resting.
- Do not use in moist environments; neither material works well when wet.

Citrus Oil Extracts (D-Limonene/Linalool)
D-limonene and linalool are citrus-peel extracts that have been used for years as food additives. Products that contain d-limonene kill larval and adult fleas, while those containing both ingredients kill all flea stages. EPA-registered citrus shampoos are mild enough for use on young animals, but veterinarians caution that some cats may suffer if the material is applied in excessive concentrations. Citrus sprays can also be applied to animal bedding but should not be used to spray entire rooms, nor should they be used outdoors.

Borates
Borate products worked into the nap of the carpet can be used to control fleas. This treatment works as an intestinal poison upon ingestion by flea larvae and will continue to kill them for as long as a year. Application of borate treatment by a professional pest control company is recommended, although this product is also sold through veterinarians.

Imidacloprid and Fipronil
Both imidacloprid (Advantage) and fipronil (Frontline) are available through veterinarians as spot-on oils, which are applied to the shoulder area of a cat or dog and distribute over the body within a few hours. (Consult a veterinarian before using either of these products on a pet other than a cat or dog.) They are nontoxic to mammals and kill almost all the fleas on the pet within 24 hours of treatment. Both products continue to kill fleas for at least 30 days after treatment. However, fleas may feed and mate before their deaths. This means that while these two products will help reduce a flea population, the fleas are still able to reproduce and lay eggs before they die.

Pyrethrins and Synthetic Pyrethroids
There are a number of flea-control premise sprays, foggers, and pet treatments containing pyrethrins and synthetic pyrethroids. These products should be used as a last resort in areas where fleas problems are severe.

Insect Growth Regulators
Insect growth regulators (IGRs) inhibit the development of immature fleas, but do not kill adult fleas. Use of an IGR product (or a borate product) in conjunction with an adulticide (imidacloprid, fipronil, pyrethrins, or pyrethroids) prevents development of immature fleas and kills adult fleas. Methoprene (Precor, Ovitrol) and pyriproxyfen (Nylar, BioSpot) are available in pet sprays, pet collars, and premise treatments. Fenoxycarb (Logic, Torus) is available through professional pest control companies and is for outdoor use only. Lufenuron (Program) is orally administered to the pet.

Pests: Flies

IPM for Flies in Schools

Edited by Timothy C. McCoy; originally written by S. Darr, T. Drlik, H. Olkowski, and W. Olkowski.

Introduction

Many species of flies can be problems in schools. Each kind of fly has a distinct breeding site inside or outside the school building. In order to control pest flies, it is necessary to know which fly is causing the problem and where it is breeding. Common pest flies encountered in schools can be identified by characteristics.

Garbage and Manure-Breeding Flies

Identification and Biology


House fly


Blue bottle fly


Green bottle fly


Paper wasp

Flies such as house flies, dump flies, blow flies, blue bottle and green bottle flies, which breed in food wastes (garbage) and/or animal feces generally are referred to as "filth flies."

Sometimes flies are confused with wasps. However, flies have two wings, while wasps and all other winged insects have four wings arranged in two pairs. Wasps, unlike flies, fold their wings alongside their bodies when at rest. Most pest wasps are colorfully marked with yellow, red, black, and white and have narrowly constricted waists. Generally, wasps are less likely to come indoors, are aggressive in their flight around foods, particularly sweets, and are larger than filth flies. Filth flies are not aggressive and do not bite.

Filth flies pass through four distinct stages in their life cycle: egg, larva (maggot), pupa, and adult. Adult female filth flies look for moist places with the right smell to lay their eggs. This can be in food waste in a garbage can or dumpster, in dog or cat feces, in dead animals, in kitchen drains, in grass clippings allowed to rot in a pile, and even in moist soil that is mixed with garbage. The larva hatches from the egg and grows until it is ready to form a puparium (a kind of cocoon) from which an adult fly will emerge. Once the adult fly emerges, it doesn't grow any larger; small flies do not grow into larger flies.

Damage

Flies that invade cafeterias and kitchens are not only a nuisance, they also present a health hazard because they can contaminate food, utensils, and food preparation surfaces.

Detection and Monitoring

It is important to correctly identify the problem flies and pinpoint their breeding sites. Some of their characteristics can help you with identification, or specimens can be taken to a county extension agent who should be able to assist in identification. If they cannot identify the specimen they will be able to refer you to a person who can.

To collect specimens inside, use sticky flypaper or gather dead specimens from windowsills and light fixtures. Outside, trapping is one of the easiest methods of catching flies for identification (see the discussion below for trap construction, placement, and baits). If adult flies consistently avoid baited traps, it may indicate that the pest fly is not a filth fly.

Management Options

To manage flies, you must find and reduce breeding sites, install and maintain screens to keep flies out of buildings, kill those flies that do get inside with a fly swatter or flypaper, and reduce or eliminate the odors that attract flies.

In a school with a frequent waste removal program, it is very possible that few flies are breeding on the school property. It is more likely that odors from dumpsters, garbage cans, kitchens, and cafeterias are attracting flies to the school from the surrounding neighborhood. House flies and blow flies, the species that most commonly invade buildings, usually develop outside and follow odors into the building. They also can be pests when students or staff are eating outside. In schools where waste removal is infrequent, fly populations can be breeding at the waste collection site.

Habitat Modification

This is one of the most important aspects of fly control. Without controlling wastes and odors, it is impossible to control filth flies.

Food Waste

- All food waste from the kitchen, cafeteria, and other areas should be separated from other garbage, drained so it will be as dry as possible, and then stored in sealed plastic bags before discarding.
- Place containers with small amounts of food waste, such as milk or yogurt cartons, into sealed plastic bags before disposal. This method will reduce access to flies.
- Promptly fix drains or electric garbage disposal units that leak, or drains that allow food waste to accumulate under sinks or floors. Leaky drains can attract many species of flies. Remove any food waste that has accumulated under sinks or floors or in crawl spaces or basements at the site of the broken drain, and then clean the area thoroughly.

Other Garbage

In food preparation areas, rinse all cans, bottles, and plastic containers before recycling or discarding.

Exterior Garbage Cans and Dumpsters

- Inform students, teachers, and staff of the importance of placing garbage inside the proper containers. Garbage should not be left lying on the ground.
- To avoid attracting flies into the building, place dumpsters and recycling containers upwind from the outside doors of the school, particularly doors to the kitchen or cafeteria. When dumpsters are downwind, flies are attracted to the waste odors and then find the odor trails that the breeze blows down from the doorways. Following these odor trails, they find their way into the building.
- Wastes should be collected and moved off site at least once a week. Since flies breed faster in warm weather, garbage collection may have to be scheduled twice a week to reduce breeding sites.
- Make sure garbage can and dumpster lids seal tightly when closed and remain closed when not in use. Repair or replace garbage cans with holes or with lids that do not close tightly.
- Regularly clean garbage cans and dumpsters to prevent the build-up of food waste, an ideal place for flies to lay eggs. Use a high-pressure stream of water or a brush and soapy water, if necessary. A solution of borax and water will eliminate odors. If possible, dumpsters should be fitted with drains so they can be hosed or scrubbed out as needed. Another option is to require the refuse company to clean the dumpster or replace it with a clean one more frequently.
- Flies can develop in soil soaked with water used to clean garbage cans and dumpsters. Check these areas regularly. If you see maggots, scrape them up along with the soil and dispose of everything in a plastic bag sealed tightly.
- Inspect dumpsters and other outdoor trash receptacles daily and remove any wastes lying on the ground.
- Garbage cans on the school grounds should have removable domed tops with self-closing, spring-loaded swinging doors. Cans should be lined with plastic bags that can be tightly sealed and removed daily.

Animal Feces

Remove droppings promptly and put them into plastic bags that are sealed before disposal. Dog feces that dry quickly may attract adult flies with their odor but are unlikely to host many maggots. Droppings that remain damp because of humidity or rain can serve as an excellent breeding site.

Odor

Flies can detect odors over long distances. Smells of souring milk from hundreds of containers thrown in dumpsters can attract thousands of flies from the surrounding neighborhood. Storing garbage in sealed plastic bags and having cans and dumpsters cleaned and emptied frequently to eliminate odors is very important. Removing pet feces also helps reduce attractive odors.

Flies attracted to open kitchen or cafeteria doors, or to dumpsters or garbage, will rest on nearby walls, eaves, and rafters. While resting, they leave fly specks, which have a strong fly-attracting odor. These brown- to cream-colored specks should be washed off with an odor-eliminating cleaner (a mild solution of borax and water can be particularly effective). Otherwise, they will continue to attract flies.

Physical Controls

Screens

Keeping adult flies out of sensitive areas is the most important control measure that can be undertaken. Install screens over windows, doors, and vent holes to prevent flies from entering buildings. Weather-stripping or silicone caulk can be used to insure a tight fit. Torn screens can be repaired with clear silicone caulk. Screen doors should be fitted with springs or automatic closing devices that close the screen door firmly after it is opened. External doors that cannot be screened should be fitted with automatic closing devices, and/or vertical strips of overlapping plastic that allow human access but prevent fly entry. "Air walls" that force air across openings are another alternative to screen doors.

Fly Swatters

In many instances, the old-fashioned fly swatter is the safest and quickest way to kill flies that have found their way into a room. Aim the fly swatter about 1 1/2 inches behind the fly, rather than directly at it, because research has shown that when a house fly takes off from a horizontal surface, it jumps upward and backward. Stiff plastic swatters seem to work better than wire-mesh ones. The fly's unblurred range of vision is about 1 1/2 feet, and the swatter can be moved to this distance before striking.

Flypaper

Sticky flypaper is effective at catching flies because it takes advantage of their natural habit of moving up to the ceiling to rest. It will take several days for a new strip of flypaper to start catching flies. Use a number of strips at a time and replace them when they are covered with flies or when they begin to dry out. Flypaper can be very useful in areas where there are too many flies to kill with a fly swatter, and where aesthetic appeal is not of primary importance. Flypaper is also a useful monitoring tool. Do not place flypaper or sticky strips above or near food preparation areas.

Fly Traps

Fly traps can be used to reduce adult fly populations, capture specimens for identification, and monitor the effectiveness of control programs. Fly traps are not toxic and are more selective than using insecticide. Traps need to be serviced regularly, appropriately placed, and repaired or replaced when damaged.

Trapping Flies Indoors

Electrocuting light traps are preferred for indoor use and can be used in food preparation and storage areas. Light traps will not work well in a room with many and/or large windows because the bright light coming in the windows is a much more powerful attractant than the comparatively weak light coming from the trap.

Contrary to the advice provided in some promotional literature for ultraviolet light or electrocutor traps, these traps should not be used outdoors. They are relatively nonselective in the insects they attract and will kill many more beneficial and innocuous insects than pests.

The following are key points to remember when using light traps for indoor flies:

- Use the number of traps recommended by the manufacturer or, as a general rule, one trap for every 30 feet of wall.
- Mount traps 3 feet from the floor on the perimeter walls of the room, because hungry flies circle the perimeter of a room close to the floor when looking for food. However, electrocuting light traps should not be placed within 6 feet of food preparation counters. At least one study has shown that "exploding" flies can throw body parts up to this distance. Fly body parts may contain harmful bacteria or other organisms.
- Mount traps 5 feet away from any open food and 25 feet from any doors or windows. Traps work best in rooms without windows.
- Empty and clean the traps weekly to prevent dead flies from becoming an attractive food source for other insects.
- Replace lamps at least once a year.
- The more expensive black-light "blue" bulbs do not attract more flies than regular black-light bulbs.
- The lamp should be directed toward the interior of the building. Do not place traps where flies that are outside can see the light bulb. This may attract more flies.
- Place traps near odor sources (such as cooking areas, garbage cans, outdoor restrooms), since odors will be more attractive (especially from a distance) than the light.

Trapping Flies Outdoors

To capture flies outside, use traps with a screen cone suspended above the bait. These cone-type traps take advantage of the fly's habit of flying or walking toward light. Cone traps can be easily made from wood together with aluminum or plastic screening; use the dimensions shown in the figure. Flies are attracted to the bait in the pan under the trap. Once the flies are under the trap, the brightest spot they see is the hole in the cone above them. They walk up through the hole and are trapped in the outer screen cage. Since flies are attracted to the light and it is always lighter above them, they do not find their way back out through the hole in the cone.

Cone Trap. The bait pan is placed beneath the cone. Make sure the top edge of the bait pan is above the bottom edge of the trap. The top is also made of screening. The top should be hinged (to empty the trap) and closed with a hook and eye. Weather-stripping or a strip of foam or cloth glued to all four sides of the underside of the lid will prevent flies from squeezing out.

The following are key points to remember when trapping flies outdoors:

Trap placement is important:

- If an area has a small or moderate fly problem, traps placed close to buildings can attract flies from all over the neighborhood and make the problem worse. It is better to set the traps close to fly breeding sites with any prevailing breeze blowing from the trap toward the breeding area.
- Do not set traps near doorways or entrances to buildings.
- Place traps away from outdoor areas that are used for eating or recreation.
- Generally, traps are most effective when placed on the ground, but they can be hung over the openings of dumpsters and from buildings or fences as well. Traps hung in these areas must not interfere with the opening and closing of the dumpster, and should be placed in areas where people will not tamper with them and will not be offended by the bait odors.
- Place traps in sunlight. Flies are more active in sunlight, both outside and inside the trap.

Empty the trap when dead flies cover about one quarter of the cone. Do not release live flies that are in the trap. Kill them by enclosing the trap in a plastic bag and placing it in the sun. After the flies are dead, the contents of the trap should be poured into the plastic bag, sealed, and discarded in a dumpster or garbage can.

Do not clean the trap between uses. The smell of the millions of fly specks deposited on the screen is very attractive to flies.

Bait is important to the performance of the trap:

Fly Bait Recipes

- Liquid bait, either the Yeast Bait or the Beltsville Bait, is a superior attractant that will not breed flies unless it is allowed to dry to a sludge. If either of these baits contaminate clothing and hands, use baking soda and water to remove the odors.
- Yeast Bait has a foul odor that is particularly attractive to female flies because it smells like a good place to lay eggs. This bait will lure flies from even the most attractive breeding sites.
- Beltsville Bait will attract male flies as well as females because it contains sugar. This sweet bait can be used in cool weather, when the main aim of trapping is to reduce the total number of flies rather than to suppress breeding.
- Baits such as decaying meat or fish scraps will attract mainly blow flies and flesh flies. These baits should always be put inside a rolled-down plastic bag and then placed in the bait pan. Periodically check the bait so that it does not become a breeding site for flies. The larvae feeding on the bait can crawl out of the plastic bag and away from the trap to pupate. If larvae are found in the bait, the plastic bag should be sealed, thrown away, and replaced with a new bag and bait.
- Sex pheromone baits for flies do not last long and do not attract flies from a distance. They are likely to be more expensive and less effective than other food-type baits, which can be mixed from common materials and attract both sexes.
- Do not add poison to the bait. Flies are more attracted to the live flies in the trap than they are to dead ones.
- The top edge of the bait pan must be at least 1/2 inch above the bottom edge of the trap. If flies can sit on the top edge of the bait pan and look out under the trap, trap catches will be poor.

- Prevent excessive amounts of water from getting into the trap. If dead flies in the trap get wet and begin to rot, they will attract blow flies that will lay their eggs on the outside of the screen. When the tiny blow fly larvae hatch, they crawl through the screen to feast on the rotting mass of flies. This turns the trap into a messy breeding site for flies.
- Do not place traps where sprinklers will get them wet.
- In areas where there are frequent rainstorms, it may be necessary to fit the trap with a clear Plexiglas top.

Chemical Controls
Except for odor-eliminating chemicals (such as borax) and baits, *pesticides are not recommended for fly control.*

Borates
Low concentrations of borax in water can be used to eliminate fly odors. This solution is particularly effective for removing fly specks from walls and eaves, and for rinsing out garbage cans and dumpsters. These solutions should not be used near ponds, streams, lakes, or other bodies of water, and should not be poured onto plants.

Fruit Flies, Cluster Flies, and Phorid Flies

Identification and Biology

Fruit Flies
Fruit flies are small flies commonly seen flying around ripe fruit, especially bananas. They are about 1/8 inch long and usually have red eyes. They lay their eggs near the surface of fermenting fruits and vegetables and other moist organic materials (including damp mops and cleaning rags as well as residues in bottles, cans, garbage disposals, and drains). Their life cycle, from egg through maggot and pupa to adult, takes little more than a week, and the number of flies that can be produced by a single piece of fruit is enormous. These flies are most often a problem in late summer and early fall, so careful storage of fruit and vegetables is necessary at these times of the year.

Cluster Flies
Cluster flies are larger and darker than house flies and have a distinctive yellowish color caused by the crinkled yellow hairs on their bodies. In the summer, cluster flies lay their eggs in soil, where the maggots parasitize earthworms. Soil containing many earthworms is a common source of these flies. In the fall, the adults can be seen clustering on the south and west sides of buildings. As the weather gets cooler, these flies begin looking for sheltered places to spend the winter and often enter buildings.

Phorid Flies
The most common phorid fly, *Megaselia scalaris*, is small (1/16 to 1/8 inch) with a yellowish-brown body and light-brown wings. The adults seem reluctant to fly, and they run around on walls, windows, and tables with a characteristic quick, jerky motion. The females are strongly attracted to odors and lay their eggs on or next to decaying material, both plant and animal. Food sources for the larvae are highly varied, from decomposing fruit, vegetables, and meat to open wounds in animals and people, and human and animal feces. The life cycle from egg to adult takes from 14 to 37 days.

Management Options

Fruit Flies
Fruit flies are most active from late summer through early fall. Problems with these flies can be avoided by ripening fruit in paper bags. Seal the bags by folding the top over several times and closing it with a paper clip or clothes pin. Once fruit is ripe, it should be stored in the refrigerator. Careful storage of fruit during the rest of the school year may not be necessary.

If an infestation is discovered, look for and remove the material that is breeding the flies. Begin by searching for the obvious sources, such as ripe fruit and vegetables, and then look at water from refrigerators, humidifiers, or sink drains that may be fermenting; spoiled animal food; or even damp, sour mops or rags. Areas outside the building near windows and doors should be checked for rotting vegetable matter. All breeding sources should be removed and disposed of in a sealed plastic bag. Make sure that screens and windows near food preparation areas are in good repair.

Fruit Fly Trap
To make a simple trap for fruit flies, combine 1 cup of vinegar, 2 cups of water, and 1 tablespoon of honey in a 2-liter soda bottle. Replace the cap, shake the mixture well, and punch holes in the side of the bottle above the liquid so the flies can get in. Using string, hang the bottle about 5 feet above the ground. Periodically, the dead flies should be strained out and the liquid reused.

Cluster Flies
Cluster flies are not as strong fliers as house flies and can easily be killed with a fly swatter or removed with a vacuum. Cluster flies can also be allowed to exit by opening the window. They can find their way into buildings through unscreened doors and windows, openings under siding and around roofs, unscreened ventilating spaces, cracks around windows, and holes where wires penetrate the walls of the building. During warm winter periods, cluster flies hidden in buildings become active and are attracted to windows.

Phorid Flies
Phorid flies breed in diverse sources of organic matter, so it may take considerable sleuthing to find their breeding sites. Once the site is found it must be thoroughly scraped, cleaned, and dried. Large infestations of these flies often are the result of broken drains or garbage disposals that allow organic matter to accumulate in out-of-the-way places such as wall voids, under floors, in basements, or in the soil of crawl spaces.

Pests: Head Lice

Biology and Control of Head Lice

Clay Scherer and Philip Koehler

Introduction

The head louse, *Pediculus humanus capitis* De Geer, infests 10 to 12 million people each year in the United States. Pediculosis, or "lousiness," is one of the most prevalent communicable conditions in this country. Lice are transferred from person to person by direct contact or by several people using the same combs, brushes, hats, or bedding. Head lice are not found on animals or household pets and are not transmitted from pets to humans. Head louse infestations are normally found on children, but can also be spread to adults. The head louse is not considered to be a serious vector of disease in the United States, although severe infestations may cause irritation, scratching and subsequent invasion of secondary infection.

Biology of the Head Louse

Lice have three pairs of legs, which makes them true insects. Lice do not have wings or powerful jumping legs so they move about by clinging to hairs with clawlike legs. Head lice prefer to live on the hair of the head, although they have been known to wander to other parts of the body. Head lice do not normally live in rugs, carpet, or school buses.

Nits (closeup)

Nits on scalp

Adult louse

The eggs of lice are called nits. They are oval white cylinders, 1/16 inch long. The eggs of head lice usually are glued to hairs of the head near the scalp. The favorite areas for females to glue the eggs are near the ears and back of the head. Under normal conditions the eggs will hatch in seven to 10 days. The young lice that escape from the egg must feed within 24 hours or they will die. Newly hatched lice will periodically take blood meals and molt three times before becoming sexually mature adults. Normally a young louse will mature in 10 to 12 days to an adult 1/8 inch in length. Adults range in color from white to brown to dark gray.

Female lice lay six to seven eggs (nits) per day and may lay a total of 50 to 100 eggs during their life, which may last up to 40 days. Adults can survive only one to two days without a blood meal. The nymphs and adults all have piercing-sucking mouthparts that pierce the skin for a blood meal. The reaction of individuals to louse bites can vary considerably. Persons previously unexposed to lice experience little irritation from their first bite. After a short time individuals may become sensitized to the bites, and may react with a general allergic reaction, including reddening of the skin, itching, and overall inflammation.

Prevention of Head Lice

Children should be encouraged not to share combs, hats, and other personal belongings. Daily washing and changing of clothes and keeping hair as short as possible will also help discourage lice. However, head lice should not be associated solely with uncleanness, since they may be easily transferred from person to person. Periodic inspections will aid in early detection of any individual lice, which are more easily controlled than advanced infestations where dozens of mature lice and possibly hundreds of nits are present. During the early fall months (August through November) children should be inspected weekly, because back-to-school seems to be when lice are most commonly transmitted, resulting in widespread infestations by December and January. September is National Head Lice Prevention Month.

Control of Lice

Nonchemical Control

Once an infestation is detected all clothes should be washed in hot, soapy water. Pillow cases, sheets, blankets and other bedding material should also be washed and placed in the clothes dryer on high heat cycle to kill the lice and their eggs. Any nonwashable items such as children's toys should be tightly sealed in plastic bags for at least seven to 10 days to kill adult lice.

Chemical Control

Chemicals are available as prescription or nonprescription drugs to control lice. Over-the-counter products that should be effective include those containing permethrin or pyrethrins (pyrethrum extract) as active ingredients. These drugs are available as creams, lotions, or shampoos. Shampoos are preferred for control of head lice. The application of these insecticidal drugs will kill nymphs, adults, and some eggs. Eggs killed by treatment as well as unaffected eggs may remain attached to hair shafts and should be removed as soon as possible. To remove these eggs it may be necessary to do some "nit-picking" using a special fine-toothed lice comb. Combs and other tools used to remove lice should be soaked in a lice-killing solution, such as rubbing alcohol, after use.

Use of lice sprays to treat objects such as toys, furniture, and carpet is not recommended because lice cannot live off the host longer than a couple of days. The same holds true for classrooms. Use of these products is considered ineffective and unnecessary.

Cream and shampoo products include:**

Pyrethrin-containing products (kill in 10 to 12 minutes, but have no residual activity which means more than one application may be necessary).
- Rid Liquid
- R & C Shampoo
- Licetrol
- Pronto (0.33% Pyrethrins and 4.0% Piperonyl Butoxide)
- A-200 (0.33% Pyrethrins and 4.0% Piperonyl Butoxide)
- Clear (0.33% Pyrethrins and 4.0% Piperonyl Butoxide)

Permethrin-containing products (kill in 10 to 12 minutes, activity lasts up to 10 days):
- Nix (1% Permethrin). No prescription necessary.
- Elimite (5% Permethrin). Prescription necessary.

** Careful attention should be given to follow directions on all product labels.

Products not recommended due to reports of potential side effects:

Malathion-containing products:
- Ovide (0.5% Malathion). Product available through prescription only.

Lindane-containing products:
- Kwell (1% Lindane). Product available through prescription only, not recommended due to various reports describing adverse effects, including seizures.

Frequently Asked Questions

1) *What's the difference between pyrethrins and permethrin?*
Pyrethrins are naturally occurring compounds extracted from chrysanthemum plants. Insects possess mechanisms to break down pyrethrins so a synergist, piperonyl butoxide, is usually added to the formula, which inhibits the insect's ability to break down the pyrethrins. Permethrin has the same basic chemical makeup but is synthetically enhanced to be more effective. Permethrin has much longer residual activity and does not require the use of a synergist.

2) *Can lice be transmitted from my dog or cat to my children?*
No. Head lice are specific to humans. They can only survive on a human host. If a head louse is removed from its host, it will die within a day or two.

3) *How big are lice?*
An adult head louse is approximately 2.5 to 3.5 mm long. A louse egg, or "nit," is roughly 0.5 to 1.0 mm long.

4) *I've heard that head lice are resistant to some of the lice treatments. Is this true?*
In some locations there have been reports of potential resistance to several different pediculicides (lice killing agents). Experts are researching this issue and are trying to determine to what extent resistance exists. The best way to avoid this situation is to follow the directions on the product label closely. Improper application of pediculicides has significantly contributed to the presence of resistance in lice.

5) *How long do lice live?*
A louse egg hatches about 10 days after being glued to a hair shaft. Upon hatching, a louse will molt three times over a 10-to-12-day period before molting into a mature adult. An adult louse can live up to 40 days.

6) *How long after my child contracts lice will I be able to detect them?*
It only takes one adult female louse to begin an infestation. A female louse can lay several eggs each day. Within a couple of weeks a child may have dozens of immature lice living on his/her head. The more lice present, the more quickly the child will begin feeling an itchy scalp, which would usually lead to an inspection by a parent or school official. Looking for one louse or one nit might be difficult, but dozens should be readily apparent through close inspection.

Landscape Pests

Landscape Integrated Pest Management

Clay Scherer, Philip Koehler, and Donald Short

Introduction

To combat landscape plant insect pests successfully, something should be known about the manner in which they develop and feed. Insects normally hatch from eggs deposited on or near the food supply, although in some cases, as with aphids, they hatch within the female's body, and the active young emerge from the female. Adults usually have fully developed wings, although a few species of insects never develop wings.

Insects pass through several stages during their development (metamorphosis). Plant bugs, leafhoppers, thrips and grasshoppers hatch from the egg in a form known as a nymph. The nymph resembles the full-grown insect, except that it lacks wings and is smaller. It molts periodically as it increases in size (gradual metamorphosis). Moths, beetles and flies, on the other hand, hatch from the eggs in a worm-like form (larva) that is much different in appearance from the adult. The larva of a moth or butterfly is commonly called a caterpillar, the larva of a beetle is called a grub, and the larva of a fly is known as a maggot. Larvae molt periodically and when mature they transform to an inactive form known as a pupa. The adult moth, beetle or fly emerges from the pupa after a period of no feeding and little activity (complete metamorphosis).

The length of the life cycle varies greatly with many species of insects. Some develop from egg to adult in a few days or weeks, many require a year, and a few take two or more years to reach maturity.

Identification

Proper identification is very important. When the insect is correctly identified, information regarding its life cycle, food preference, habits, and whether it is beneficial or harmful can be looked up in various leaflets or books available at the county Cooperative Extension Service office or local library.

Beneficials

Less than one-half of 1 percent of all insects are pests on plants. Many beneficial insects feed upon harmful ones. Common examples of predators are lady beetles, praying mantids, assassin bugs, ambush bugs, and aphid lions. Spiders also prey on numerous insect pests. Several species of mites do not damage plants but instead feed upon other plant-feeding mites. Also, many harmful insects are destroyed by tiny wasplike parasites. It is important to learn to identify these beneficials and to recognize when they are holding pests in check. If such pests as aphids, scales, or whitefly nymphs have a small hole, as if stuck by a straight pin, it is evidence that they have been parasitized by tiny wasps. If predators are present or the pests show signs of parasitism, every effort should be made to preserve the beneficial insects. Delay applying a pesticide, and allow the beneficials a chance to control the pest population.

Inspecting Plants

Examine your plants weekly during the spring, summer, and fall. Look at the undersides of a few leaves on each plant and observe the stems for pests. While many plants are relatively pest free, others are commonly infested with key pests (e.g., mites on roses, oleander caterpillars on oleanders, aphids on crepe myrtles.) Concentrate your scouting efforts on the plants that are likely to have problems. The use of a 10-to-15-power magnifying glass aids in detecting and identifying insects and related organisms. Many insects merely rest on the plant and are neither pests nor beneficial. Learn to determine when a pest is present in damaging numbers and to evaluate the potential of the predator or parasite population.

Watch for sooty mold on leaves. This fungus grows on the "honeydew" excreted by insects such as whiteflies, aphids, and soft scales. Because ants also feed on this honeydew excrement, their presence on plants often indicates an insect infestation. To aid in locating small insects such as thrips or mites, a sheet of white paper or cloth may be held beneath the leaves and the foliage struck sharply. The insects or mites will fall onto the paper and can be more easily observed and identified than on the green foliage.


Aphids


Mealybug


Thrips


Lacebug

Most plants in the urban landscape are over-sprayed, resulting in unnecessary environmental contamination and often upsetting the natural predator/parasite-pest balance. Don't apply a control measure until a pest population is present and damage is beginning to occur. If you must spray, use the least toxic remedy possible (such as soap, oil, *Bacillus thuringiensis*) and exercise great care to avoid contaminating yourself and other living creatures.

Groups of Pests

Pests of ornamentals may be divided into five groups according to the way they damage plants.

Insects with Piercing-Sucking Mouthparts. These insects have beaklike mouthparts that are used for piercing the plant tissue and sucking the plant juices. Examples: scales, aphids, whiteflies, mealybugs, thrips, lace bugs.

Foliage-Feeding Insects. They may feed on the leaves, flowers or attack the roots. Examples: caterpillars, beetles, grasshoppers, katydids.

Spider Mites. These pests are not insects but closely related to spiders and scorpions. Spider mites suck plant juices with their piercing-sucking mouthparts.

Leafminers. These are very small larvae of flies, beetles, or moths that tunnel between the upper and lower leaf surfaces. Examples: Blotch leafminers and serpentine leafminers.

Borers. There are many species of insects that bore into the twigs or trunks of plants and trees. These are either the larvae of moths or beetles. Examples: pine bark beetles, seagrape borer, carpenter worm.

Oleander caterpillar

Grasshopper

Spider mite

Noninsecticidal Control

Sometimes it is possible to remove pests and keep populations below damaging levels by spraying landscape plants with a forceful stream of water. Use a garden hose with an adjustable nozzle and spray undersides of leaves and stems when such pests as aphids, mealybugs, spider mites, thrips or lace bugs appear.

Insecticidal soaps and horticultural oils are available that are formulated for controlling insects and related pests. An effective, environmentally safe, general purpose spray against insects or mites attacking landscape plants is a soap-plus-oil mixture. These are commercially available or can be homemade by mixing 2 tablespoons of vegetable cooking oil (corn, soybean, peanut, or sunflower oil) and 2 tablespoons of liquid dishwashing detergent per gallon of water. Thorough coverage of the undersides of leaves is very important, because the insects must be contacted directly by the soap and oil. Monitor plants and reapply when needed.

Commercial formulations of *Bacillus thuringiensis*, a bacterium, are available and provide good control of caterpillars. This bacteria has no effect on other groups of insects, including the predators and parasites. Mechanical control is sometimes practical for small numbers of the larger insects such as caterpillars, grasshoppers, and beetles. Frequently insects can be picked or knocked off the plant and destroyed. Large numbers of newly hatched caterpillars or beetle larvae may be detected by watching for freshly skeletonized leaves and destroyed in this way. After hatching, small caterpillars and beetle larvae remain on the leaf for several days. Damaged leaves can be removed and destroyed before the larvae have dispersed over the plants. Early stage lubber grasshoppers also feed in aggregates and can be handpicked and destroyed.

Chemical Control

Insecticides may be required to control insects and related pests when they reach damaging levels on landscape plants. Most insecticides kill by either contact with the insect or as a stomach poison. Some also exert a fumigating or vapor action under certain conditions.

Materials should be selected that will be effective in controlling the pests without injuring the plant, or causing buildup of other pests. Before using a chemical insecticide, the following points should be considered:

- Select the right material. Use only an insecticide that has the plant and pest listed on the label.
- Use the right amount. Use the recommended amount. Too little won't control the pest; too much may injure the plant. Read the container label carefully for correct dosage rate.
- Apply it in the right way. Thorough coverage of the leaves (especially the underside), twigs, and branches is essential, but spray only to the point of runoff. The insecticide spray must reach the area of the plant where the pest is feeding. Most failures to control pests are the fault of incorrect application, not one of the insecticide. The addition of a spreader sticker to the spray mixture, especially with wettable powder formulations, is recommended when spraying ornamental plants. Use of a spreader-sticker will aid in the pesticide adhering to the leaves and improve the coverage for better control.

Sprayers

Sprayers of various types and sizes are available, including simple trombone action sprayers, 1 to 3 gallon compressed air sprayers, and 1 to 3 gallon knapsack sprayers. Sprayer type varies with the size and type of planting to be protected. With all sprayers, it is important that the leaves and wood be covered to the point of runoff. Sprayers that attach to the end of garden hoses are popular with home gardeners. Such types are less satisfactory, in general, for use on ornamental plants and in particular against pests like scales and spider mites. The spray pattern is usually coarse, and it is difficult to direct the spray to reach and adequately cover the undersides of the leaves, especially those near the ground and on the side of plants close to a building or fence. Considerably more insecticide is used with the hose end attachment, and this leads to greater harm to the environment. If a hose attachment is used, be sure it is one manufactured for use on ornamental plants and not one for use on lawns.

Systemic Insecticides

A systemic insecticide is a chemical compound that is absorbed by the host plant, translocated throughout its tissues, and makes the host toxic to certain insect and mite pests. Several systemic insecticides are taken up from the soil by the roots of plants and translocated throughout the plant tissues. Others can be absorbed by foliage sprays, or from injections into the plants' stems.

Systemic insecticides have been effective primarily in controlling small sucking pests, including aphids, whiteflies,

scales, mealybugs, lace bugs, and spider mites. In general, they have not given satisfactory control of chewing insects.

Systemic insecticides applied to the soil as drenches or granules can remain effective over six weeks. Also, when applied in this manner, they are relatively harmless to any insect predators and parasites that may be present, as these insects do not feed on the plant.

Systemic insecticides are available in different formulations and concentrations, and the amounts may vary for different ornamental plants. Follow the directions and cautions on the manufacturer's container label for the amounts to use on the ornamental plants specified on the label.

Phototoxicity or Plant Injury

A pesticide or mixture of pesticides may cause injury to certain plants. The condition under which the injury occurs may vary considerably depending upon temperature, humidity, and other environmental factors. In general, it is best to apply pesticides during the cooler part of the day. Plants are less likely to be injured when protected by at least broken shade as opposed to being in direct sun.

It is a good practice to water or irrigate ornamental plants one to two days before applying pesticides. Some materials can injure plants when they are stressed for moisture. Wettable powders are generally safer to use on plants than emulsifiable concentrates because they do not contain emulsifiers and solvents.

Precautions

Insecticides are poisons and should be handled as such. Read the manufacturer's label carefully before opening the container and observe all instructions and precautions. Wear rubber gloves and boots when handling and applying insecticides. Avoid breathing mists or fumes. Do not spill sprays on the skin. Change clothes and wash all exposed parts of the body immediately after using pesticides. Store pesticides in original labeled containers in a locked area out of reach of children. Rinse empty containers three times and put rinsings in spray tank. To dispose of empty containers (one gallon or smaller), wrapp in newspaper, then crush or puncture to prevent reuse, and put in the garbage can for disposal in an approved sanitary landfill.

Lawn Pests

Lawn Insect Integrated Pest Management

Clay Scherer, Philip Koehler, and Donald Short

Introduction

Several insects and related pests are common in lawns in Florida. Chinch bugs and spittlebugs suck plant juices. Mole crickets, white grubs, and billbugs live in the soil and damage the grass roots. Others including sod webworms, grass loopers, and armyworms, eat the grass leaves. To these groups can be added insects and related pests such as fleas, millipedes, chiggers, sowbugs, and snails that do not damage the lawn but may become nuisances because of their biting people or crawling into houses, garages, or swimming pools.

Chinch bugs

Spittlebug

Beneficials

One group of insects often confused with these pests is actually beneficial. This group includes big-eyed bugs, anthocorids, and nabids that resemble chinch bugs but actually feed on chinch bug eggs and nymphs. The *Labidura* earwig, ground beetles, and spiders search through the grass and feed on chinch bugs, webworms, and several other lawn pests. The presence of these beneficial organisms will often prevent the insect pests from reaching damaging levels. It is necessary that a small population of pests be present to maintain these beneficial organisms. Preventive or scheduled treatments (pesticide applications every four to eight weeks) will reduce these beneficial organisms and may actually contribute to a persistent chinch bug, sod webworm or other pest problem. Apply pesticides only when damage is beginning to occur.

Big-eyed bug

Earwig

Ground beetle

Monitoring

Inspect the lawn weekly during the spring, summer, and fall months and biweekly during the winter months, as outlined in the sections of this publication relating to the various pests, to determine if damage is beginning to occur and if insects are the problem.

Cultural Practices

Studies throughout Florida the past several years have demonstrated that the need for pesticide applications to control chinch bugs, sod webworms, and armyworms can be drastically reduced by following certain management practices.


White grubs


Sod webworm


Fall armyworm

Cultural practices can influence the susceptibility of lawn grasses to insect pests. Attention to the following practices will aid in a reduction of pesticide use, which can result in less contamination of the urban environment and preservation of beneficial organisms. Rapid succulent growth resulting from frequent or high applications of water soluble nitrogen fertilizers acts as an attractant and substantially increases the chances of chinch bug and sod webworm attack. Incidence of damage from these pests can be greatly reduced with applications of minimum amounts of slow-release nitrogen fertilizers in combination with other macro and minor nutrients. Contact your local Cooperative Extension Service office for fertility recommendations and sources of slow-release nitrogen fertilizer for each of the turfgrass species in your particular area of the state.

Improper mowing and excessive water or fertilization can cause lawn grasses to develop a thick, spongy mat of dead and living shoots, stems, and roots that builds up between the layer of green vegetation and the soil surface. This spongy mat, referred to as thatch, is an excellent habitat for chinch bugs and turf caterpillars, and chemically ties up insecticides, thereby reducing their effectiveness. When a serious thatch problem exists, it may be necessary to remove the thatch by vertical mowing, power raking, or other mechanical method.

Proper mowing practices can make the grass more tolerant to pests and greatly improve the appearance of a lawn. St. Augustine should be mowed at a height of 3 to 4 inches, centipede at 2 inches, and bahia at 3 to 4 inches. It is very important to keep the mower blade sharpened. The best recommendation is to mow often enough so that no more than one-third of the leaf blade is removed at each mowing. Do not remove the clippings.

Insects are only a few of the many causes of yellowish or brownish areas in grass. Diseases, nematodes, dry weather, and nutritional disorders are sometimes responsible for such injury. It is important to be sure of the cause so proper treatment can be applied to correct the trouble without needless use of pesticides and extensive damage to the grass.

An effective way to survey for chinch bugs, lawn caterpillars, mole crickets and beneficial insects is by the use of a soap mixture applied with a 2 gallon sprinkling can. This mixture is not effective in surveying for white grub or billbug larvae. Mix 1 1/2 fluid ounces of dishwashing liquid in a 2 gallon sprinkling can full of water, and drench four square feet with this solution. Observe the area for about two minutes. If the above pests are present, they will emerge to the grass surface and can be detected. If no insects are found in the first area checked, examine at least three or four places in suspected areas.

Notes on Control

If insecticides are required, apply them properly. Read and understand all directions on the container label regarding dosage rates, application information, and precautions. When a spray is applied for controlling lawn insects, it is important to apply the insecticide in a large amount of water. The jar attachment to a garden hose is the suggested lawn sprayer for use on lawns. The type that requires 15 to 20 gallons of water passing through the hose to empty the quart size jar is recommended. Put the amount of insecticide in the jar as directed on the label for 1,000 square feet. Fill the jar the rest of the way with water. Spray the contents over 1,000 square feet. To insure even coverage, spray back and forth across the measured area. Then turn at right angles and spray back and forth across the same area.

When spraying for control of soil insects (mole crickets, white grubs, and billbugs), the turf should be moist at the time of application. Immediately after spraying the insecticide, irrigate with about 1/2 to 3/4 inch water to leach the insecticide into the soil, where the insects are feeding. For control of surface feeders (chinch bugs, lawn caterpillars, bermudagrass mites, grass scales, and spittlebugs) do not irrigate after application.

Granule formulations of the recommended insecticides may be substituted for sprays in controlling chinch bugs, webworms, mole crickets, white grubs, or billbugs. If applied for soil insects (mole crickets, white grubs, or billbugs), irrigate with about 1/2 inch of water immediately after applying.

To help avoid unnecessary environmental contamination and reduction of beneficial insects, spot treatments for chinch bugs and webworms can be applied when infestations are first noticed and the damaged area is small. Treat the off-color area and about a 5-foot buffer area surrounding it. If damage is widespread over the yard or if many infested areas are detected, the entire yard should be treated. Inspect the area two to three times at biweekly intervals to determine if the infestation is under control.

If a bait is used for mole crickets, irrigate before application but do not irrigate after applying the bait. Apply late in the afternoon if possible. It is very important to scatter the bait thinly and evenly over the soil surface. A few particles should fall on every square inch of the infested area.

Precautions

Insecticides are poisons and should be handled as such. Read the manufacturer's label carefully before opening the container, and observe all instructions and precautions. Wear rubber gloves when handling and applying insecticides. Do not spill sprays on skin or clothing. Do not breathe mists or fumes. Wash exposed parts of the body with soap and water

immediately after using insecticides. Store pesticides under lock and key in original labeled containers out of reach of children. Rinse empty containers and put rinsings in spray tank. To dispose of empty containers (one gallon or smaller), wrap in newspaper, then crush or puncture to prevent reuse, and put in the garbage can for disposal in an approved sanitary landfill.

Pests: Occasional Invaders

IPM for Silverfish, Firebrats, and Booklice in Schools

Edited by Thomas Powell; originally written by S. Darr, T. Drlik, H. Olkowski, and W. Olkowski.

Introduction

Silverfish, firebrats, and booklice are grouped together because they occur in the same or similar habitats. They prefer a dark, moist environment and require a large supply of starchy foods or molds. Although they are found in closely associated environments, silverfish and firebrats belong to an entirely different insect order than booklice. Each of these insects are considered to be nuisance pests that can feed on wallpaper pastes, natural textiles, books, and manuscripts. They also feed on mold that grows on various surfaces.

Silverfish, firebrats, and booklice can live indoors or outdoors. They frequently are introduced into a structure with storage boxes, but they can also wander in from outside. They are fast-moving and can travel throughout buildings. Once these insects find a good source of food, however, they stay close to it. In general, they do very little damage, but they may cause people to take radical action based on their fear of insects.

Silverfish and Firebrats

Identification and Biology

Silverfish and firebrats belong to an order called Thysanura. Insects in this order are considered to be some of the most primitive insects alive today. Insects in the order Thysanura have three long, taillike appendages attached to the tapered posterior end, each about as long as the body. These insects are wingless, with chewing mouthparts and long antennae, and their body is covered with scales. The mouthparts of silverfish and firebrats are used for biting off small particles or for scraping at surfaces. The most common species inhabiting buildings are in the genus Lepisma (silverfish) and the genus Thermobia (firebrat). The silverfish, *Lepisma saccharina*, is about 1/2 inch long when fully grown and covered with silvery scales. It is grayish to greenish and its body has a flattened-carrot shape. The firebrat, *Thermobia domestica*, has a mottled appearance with patches of white and black, and is shaped similarly to silverfish.


Silverfish


Firebrat

Silverfish and firebrats eat material high in protein, sugar, or starch, including cereals, moist wheat flour, starch in book bindings, sizing in paper, and paper on which there is glue or paste. These insects often attack wallpaper, eating irregular holes through the paper to get to the paste. Silverfish may bite very small holes in various fabrics, including cotton, linen, and silk, even though they cannot digest either linen or cotton. Firebrats will feed extensively on rayon, whereas silverfish usually damage it only slightly.

Characteristics of the silverfish, *Lepisma saccharina*:

- They lay eggs in any season. Eggs take 19 to 43 days to hatch.
- The life cycle from egg to adult is three to four months, molting at least three to four times.
- They prefer moist areas (75 to 97 percent humidity) and moderate temperatures (70 F to 80 F).
- They are active at night or in dark places and may be found throughout the building.
- Adults lay one to three eggs per day and live two to 3.5 years. The biotic potential of one female is 1,500 to 3,500 offspring.
- Adults molt up to 50 times.
- They leave yellowish stains on fabric.
- Outdoors, they live in nests of insects, birds (especially pigeons), and mammals, and under the bark of trees.

Characteristics of the firebrat, *Thermobia domestica*:

- They lay eggs in cracks and crevices. Eggs hatch in 12 to 13 days.
- The life cycle from egg to adult is two to four months. Nymphs molt at least 12 times.
- They prefer moist areas with temperatures above 90 F.
- Adults lay 50 eggs per batch and live for two to three years. The biotic potential of one female is 9,050 offspring.
- Adults molt up to 50 times.
- They are active at night or in dark places.
- They are found where heat and starches are present (for example, in bakeries). Also found in furnace rooms, steam pipe tunnels, and partition walls of water heater rooms.

Booklice

The most common booklouse (*Liposcelis* spp.) is a small, grayish, soft-bodied insect with chewing mouthparts and long antennae. It has a very flat shape that superficially resembles the shape of head lice. The common house-dwelling booklouse is wingless or its wings are reduced to small scalelike,


Booklouse

nonfunctional wings. The size of an adult is approximately 1/25 to 1/12 inch. Booklice cause little direct damage to plants and wood because they feed chiefly on mold. They are found commonly in confined areas, like the bindings of books, where they eat the starch sizing in the bindings and along the edges of pages. Characteristics of booklice:

- Eggs hatch in 21 days.
- The life cycle from egg to adult is around 110 days, with the insect molting two to three times.
- Adults lay 20 to 50 eggs depending on seasonal conditions, and live 24 to 110 days.
- The biotic potential is 120 to 456 offspring per female.
- They prefer warm, moist conditions that are conducive to the growth of mold and mildew and require humidity of at least 60 percent.
- They are found in books and paper products.
- Sometimes they are found on houseplants, where they may be feeding on honeydew (a protein-rich substance excreted by plant-eating insects such as aphids) or, more likely, on the sooty mold that grows on the honeydew.

Detection

Silverfish are found in bookcases, on closet shelves, behind baseboards, wallpaper, window or door frames, wall voids, attics, and sub-floor areas. They prefer bathrooms and kitchens because of the moisture associated with these areas. Firebrats are found in similar but warmer areas. Both silverfish and firebrats molt as many as 50 times during their adult lives. Therefore, the appearance of cast skins may be a useful detection tool. Booklice prefer damp and warm habitats, so they are most numerous during the spring and summer. New buildings are not immune to infestations of booklice. It is essential that conditions conducive to booklice development be identified before control measures can be initiated. Silverfish, firebrats, and booklice can be detected by placing sticky cockroach traps in the area where damage is occurring. When the insects are caught, they should be preserved in alcohol for professional identification.

Physical Control

Dehumidifying

Dehumidifying reduces the moisture content of the air that these insects find essential. Some methods for dehumidifying include:

- Mend leaking pipes.
- Ventilate closed rooms and attics.
- Eliminate standing water.
- Use a dehumidifier.
- Use anhydrous calcium carbonate or silica gel.

Vacuuming

Regularly vacuuming cracks and crevices with a narrow vacuum tip also can be a good method to physically remove these insects from their harborages.

Removal of food

Excess food material should be eliminated. Food sources that cannot be removed should be sealed in containers.

Trapping

Silverfish can be trapped in small glass jars, with the outside of the jar wrapped with masking tape so the insects have something to grip as they climb up. Set the jars upright in areas where silverfish have been seen. Silverfish can also be trapped on cockroach glue board traps.

Eliminating Harborage Sites

Wherever possible, potential hiding areas should be sealed with caulk, especially around windows, cabinets, and moldings. Increasing the lighting makes harborages less hospitable. Removal of leaf litter from around the home can decrease the chance of an outside invasion.

Drying Stored Articles

Periodic airing and drying of articles stored in damp areas may help reduce the mold on which these insects feed. Disposing of moldy articles is often the simplest way of removing an infestation in an area.

Chemical Control

Diatomaceous earth, borate-based insecticidal dust products, and silica aerogel can be used to kill these insects. Diatomaceous earth and borate-based products must be kept dry to be most effective, but silica aerogel will work under damp conditions.

Residual insecticides should be applied to the area where silverfish, firebrats, and booklice are commonly seen. Residual insecticides and dusts are frequently used in combination and their effectiveness can be increased with a flushing agent, usually a pyrethrin-based insecticide.

Some insecticides are registered to control silverfish and firebrats and/or booklice indoors, whereas others are registered for outdoor use only.

Pests: Rodents

Nonchemical Rodent Control

William Kern and Philip Koehler

Introduction

Rats and mice often enter homes, farm buildings, and warehouses in search of food and shelter. The most common rodent pests are the commensal rats and mice. These are Old World rodents that have adapted to live with man. They include the roof rat, Norway rat, and house mouse. These commensal rodents have been carried by man to every corner of the earth. Rats and mice consume or contaminate large quantities of food and damage structures, stored clothing, and documents. They also serve as reservoirs or vectors of numerous diseases, such as rat-bite fever, leptospirosis (Weil's disease), murine typhus, rickettsial pox, plague, trichinosis, typhoid, dysentery, salmonellosis, hymenolepis, tapeworms, lymphocytic choriomeningitis, and rabies.

In most cases of rodent infestation, the pest animals can be controlled without having to resort to the use of poisons. The practices of good sanitation and exclusion will prevent most problems. If rodents do find their way indoors, small populations can be easily eliminated with various nontoxic methods. Rodenticides (rodent poisons) need only be used in cases of large or inaccessible infestations. The trapping of rodent pests is often preferable to the use of poisons. Traps prevent rodents from dying in inaccessible places and causing an odor problem. There is no chance of an accidental poisoning or secondary poisoning of nontarget wildlife, pets, or children with the use of traps. Secondary poisoning of pets or wildlife can result from eating poisoned rodents. Traps can be used in situations where poisons are not allowed, such as in food handling establishments.

Rodent Ecology


House mouse

The house mouse is the most common commensal rodent invading houses. It is primarily nocturnal and secretive. The presence of mice is usually indicated by sightings, damage from gnawing into food containers, or presence of droppings. In the wild, house mice feed primarily on seeds. In the home, they prefer grain products, bird seed, and dry pet food. Peanut butter or gum drops stuck to the trigger, rolled oats or bird seed sprinkled on the trap are good baits. House mice are inquisitive and actively explore anything new. They tend to nibble on many small meals a night.

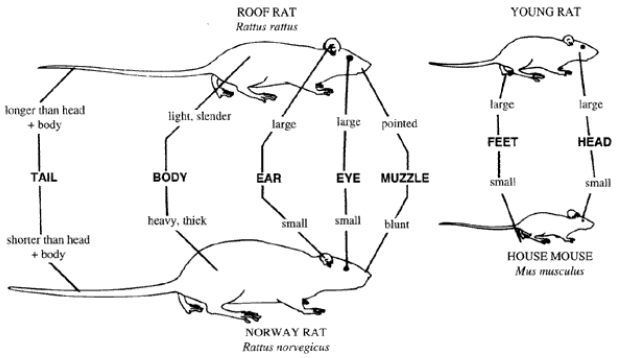
House mice are good climbers. They have a small home range and usually stay within 10 to 30 feet of their nest. Therefore, traps for mice should be set 6 to 10 feet apart. Nests are usually in structural voids, in undisturbed stored products or debris, or in burrows outdoors. When food is abundant, nesting material, such as a cotton ball, tied to the trigger can act as an effective lure. Mice and rats are very nervous about moving in the open. The more cover they have, the more comfortable they are. They would prefer running behind an object or along the baseboard of a wall than to run across an open space.


Roof rat


Norway rat

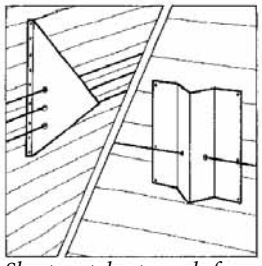
The roof rat, or black rat, is the most common rat encountered in buildings. These rats are excellent climbers and often nest in attics, wall voids, hollow trees, and in palm thatch. They prefer to travel off the ground and enter houses from nearby trees or along power lines. Roof rats prefer fruit (they are sometimes called citrus rats), but will eat any type of human, pet, or livestock food. Peanut butter, pieces of fruit, or nut meats are the best baits. Rats are usually fearful of new items in their environment and avoid them for several days. This means that traps should be left in place for at least one week before they are moved to a new location. The presence of roof rats can be determined by gnawing damage, the presence of droppings, sightings, sounds of scratching, squeaking, or gnawing in walls or ceilings, and characteristic dark, greasy rub marks along frequented paths along walls and on rafters. Rats have large home ranges and may travel over 50 yards to reach food or water. Concentrating traps along rat runways or favorite routes of travel is most effective.

Rats occurring in sewers are generally Norway rats. These rats are strong burrowers, but can also climb well. They are excellent swimmers and can swim under water for up to 30 seconds and can enter houses by coming up toilet pipes. These rats usually dig burrows along building foundations and under debris piles. They have a strong preference for meat and fish, but will do well on any type of human or pet food. Raw or cooked meat and fish, especially sardines, are excellent baits, but peanut butter also works well. Like the roof rat, the Norway rat is cautious of new objects and has a very large home range, over 50 yards in radius. The Norway rat is very aggressive and will drive roof rats out of an area. However, both species of rats can be found in the same building, with roof rats in the attic and Norway rats in the basement.

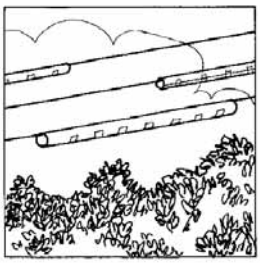


Sanitation and Exclusion

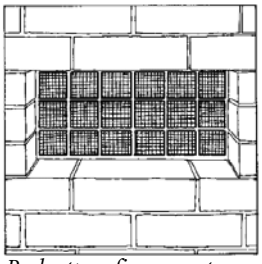
Proper sanitation will do a great deal to control rodent pests. All animals have three requirements for life: food, water, and cover. Removal of any one will force an animal to leave. The removal of debris such as piles of waste lumber or trash, used feed sacks, abandoned large appliances, and trimming the dead fronds from palm trees will substantially reduce the harborages for rodent pests. Stacked firewood stored for long periods provides good harborage for all three commensal rodents. Storage of pet food and seeds, such as wild bird seed, in rodent-proof containers of glass or metal, will eliminate these food sources. Collect and remove fallen fruit from backyard trees and orchards. Keeping lids on trash cans and closing dumpsters at night will also make an area less attractive to rats and mice. The drainage holes in dumpsters should be covered with hardware cloth to keep rodents out.



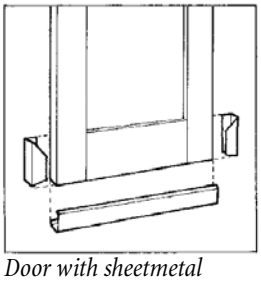
Sheet metal ratguards for utility wires near a wall



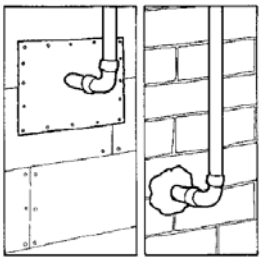
Utility wire ratguards made using plastic tubes



Rodentproofing a vent with 1/4" hardware cloth

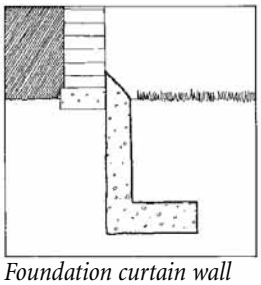


Door with sheetmetal channel and cuffs

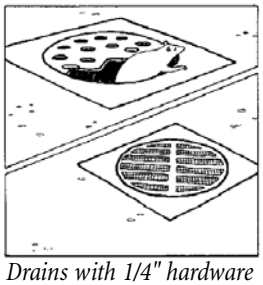


Pipes with sheet metal (L) and concrete

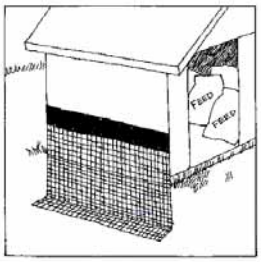
Airvents and chimneys with 1/4" hardware cloth



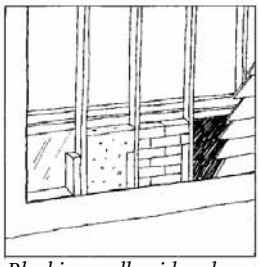
Foundation curtain wall made of cement



Drains with 1/4" hardware cloth



Curtain wall made of hardware cloth and sheet metal



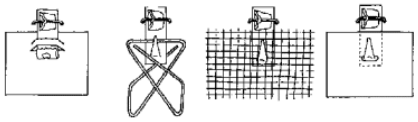
Blocking wall void end spaces with sheet metal, concrete, brick or wood

Exclusion is also called rodent-proofing. This involves making your home a fortress that rodents cannot breach. Rodents can squeeze through any opening that their head can fit through. That is a 1/4 inch opening for mice and a 1/2 inch opening for young rats. Young rats and mice are the dispersing individuals, so these are the ones most likely to invade new areas, like your home. Any opening that a pencil can fit through will admit a mouse. Below is a list of recommended materials for excluding rats and mice.

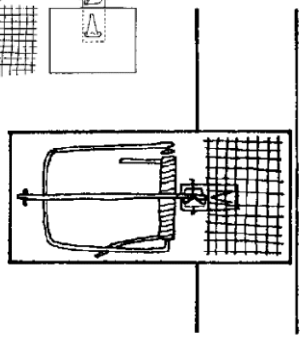
- Galvanized, stainless, or other nonrusting metal.
  - Sheet metal, 24 gauge or heavier.
  - Expanded metal, 28 gauge or heavier.
  - Perforated metal, 24 gauge or heavier.
  - Hardware cloth, 19 gauge or heavier, 1/4 inch or smaller mesh.
- Cement mortar with a 1 part cement: 3 part sand mix or richer.
- Concrete with a 1 part cement: 2 part gravel: 4 part sand mix or richer. Broken glass added to mortar or concrete will deter rodents from tunneling through a patched hole before the material hardens.
- Brick, concrete block, tile, or glass will exclude rodents if in good repair.
- Wood will exclude rodents if no gnawing edges are present.

Traps

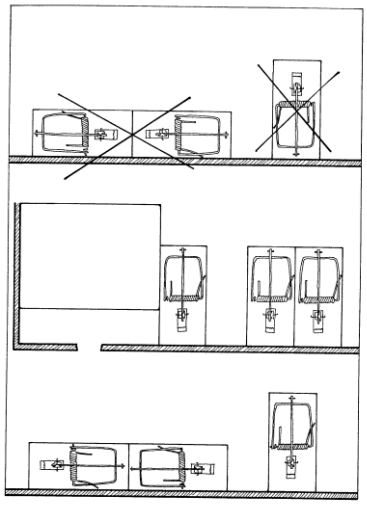
There are four main types of rodent traps: snap traps, multicatch traps, single-catch live traps, and glue board traps. Snap traps include the classic rodent traps with the wood base and the newer metal clothespin traps. They are designed to kill the trapped animal quickly and humanely. Snap traps should not be set where children or pets will come in contact with them. There are three different types of triggers: wood/



Top: Methods to convert metal bait-triggers to expanded triggers for runway sets.



Right: Snaptrap placement on pipes or rafters. Secure trap with duct tape, wire, or small nails.



Top: Improper placement of snap traps.

Middle: Proper placement of double traps and use of structure to guide rodents into traps.

Bottom: Proper placement.

prebaited, metal for holding bait, and expanded trigger, which is used in runways. The expanded trigger is the most versatile type since it can also be baited. Older snap traps with other types of triggers can be modified to produce an expanded trigger.

Traps should be placed where rodents are likely to be. Rodents are creatures of habit and prefer to follow the same runways they usually use. It is important to identify these runways and place traps there. Runways can be identified by sprinkling a fine layer of flour or baby powder in suspected areas and looking for tracks. This is a safe diagnostic method for determining rodent activity, but should not by confused with the use of rodenticide tracking powders, which require a restricted-use pesticide license. Rodents often run along edges and traps should be set along walls, especially where objects such as a box or appliance will guide them into the trap. The type of bait used depends on the species of rodent pest. Roof rats prefer to travel above the ground and are easier to trap along these precarious pathways than on the ground.

Multicatch traps are designed to repeatedly catch a rodent and reset themselves for another capture. Advantages of these traps are the ability to capture several rats or mice with one setting and the scent from the captured mice entices others to the trap. The disadvantages are that the captured mice or rats are alive and must be dealt with, and these traps are expensive. Methods for dealing with the captive rodents includes submerging the entire trap in a bucket of water and drowning them, using drowning attachments available for some traps, placing glue boards in the holding compartment of the trap, or finding someone with a pet snake that eats mice or rats. The release of commensal rodents outside is not a solution, since they will quickly find a way back into your home or someone else's. Trap-wise rodents are also more difficult to trap than naive ones. Multicatch traps must be checked on a regular basis like any other trap to prevent the capture rodents from starving or dying of thirst and creating an odor problem. Available multicatch traps include the Kness "Ketch-All" Automatic Mouse Trap, the Victor Tin Cat Repeating Mouse Trap, and the "Rat Katcher" (previously the "Katch-All") Repeating Rat Trap.

Single-catch live traps are rodent-sized cage traps of various styles. These traps capture the rat or mouse alive and unharmed but, again, you have to deal with the captured rodent. The native rodents, cotton mice and eastern wood rat that occasionally invade rural and suburban homes can be released back in the woods with little chance of returning indoors. They can be recognized by their fine brown fur, white belly, large eyes, and very large ears. Commensal rodents should not be released because they will return to your home or someone else's. Rodents caught in these traps are best dispatched by submerging the entire trap in a bucket of water. These traps should be used in areas known to be occupied by endangered native rodent species, for example, on barrier islands and the Florida Keys, to confirm the species of invading rodent and prevent the accidental killing of an endangered species.

These traps should be placed against walls or in runways. The most effective bait for mice with this type of trap is rolled oats (uncooked oatmeal) sprinkled inside the trap with a fine trail leading out. Rat-sized live traps are produced by Havahart, Kness Mfg., Mustang Live-catch Traps, Safeguard Live Animal Traps, Sherman Live Traps, and Tomahawk Live Traps. Mouse-sized live traps are produced by Havahart, Sherman Live Traps, Tomahawk Live Traps, and Trap-Ease Mouse Live Trap.

Glue boards are used just like snap traps. While both rat- and mouse-sized glue boards are made, these traps are most effective against mice. Rats often are strong enough to pull themselves free from glue traps. Glue boards should not be set in wet or dusty areas because these conditions render the traps ineffective. Wet feet and fur will not stick to the glue, and dust coats the glue till it is no longer sticky. These traps also should not be set where children or pets will contact them. Glue boards are not hazardous to children or pets, but the encounter will create a frustrating mess.

Clean up hands with room-temperature cooking oil, and clean surfaces with paint thinner or mineral spirits. The best glue boards have at least a 1/8 to 1/4 inch layer of glue. Do not set glue boards near open flames or above carpets. Glue boards should be secured with a tack or small nail, wire, or double-sided tape if they are placed on ledges, pipes, or rafters over food preparation surfaces or carpets.

Predators

Predators are nature's method of controlling rodent populations. There are many native and domestic predators that feed on rats and mice. Snakes such as black racers, yellow, black, or gray rat snakes, corn snakes (red rat snakes), king snakes, Florida pine snakes (gopher snakes), and coachwhips are non-poisonous native reptiles that feed primarily on rodents and may help control outdoor infestations.

Hawks and owls, especially barn owls, eat large numbers of rats and mice. Nest boxes of the proper proportion will encourage barn owls and screech owls to nest in your area and raise their young. Hawk and owl parents kill many more rodents when they are feeding their hungry broods. Foxes, bobcats, striped and spotted skunks, weasels, and mink will all

eat plenty of rodent pests, but these wild predators avoid people.

Domestic cats, dogs, and ferrets help in controlling rodents in some situations. In general, dogs and cats are most effective at preventing an infestation than eliminating a current population. This is because they are better able to catch and kill an invading rodent that does not know any escape routes than an established animal that knows numerous escape points. Cats are very effective predators of mice, but usually will not attack an adult rat. They will also kill birds at bird feeders, wild rodents, and baby rabbits, so these factors must also be considered. To prevent cats from becoming a pest themselves, be sure to have any cat you release spayed or neutered. This service is required and provided by most county humane societies at the time of adoption. Pet ferrets will kill rats and mice indoors but should never be released outside. The establishment of wild ferret populations could decimate our native wildlife.

Many people propose the mongoose for rodent control, but the importing, possession, or release of any mongoose is strictly illegal because of the ecological damage they can do. The mongoose has repeatedly shown a preference for native birds and mammals over commensal rodent pests.

Ultrasound Devices

The principal of ultrasonic devices is to create a loud noise above the range of human hearing (above 18 – 20 kHz) that is unpleasant to pest species. The problems with ultrasound are numerous. Animals can adapt to most situations, and in a short amount of time they become accustomed to the sound. If the original attractant, such as food, is present, the rodents will return. The short wavelengths of ultrasound are easily reflected. This creates sound shadows, and the rodents simply shift their activity to these low-noise shadows.

Ultrasonic devices will not drive rodents from your home if food, water, and shelter are available. However, ultrasonic devices may have a part to play in rodent Integrated Pest Management. Ultrasonic devices may increase trapping effectiveness by altering the normal movement patterns of individual rodents. Traps set in the sound shadow areas will become more effective since the rodents will be concentrated in these areas. The high cost of the units must be considered against the increase in trapping effectiveness to determine if they are cost effective.

Pests: Spiders

IPM for Spiders in Schools

Edited by Deanna Branscome; originally written by S. Darr, T. Drlik, H. Olkowski, and W. Olkowski.

Introduction

Although diminutive in size, spiders have invoked fear and revulsion in humans throughout history. Because of this, they have been a source of endless fascination, the subject of numerous folktales and myths. To be certain, little Miss Muffet and the spider that frightened her are familiar to most people. Fears about spiders are largely unwarranted, for they provide a great benefit to mankind by consuming vast numbers of insects in and around our homes. It is only a few species of spiders that are considered truly dangerous to humans. Therefore, it is important to be able to differentiate between relatively harmless spiders and those which should be avoided and/or controlled.

The species of spiders that cause the most concern in the home or school environment are the black widow, brown recluse, and the aggressive house/hobo spider. These spiders are potentially dangerous to humans, and bites from these spiders may cause severe reactions or even death. However, these spiders will usually bite only if provoked, and only under certain circumstances.

First Aid for Spider Bites

If possible, capture the spider so the specimen can be taken to a doctor. Proper treatment may depend on identifying the species. Even the squashed remains of the spider can be useful for identification purposes.

Wash the area around the bite, calm the victim, and consult a doctor as soon as possible. Those particularly at risk are the very young, the elderly and sick, or people with high blood pressure. Although the illness and lesions from bites of the three spiders discussed in this chapter can be serious, deaths are rare.

Avoiding Spider Bites

The three dangerous spiders described in this section have particular nesting and hiding places, which are described below. If any of these spiders is common around your school, it is important to be cautious when working near these places. Gardeners and custodians should be careful about where they put their hands when doing outdoor work, and wear gloves and a long-sleeved shirt when working around woodpiles and other items stored outdoors that are likely to harbor the spiders.

Make sure students and staff can identify any dangerous spiders in your area and know their likely nesting and hiding places. Children should be taught not to tease spiders in their webs or poke at them, and to not put their hands in dark crevices without looking first. The dangers of spider bites should be explained without exaggeration to avoid unnecessary fears. Teach students and staff that the "black spiders" they see walking around are not likely to be black widows, since the females (males aren't dangerous) do not travel away from their webs.

Nesting and Hiding Places for Three Problem Spiders

Black widows like dry, undisturbed places such as lumber and rock piles, stacked pots or baskets, rodent burrows, water meters, the underside of bricks and stones, and dry crawl spaces. Females stay in the web.

Brown recluse spiders prefer undisturbed places for their webs, hunt primarily at night, and take refuge in clothing and bedding. They often are found in unused closets and storerooms, behind furniture, and in baseboard cracks and crevices. Outside, they can be found in foundation cracks, cracks in the soil, and window wells.

Aggressive house spiders prefer dark, moist places with cracks and crevices for its funnel-shaped web. They are poor climbers so rarely are seen above ground level. Males wander (especially from June through September) and sometimes become trapped in clothes, toys, bedding, or shoes. Inside, this spider is likely to be found in basements and on ground floors between stored items, in window wells, in closets, and behind furniture. Outside, it can be found in areas similar to both the black widow and brown recluse.

Removal of a Nondangerous Spider

For those spiders that are considered nondangerous, it may be best just to leave them where they are found. However, if this is considered unacceptable, the spider may be removed without harming it. This may be done by inverting a container of some sort over the spider, sliding a stiff piece of paper over the mouth of the container, and then releasing the spider outside.

General Spider Management

Nonchemical control: Employing nonchemical control is usually considered most effective. Specifically, this would include eliminating hiding or harborage sites. One recommendation is to store boxes off the floor and away from walls, sealing them tightly with tape to preclude access by spiders (and insects as well). Removal of debris and excess clutter will also reduce the number of harborage sites available. Debris and stacks of firewood should be moved a distance from schools or homes and elevated off the ground as much as possible. Vegetation should be removed from the sides of buildings and grass should be kept mown.

For spiders already in residence, removal of their webs and egg sacs discourages subsequent infestation. Vacuuming is an excellent way to accomplish removal. Exclusion practices may also be employed. Examples of this are maintaining tight-fit-

ting screens in windows and sealing entrance sites such as doors and cracks in walls. Additionally, it is recommended that sufficient ventilation be maintained in attics and basements to reduce moisture, thus reducing the amount of prey insects available as a food source for spiders.

Chemical control: A wide variety of chemicals are available for the control of spiders. However, chemical control is most effective when conducted by a certified pest control operator. Misapplied chemical treatments may cause more harm than the real or perceived threat from spiders. Examples of some of the treatment methods that professionals might use are contact, spot, crack-and-crevice, space, and perimeter treatments. In situations where a severe infestation is present, fumigation of the building may be deemed necessary.

Black Widow Spiders

Identification and Biology

All of the adult females of the three most common species of black widows in the United States (the northern widow, *Latrodectus variolus*; the black widow, *L. mactans*; and the "western" widow, *L. hesperus*) are large (body size is 1/2 inch or larger). They are typically shiny black spiders with a red hourglass design on the underside of their abdomen. Because their webs are near the ground and the spiders hang upside down in the web, their distinctive marking is readily apparent. The adult male, which is not dangerous, is small and patterned with whitish streaks, bars, or dots on the top of the abdomen.


Black widow


Red widow


Brown widow

There is a red form (the red widow, *L. bishopi*) of this genus in the sandy, scrub pine areas of central and southeastern Florida, as well as a tropical brown widow, *L. geometricus*, that has become established in southern Florida.

The female black widow spider spins an irregular, tangled web, with a tunnel in the center. The webs are typically constructed in quiet, undisturbed locations that are usually, but not always, close to the ground.

The female spends her life entire life in the web and retreats into the tunnel when disturbed. Her eggs are placed in white, spherical sacs within the web. After hatching, the young spiders stay near the sac for a few hours to several days and then climb to a high point, wait for suitable air currents, and spin a silken thread so they can float on the breeze like a kite. This method of "ballooning" distributes them over a considerable distance. Once they land, the spiders begin to construct their own webs. The abdomen of a young black widow is patterned with red, white, and yellow, but has the black legs and general appearance of the adult.

Bites

Black widows are shy, retiring creatures that bite reluctantly and then only in self-defense when threatened. However, when a female is defending her egg sac, she can become quite aggressive. After the bite is inflicted, it may not initially cause pain. However, after a few minutes, the bite site becomes quite painful. Symptoms from the bite of a black widow include headache, general body ache, nausea, shortness of breath, intense muscle pain, and rigidity of the abdomen and legs. If reactions are mild, no treatment is usually administered. However, if symptoms do become severe, diazepam may be administered for muscle pain and cramps. The bite of the black widow is usually more serious for small children and the elderly.

Detection and Monitoring

Monitor for black widows at night with a flashlight or head lamp. This is the time when they move to the center of their webs and will be most visible. When making your inspections, focus on areas that are dark and undisturbed during the day, but not necessarily close to the ground.

Look in and around the following places:

- Small crevices anywhere from the foundation to the eaves of buildings
- The undersides of outdoor wooden furniture (for example, beneath the seats in the corners where the legs are braced)
- Piles of wood, bricks, stones, or similar materials
- The openings of rodent burrows
- Water meters
- Cellar doors
- Outhouses
- Storage rooms

Black widow webs have high tensile strength and, with little experience, can be identified by the way they pop when broken. An experienced pest manager can use this information to find webs during the day.

Management Options

Physical Controls

To achieve some kind of permanent control of black widow spiders, you must attempt to eliminate not only the spiders but their preferred habitats as well. If this is not accomplished, another black widow may locate the same habitat and move in. If black widows regularly build their webs in certain locations indoors, try to modify these areas by increasing the light, caulking crevices, or reducing the insect population the spiders are feeding upon. As previously mentioned, check window and door screens for holes that allow access for insects, and make sure that foods and organic wastes are stored properly to prevent insect infestations. To reduce or eliminate possible web sites outdoors, debris and litter should be removed and discarded. All crevices in foundations and walls that are child height and wide enough to stick a finger into should be caulked closed.

Brown Recluse Spider

Identification and Biology


Brown recluse

Brown recluse spiders (*Loxosceles* spp.) are identified by their long thin legs, an oval abdomen that is light tan to dark brown, and a very distinctive violin-shaped mark on their back. This marking gives rise to their other common name, violin spider. Their overall size is 3/4 inch to 1 1/4 inches. The males are slightly smaller than the females.

There are many species of brown recluse spider in the United States. They are found mostly in the Midwestern and south-central states, the Southwest, and Puerto Rico. As the common name "recluse" suggests, these spiders are shy, retreating from humans when possible and preferring dark, undisturbed places on or near the ground for web building. Unlike the black widow, brown recluse spiders hunt for prey some distance from their webs. They usually come into contact with humans because they have taken temporary refuge in clothing or bedding. Items left lying undisturbed on the floor, such as supplies, toys, or clothing, are perfect daytime refuges for these spiders. Such objects should be shaken out thoroughly if they have been on the floor for any length of time, particularly in regions where the brown recluse is prevalent.

Bites

Brown recluse spiders avoid areas of human activity. Bites are rare and are usually the result of unused rooms suddenly being put to use, or accidental contact resulting from pressing the spider between the body and either clothing or sheets. The bites are almost always very unpleasant, producing an ulcerous wound, called a necrotic lesion, that turns dark within a day and takes a long time to heal. Young children, the elderly, and the infirm are most likely to be affected severely. Victims should seek medical attention, but should allow only a doctor to excise the affected tissue in extreme cases.

Detection and Monitoring

The brown recluse spider wanders at night searching for prey. It seeks dark, uninhabited areas for protection. Brown recluse spiders are usually found on floors and baseboards. Only rarely are they seen on desks and tables, and they are never found on walls.

Searches for this spider should concentrate on uninhabited areas close to the floor, particularly in boxes, around piles of paper, clothing, and debris, in closets, and under furniture. Periodic checks outdoors should focus on storage sheds, piles of debris or wood, cracks in the soil or in foundations, walls, and window wells, especially if small children play near these places. Employing traps in monitoring also is useful in establishing the extent of brown recluse infestations, and is helpful in providing a measure of control.

Management Options

Physical Controls

Because these spiders prefer undisturbed places for nesting and hiding, periodic, thorough cleaning can help reduce their numbers. Floors should be kept well-vacuumed. Boxes of paper and other items stored in closets, or anywhere else that is dark and undisturbed, should be handled carefully when first inspected. If brown recluse spiders are suspected, the boxes can be placed in a bin-type freezer for 48 hours to kill the spiders before the boxes are unpacked. A small hand-held, battery-powered vacuum can be used while checking through stored items. If a spider is vacuumed up, the vacuum bag can be placed into a plastic bag and then into a freezer.

Outside, remove piles of debris, wood, and rock. Fill cracks in walls and foundations with mortar or caulk. Inside, clothing and other objects should be removed from floor areas in closets, locker rooms, and other storage spaces. Because most bites are received when putting on shoes or clothing that has lain on the floor, clothes normally stored near the floor should be moved to a higher location. Shake out clothes if they were on a floor overnight. Hanging shoes or placing them in sealed plastic bags reduces the likelihood of being bitten. Wearing leather gloves while searching through stored items can help prevent bites.

Aggressive House Spider

Identification and Biology

The aggressive house spider (*Tegenaria agrestis*) is a fairly large (1 3/4 inches, including legs), fast-moving spider. Its legs are long and hairy, and its body is brown with darker markings on its oval abdomen. This spider builds a funnel-shaped web in moist, dark places. The aggressive house spider waits in its funnel and, when it feels vibrations, rushes out to grab its prey.

This spider mates in the summer and early fall, and the female lays eggs in the fall in silken sacs that are placed behind or beside the web. Eggs hatch in the spring and the spiderlings develop for a year before they are sexually mature.

The aggressive house spider is found throughout the Pacific Northwest, Idaho, and Utah and appears to be rapidly expanding its range.

Bites

Very few people are bitten by this spider and even fewer develop severe symptoms. Bites most commonly occur from July to September, when males are wandering in search of females. Often bites occur when the spider is squeezed between clothing and a person's body. The bite of an aggressive house spider can produce symptoms similar to those produced by a brown recluse. The initial bite may not be painful, but within a few minutes a hard, sensitive area develops. Other symptoms include severe headache, nausea, weakness, and joint pain. Later, the area blisters, oozes serum, and eventually scabs over. The lesion may take months to heal.

Detection and Monitoring
The distinctive funnel-shaped web of the aggressive house spider is easy to spot in dark, moist locations at ground level or in basements. Specially designed traps may be useful in detection and possibly control.

Management Options

Physical Controls
As with other spiders, regular, thorough vacuuming behind furniture and stored articles, under baseboard heaters, and in closets will help eliminate spiders and their webs. Repair torn screens and broken windows, and ensure that doors are able to close tightly without gaps. If this spider is common in your area, do not store shoes, clothing, or bedding at ground level where spiders could become entrapped. Outside, caulk holes and crevices in foundations or walls and eliminate piles of debris, lumber, and rocks, as much as possible. Cut or eliminate long grass growing near foundations. Wear protective clothing when working outside in areas that might harbor spiders, and inspect items that you pick up. Always check articles that you bring into the school from outside storage sheds to make sure you don't bring in spiders or their egg sacs.

Pests: Wood-destroying Insects

Subterranean Termite Control for Public Educational Facilities

Clay Scherer, Steve Dwinell, and Philip Koehler

Introduction

This document is based on proposed changes to the Florida Building Code as of 2001. This document was written by the Florida School IPM Advisory Board and is intended to provide suggestions to school officials when considering subterranean termite treatments to school buildings. The implementation of Integrated Pest Management (IPM) into Florida schools has reduced the risk of pesticide exposure to children and reduced the risk of exposure to pests. This document is consistent with implementation of IPM. This document has two main sections, "Building Practices and Standards" and "Treatment Methods and Practices."

Subterranean termites (referred to as simply "termites" throughout this document) are insects that can invade and damage structures in Florida. They occur everywhere in the state. They constantly forage for sources of cellulose and can enter a structure through a gap as small as 1/64 inch. Sources of cellulose can be structural wood, finish wood, paper covering of drywall, books, records, stored products, furniture, and many other wood- or paper-based products. Termite feeding on these materials can cause tens of thousands of dollars of damage.

Public educational facilities are vulnerable to termite damage, even if constructed with nonwood structural elements. The time to institute control measures for termites is during planning and construction. This document will provide information on building practices and standards that will assist in termite control and on control techniques that are implemented during and after construction. The use of an Integrated Pest Management approach to termite control will offer the highest probability of preventing termite infestation and damage.

Building Practices and Standards

The following building practices should be observed to construct a facility that is not conducive to termite infestation. While it is not possible to build a structure that is "termite proof," it is possible to avoid creating conditions that favor termite infestation or make it difficult or impossible to control termites.

A. Posting of Treatment Notices

Certificate of Soil Treatment for prevention of termites. A weather-resistant job site posting board should be provided

to receive duplicate Treatment Certificates as each required chemical soil treatment is completed, providing a copy for the person the permit is issued to and building permit files. The Treatment Certificate shall provide the identity of the applicator, time and date of the treatment, site location, area treated, chemical used, percent concentration, and number of gallons used, to establish a verifiable record of protective treatment. Final exterior treatment shall be completed prior to final building approval.

B. Exterior Siding (Wall Covering)

Veneered Walls

In order to provide for inspection for termite infestation, and to prohibit exterior siding contact to soil, clearance between exterior wall coverings (i.e., stucco, siding) and soil on the exterior of a building should not be less than 6 inches (152 mm).

EXCEPTION:

1. Paint or decorative cementitious finish less than five-eighths of an inch thick applied directly to the masonry foundation sidewall.
2. Access or vehicle ramps which rise to the interior finish floor elevation for the width of such ramps only.
3. A four (4) inch inspection space above entry areas, exterior slabs adjacent to school buildings.
4. Masonry veneers.

C. Roof Assemblies and Rooftop Structures

Weather Protection

Protection against decay and termites. All condensate lines, and roof downspouts should discharge at least one foot away from the structure sidewall, whether by underground piping, tail extensions, or splash blocks. Gutters with downspouts are required on all buildings with eaves of less than six inches horizontal projection except for gable end rakes or on a roof above another roof. Irrigation/sprinkler systems and risers for spray heads should have sprinkler heads or be located two (2) feet from the building so as to prevent water contacting walls and prevent soil disturbance and leaching of termiticides. Inclusion of drought tolerant plants (being consistent with Educational Codes on Landscapes) into landscape plans can aid in achieving this goal.

The purpose of these suggestions is to limit all possible soil disturbance near the foundations of buildings. Liquid soil termiticide applied to these areas during construction can be easily disturbed by subsequent landscape operations and water input, rendering a failed termiticide barrier.

D. Foundation Treatment

Termite Protection (see also Treatment Methods and Practices)

Soil treatment. Termite protection should be provided by chemical soil treatment with termiticides or other approved methods of termite protection.

Initial chemical soil treatment inside foundation perimeter should be completed after all excavation, backfilling, and compaction is complete.

Soil area disturbed after initial chemical soil treatment should be retreated with a chemical soil treatment, including spaces boxed or formed.

Spaces in concrete floors boxed out or formed for the subsequent installation of plumbing traps, drains, or for any other purpose should be created by using plastic or metal permanently placed forms of sufficient depth to eliminate any planned soil disturbance after initial chemical soil treatment.

Chemically treated soil should be protected with a minimum 6 mil vapor retarder to protect against rainfall dilution. If rainfall occurs before vapor retarder placement, retreatment is required. Any work, including placement of reinforcing steel, done after chemical treatment until the concrete floor is poured, should be done in such manner as to avoid penetrating or disturbing treated soil.

Concrete overpour or mortar accumulated along the exterior foundation perimeter should be removed prior to exterior chemical soil treatment, to enhance vertical penetration of the chemicals.

Chemical soil treatments should also be applied under all exterior concrete on grade within one (1) foot of the primary structure sidewalls. Also, a vertical chemical barrier should be applied promptly after construction is completed, following initial landscaping and irrigation/sprinkler installation. The vertical barrier is a termiticide applied to the perimeter of the structure at the label rate of 4 gallons per 10 linear feet per foot of depth. The vertical barrier is part of the entire pretreatment requirement and should be completed after final grade. Any soil within one foot of structure disturbed after the chemical vertical barrier is applied shall be promptly retreated.

Penetrations. Protective sleeves around metallic piping penetrating concrete slab-on-grade floors should not be of cellulose-containing materials and should receive application of a termiticide.

E. Foundation Masonry

Termite Inspection

Cells and cavities in masonry units and air gaps between brick, stone, or masonry veneers and the structure should be cleaned of all nonpreservative treated or nonnaturally durable wood, or other cellulose-containing material prior to concrete placement.

EXCEPTION: Inorganic material manufactured for closing cells in masonry construction or clean earth fill.

Brick, stone, or other veneer should be supported by a concrete-bearing ledge of such thickness as required in Chapter 14 (Florida Building Code), which is poured integrally with the concrete foundation. No hidden cold joint should exist in the foundation unless there is an approved physical barrier. An approved physical barrier should also be installed from below the wall sill plate or first block course horizontally to embed in a mortar joint.

EXCEPTION: Veneer supported by a structural member secured to the foundation sidewall, provided at least a six-inch

Table 1. Florida Registered Soil Termiticides (Alphabetical by Active Ingredient)

Product[1]	Active Ingredient[2] concentration in solution	Active ingredient (mg per kg of body weight)[4]	Relative Toxicity	Repellent/ Nonrepellent[5]
Biflex Talstar	bifenthrin	0.06 – 0.12%	Oral Rat LD50 = 375 Dermal Rat LD50 >2,000	Repellent Repellent
Dursban Equity Cyren	chlorpyrifos	0.75 – 1.0%	Oral Rat LD50 = 96 – 270 Dermal Rabbit LD50 = 2,000	Nonrepellent
Prevail Demon TC	cypermethrin	0.25% – 0.50%	Oral Rat LD50 = 250-4123 Dermal Rabbit LD50 >2,000	Repellent
Tribute	fenvalerate	0.5 – 1.0%	Oral Rat LD50 = 451 Dermal Rat LD50 >5,000	Repellent
Termidor	fipronil	0.06 – 0.125%	Oral Rat LD50 = 296 Dermal Rabbit LD50 = 374	Nonrepellent
Premise	imidacloprid	0.05 – 0.10%	Oral Rat LD50 = 1,858 – 2,591 Dermal Rat LD50 >2,000	Nonrepellent
Prelude Dragnet	permethrin	0.50%	Oral Rat LD50 = 430 – 4,000 Dermal Rat LD50 >2,500	Repellent

clear inspection space of the foundation sidewall exterior exist between the veneer and the top of any soil, sod, mulch or other organic landscaping component, deck, apron, porch, walk, or any other work immediately adjacent to or adjoining the structure.

F. Foundation Preparation

The foundation and the area encompassed within one foot therein should have all vegetation, stumps, large dead roots, cardboard, trash, and foreign material removed and the fill material should be free of vegetation and foreign material. The fill should be compacted to assure adequate support of the foundation. Foreign cellulose material such as stumps, cardboard, form boards and the like can become food sources for termites, which then are able to gain access to the structure.

After all work is completed, loose wood and debris shall be completely removed from under the building and within six inches thereof. All wood forms and supports should be completely removed. This includes, but is not limited to: wooden grade stakes, forms, contraction spacers, tub trap boxes, plumbing supports, bracing, shoring forms, or other cellulose-containing material placed in any location where such materials are not clearly visible and readily removable prior to completion of the work. Wood should not be stored in contact with ground under any building.

EXCEPTION: Materials that are of naturally durable wood or are pressure treated for ground contact, and that are installed with at least six inches clear space from the structure to allow for inspection and treatment for termites.

In order to reduce chances of termite infestation, no wood, vegetation, stumps, dead roots, cardboard, trash, or other cellulose-containing material should be buried on the building lot within fifteen (15) feet of any building or the position of any building proposed to be built.

G. Termite Protection for Wood Framing
Protection against decay and termites

In areas where hazard of termite damage is very heavy, the building official should require floor framing of naturally durable wood, preservative-treated wood, soil treatment, or other approved methods of termite protection.

Decks, fences, patios, planters, or other wooden building components that directly abut the sidewall of the foundation or structure shall be constructed so as to provide:

1. Eighteen (18) inch clearance beneath; or
2. Six inch clearance between the top of the component and the exterior wall covering; or
3. Components that are easily removable by screws or hinges to allow access for inspection of the foundation sidewall and treatment for termites.

Treatment Methods and Practices

The following treatment methods are available for control of subterranean termites.

A. Soil Treatment with Residual Termiticides

Insecticides registered for use as soil-applied termiticides are

listed in Table 1. In order to be registered, these products had to demonstrate (under slab) 100 percent protection of wood from termite attack for five years under Florida conditions. These products, then, will work if they are applied properly and the protection is not defeated through construction or maintenance practices.

Proper application of soil applied termiticides requires that the material be applied to create a continuous barrier between the structure and termite colonies in the soil. Creation of this barrier requires at least two separate applications during construction and may require additional applications, depending on the construction. These applications are:

- Under the slab (horizontal barrier)
- To the perimeter of the foundation (vertical barrier)
- Band application (minimum 1 foot) under any adjacent slabs such as driveways, patios, or walkways

The rate of application of termiticide solution is the same for all the registered products. Termiticide solution will contain a specific concentration of active ingredient and water. The application rates given below are for the solution. The concentration of active ingredient typically used in these solutions is given in Table 1.

Description of Table Columns:

1. Product Names: These are the trade names assigned to products by the manufacturer and are trademarked. Termiticides are usually best known by pest management professionals by these names.
2. Active Ingredient: This is the name of the chemical insecticide formulated in the product. This is the compound that kills the insect pest.
3. Active Ingredient Concentration: Soil termiticides are formulated by the manufacturer at various concentrations based on research and experimentation that show the best results under certain conditions. Soil termiticides are usually diluted on-site, as they are usually packaged as concentrates.
4. Relative Toxicity: This is a toxicological standard used by the EPA when evaluating toxicity of insecticides. LD50 refers to the amount of insecticide necessary to cause mortality in 50 percent of test animals. LD50s are recorded as milligrams (mg) of active ingredient per kilogram (kg) of test animal. For instance, if the rat LD50 of a compound is 500, this means that it required 500 mg of an active ingredient to kill 50 percent of a population of rats that each weighed 1 kg. The higher the LD50 number, the less toxic the compound. The US EPA has four toxicity classifications for pesticides based on oral toxicity: LD50 = 0 – 50 is category I, LD50 = 50 – 500 is Category II, LD50 = 500 – 5000 is Category III, and LD50 > 5,000 is Category IV. Two additional routes of exposure for which LD50 values are determined are "Dermal" and "Inhalation."
5. Repellent/Nonrepellent: A termiticide barrier composed of a repellent termiticide repels termites. A properly applied repellent termiticide will provide protection for the structure unless the barrier is disturbed. A termiticide barrier composed of a nonrepellent termiticide kills termites. A properly applied nonrepellent termiticide can provide protection for the structure even if the barrier is disturbed.

   Note: Concentration of active ingredient in the tank mix varies with product. For all products, rates of finished mix applied are the same:

For monolithic slabs:

- 1 gallon per 10 square feet for the horizontal barrier.
- 4 gallons per 10 linear feet for vertical barrier around perimeter.

For supported or floating slabs:

- 1 gallon per 10 square feet for the horizontal barrier.
- 4 gallons per 10 linear feet for inside perimeter of stem wall (concrete block walls), plus 2 gallons per 10 linear feet for block voids, plus 4 gallons per ten linear feet for the exterior vertical barrier.

For monolithic slabs: No interior vertical treatment is needed.

On labels where timing of establishment of vertical barriers is not specified by label language, the appropriate barrier (interior, exterior, or block void) should be established at the point in construction where it is most appropriate. This means prior to pouring of slab for the interior and block void barriers in supported and floating slab construction. The exterior vertical barrier should be established after establishment of the final grade.

Products and Manufacturers (World Wide Web Information)

Dursban, Equity; DowAgroSciences;
http://www.dowagro.com/
Cyren; CheminovaAgro;
http://www.cheminova.com
Prevail; FMC;
http://www.fmc-apgspec.com/
Demon TC; Zeneca; http://www.zenecaprofprod.com
Premise; Bayer Corp.;
http://www.nobugs.com
Prelude; Zeneca;
http://www.zenecaprofprod.com
Dragnet; FMC;
http://www.fmc-apgspec.com
Biflex, Talstar; FMC;
http://www.fmc-apgspec.com
Tribute, Termidor; Aventis Environmental Science;
http://www.aventis.com

B. Installation of Termite Colony Monitoring and Baiting Systems

Termite baits use small amounts of insecticide to knock out

Product	Active Ingredient	Rat Dermal LD50	Rat Oral LD50
Sentricon	hexaflumuron	>2,000 mg/kg	>5,000 mg/kg
FirstLine	sulfluramid	>2,000 mg/kg	>5,000 mg/kg
Exterra	diflubenzuron	>10,000 mg/kg	>4,600 mg/kg

populations of termites foraging in and around the structure. Some baits may even eradicate entire termite colonies. Termite baits consist of paper, cardboard, or other termite food combined with a slow-acting substance lethal to termites. Regardless of which bait is used, the customer must be prepared and willing to accept the possibility of a lengthy baiting process.

Some bait products are inserted belowground out in the yard, whereas others are installed above ground level on the inside of the structure. Baits are applied belowground by enticing termites to feed on wooden stakes, cardboard, or some other cellulose-based material. The toxicant-laced bait can either be installed initially or substituted after termites have been detected in an untreated monitoring device. Only after a monitoring station has been identified as having active termite foraging is a toxicant-treated bait material placed into the monitoring station. The more belowground stations installed, the better the chances of intercepting termites. Planning, patience, and persistence are requisites for successfully using belowground termite baits as it may take several months to a year to eliminate termites from a structure.

Termite baits may also be installed aboveground in known areas of termite activity. Typically, the stations are installed directly in the path of active termite tunnels after the mud tubes have been broken. Effects tend to be more rapid with aboveground baiting because the procedure does not depend upon chance termite encounters with the stations.

1. The Sentricon™ System. This method of termite baiting has been the most extensively tested of those currently on the market. The Sentricon Colony Elimination System™ was developed by DowAgrosciences and is sold only through authorized pest control firms. The Recruit™ bait contains hexaflumuron (0.5%), a slow-acting ingredient that disrupts the normal growth process in termites (i.e., termites die while attempting to molt). Termite control with the Sentricon System involves a three-step process: 1) Initial monitoring to "pinpoint" termite activity, 2) delivery of the bait, and 3) subsequent monitoring to provide ongoing protection. Recruit AG™ is a termite bait for use as an above ground delivery system for elimination of subterranean termite colonies. Recruit AG can be used only in conjunction with the Sentricon Colony Elimination System and is not available as a separate program.

2. FirstLine™. The FirstLine Termite Bait Station is intended for aboveground baiting of active termite tubes. The station consists of a semitransparent plastic housing (4 x 4 x 1 inches) with open slots at the base. Contained within is corrugated cardboard treated with a slow-acting ingredient (sulfluramid) lethal to termites.

Another formulation of FirstLine was introduced for belowground use, FirstLine GT™ ("GT" stands for ground treatment). Label directions emphasize placement of baits in areas where termite activity is known or suspected, i.e., installation may not involve insertion of baits at fixed intervals around the entire perimeter of the building as is required with the Sentricon system. FirstLine GT may be installed in the soil initially, in effect bypassing the unbaited monitoring step utilized with Sentricon.

3. Exterra™ Termite Interception and Baiting System™. Use of Exterra is a multi-step process. The first step is the placement of stations in the ground around the perimeter of the structure. The next step is inspection of the stations and baiting of active stations with Labyrinth™ (bait that contains the active ingredient). The next step is reinspection of stations and replenishment of consumed bait. When termite activity in the station is eliminated, the station is refurbished and the cycle of inspection and baiting begins again. The toxic bait in Labyrinth™ is diflubenzuron (0.25%), a chitin synthesis inhibitor that causes termites to die while attempting to molt. The biggest advantage of Exterra is that stations can be monitored or refilled with bait without disturbing termites in the station.

C. Installation of Physical Barriers to Termite Infestation

Termi-mesh™ Termite Barrier. Termi-mesh is a flexible, corrosion-resistant, high-grade, stainless steel mesh that termites cannot penetrate. The holes of the mesh are too small for termites to crawl through and it is too strong for termites to chew through. Termi-mesh is designed to prevent subterranean termites from entering a structure through any entrances through the foundation. It is applied over the soil surface beneath the foundation in potential termite entry areas, ie., around plumbing pipes. For this reason, Termi-mesh can be installed only during new construction. Termi-mesh must be installed by specially trained technicians approved by Termi-mesh, Inc. Termi-mesh is very new to the continental United States. However, it has been available in Hawaii and Australia for several years.

D. Treatment of Structural Wood with Borate-containing (DOT) Compounds

Disodium octaborate tetrahydrate (DOT), which is similar to boric acid, acts as a stomach poison. Termites generally avoid wood that has been treated with borate compounds. Borate products are usually directly applied to wood as a liquid or dust formulation. The treatment is applied to all wood within 24" of the ground. This would include sill plates, studs, and exterior sheathing.

1. Bora-Care® (40% DOT) (http://www.nisuscorp.com) active ingredient concentration in solution applied to wood = 23% (1:1) or 16% (2:1)
2. TimBor® (98% DOT) (http://www.borax.com) active ingredient concentration in solution applied to wood = 10% or 15%

Product	Active Ingredient	Rat Oral LD50	Rat Dermal LD50
Bora-Care	borates	>2,000 mg/kg	>5,000 mg/kg
TimBor	borates	2,550 mg/kg	>2,000 mg/kg

Other Resources

University of Florida/IFAS,
http://www.ifas.ufl.edu
Florida Dept. of Education,
http://www.firn.edu/doe/doehome.htm
Univ. of Fla. Ft. Lauderdale Research and Education Center,
http://www.ftld.ufl.edu/entomolo.htm
Florida Dept. of Agriculture and Consumer Services/Bureau of Entomology and Pest Control,
http://doacs.state.fl.us/~aes-ent/
Florida Termite Help,
http://www.floridatermitehelp.org

Termite Baits

Philip Koehler and Thomas Weissling

Introduction

Many pest control companies are offering termite baits as a method of termite prevention and control. People are trying to decide whether to protect their homes with soil termiticides or baits. This information is designed to provide information about termite baits so they can make an intelligent decision about termite control options.

Termite baits use small amounts of insecticide to knock out populations of termites foraging in and around the structure. Some baits may even eradicate entire termite colonies. Termite baits consist of paper, cardboard, or other termite food combined with a slow-acting substance lethal to termites. Regardless of which bait is used, the customer must be prepared and willing to accept the possibility of a lengthy baiting process.

Some bait products are inserted belowground out in the yard, whereas others are installed above ground level on the inside of the structure. Baits are applied belowground by enticing termites to feed on wooden stakes, cardboard, or some other cellulose-based material. The toxicant-laced bait can either be installed initially, or substituted after termites have been detected in an untreated monitoring device. The more belowground baits installed, the better the chances of locating termites. Planning, patience, and persistence are requisites for successfully using belowground termite baits.

Termite baits may also be installed aboveground in known areas of termite activity. Typically, the stations are installed directly in the path of active termite tunnels after the mud tubes have been broken. Effects tend to be more rapid with aboveground baiting because the procedure does not depend upon chance termite encounters with the stations.

Termite Bait Systems

The Sentricon™ System. This method of termite baiting has been the most extensively tested of those currently on the market. The Sentricon Colony Elimination System™ was developed by DowElanco (Indianapolis, IN; 800-888-5511) and is sold only through authorized pest control firms. The Recruit™ bait contains hexaflumuron, a slow-acting ingredient that disrupts the normal growth process in termites (i.e., termites die while attempting to molt). Termite control with the Sentricon System involves a three-step process: (1) initial monitoring to pinpoint termite activity, (2) delivery of the bait, and (3) subsequent monitoring to provide ongoing protection. Recruit AG™ is a termite bait for use as an aboveground delivery system for elimination of subterranean termite colonies. Recruit AG can be used only in conjunction with the Sentricon Colony Elimination Systemtm and is not available as a separate program.

FirstLine™. Another termite bait is the FirstLine Termite Bait Station, manufactured by FMC Corporation (Princeton, NJ; 800-321-1FMC). The product is intended for aboveground baiting of active termite tubes. The station consists of a semi-transparent plastic housing (4 x 4 x 1 inch) with open slots at the base. Contained within is corrugated cardboard treated with a slow-acting ingredient (sulfluramid) lethal to termites.

Another formulation of Firstline was introduced for belowground use, FirstLine GT™ ("GT" stands for ground treatment). Label directions emphasize placement of baits in areas where termite activity is known or suspected, i.e., installation may not involve insertion of baits at fixed intervals around the entire perimeter of the building as is required with the Sentricon system. Firstline GT may be installed in the soil initially, in effect, bypassing the unbaited monitoring step utilized with Sentricon.

Terminate™ is a termite bait product sold to homeowners over the counter in garden stores. The active ingredient is identical to the FirstLine product but was developed completely independently of FMC and without FMC's knowledge or approval. The product guarantees termite control or the homeowner can remove the stakes from the ground after nine months and return them for a full refund. The formulation has not been tested by university researchers to determine how well it works when applied according to label directions.

Exterra™ Termite Interception and Baiting System™ is a new termite bait developed by Ensystex (888-EXTERRA). Use of Exterra is a multi-step process. The first step is the placement of stations in the ground around the perimeter of the structure. The next step is inspection of the stations and baiting of active stations with Labyrinth™ (bait that contains the active ingredient). The next step is reinspection of stations and replenishment of consumed bait. When termite activity in the station is eliminated, the station is refurbished and the cycle of inspection and baiting begins again. The toxic bait in Labyrinth is diflubenzuron, a chitin synthesis inhibitor that

Table 1. Examples of commonly used insecticides and their mode of action.

Insecticide Class	Common Name	Example (Trade Name)	Primary Site Affected
Pyrethroid	Permethrin	Flee	Nervous System
Carbamate	Propoxur	Baygon	Nervous System
Organophosphorus	Chlorpyrifos	Dursban	Nervous System
Avermectins	Abamectin	Avert	Nervous System
Chloronicotinyl	Imidacloprid	Advantage	Nervous System
Cyclodiene	Aldrin	*	Nervous System
Amidinohydrazone	Hydramethylnon	Amdro	Energy Production
Sulfonamide	Sulfluramid	Raid Max	Energy Production
Fumigant (Inorganic)	Sulfuryl Fluoride	Vikane	Energy Production
Juvenile Hormone Analog	Hydroprene	Gencor	Endocrine System
Juvenile Hormone Analog	Methoprene	Pharorid	Endocrine System
Juvenile Hormone Mimic	Fenoxycarb	Logic	Endocrine System
Juvenile Hormone Mimic	Pyriproxyfen	Archer	Endocrine System
Benzoylphenyl Urea	Diflubenzuron	Dimilin	Chitin Production
Benzoylphenyl Urea	Lufenuron	Program	Chitin Production
Benzoylphenyl Urea	Hexaflumuron	Sentricon	Chitin Production
Inorganic	Borates	Roach Prufe	Water Balance
Inorganic	Silica Aerogels	Dri-Die	Water Balance
Inorganic	Diatomaceous Earth	Shell Shock	Water Balance

*No longer registered for use.

causes termites to die while attempting to molt. The biggest advantage of Exterra is that stations can be monitored or refilled with bait without disturbing termites in the station.

Deciding on Baits or Termiticide Barriers

Buildings with hard-to-treat construction or chronic retreatment histories are logical candidates for termite baits. Some structures have construction features that interfere with conventional soil treatment methods, such as wells, cisterns, plenums, drainage systems, and inaccessible crawl spaces. With baits, gaining access for treatment is seldom a problem, since foraging termites are as likely to encounter belowground bait stations around the foundation exterior as well as beneath the structure.

Homeowners who do not want floors drilled and furniture, stored items, or carpeting moved are good candidates for baits. Baiting requires fewer disruptions than does conventional barrier treatment. Installation and subsequent monitoring of bait stations generally does not even require the technician to come indoors. Noise, drill dust, and similar disruptions associated with conventional treatment are avoided.

Homeowners who are strongly opposed to the use of pesticides around their home are good candidates for baits. Although conventional liquid termiticides pose no significant hazard to humans, pets or the environment when applied according to label directions, some individuals are still apprehensive. Chemically concerned homeowners may find the concept of baiting more attractive. With baits, the total amount of pesticide applied is small in comparison to the high gallonages needed to achieve a thorough and effective soil barrier treatment.

Homeowners on limited budgets are good candidates for traditional termiticide barriers. The average termite treatment is usually about $500 to $800 and with a renewable service agreement (warranty) costing $80 to $200 in case the termites return. A baiting program usually ends up costing more than a conventional treatment (averaging about $1,500) because baiting programs require multiple visits to the property for routine monitoring of bait stations. Also, the annual renewal fee for baiting typically is as much as two to three times higher than termiticide barrier treatment.

Property owners with a serious termite problem or those involved in a real estate transaction are good candidates for termiticide barriers. They may not be able to wait two to six

months (sometimes longer) for baits to suppress or eliminate the infestation. People living in attached housing (condos, attached residences) where the entire structure cannot be baited are good candidates for termiticide barriers. Often all the people living in attached housing cannot afford the termite baiting procedure.

Some houses may require treatment with both baits and termiticide barriers. With comprehensive baiting programs such as Sentricon and Exterra, liquid applications (when deemed necessary) are usually made as partial treatments to infested areas, rather than to the entire structure. Other bait products (e.g., FirstLine) are more suited for spot-treatment of active tunnels, feeding galleries, and localized areas in the soil. Such products are typically used in conjunction with more extensive barrier treatments.

Pesticides

Insecticides Used in the Urban Environment: Mode of Action

Steve Valles and Philip Koehler

Introduction

Most people know that insecticides kill insects. However, the way in which these chemicals work is a mystery to most of us. How an insecticide works is called its mode of action. A complete understanding of the mode of action of an insecticide requires knowledge of how it affects a specific target site within an organism. The target site usually is a critical protein or enzyme in the insect, but some insecticides affect broader targets. For example, silica aerogels affect the entire lipid layer on the insect cuticle. Although most insecticides have multiple biological effects, toxicity is usually attributed to a single major effect. This fact sheet is intended to explain what insecticides do in insects to cause toxicity and death.

Insecticides can be classified according to their mode of entry into the insect as: 1) stomach poisons, 2) contact poisons, and 3) fumigants. However, many insecticides belong to more than one category when grouped in this way, limiting their usefulness. Another way insecticides can be classified is by their mode of action. Most insecticides affect one of five biological systems in insects. These include: 1) the nervous system, 2) the production of energy, 3) the production of cuticle, 4) the endocrine system, and 5) water balance. This method of classification is preferred among scientists.

Insecticides that Affect the Nervous System

Most traditional insecticides fit into this category. Pyrethroid, organophosphorus, and carbamate insecticides all adversely affect the nervous system.

Pyrethroids are synthetic chemicals whose structures mimic the natural insecticide pyrethrin. Pyrethrins are found in the flower heads of plants belonging to the family Compositae (e.g., chrysanthemums). These insecticides have a unique ability to knock down insects quickly. Synthetic pyrethrins (also known as pyrethroids) have been chemically altered to make them more stable. Pyrethroids are axonic poisons (they poison the nerve fiber). They bind to a protein in nerves called the voltage-gated sodium channel. Normally this protein opens, causing stimulation of the nerve, and closes to terminate the nerve signal. Pyrethroids bind to this gate and prevent it from closing normally, which results in continuous nerve stimulation. This explains the tremors exhibited by poisoned insects. They lose control of their nervous system and are unable to produce coordinated movement.

Carbamate and organophosphorus insecticides also affect the nervous system. However, these insecticides are synaptic poisons. The synapse is a junction between two nerves or a nerve connection point (hence the name synaptic poison).

Specifically, organophosphorus and carbamate insecticides bind to an enzyme found in the synapse called acetylcholinesterase. This enzyme is designed to stop a nerve impulse after it has crossed the synapse. Organophosphorus and carbamate insecticides bind to and prevent the enzyme from working. Therefore, poisoned synapses cannot stop the nerve impulse. Consequently, continued stimulation of the nerve occurs as observed with pyrethroids. Again, poisoned insects exhibit tremors and uncoordinated movement.

Avermectins belong to a group of chemicals called macrolactones. These chemicals are derived from a fungus and also adversely affect the nervous system. Avermectins are axonic poisons (affect the nerve fiber). They bind to another protein in the nerve fiber called the (gamma) amino butyric acid (GABA)-gated chloride channel. This protein forms a channel within the nerve that attenuates some nerve impulses. Avermectins block the channel causing nerve hyperexcitation. Again, the result is that the nervous system becomes overexcited, resulting in tremors and uncoordinated movement.

Two new insecticides have been introduced recently that also cause toxicity by affecting the nervous system. Imidacloprid belongs to the chloronicotinyl chemical class of insecticides. Imidacloprid is also a synaptic nervous system poison. Specifically, this chemical mimics the action of a neurotransmitter called acetylcholine. Acetylcholine normally turns on a nerve impulse at the synapse, but its effects are terminated very quickly. Imidacloprid turns on the nerve impulse but cannot terminate it because of its chemical structure. Therefore, the nervous system is overexcited (as with organophosphates, carbamates, and pyrethroids), resulting in tremors and uncoordinated movement. Imidacloprid is more specific for insect nervous tissue compared with mammalian nervous tissue.

The other new insecticide that affects the nervous system is fipronil. Fipronil is a phenylpyrazole chemical class insecticide. Its mode of action is similar to cyclodiene insecticides (e.g., chlordane or aldrin) that were used extensively as termiticides during the '60s and '70s and the abamectins described above. These chemicals are axonic poisons that affect the GABA-gated chloride channel.

Insecticides that Inhibit Energy Production

Only a handful of chemicals that inhibit the production of energy are currently in use as insecticides. However, significant research and development of new chemicals with this mode of action are currently under way by many pesticide manufacturers.

The most pervasive and well-known energy inhibiting insecticide is hydramethylnon, the active ingredient in Amdro®, Siege Gel Bait®, and Combat®. This insecticide belongs to the chemical class amidinohydrazone. This chemical binds to a protein called a cytochrome in the electron transport system of the mitochondrion. This binding blocks the production of ATP. Insects killed by these chemicals die on their feet. They essentially "run out of gas."

Another insecticide currently available that inhibits energy production is sulfluramid. This insecticide belongs to the halogenated alkyl sulphonamide chemical class. It is the active ingredient found in Raid Max® ant bait. Sulfluramid is made more toxic by the organism. The parent chemical is converted to toxic metabolites by enzymes in the body.

Finally, the fumigant sulfuryl fluoride inhibits energy production. This chemical is very volatile and typically is used to fumigate houses for drywood termite infestations. Sulfuryl fluoride is fast acting and its mode of action is similar to hydramethylnon and sulfluramid. However, the enzyme affected is different.

Many new chemicals are being developed for use as energy production inhibitors. Chemicals in the class pyrrole, thiourea, and quinazoline are showing great promise as pesticides that inhibit energy production.

Insecticides that Affect the Insect Endocrine System

These chemicals are typically referred to as insect growth regulators, or IGRs. IGRs act on the endocrine or hormone system of insects. These insecticides are specific for insects, have very low mammalian toxicity, are nonpersistent in the environment, and cause death slowly. Most of the currently registered IGRs mimic the juvenile hormone produced in the insect brain. Juvenile hormone tells the insect to remain in the immature state. When sufficient growth has occurred, the juvenile hormone production ceases triggering the molt to the adult stage. IGR chemicals, such as hydroprene, methoprene, pyriproxyfen, and fenoxycarb, mimic the action of juvenile hormone and keep the insect in the immature state. Insects treated with these chemicals are unable to molt successfully to the adult stage, and cannot reproduce normally.

Insecticides that Inhibit Cuticle Production

These chemicals are known as chitin synthesis inhibitors, or CSIs. They are often grouped with the IGRs. The most notable chemicals being used as CSIs are the benzoyphenyl ureas. This class of insecticides includes lufenuron (Program®), which is a systemic insecticide used for flea control (fed to your pet), diflubenzuron (Dimilin®), used against fly larvae in manure, and hexaflumuron (Sentricon®), used in a termite bait station. These chemicals inhibit the production of chitin. Chitin is a major component of the insect exoskeleton. Insects poisoned with CSIs are unable to synthesize new cuticle, thereby preventing them from molting successfully to the next stage.

Insecticides Affecting Water Balance

Insecticides with this mode of action include boric acid, diatomaceous earth, and sorptive dusts. Insects have a thin covering of wax on their body that helps to prevent water loss from the cuticular surface. Silica aerogels (sorptive dusts) and diatomaceous earth are very effective at absorbing oils. Therefore, when an insect contacts one of these chemicals it absorbs the protective waxy covering on the insect, resulting in rapid

water loss from the cuticle and eventual death from desiccation. Unfortunately, insects that live in environments with high relative humidities, or that have ready access to a water source, show an increased tolerance to silica aerogels and diatomaceous earth. This is because water loss can be minimized by either of these conditions, and the insect may survive despite the absence of a wax layer.

Borate-containing insecticides also disrupt water balance in insects. The exact mode of action (more specifically the target site) of borate-containing insecticides is not currently known.

Toxicity of Pesticides

O. Norman Nesheim

Introduction

This document describes how pesticides work on living things, so you can learn to reduce or eliminate exposure. Pesticides are designed to control pests, but they also can be toxic (poisonous) to desirable plants and animals, including humans. Some pesticides are so highly toxic that very small quantities can kill a person, while exposure to a sufficient amount of almost any pesticide can make a person ill. Since even fairly "safe" pesticides can irritate the skin, eyes, nose, or mouth, it is a good idea to understand how pesticides can be toxic so you can follow practices designed to reduce or eliminate your exposure and the exposure of others to them.

How Pesticides Enter the Body

Before a pesticide can harm you it must be taken into the body. Pesticides can enter the body orally (through the mouth and digestive system), dermally (through the skin), or by inhalation (through the nose and respiratory system).

Oral Exposure

Oral exposure may occur because of an accident but is more likely to occur as the result of carelessness, such as blowing out a plugged nozzle with your mouth, smoking or eating without washing your hands after using a pesticide, or eating fruit that has been recently sprayed with a pesticide. The seriousness of the exposure depends upon the oral toxicity of the material and the amount swallowed.

Dermal Exposure

Dermal (skin) exposure accounts for about 90 percent of the exposure pesticide users receive from nonfumigant pesticides. It may occur any time a pesticide is mixed, applied, or handled, and it often goes undetected. Dry materials — dusts, wettable powders, and granules, as well as liquid pesticides — can be absorbed through the skin.

The seriousness of dermal exposure depends upon:

- The dermal toxicity of the pesticide;
- Rate of absorption through the skin;
- The size of the skin area contaminated;
- The length of time the material is in contact with the skin; and
- The amount of pesticide on the skin.

Rates of absorption through the skin are different for different parts of the body. Using absorption through the forearm as the standard, absorption is over 11 times faster in the lower groin area than on the forearm. (Absorption through the skin in the scrotal area is rapid enough to approximate the effect of injecting the pesticide directly into the bloodstream.)

Absorption continues to take place on all of the affected skin area as long as the pesticide is in contact with the skin. The seriousness of the exposure is increased if the contaminated area is large or if the material remains on the skin for a period of time.

Inhalation Exposure

Inhalation exposure results from breathing pesticide vapors, dust, or spray particles. Like oral and dermal exposure, inhalation exposure is more serious with some pesticides than with others, particularly fumigant pesticides.

Inhalation exposure can occur from the applicator's smoking, breathing smoke from burning containers, breathing fumes from pesticides while applying them without protective equipment, and inhaling fumes while mixing and pouring pesticides.

Toxicity

Toxicity refers to the ability of a poison to produce adverse effects. These adverse effects may range from slight symptoms such as headaches to severe symptoms like coma, convulsions, or death. Poisons work by altering normal body functions. Consequently, toxicity can occur in as many ways as there are body functions. Most toxic effects are reversible and do not cause permanent damage if prompt medical treatment is sought. Some poisons, however, cause irreversible (permanent) damage.

All new pesticides are tested to establish the type of toxicity and the dose necessary to produce a measurable toxic reaction. In order to compare the results of toxicity tests done in different labs, there are strict testing procedures. Toxicity testing is extensive (involving many phases) and, therefore, expensive. Humans, obviously, cannot be used as test animals so toxicity testing is done with animals. Since different species of animals respond differently to chemicals, a new chemical is generally tested in mice, rats, rabbits, and dogs. The results of these toxicity tests are used to predict the safety of the new chemical to humans.

Toxicity tests are based on two premises. The first premise is that information about toxicity in animals can be used to predict toxicity in humans. Years of experience have shown that toxicity data obtained from a number of animal species

can be useful in predicting human toxicity, while data obtained from a single species may be inaccurate. The second premise is that by exposing animals to large doses of a chemical for short periods of time, we can predict human toxicity from exposure to small doses for long periods of time.

Toxicity is usually divided into two types, acute or chronic, based on the number of exposures to a poison and the time it takes for toxic symptoms to develop. Acute toxicity is due to short-term exposure and happens within a relatively short period of time, whereas chronic exposure is due to repeated or long-term exposure and happens over a longer period (see Table 1).

Table 1. Types of Toxicity

Type	Number of Exposures	Time for symptoms to develop
Acute	Usually 1	Immediate (minutes to hours)
Chronic	More than a few	One week to years

Acute Toxicity

The acute toxicity of a chemical refers to its ability to do systemic damage as a result of a one-time exposure to relatively large amounts of the chemical. A pesticide with a high acute toxicity may be deadly if even a very small amount is absorbed. The signal words on the label (see Table 2) are based on the acute toxicity of the pesticide. Acute toxicity may be measured as acute oral (through the mouth), acute dermal (through the skin), and acute inhalation (through the lungs or respiratory system).

Acute Toxicity Measure

The commonly used term to describe acute toxicity is LD50. LD means Lethal Dose (deadly amount) and the subscript 50 means that the dose was acutely lethal to 50 percent of the animals to whom the chemical was administered under controlled laboratory conditions. The test animals are given specific amounts of the chemical in either one oral dose or by a single injection, and are then observed for 14 days.

Since LD 50 values are measured from zero up, the lower the LD50 the more acutely toxic the pesticide. Therefore, a pesticide with an oral LD50 of 500 would be much less toxic than a pesticide with an LD50 of 5. LD50 values are expressed as milligrams per kilogram (mg/kg) which means milligrams of chemical per kilogram of body weight of the animal. Milligram (mg) and kilogram (kg) are metric units of weight similar to ounce and ton. Milligrams per kilogram is the same as parts per million.

For example, if the oral LD50 of the insecticide parathion is 4, a dose of 4 parts of parathion for every million parts of body weight would be lethal to at least half of the test animals.

LD50 values generally are expressed on the basis of active ingredient. If a commercial product is formulated to contain 50 percent active ingredient, it would take two parts of the material to make one part of the active ingredient. In some cases, other chemicals mixed with the active ingredient for formulating the pesticide product may cause the toxicity to differ from that of the active ingredient alone.

Acute inhalation toxicity is measured by LC50. LC means Lethal Concentration. Concentration is used instead of dose because the amount of pesticide inhaled from the air is being measured. LC50 values are measured in milligrams per liter. Liters are metric units of volume similar to a quart. The lower the LC50 value, the more poisonous the pesticide.

Chronic Toxicity

Chronic toxicity refers to harmful effects produced by long-term, low-level exposure to pesticides. Less is known about the chronic toxicity of pesticides than is known about their acute toxicity, not because it is of less importance, but because chronic toxicity is much more complex and subtle in how it presents itself. While situations resulting in acute exposure (a single large exposure) do occur, they are nearly always the result of an accident or careless handling. On the other hand, persons may be routinely exposed to small amounts of pesticides while mixing, loading, and applying pesticides or by working in fields after pesticides have been applied.

Chronic Toxicity Measures

There is no standard measure like the LD50 for chronic toxicity. How chronic toxicity of chemicals is studied depends upon the adverse effect being studied. Chronic adverse affects may include carcinogenesis, teratogenesis, mutagenesis, and reproductive toxicity.

Carcinogenesis (oncogenesis)

Carcinogenesis means the production of malignant tumors. Oncogenesis is a generic term meaning the production of tumors that may or may not be carcinogenic. The terms tumor, cancer, or neoplasm are all used to mean an uncontrolled progressive growth of cells. In medical terminology, a cancer is considered a malignant (potentially lethal) neoplasm. Carcinogenic or oncogenic substances are substances that can cause the production of tumors. Examples are asbestos and cigarette smoke.

Teratogenesis

Teratogenesis is the production of birth defects. A teratogen is anything that is capable of producing changes in the structure or function of the offspring when the embryo or fetus is exposed before birth. An example of a chemical teratogen is the drug thalidomide, which caused birth defects in children when their mothers used it during their pregnancy. Measles virus infection during pregnancy has teratogenic effects.

Mutagenesis

Mutagenesis is the production of changes in genetic structure.

Table 2. Acute Toxicity Measures and Warnings

Categories of Acute Toxicity		LD50	LD50	LC50	
Categories	Signal Word	Oral mg/kg	Dermal mg/kg	Inhale mg/l	Oral Lethal Dose[1]
I Highly Toxic	DANGER, POISON (skull & crossbones)	0 to 50	0 to 200	0 to 2,000	a few drops to a teaspoonful
II Moderately Toxic	WARNING	50 to 500	200 to 2,000	2,000 to 20,000	over a teaspoonful to one ounce
III Slightly Toxic	CAUTION	500 to 5,000	2,000 to 20,000	n/a	over one ounce to one pint
IV Relatively Nontoxic	CAUTION	5,000+	20,000 +	n/a	over one pint to one pound

[1] Probable for a 150-lb. person.

A mutagen is a substance which causes a genetic change. Many mutagenic substances are oncogenic, meaning they also produce tumors. Many oncogenic substances are also mutagens.

Reproductive Toxicity
Some chemicals have effects on the fertility or reproductive rates of animals. Males or females can be affected.

Chronic Toxicity Testing
Chronic toxicity testing is both lengthy and expensive. EPA and regulatory agencies in other countries require an extensive battery of tests to identify and evaluate the chronic effects of pesticides. These studies, which may last up to two years, utilize several species of animals to evaluate toxicity from multiple exposures or continuous long-term exposure.

Label Identification of Acute and Chronic Toxicity

To alert pesticide users to the acute toxicity of a pesticide, a signal word must appear on the label. Four different categories are used (see Table 2). Signal words are used to tell the user whether the chemical is highly toxic, moderately toxic, slightly toxic, or relatively nontoxic. These label warnings are based, for the most part, on the chemical's acute toxicity. For example, the acute oral and acute dermal toxicity of a pesticide may be in the slightly toxic category. But if the acute inhalation toxicity is in the highly toxic category, the pesticide label will have the signal words for a highly toxic pesticide. The degree of eye or skin irritation caused by the pesticide also influences the signal word.

For chronic toxicity there is no comparable set of signal words like those used for acute toxicity. Instead, a statement identifying the specific chronic toxicity problem is sometimes used on the label. Such a statement might read "This product contains (name of chemical), which has been determined to cause tumors or birth defects in laboratory animals." Chronic toxicity warning statements may be accompanied by label directions to wear certain kinds of protective clothing when handling or working with the pesticide to minimize or eliminate exposure to the pesticide.

It is important to read the label to look for signal words identifying the product's acute toxicity and for statements identifying any chronic toxicity problem. A pesticide may be low in acute toxicity (signal word "caution"), but it may have a label statement identifying potential chronic toxicity.

Safety Factors

In animal feeding studies, the pesticide under investigation is incorporated into the daily diet and fed to animals from a very young to a very old age. These, as well as the reproductive effects studies, are designed to arrive at a No-Observable-Effect-Level (NOEL); that is, a level in the total diet that causes no effect in treated animals when compared to untreated animals maintained under identical conditions. This NOEL is expressed on a mg/kg of body weight-per-day basis.

A Reference Dose (RfD), also known as Acceptable Daily Intake (ADI), is usually established at 1/100 of the NOEL, in order to add an additional margin of safety. The RfD (ADI) is the amount of chemical that can be consumed daily for a lifetime without ill effects.

Extensive residue trials are conducted to determine levels of the pesticide that remain in or on growing crops after treatment with the pesticide. These trials lead to the establishment of a tolerance for residues of the chemical on food commodities. A tolerance is the maximum allowable amount of the pesticide permitted in or on a specific food commodity at harvest. The directions for use found on the product label are written to assure that residues in food commodities are below the tolerance. The tolerance is set low enough to assure that even if someone ate only food items with residues of a given pesticide at the tolerance limit, there would still be a safety factor of at least 100 when compared to a level causing no observable effects in laboratory animals. This is, of course, a worst-case situation, since all crops on which the pesticide is registered for use would not be treated with the chemical, and in most cases residue levels would be well below the tolerance due to preharvest intervals being longer than the minimum period stated on the label. Further reduction of residues may occur in storage or from washing, trimming, and processing.

Dose-response

Ironically, the extensive amount of data developed about a pesticide often is used against it by ignoring the dose-response. For example, some acute toxicity studies, which are designed to include dosage levels high enough to produce deaths, are cited as proof of the chemical's dangers. Chronic effects seen at very high doses in lifetime feeding studies are misinterpreted and considered as proof that no exposure to the chemical should be allowed. Major improvements in analytical chemistry permit detection of the presence of chemicals at levels of parts per billion (ppb) or even parts per trillion (ppt).

We may hear that a certain chemical has been found in a food or beverage and the amount found is expressed in parts per million or parts per billion. Often, no information is provided to assist us in comprehending the meaning of these numbers. Frequently, this information neglects the issue of dose-response, the key principle of toxicology, which simply stated is "the dose makes the poison." The concentration of a chemical in any substance is meaningless unless it is related to the toxicity of the chemical and the potential for exposure and absorption. Chemicals of low toxicity such as table salt or ethyl alcohol can be fatal if consumed in large amounts. Conversely, a highly toxic material may pose no hazard when exposure is minimal.

Monitoring for Residues

Monitoring foods for pesticide residues is carried out by the Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA). Crops containing residues over the official tolerance (maximum legal level) established by the EPA must be destroyed. The threat of crop destruction with resultant financial loss is a strong incentive for farmers to observe use instructions on pesticide labels and thus assures that residues will be below established tolerances. Crops grown for export often are checked for residues by foreign residue laboratories to assure that local tolerance limits are not exceeded. Lastly, market-basket surveys (analyses of food items from grocery stores) have confirmed the low exposure of the general public to pesticides in foods.

Hazard

Hazard is a function of the toxicity of a pesticide and the potential for exposure to it. We do not have control of the toxicity of a pesticide, since toxicity is a given characteristic of a particular pesticide. However, we can have control over our exposure to pesticides. This is done by following several safety practices, including the use of protective clothing and equipment (PPE).

All pesticides are hazardous if misused, no matter what their toxicity. All pesticides can be handled safely by using safety practices that minimize or eliminate exposure to them.

Federal laws regulating pesticides have placed the burden of proving safety of pesticide usage on the manufacturer. Hazard evaluation studies generally are done by scientific laboratories maintained by the manufacturer or through outside contract laboratories. Few products are subjected to such extensive and vigorous testing as pesticides are before they are marketed. Many promising pesticide products are not marketed because they do not pass the extensive toxicology testing. Older pesticide products that were registered before the current toxicology testing standards were established are being reevaluated under current standards. Precautions and other safety information found on the product's label are based on information from these tests. By reading and following the directions on the label, users can minimize or eliminate hazards due to use of the pesticide to themselves and others.

Some of the preceding material was adapted from *Pesticide Toxicities,* Leaflet 21062, Division of Agricultural Sciences, University of California, and *The Dose Makes the Poison,* by Alice Ottoboni, Ph.D., Vincente Books.

Principles of Pest Control

Philip Koehler and Robert Belmont

Pests

A pest is anything that:

- Competes with humans, domestic animals, or desirable plants for food or water;
- Injures humans, animals, desirable plants, structures, or possessions;
- Spreads disease to humans, domestic animals, wildlife, or desirable plants; or
- Annoys humans or domestic animals.

Types of Pests

Types of pests include:

- Insects, such as roaches, termites, mosquitoes, aphids, beetles, fleas, and caterpillars;
- Insectlike organisms, such as mites, ticks, and spiders;
- Microbial organisms, such as bacteria, fungi, nematodes, viruses, and mycoplasmas;
- Weeds, which are any plants growing where they are not wanted;
- Mollusks, such as snails, slugs, and shipworms; and
- Vertebrates, such as rats, mice, other rodents, birds, fish, and snakes.

Most organisms are not pests. A species may be a pest in some situations and not in others. An organism should not be considered a pest until it is proven to be one.

Pest Identification

Accurate identification is the first step in an effective pest management program. Never attempt a pest control program until you are sure of what the pest is. The more you know about the pest and the factors that influence its development and

spread, the easier, more cost-effective, and more successful your pest control will be. Correct identification of a pest allows you to determine basic information about it, including its life cycle and the time that it is most susceptible to being controlled.

You must be familiar with the pests you are likely to encounter. To be able to identify and control pests, you need to know:

- The physical features of the pests likely to be encountered;
- Characteristics of the damage they cause;
- Their development and biology; and
- What your control goal is.

Pest Control

Any time you are considering whether pest control is necessary, remember:

- Control a pest only when it is causing or is expected to cause more harm than is reasonable to accept.
- Use a control strategy that will reduce the pest numbers to an acceptable level.
- Cause as little harm as possible to everything except the pest.

Pest Control Goals

Whenever you try to control a pest, you will want to achieve one of these three goals, or some combination of them:

- Prevention — keeping a pest from becoming a problem;
- Suppression — reducing pest numbers or damage to an acceptable level; and
- Eradication — destroying an entire pest population.

Prevention may be a goal when the pest's presence or abundance can be predicted in advance.

Suppression is a common goal in many pest situations. The intent is to reduce the number of pests to a level where the harm they are causing is acceptable.

Eradication is a rare goal in outdoor pest situations, because it is difficult to achieve. Usually the goal is prevention and/or suppression. In indoor areas, eradication is a more common goal. Enclosed environments usually are smaller, less complex, and more easily controlled than outdoor areas. In many enclosed areas, such as dwellings; schools; office buildings; and health care, food processing, and food preparation facilities, certain pests cannot or will not be tolerated.

Threshold Levels

Thresholds are the levels of pest populations at which you should take pest control action if you want to prevent the pests in an area from causing unacceptable injury or harm. Thresholds may be based on esthetic, health, or economic considerations. These levels, which are known as "action thresholds," have been determined for many pests.

A threshold often is set at the level where the economic losses caused by pest damage, if the pest population continued to grow, would be greater than the cost of controlling the pests. These types of action thresholds sometimes are called "economic thresholds."

In some pest control situations, the threshold level is zero: even a single pest in such a situation is unreasonably harmful. For example, the presence of any rodents in food processing facilities forces action. In homes, people generally take action to control some pests, such as rodents or roaches, even if only one or a few have been seen.

Pest Monitoring

In most pest control situations, the area to be protected should be monitored (checked or scouted) often. Regular monitoring can answer several important questions:

- What kinds of pests are present?
- Are the numbers great enough to warrant control?
- When is the right time to begin control?
- Have the control efforts successfully reduced the number of pests?

Monitoring of insect, insectlike, mollusk, and vertebrate pests usually is done by trapping or by scouting. Monitoring of weed pests usually is done by visual inspection. Monitoring for microbial pests is done by looking for the injury or damage they cause.

Monitoring also can include checking environmental conditions in the area that is being managed. Temperature and moisture levels, especially humidity, often are important clues in predicting when a pest outbreak will occur or will hit threshold levels.

Monitoring is not necessary in situations where a pest is continually present and the threshold is zero. For example, there is zero tolerance for the presence of bacteria in operating rooms and other sterile areas of health care facilities. In these situations, routine pest control measures are taken to prevent pests from entering an area and to eradicate any pests that may be present.

Avoiding Harmful Effects

Pest control involves more than simply identifying a pest and using a control tactic. The treatment site, whether it is an outdoor area or inside a structure, usually contains other living organisms (such as people, animals, and plants) and nonliving surroundings (such as air, water, structures, objects, and surfaces). All of these could be affected by the pest control measures you choose. Unless you consider the possible effects on the entire system within which the pest exists, your pest control effort could cause harm or lead to continued or new pest problems. Rely on your own good judgment and, when pesticides are part of the strategy, on the pesticide labeling.

Most treatment sites are disrupted to some degree by pest control strategies. The actions of every type of organism or component sharing the site usually affect the actions and well-being of many others. When the balance is disrupted, certain organisms may be destroyed or reduced in number, and others — sometimes the pests — may dominate.

Pest Control Failures

Sometimes you may find that even though you applied a pesticide, the pest has not been controlled. You should review the situation to try to determine what went wrong. There are several possible reasons for the failure of chemical pest control.

Pest Resistance

Pesticides fail to control some pests because the pests are resistant to the pesticides. Consider this when planning pest control programs that rely on the use of pesticides. Rarely does any pesticide kill all the target pests. Each time a pesticide is used, it selectively kills the most susceptible pests. Some pests avoid the pesticide. Others withstand its effects. Pests that are not destroyed may pass along to their offspring the trait that allowed them to survive.

When one pesticide is used repeatedly in the same place, against the same pest, the surviving pest population may be more resistant to the pesticide than the original population was. The opportunity for resistance is greater when a pesticide is used over a wide geographic area or when a pesticide is applied repeatedly to a rather small area where pest populations are isolated. A pesticide that leaves a residue that gradually loses its effectiveness over time will help select out resistance. Rotating pesticides may help reduce the development of pest resistance.

Other Reasons for Failure

Not every pesticide failure is caused by pest resistance. Make sure that you have used the correct pesticide and the correct dosage and that you have applied the pesticide correctly. Sometimes a pesticide application fails to control a pest because the pest was not identified correctly and the wrong pesticide was chosen. Other applications fail because the pesticide was not applied at an appropriate time — the pest may not have been in the area during the application or it may have been in a life cycle stage or location where it was not susceptible to the pesticide. Also remember that the pests that are present may be part of a new infestation that developed after the chemical was applied.

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What are Pesticides?

Philip Koehler and Robert Belmont

Introduction

A pesticide is defined as a substance or mixture of substances intended for destroying, repelling, or mitigating any pest.

A pest is any living thing that exists where it is not wanted. Ideally, a pesticide should control a pest but not be detrimental to humans or other nontarget organisms in the environment.

The following is a brief glossary of pesticides used in the pest control industry:

Pesticide	Used Against
Acaricide (Miticide)	Mites
Avicide	Birds
Fungicide	Fungi
Herbicide	Weeds
Insecticides	Insects and related animals, such as spiders, millipedes and centipedes
Molluscicides	Snails and slugs
Nematocides	Nematodes
Rodenticides	Rats, mice or other rodents

How Insecticides Enter the Insect Body

Insecticides enter the insect body by three common ways: by contact, as stomach poisons, or as fumigants. Many pesticides may enter the body by more than one of these possible routes.

Contact Insecticides

Insecticides in this class kill pests by contacting and entering their bodies either directly through the insect integument (skin) into the blood or by entering the respiratory system through the spiracles (air valves along the side of an insect's body that control gas exchange). These materials may be applied directly to the insect body or as a residue on plant or animal surfaces, habitations or other places frequented by insects. In cases where residues are used, pests usually contact the pesticide through their tarsi (feet). Generally speaking, coarse sprays or dusts are a more effective means of applying contact insecticides than are mists or fogs. Most of the synthetic organic compounds act as contact insecticide, although many also confer stomach and fumigant activity.

Stomach Poisons

Stomach poisons must be swallowed in order to cause death. They may be formulated as liquids, dusts, pastes, granules, or baits. In the case of liquids and dusts, the pesticide usually is applied to some substance the animal will chew or walk through. Pastes, bait and granules may be formulated with a

feeding attractant, which is consumed by the pest. Inorganic and botanical insecticides in general are predominantly stomach poisons. Some synthetic organic insecticides may also act in this capacity.

Fumigant Pesticides

Gaseous poisons used to kill pests are called fumigants. Their applications usually are limited to materials, structures, or organisms that can be or are enclosed in a tight enclosure. There are many fumigants. Some are distinctly odorless, while others are used in conjunction with odorless fumigants as a warning agent because of their odor.

Many fumigants can be used safely around food products, and most are very stable at stipulated temperatures. Some combine with commodities to produce corrosion or undesirable gases. When properly used, a fumigant is nonflammable and, unlike any other form of pesticide, kills all the developmental stages of an animal. In the case of insects, this includes the eggs, larvae, pupae, and adults. When a fumigant reaches the appropriate concentration, it will kill pests quicker than any other pesticide.

Miscellaneous Pesticides

This group includes pesticides that may enter the body through any one or more of the means previously mentioned, but have some specialized mode of action or means of application.

Systemic Insecticides

Systemic insecticides act mainly as stomach poisons. However, these chemicals typically are applied to one area of a plant or animal and are translocated to another area. In the case of plants, systemics are typically applied to the roots or stems of a plant and move through the vascular system to the leaves. Examples are Systox, Thimet, and Disyston.

Desiccant Dusts

When applied to an insect, these materials absorb or abrade off the outer waxy layer of the insect's cuticle, causing the loss of body fluids and death by dehydration. The common desiccating dusts used by pest control operators are silica aerogel and boric acid.

Chemosterilants

These are chemicals that cause sexual sterility in either the male or female insect or animal. Chemosterilants have not yet been used on a commercial basis.

Pheromones

These are chemicals that may be of potential use in preventing insect mating when used to saturate the habitat.

Antimetabolites

These are chemicals that interfere with the normal metabolic or physiological processes of animals.

Pesticide Groups

Pesticide classification or grouping may be based on any of several criteria. One of the most common means of classifying a pesticide is on the basis of similarities in chemical structure. Based on this mode of classification, there are three classes of pesticides commonly used in the structural pest control industry: the inorganic, botanical, and synthetic organic insecticides.

Inorganic Pesticides

Inorganic pesticides are typically derived from minerals or chemical compounds that occur as deposits in nature. Most of these compounds are quite stable and tend to accumulate in the environment. Some act as stomach poisons (borates and boric acid). Others are considered sorptive dusts (silica aerogel, diatomaceous earth) that absorb the waxy layer from the cuticle of pests. Many of the inorganic pesticides are relatively expensive and are only moderately effective in controlling insects and other pests. Common inorganic pesticides are silica aerogel, boric acid, borates, diatomaceous earth, cryolite, copper, and sulfur.

Botanicals

The botanical pesticides are extracted from various parts (stems, seeds, roots, flower heads) of different plant species. Botanical insecticides usually have a short residual activity and do not accumulate in the environment or in fatty tissues of warm-blooded animals. Many botanical pesticides act as stomach poisons, although pyrethrins act mainly as a contact poison. Common examples of botanical pesticides are pyrethrins, sabidilla, rotenone, nicotine, ryania, neem, and limonene.

Synthetic Organic Insecticides

Synthetic organic insecticides do not naturally occur in the environment, but are synthesized by man. Since all these compounds have carbon and hydrogen atoms as the basis of their molecule (as do living plants and animals), they are referred to as organic compounds. The four basic types of synthetic organic insecticides are the chlorinated hydrocarbons, organophosphates, carbamates, and pyrethroids.

Chlorinated Hydrocarbons

This large group of insecticides varies considerably in toxicity to mammals. Most are only moderately toxic. However, a few are very toxic to mammals. The use of these materials has been severely criticized for their effect on the environment. Most chlorinated hydrocarbons are very stable and do not readily decompose in the environment. Most of these insecticides accumulate in the environment and in fatty tissues of birds and mammals. The use of most chlorinated hydrocar-

bons has been prohibited in the United States. Examples of the chlorinated hydrocarbons are DDT, BHC, dieldrin, chlordane, aldrin, endrin, heptachlor and methoxychlor.

Organophosphates
The organophosphates are an extremely large and diverse group of insecticides. Their toxicity to mammals ranges from extremely toxic to some of the least toxic pesticides known. Most organophosphates are not persistent and will break down to nontoxic materials in one to 30 days, depending on the compound. Organophosphates do not accumulate in fatty materials and do not accumulate in food chains. These compounds act mainly as contact insecticides, although they may also act as stomach poisons and fumigants. Common organophosphates are malathion, chlorpyrifos (Dursban), diazinon, dichlorvos (Vapona), acephate (Orthene), and propetamphos (Safrotin).

Carbamates
The carbamate compounds also are a large group of insecticides. As a rule, these compounds are slightly more persistent in the environment than the organophosphorus compounds, but do not accumulate in the environment or fatty tissues of mammals. Most carbamates are only moderately toxic to mammals. They mainly act as contact insecticides with some stomach activity. Common carbamate insecticides are carbaryl (Sevin) and propoxur (Baygon).

Insect Growth Regulators
Insect growth regulators are chemicals that affect the ability of insects to grow and mature normally. They are based on and often mimic the growth hormones that occur naturally within the insect's body. Because mammals do not molt like insects do, most insect growth regulators are not very toxic to man and domestic animals. Common insect growth regulators are methoprene (Precor), hydroprene (Gentrol, Gencor), fenoxycarb (Torus), and hexaflumuron (Sentricon).

Microbial Pesticides
Microbial pesticides are formulated disease organisms of pests, many of which are grown in large quantities in manufacturing plants. Some of the microorganisms available for pest control are bacteria, fungi, and nematodes. Some of the bacterial pesticides available are *Bacillus thuringiensis* variety *kurstaki* (Thuricide, Javelin) for control of caterpillars and *Bacillus thuringiensis* variety *israelensis* (Teknar, Vectobac) for control of mosquitoes. Some of the fungi available for pest control are *Metarhyzium* (Biopath) for control of cockroaches. Some of the nematodes available for pest control are *Steinernema feltiae* (Vector) for flea control.

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Pesticide Handling Decisions

Philip Koehler and Robert Belmont

For any pesticide handling or application activity, you must decide how to ensure the safety of yourself, others, and the environment.

Personal Safety Considerations

Make safety one of your first concerns every time you handle pesticides. You can prevent many pesticide accidents and reduce the severity of others by asking yourself these basic safety questions:

Have I Read the Label?

Always read the pesticide label before you open a pesticide container or begin any pesticide handling activity. Pesticide labeling contains, 1) precautions and instructions that you must follow in order to use the product safely and appropriately, and 2) very specific information that concerns the task you plan to do. Be sure you understand everything you need to know about the pesticide product before you are exposed to it.

How Can I Avoid Exposure to Pesticides?

- Always keep personal clothing, food, drinks, chewing gum, tobacco products, and other belongings away from where pesticides are stored or handled. They could become contaminated and poison or injure you when you use them.
- When you take a break, wash your gloves on the outside, remove your gloves, and wash your hands and face thoroughly. Then you can safely chew gum, eat, drink, or smoke, if you wish.
- Take the time to wash your hands thoroughly before using the toilet, and be careful not to contaminate yourself from pesticides that may be on the outside of your clothing.
- Protect yourself not only during mixing, loading, and application, but also during spill cleanup, repairing or maintaining equipment, and when transporting, storing, or disposing of pesticide containers.

What Personal Protective Equipment Is Needed?

You must use the personal protective equipment that the labeling requires. Make sure that the personal protective equipment is clean and in good operating condition. Put on and remove the equipment carefully so that you will not come in contact with any pesticides that may be on the outside of it.

Is the Equipment Ready and Safe?

Make sure that you have all the equipment you need and that it is clean and in good operating condition. Make sure you know how to operate the equipment safely and correctly. Do not allow children, pets, or unauthorized people to touch the

equipment. If they are injured or poisoned, you are responsible.

Am I Avoiding the Accidental Spread of Pesticides?

You may transfer pesticides to objects, people, and animals when you touch them with gloves that you wore while handling pesticides. When you sit in your car or on a chair while wearing your pesticide-handling outfit, you may leave pesticides behind. If you step into your office or home to answer the telephone or use the toilet, you may leave pesticides on surfaces.

Any time you take home or wear home your work clothing or personal protective equipment, the pesticides can rub off on carpeting, furniture, and laundry items. When you do not clean up a spill, no matter how small, other people or animals may get pesticide on themselves without knowing they are being exposed. Pesticides that you spread may harm whoever or whatever touches them.

Am I Prepared for Emergencies?

Before you begin any pesticide handling activity, be sure you are prepared to deal with emergencies such as spills, injuries, and poisonings. Your emergency supplies should include at least:

- Personal decontamination equipment — Keep plenty of clean water, detergent, and paper towels nearby in a protected container to allow for fast decontamination in an emergency. Have an extra coverall-type garment nearby in case clothing becomes soaked or saturated with pesticide and must be removed.
- First aid equipment — Have a well-stocked first aid kit on hand. It should include a plastic eyewash dispenser that has a gentle flushing action.
- Spill cleanup equipment — Keep a spill cleanup kit on hand at all times. The kit should contain not only all the items needed for prompt and complete spill cleanup, but also personal protective equipment to protect you while you are dealing with the spill.

Know who to call in a medical emergency, and be familiar with the signs and symptoms of poisoning caused by the pesticides you handle. In a poisoning emergency, get the person out of the exposure at once, quickly summon medical assistance, and provide first aid.

Are People and Animals Out of the Area?

You have the legal responsibility to make sure that no one is overexposed to pesticides that you are handling. Always warn workers, supervisors, and any other people who may be near the application about which sites you plan to treat and how long they must stay out of those sites.

Preapplication Decisions

Choice of Pesticide

One of the first things you must decide is which pesticide to use. The certified applicator for your company has the knowledge to make that decision. He has selected the safest and most effective pesticide for the job.

Application Site

Some formulations are more likely than others to cause unwanted harm to surfaces, plants, and animals in the application site. Emulsifiable concentrates, for example, tend to pit or stain some surfaces, are easily absorbed through the skin of some animals, and may injure some plants. Dusts and powders are likely to leave a visible residue that may be unacceptable.

Pesticide Movement

Consider whether runoff or air movements are likely to carry the pesticide out of the application site.

Personal Safety

Some pesticide formulations are more hazardous to people than others. Emulsifiable concentrates and ultra-low-volume concentrates often contain solvents that are hazardous themselves or that allow the pesticide to pass through the skin more quickly. Aerosols are easily inhaled. Wear appropriate protective equipment to protect yourself from pesticides.

Scheduling Pesticide Applications

Each pesticide application involves a different set of conditions. Your responsibility is to assess the conditions and decide when to apply the pesticide and whether to take any special precautions.

Avoid Heat Stress

Several factors work together to cause heat stress. Before you begin a pesticide-handling task, think about whether any of these factors are likely to present a problem. Consider what adjustments you may need to make in the task itself or in the workplace conditions, including:

- Heat factors — temperature, humidity, air movement, and sunlight;
- Work load;
- Personal protective equipment; and
- Water.

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Pesticide Labeling

Philip Koehler and Robert Belmont

Pesticide product labeling is the main method of communication between a pesticide manufacturer and pesticide users. The information printed on or attached to the pesticide container is the label. Labeling includes the label itself, plus all other information you receive from the manufacturer about the product when you buy it. Pesticide labeling gives you instructions on how to use, store, and dispose of the product safely and correctly. Pesticide users are required by law to comply with all the instructions and directions for use in pesticide labeling.

EPA Approval of Pesticide Labeling

EPA reviews the labeling to make sure that it contains all the information needed for safe and effective use of the pesticide product. EPA may require the manufacturer to change the labeling if it does not contain enough information or if the information is wrong. EPA also may require that the labeling include other information about laws or regulations that have been adopted to protect humans or the environment.

Parts of Pesticide Labeling

The information on pesticide labeling usually is grouped under headings to make it easier to find the information you need. Some information is required by law to appear on a certain part of the labeling or under certain headings. Other information may be placed wherever the manufacturer chooses.

Identifying Information

Pesticide labeling contains basic information that helps users clearly identify the product. Some of these items will be on the front panel of every label, because EPA requires that they appear there. Other items, while generally on the front panel, may be located elsewhere on the label or in the labeling if the manufacturer chooses.

Brand name — Each manufacturer has a brand name for each of its products. Different manufacturers may use different brand names for the same pesticide active ingredient. The brand or trade name is the one used in advertisements and by company salespeople. The brand name shows up plainly on the front panel of the label. Always read the ingredient statement to determine the active ingredients that a product contains.

Ingredient statement — Each pesticide label must list what is in the product. The list is written so you can readily see what the active ingredients are and the amount of each ingredient (as a percentage of the total product). The ingredient statement must list the official chemical name and/or common name for each active ingredient. Inert ingredients need not be named, but the label must show what percent of the total contents they make up.

The chemical name is a complex name that identifies the chemical components and structure of the pesticide. This name is almost always listed in the ingredient statement on the label.

Because pesticides have complex chemical names, many are given a shorter common name. The official common name may be followed by the chemical name in the list of active ingredients.

Registration and establishment numbers — These numbers are needed by the pesticide handler in case of poisoning, claims of misuse, or liability claims.

- An EPA registration number indicates that the pesticide label has been approved by EPA.
- The establishment number appears on either the pesticide label or container. It identifies the facility where the product was made. In case there are questions or concerns about the pesticide product, the facility that made the product can be determined.

Name and address of manufacturer — The law requires the maker or distributor of a product to put the name and address of the company on the label. This is so you will know who made or sold the product.

Net contents — The front panel of the pesticide label tells you how much is in the container.

Type of pesticide — The type of pesticide usually is listed on the front panel of the label. This short statement indicates in general terms what the product will control.

Type of formulation — The front panel of some pesticide labels will tell you what kind of formulation the product is. The formulation may be named or the label may show only an abbreviation, such as WP for wettable powder, D for dust, or EC for emulsifiable concentrate.

Restricted-Use Designation

When a pesticide is classified as restricted, the label will state "Restricted Use Pesticide" in a box at the top of the front panel. Below this heading may be a statement describing the reason for the restricted-use classification. Usually another statement will describe the category of certified applicator who can purchase and use the product. Restricted-Use pesticides may be used only by applicators certified by the state or by the EPA. Pesticides that are unclassified have no designation on the product label.

Front-Panel Precautionary Statements

Signal words and symbols — The signal word DANGER, WARNING, or CAUTION must appear in large letters on the front panel of the pesticide label. It indicates how acutely toxic the product is to humans. It reflects the hazard of any active ingredients, carriers, solvents, or inert ingredients. The signal word is immediately below the statement, "Keep out of reach of children," which also must appear on every label.

Use the signal word to help you decide what precautionary measures are needed for yourself, your workers, and other persons (or animals) that may be exposed.

- DANGER — This word signals you that the pesticide is highly toxic. The product is very likely to cause acute illness from oral, dermal, or inhalation exposure, or to cause severe eye or skin irritation.
- POISON/SKULL AND CROSSBONES — All highly toxic pesticides that are very likely to cause acute illness through oral, dermal, or inhalation exposure also will carry the word POISON printed in red and the skull and crossbones symbol. Products that have the signal word DANGER due to skin and eye irritation potential will not carry the word POISON or the skull and crossbones symbol.
- WARNING — This word signals you that the product is moderately likely to cause acute illness from oral, dermal, or inhalation exposure or that the product is likely to cause moderate skin or eye irritation.
- CAUTION — This word signals you that the product is slightly toxic or relatively nontoxic. The product has only slight potential to cause acute illness from oral, dermal, or inhalation exposure. The skin or eye irritation it would cause, if any, is likely to be slight.

Statement of practical treatment (first aid) — Most pesticide products are required to include instructions on how to respond to an emergency exposure involving that product. The instructions usually include first aid measures and may include instructions to seek medical help.

Hazards to Humans and Domestic Animals

Acute effects statements — The label or labeling will contain statements that indicate which route of entry (mouth skin, eyes, lungs) you must particularly protect and what specific action you need to take to avoid acute effects from exposure to the pesticide. The statements will warn you if you may be harmed by swallowing or inhaling the product or getting it on your skin or in your eyes.

Delayed effects statements — The labeling of pesticides that the Environmental Protection Agency considers to have the potential to cause delayed effects must warn you of that fact. These statements will tell you whether the product has been shown to cause problems such as tumors or reproductive problems in laboratory animals.

Allergic effects statement — If tests or other data indicate that the pesticide product has the potential to cause allergic effects, such as skin irritation or asthma, the product labeling must state that fact. Sometimes the labeling refers to allergic effects as "sensitization."

Personal protective equipment statements — Immediately following the statements about acute, delayed, and allergic effects, the labeling usually lists personal protective equipment requirements. These statements tell you the minimum personal protective equipment that you must wear when using the pesticide. Sometimes the statements will require different personal protective equipment for different pesticide handling activities. Sometimes the statements will allow reduced personal protective equipment when you use safety systems, such as closed systems.

Environmental Hazards

This section of the pesticide labeling will indicate precautions for protecting the environment when you use the pesticide. Some general statements appear on the labeling of nearly every pesticide. Most pesticide labeling, for example, will warn you not to contaminate water when you apply the pesticide or when you clean your equipment or dispose of pesticide wastes. The labeling will contain specific precautionary statements if the pesticide poses a specific hazard to the environment. For example, it may warn you that the product is highly toxic to bees or other wildlife.

Physical or Chemical Hazards

This section of the pesticide labeling will tell you of any special fire, explosion, or chemical hazards the product may pose. For example, it will alert you if the product is so flammable that you need to be especially careful to keep it away from heat or open flame or if it is so corrosive that it must be stored in a corrosion-resistant container. If pesticides are flammable, smoking while handling them is extremely hazardous.

Directions for Use

Directly under the heading "Directions for Use" on every pesticide product labeling is the following statement: "It is a violation of Federal Law to use this product in a manner inconsistent with its labeling." The Directions for Use section also contains sections on storage and disposal and may contain a section on entry into treated areas after a pesticide application. In addition, the Directions for Use section will contain the specific directions for using the product.

Use inconsistent with the labeling — It is illegal to use a pesticide in any way not permitted by the labeling. A pesticide may be used only on the plants, animals, or sites named in the directions for use. You may not use higher dosages, higher concentrations, or more frequent applications. You must follow all directions for use, including directions concerning safety, mixing, diluting, storage, and disposal. You must wear the specified personal protective equipment even though you may be risking only your own safety by not wearing it. The use directions and instructions are not advice, they are requirements.

Entry statement — Some pesticide labeling contains a precaution about entering a treated area after application. This statement tells you how much time must pass before people can enter a treated area except under special circumstances.

Storage and disposal — All pesticide labeling contains some instructions for storing the pesticide. These may include both general statements, such as "Keep out of reach of children and pets," and specific directions, such as "Do not store in temperatures below 32 degrees F."

Pesticide labeling also contains some general information about how to dispose of excess pesticide and the pesticide container in ways that are acceptable under Federal regulations. State and local laws vary, however, so the labeling usually does not give exact disposal instructions.

Additional Resources

Pesticide Labeling Tutorial

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Pesticide Formulations

Philip Koehler and Robert Belmont

Introduction

The active ingredients in a pesticide are the chemicals that control the target pest. Most pesticide products you buy also have other ingredients, called inert (inactive) ingredients. They are used to dilute the pesticide or to make it safer, more effective, easier to measure, mix, and apply, and more convenient to handle.

Usually the pesticide is diluted in water, a petroleum-based solvent, or another diluent. Other chemicals in the product may include wetting agents, spreaders, stickers, or extenders. This mixture of active and inert ingredients is called a pesticide formulation.

Some formulations are ready for use. Others must be further diluted with water, a petroleum-based solvent, or air (as in airblast or ULV applications) by the user before they are applied. A single active ingredient often is sold in several different kinds of formulations. If you find that more than one formulation is available for your pest control situation, you must choose the best one for the job.

Liquid Formulations

Emulsifiable concentrates (EC or E)

An emulsifiable concentrate formulation usually contains liquid active ingredient, one or more petroleum-based solvents, and an agent that allows the formulation to be mixed with water to form an emulsion.

Advantages:
- Relatively easy to handle, transport, and store;
- Little agitation required — will not settle out or separate when equipment is running;
- Not abrasive;
- Do not plug screens or nozzles; and
- Little visible residue on treated surfaces.

Disadvantages:
- High concentration makes it easy to overdose or underdose through mixing or calibration errors;
- May cause unwanted harm to plants;
- Easily absorbed through skin of humans or animals;
- Solvents may cause rubber or plastic hoses, gaskets, and pump parts and surfaces to deteriorate;
- May cause pitting or discoloration of painted finishes;
- Flammable — should be used and stored away from heat or open flame; and
- May be corrosive.

Solutions (S)

Some pesticide active ingredients dissolve readily in a liquid solvent, such as water or a petroleum-based solvent. When mixed with the solvent, they form a solution that will not settle out or separate. Formulations of these pesticides usually contain the active ingredient, the solvent, and one or more other ingredients.

Advantages:
- No agitation necessary.

Disadvantages:
- Limited number of formulations of this type available.

Ultra–low-volume (ULV)

These concentrates may approach 100 percent active ingredient. They are designed to be used as is or to be diluted with only small quantities of specified solvents.

Advantages:
- Relatively easy to handle, transport, and store;
- Little agitation required;
- Not abrasive to equipment;
- No plugging of screens and nozzles; and
- Little visible residue on treated surfaces.

Disadvantages:
- Difficult to keep pesticide in the target site — high drift hazard;
- Specialized equipment required;
- Easily absorbed through skin of humans or animals; and
- Solvents may cause rubber or plastic hoses, gaskets, and pump parts and surfaces to deteriorate.

Flowables (F or L)

Some active ingredients are insoluble solids. These may be formulated as flowables in which the finely ground active ingredients are mixed with a liquid, along with inert ingredients, to form a suspension. Flowables are mixed with water for application and are similar to EC or wettable powder formulations in ease of handling and use.

Advantages:
- Seldom clog nozzles; and
- Easy to handle and apply.

Disadvantages:
- Require moderate agitation; and
- May leave a visible residue.

Aerosols (A)

These formulations contain one or more active ingredients and a solvent. Most aerosols contain a low percentage of active ingredient. There are two types of aerosol formulations — the ready-to-use type, and those made for use in power aerosol generators.

Advantages of ready-to-use formulations:
- Ready to use;
- Easily stored;
- Convenient way to buy small amount of a pesticide; and
- Retain potency over fairly long time.

Disadvantages of ready-to-use aerosols:
- They are practical for very limited uses;
- Risk of inhalation injury;
- Hazardous if punctured, overheated, or used near an open flame; and
- Difficult to confine to target site or pest.

Advantages of power aerosol generators:
- Easy way to fill entire space with pesticide.

Disadvantages of power aerosol generators:
- Highly specialized use and equipment;
- Difficult to confine to target site or pest; and
- May require respiratory protection to prevent risk of inhalation injury.

Dry Formulations

Dusts (D)
Most dust formulations are ready to use and contain a low percentage of active ingredient (usually 1/2 percent to 10 percent), plus a very fine dry inert carrier made from talc, chalk, clay, nut hulls, or volcanic ash. The size of individual dust particles varies. Dusts are always used dry, and they easily drift into nontarget sites.

Advantages:
- Usually ready to use, with no mixing;
- Effective where moisture from a spray might cause damage;
- Require simple equipment; and
- Effective in hard-to-reach indoor areas.

Disadvantages:
- Easily drift off target during application;
- Residue easily moved off target by air movement or water;
- May irritate eyes, nose, throat, and skin;
- Do not stick to surfaces as well as liquids; and
- Difficult to get an even distribution of particles on surfaces.

Baits (B)
A bait formulation is an active ingredient mixed with food or another attractive substance. The bait either attracts the pests or is placed where the pests will find it. Pests are killed by eating the pesticide the bait contains.

Advantages:
- Ready to use;
- Entire area need not be covered, because pest goes to bait; and
- Control pests that move in and out of an area.

Disadvantages:
- Can be attractive to children and pets;
- May kill domestic animals and nontarget wildlife outdoors;
- Pest may prefer the crop or other food to the bait;
- Dead pests may cause odor problem;
- Other animals may be poisoned as a result of feeding on the poisoned pests; and
- If baits are not removed when the pesticide becomes ineffective, they may serve as a food supply for the target pest or other pests.

Granules (G)
Granular formulations are similar to dust formulations except that granular particles are larger and heavier. The coarse particles are made from an absorptive material such as clay, corn cobs, or walnut shells. The active ingredient either coats the outside of the granules or is absorbed into them.

Granular formulations also are used to control larval mosquitoes and other aquatic pests. Granules are used in agricultural, structural, ornamental, turf, aquatic, right-of-way, and public health (biting insect) pest control operations.

Advantages:
- Ready to use — no mixing,
- Drift hazard is low, and particles settle quickly;
- Little hazard to applicator — no spray, little dust;
- Weight carries the formulation through foliage to soil or water target;
- Simple application equipment, such as seeders or fertilizer spreaders; and
- May break down more slowly than WPs or ECs through a slow-release coating.

Disadvantages:
- Do not stick to foliage or other nonlevel surfaces;
- May need to be incorporated into soil or planting medium;
- May need moisture to start pesticidal action; and
- May be hazardous to nontarget species, especially waterfowl and other birds that mistakenly feed on the grain- or seedlike granules.

Wettable powders (WP or W)
Wettable powders are dry, finely ground formulations that look like dusts. They usually must be mixed with water for application as a spray. Wettable powder particles do not dissolve in water. They settle out quickly unless constant agitation is used to keep them suspended.

Advantages:
- Easy to store, transport, and handle;
- Less likely than ECs and other petroleum-based pesticides to cause unwanted harm to treated plants, animals, and surfaces;
- Easily measured and mixed; and
- Less skin and eye absorption than ECs and other liquid formulations.

Disadvantages:
- Inhalation hazard to applicator while pouring and mixing the concentrated powder;
- Require good and constant agitation (usually mechanical) in the spray tank and quickly settle out if agitation is turned off;
- Abrasive to many pumps and nozzles, causing them to wear out quickly;
- Difficult to mix in very hard or very alkaline water;
- Often clog nozzles and screens; and
- Residues may be visible.

Soluble powders (SP or WSP)
Soluble powder formulations look like wettable powders. However, when mixed with water, soluble powders dissolve readily and form a true solution. After they are mixed thoroughly, no additional agitation is necessary. Soluble powders have all the advantages of wettable powders and none of the disadvantages except the inhalation hazard during mixing.

Microencapsulated pesticides (M)
Microencapsulated formulations are particles of pesticides (liquid or dry) surrounded by a plastic coating. The formulated product is mixed with water and applied as a spray. Once applied, the capsule slowly releases the pesticide. The encapsulation process can prolong the active life of the pesticide by providing a timed release of the active ingredient.

Advantages:
- Increased safety to applicator;
- Easy to mix, handle, and apply; and
- Releases pesticide over a period of time.

Disadvantages:
- Constant agitation necessary in tank; and
- Some bees may pick up the capsules and carry them back to their hive, where the released pesticide may poison the entire hive.

Adjuvants
An adjuvant is a chemical added to a pesticide formulation or tank mix to increase its effectiveness or safety. Most pesticide formulations contain at least a small percentage of adjuvants. Some of the most common adjuvants are surfactants — "surface active ingredients" that alter the dispersing, spreading, and wetting properties of spray droplets.

Common adjuvants are:
- Spreaders — allow pesticide to form a uniform coating layer over the treated surface.
- Stickers — allow pesticide to stay on the treated surface.
- Foaming agents — reduce drift.
- Thickeners — reduce drift by increasing droplet size.
- Buffers — allow pesticides to be mixed with diluents or other pesticides of different acidity or alkalinity.

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Mixing, Loading, and Application of Pesticides

Philip Koehler and Robert Belmont

Mixing, loading, and application are the primary pesticide-handling tasks. They also are among the most hazardous aspects of a handler's job. Never try to cut corners where safety is concerned, and do not assume that every job will be like every other. For example, even though you are familiar with a pesticide, take the time to read the labeling — important directions are changing more often than in the past, and new information may have been added.

Safe Mixing And Loading Practices

Pesticide handlers are most often exposed to harmful amounts of pesticides when mixing or loading concentrated pesticides. Handlers who mix and load concentrated pesticides with high acute toxicity have an especially high risk of accidental poisoning. By observing some simple precautions, you can reduce the risks involved in this part of your job.

Select an Appropriate Area
Choose the pesticide mixing and loading area carefully. It should be outdoors or in a well-ventilated area away from unprotected people, animals, food, other pesticides, and other items that might be contaminated. Choose a place with good light, especially if you are working at night. Be particularly careful not to mix or load pesticides indoors unless lighting and ventilation are adequate.

Protect Your Water Source
Avoid mixing or loading pesticides in areas where a spill, leak, or overflow could allow pesticides to get into water systems. Protect your water source by keeping the water pipe or hose well above the level of the pesticide mixture. This prevents contamination of the hose and keeps pesticides from backsiphoning into the water source. If you are pumping water directly from the source into a mix tank, use a check valve, antisiphoning device, or backflow preventer to prevent backsiphoning if the pump fails.

Personal Protective Equipment
Before opening a pesticide container, you must put on the appropriate personal protective equipment. By law, you must use all of the personal protective equipment that the pesticide labeling requires for mixers and loaders. Consider using additional personal protective equipment in certain mixing and loading situations.

Opening Containers
Do not tear paper or cardboard containers to open them. Use a sharp knife. Clean the knife afterwards, and do not use it for other purposes. Open containers of pesticides only when they are sitting on a flat, stable surface. If they are tipped on an angle or are in an unstable position, they can easily spill over or leak out when the seal is broken.

Transferring Pesticides
When pouring any pesticide from its container, keep the container and pesticide below face level. This will avoid a splash, spill, or dust from getting on your face or into your eyes and mouth. If there is a wind outdoors or a strong air current indoors, stand so the pesticide cannot blow back on you.

Spills
To prevent spills, close containers after each use. Even if you plan to mix more pesticide soon, close the container tightly each time. Never leave a tank unattended while it is being filled. It may overflow and contaminate the area.

If you splash or spill a pesticide on yourself while mixing or loading, stop right away and remove your contaminated clothing. Wash thoroughly with a mild liquid detergent (or soap) and water as quickly as possible. Put on clean personal protective equipment. Then clean up the spill.

Empty Pesticide Containers
Even after it appears that all the pesticide product has been removed from a container, it usually is not truly empty. The pesticide that clings to the inside of the container can be dangerous to you, other people, and the environment. Take care of empty containers at once.

If containers are rinsable, rinse them as soon as they are empty. Return all pesticide containers to the pesticide storage area or the container holding area when you finish your task. Do not leave them unattended at the mixing, loading, or application site. Never give pesticide containers to children to play with or to adults to use.

If you have empty pesticide containers that cannot be refilled, reconditioned, recycled, or returned to the manufacturer, crush, break, or puncture them. This will make the containers unusable and may also save storage space. Dispose of containers in accordance with label directions.

Nonrinsable containers — You may not be able to rinse bags, boxes, and other containers of dry pesticides, because the container will not hold up to the rinsing. You also may not be able to rinse containers of ready-to-use pesticides, because there is no place to put the rinsate. Containers that cannot or should not be rinsed must be emptied as completely as possible. Shake or tap the container to remove as much of the pesticide product as you can. Drain containers of liquid pesticides for at least an additional 30 seconds.

Rinsable containers — When you are diluting pesticides, you should rinse the empty pesticide containers, unless the labeling directs you not to. Such rinsing often saves money, because each rinse removes pesticide from the sides and bottom of the container and allows you to add it to the pesticide mixture. If you rinse empty pesticide containers thoroughly, you usually can dispose of them as nonhazardous waste.

Glass, metal, and plastic containers, plastic-lined paper or cardboard containers, and even unlined paper or cardboard containers that can withstand the rinsing process should be triple rinsed or pressure rinsed. The liquid you use for rinsing should be the diluent (water, kerosene, high-grade oil, or another liquid) listed on the pesticide labeling for diluting the pesticide for application. After rinsing, add the rinsate to your pesticide mixture.

To triple rinse a container:
1. Empty the container into the tank. Let it drain an extra 30 seconds.
2. Fill it one-fifth to one-fourth full of water.
3. Replace the closure and rotate the container for about 30 seconds. Invert the container so the rinse reaches all the inside surfaces.
4. Drain the rinse water from the container into the tank. Let the container drain for 30 seconds.
5. Repeat steps 2 through 4 two more times for a total of three rinses.

Applying Pesticides Safely

Every time you apply pesticides, you have two major responsibilities:
- Protect yourself, others, and the environment; and
- Make sure that the pesticide is applied correctly.

Personal Protective Equipment
By law, you must wear the personal protective equipment and other clothing that the pesticide labeling requires for applicators. Consider using additional protection for some types of pesticide application tasks. You may need to weigh several factors before you can make good decisions about the personal protective equipment you should wear.

Hand-carried application equipment — When you carry

the application equipment, such as hand-held sprayers or shake cans, you risk being directly exposed to the pesticide. A dripping or partially clogged nozzle, an unfastened cap, a leaky hose, or a loose connection are extremely likely to cause exposure. Consider wearing extra personal protective equipment to protect the area of your body that is in contact with the equipment.

Entering the path of the released pesticide — Many applications performed while on foot cause you to walk into the path of the pesticide you are releasing. Whenever possible, apply pesticides so that you are backing into the untreated area, away from where the pesticide is being released. Under many conditions, however, it is unsafe to walk backwards in an application site.

If you must walk into the path of the released pesticide, consider wearing shin-high or knee-high boots, or protective footwear with chemical-resistant pants. Spraying a thick coating of fabric starch or fabric stain protectant on the lower legs of your coveralls can provide a temporary barrier for low-toxicity pesticides and also makes the coveralls easier to clean.

Whether you are walking or riding, if the pesticide is not directed downward or if it remains suspended in the air long enough to cause exposure to the front of your body, consider wearing an apron or chemical-resistant suit. If the pesticide mist or dust reaches as high as your face, consider a dust/mist respirator and eye protection.

Walking into a just-treated area — You may need to walk into an area that you have just treated. For example, you may need to repair or adjust the equipment or check the pesticide dispersal. Consider putting on additional personal protective equipment.

If the vegetation in the treated area is covered with pesticide spray or dust and is fairly short, consider shin-high or knee-high boots, or protective footwear with chemical-resistant pants. In this situation, as with walking into the path of the released pesticide, it may be useful to apply spray starch or fabric stain protector to the pants legs.

If spray is dripping or dust is falling from overhead, consider a hood or wide-brimmed hat in addition to the body protection and footwear. A dust/mist respirator and protective eyewear may be necessary, too.

High-exposure applications — Certain types of pesticide applications pose a special exposure risk, because they engulf you in pesticide fallout. They include:

- Aerosol and fog applications, especially indoors;
- Some applications using high-pressure sprayers and power dusters; and
- Applications directed upward over your head, such as to tree canopies or roof eaves.

Whenever you work in these situations, large amounts of pesticide fallout are likely to be deposited on your skin and clothing, often to the point of completely drenching or covering you. Usually, you cannot avoid this exposure, even if you perform the application in conditions of little or no air currents.

Applications in enclosed spaces — Pesticides sometimes are applied in enclosed spaces such as warehouses, factories, homes, and other buildings; railcar, ship, and truck cargo areas; silos, elevators, and other grain storage areas; and greenhouses. When you use pesticides in enclosed spaces, you increase the risk of being exposed to the pesticide by inhalation. You may need to use a respirator even if you would not need one for the same application outdoors.

Adjusting pesticide-coated equipment — You may need to wear a protective apron while doing some types of equipment adjustments and repairs.

Applying in air currents — If you will be applying pesticides into or across wind or air currents, consider wearing extra personal protective equipment, because pesticide may be blown onto you. More body protection, protective eyewear, and a dust/mist filtering respirator may be appropriate.

Applying concentrates — You may be exposed to highly concentrated pesticides during some applications. Ultra–low-volume concentrates and fumigant formulations may be close to 100 percent active ingredient and often are highly toxic. Consider using extra personal protective equipment when applying concentrates, such as that required for mixing and loading of those formulations.

Application Procedures

Every time you apply a pesticide, follow these basic procedures to make sure that you are using the pesticide safely and effectively:

Deliver the pesticide to the target — Take the time to be sure that the pesticide is reaching the surface or space to which you are directing it. Pesticide that is deposited elsewhere is a waste of time and money and may harm the nontarget areas.

Check the delivery rate — Check to be sure that you are applying the pesticide evenly and in approximately the right amounts. No puddles of liquid pesticide or mounds of dry pesticide should be deposited in the application area. Be especially careful in areas where you turn or pause. Many types of application equipment will continue to release pesticide even when not in motion.

Check for appearance — As you apply, notice whether the pesticide you are releasing looks the way it should. Applications of wettable powders usually have a whitish color. If the liquid is clear, check to be sure that you are agitating the mixture enough to keep the wettable powder mixed with the water. Granules and dusts should appear dry and should not form clumps. Emulsifiable concentrates usually look milky. If the pesticide does not look right, be sure that you have the right mixture and that it is still blended evenly.

Check the appearance of the target area where you have just released the pesticide. If the surface is changing colors or is stained unexpectedly, stop and check whether you are harming the surface.

Avoid nontarget organisms — Before you apply a pesticide, clear all unprotected people from the area. Also remove any pets or livestock that are not being treated with the pesticide. Check the pesticide labeling to find out when people and nontarget animals can go back into the application area. Even if

the pesticide labeling has no such instructions, do not allow anyone to enter the treated area at least until any dusts and mists have settled out of the air and any vapors have dispersed.

Avoid nontarget surfaces — When possible, remove from the application site any items that should not be contaminated with pesticides. Cover or protect any items that cannot be removed from the area and that are not involved in the handling activity. Items that should be removed or covered include such things as food and food utensils; bedding; toys; pet or livestock feed, water, or supplies; and other items that could transfer pesticides to people, pets, or livestock.

Operate equipment safely — Turn off your equipment whenever you pause for any reason. Take special care to turn it off before making any adjustments or repairs. When you stop application to take a break, to move to another site, or for repairs, depressurize any pressurized tanks. Turn off the main pressure valve on the tank and release any pressure remaining at the nozzles.

After Mixing, Loading and Application

As soon as you finish mixing, loading, or applying a pesticide, you should do a few important follow-up tasks. Take the time to clean up properly. Wash your pesticide equipment and then wash yourself. Return equipment to its designated place, and safely store or dispose of all pesticide materials and other chemicals that you have used. Be sure that your work site presents no hazards to people or to the environment. Never leave the site unattended until everything has been cleaned up and put away. While you can still remember the facts, make a record of what you have applied and the conditions at the application site.

Equipment Cleaning

Always clean mixing, loading, and application equipment as soon as you finish using it — do not leave equipment with pesticides on or in it at the mixing and loading site or at the application site. When the job is completed and the tank or hopper is empty, return the equipment to the designated equipment cleanup area.

Benefits of correct cleaning — Sloppy cleanup practices are one of the main causes of equipment failure or malfunction. Never keep excess pesticides in your equipment for more than a short time. Even small amounts of pesticide residues that are left in equipment can damage it.

Cleaning procedures — After the equipment is empty, clean both the inside and outside thoroughly, including nozzles or hopper openings. Sometimes you may need to use the diluent used in the pesticide mixture (kerosene or high-grade oil), special cleaning agents, or water under pressure. In other cases, ordinary water may be enough.

Collect the rinsate — the liquid that results from the washing process. If you do not have a way to reuse or dispose of the rinsate, limit the amount of material you use, so you will create less waste.

Rinsates — Remember that the rinsates you create when you clean your equipment contain pesticides and can be harmful to people and the environment. Do not allow rinsates to flow into water systems, including sink or floor drains, rainwater culverts, wells, streams, lakes, and rivers. Do not create puddles that children, other unprotected persons, or animals could get into.

You may use equipment rinsate as a diluent for future mixtures of pesticides, if:

- The pesticide in the rinsate is labeled for use on the target site where the new mixture is to be applied;
- The amount of pesticide in the rinsate plus the amount of pesticide product in the mixture does not exceed the labeling rate for the target site;
- The rinsate is used to dilute a mixture containing the same pesticide or a compatible pesticide; or
- You comply with other application instructions specified on the labeling, including any specific labeling instructions for application as an excess pesticide.

The rinsate cannot be added to a pesticide mixture if:

- The pesticide labeling does not list the rinsate as an acceptable diluent; for example, if the rinsate contains a strongly acidic or alkaline neutralizing agent;
- The rinsate contains strong cleaning agents, such as bleach or ammonia, that might harm the plant, animal, or surface to which the pesticide will be applied; or
- The rinsate would alter the pesticide mixture and make it unusable; for example, if the pesticides are physically or chemically incompatible.

If you have any rinsates that you cannot use, dispose of them as you would excess pesticides.

Personal Cleanup

When you finish working with pesticides or pesticide-contaminated equipment, take time for personal cleanup. Wash the outside of your gloves first, before taking them off. Then carefully peel back your personal protective equipment to avoid getting pesticides on your skin. Remove any other clothing that has pesticide on it.

If you cannot take a shower right away, use a mild liquid detergent and warm water to wash your face, hands, forearms, and any other area that may have pesticides on it. As soon as you can — no later than the end of the work day — wash your whole body and hair thoroughly with a mild liquid detergent and plenty of warm water.

When you remove your personal protective equipment and work clothing, put it in a plastic box or bag until it can be laundered. Do not allow children or pets to play with these items. Do not wash work clothing and personal protective equipment in the same wash water with the family laundry.

Recordkeeping

Keeping records of pesticide use and application is a good idea. Records can establish proof of proper use. If an error has been made, records are helpful in finding the cause. They also can provide you with information to use in response to claims of excess residues or damages.

Records can help you reduce pesticide mistakes or misuse. If a pest is not controlled, if damage has occurred in the target area, or if a pesticide has moved off the target area and caused problems, you may be able to determine what went wrong. Then you can take steps to avoid such a situation in future pesticide applications.

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Applying The Correct Amount

Philip Koehler and Robert Belmont

Introduction

One of the most important tasks for a pesticide applicator is making sure that the correct amount of pesticide is being applied to the target site. Applying either too little or too much pesticide can cause problems.

Underdosing is expensive. If you apply too little pesticide, you may not fully control the pest. Sometimes you can repeat the entire application, but that can be very costly in both time and money. In other cases, a repeat application may not be possible, because it would result in an overdose.

Overdosing is expensive. Do not use any more than the amounts listed in the "Directions for Use" section of the pesticide labeling. Using more product than the labeling recommends will not do a better job of controlling pests, and it is illegal. Overdosing may cause damage or injuries, leave illegal residues, and cause you to be fined or to be liable for damages.

Deciding How Much To Apply

Study the "Directions for Use" section of the pesticide labeling to find out how much pesticide you should apply. If the labeling lists a range of possible amounts, use the least amount of pesticide that will achieve good control of the pest.

Mixing, Loading and Calibration Alternatives

You must determine how to deliver the correct amount to the target site. Depending on the type of formulation you choose and the type of application equipment you will use, you may have to do some combination of three basic tasks — mixing the pesticide, loading it into your equipment, and calibrating the equipment so you will know exactly how much pesticide it is delivering.

- Mixing — Except for ready-to-use formulations, you must carefully combine the right amounts of concentrated pesticide formulation and diluent to make the needed application-strength pesticide mixture.
- Loading — You may need to transfer the pesticide into the equipment before it can be applied.
- Calibrating — For many kinds of applications, you must measure and adjust the amount of pesticide your equipment will apply to the target site.

Calibrating Your Equipment

Most pesticide applications involve equipment that must be measured and adjusted to release the correct amount of pesticide to the target site. To be sure your equipment is releasing the right amount of pesticide, take time to calibrate it carefully and correctly. Recheck it regularly to detect changes caused by wear, corrosion, and aging.

Before you begin to calibrate the equipment, check it carefully to be sure that all components are clean and in good working order. Pay particular attention to the parts that regulate the amount of pesticide being released, such as nozzles and hopper openings.

Study the manufacturer's instructions carefully — they explain exactly how to adjust the equipment. They often contain suggestions on such things as the appropriate rate of travel, the range of most efficient pump pressures, approximate settings for achieving various delivery rates, and types of nozzles that can be used.

Speed

For some types of application equipment, the speed at which the equipment moves (or is carried) through the target site is one of the main factors in determining the rate of application. For some other types of equipment, you do not need to consider speed when calibrating.

Equipment with gravity-glow dispersal — Some equipment, such as some granule spreaders, needs to be calibrated only to adjust the rate of flow or delivery. If the speed of the equipment is kept at an even, moderate pace, the amount of pesticide being released per unit area will be uniform.

Equipment with powered dispersal — If your equipment has a pump or other mechanism to disperse the pesticide, you will need to determine the rate of speed best suited for the type of equipment and for the particular requirements of your application job. Keep the speed as constant as possible during the calibration process and during the actual application. The equipment manufacturer's directions may offer a range of appropriate speeds.

Uniform release. If the application equipment you will be using has more than one nozzle or hopper, part of the calibration process is to measure the output from each to be sure that they all are releasing the correct amount of pesticide. Note whether the pesticide output from one or more nozzles (or cluster of nozzles) or hoppers is 5 percent more or less than the amount desired.

Calibration Methods

No matter what calibration method you use, you will be measuring how much pesticide is being applied in a specific area. Calibration usually requires you to operate the equipment over a pre-measured distance.

The rate of application depends partly on the particle or droplet size, texture, and other properties of the pesticide being applied. Also, the rate of application sometimes depends on the pressure and on the nozzle size or hopper opening. The equipment manufacturer's directions are the best guide to these selections.

Do a Test Application
Calibrate your application equipment by:
- Accurately measuring the amount in the tank or hopper;
- Operating the equipment over the premeasured distance while maintaining your chosen speed (if speed affects the delivery rate of the equipment you are using); and
- Accurately measuring the amount needed to fill the tank or hopper back up to the pre-application level.

Figure the Application Rate
The amount of pesticide dispersed divided by the distance covered is the application rate.

Check Calibration Often
Once you have calibrated your equipment, do not assume that it will continue to deliver the same rate during all future applications. Clogging, corrosion, and wear may change the delivery rate, or the settings may gradually get out of adjustment.

Measure Accurately
Carefully measure the amount of pesticide to add. Do not guess or approximate the amount you are adding, and do not add a little extra "just to be sure." Also, measure the amount of diluent carefully. Adding the correct amount of concentrate to an approximated amount of diluent can result in a whole tankful of the wrong strength of pesticide mixture. Mix only the amount you have calculated is needed for the application.

If water or another liquid is being used to dilute the concentrate, rinse the measuring utensils with the diluent and put the rinsate into the mix tank. Repeat this three times to be sure all the pesticide is removed from the measuring utensil. Measuring utensils such as spoons, cups, jugs, pails, and scales that you use with pesticides should never be used for other purposes. Clean them thoroughly after each use and store them with your other pesticide equipment.

Diluting Pesticides Correctly

Some of the pesticides you buy are dilute formulations that are sold at application strength. These often are labeled "Ready-To-Use" or "RTU." But many pesticide formulations that you use are concentrates, which are sold at strengths many times that needed for application. These formulations must be diluted before you can apply them. They are usually powders or liquids. Granules and dusts are rarely sold as concentrates; fumigants and ultra-low-volume formulations are concentrates that are applied full strength.

The pesticide labeling or other recommendations will tell you:
- What to use to dilute the formulation;
- How much to dilute the formulation; and
- How much of the dilute pesticide to apply per unit of area.

Depending on the situation, you also may need to know:
- How much your equipment holds when full or how much mixture you will need to complete the job;
- How much mixture your equipment applies per unit of area; and
- The size of the site you need to treat.

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Transportation, Storage, Disposal, and Spill Cleanup

Philip Koehler and Robert Belmont

When you transport, store, or dispose of pesticides and their containers, you must take safety precautions. You can prevent many pesticide accidents and reduce the severity of others, if you are prepared before you start these tasks. Before you begin any pesticide handling task, know what do to in case of spills, and have the proper spill cleanup equipment on hand.

Transportation of Pesticides

You are responsible for the safe transport of pesticides in your possession. Carelessness in transporting pesticides can result in broken containers, spills, environmental contamination, and harm to yourself and others. Accidents can occur even when you are transporting materials a short distance. Do all you can to prevent a mishap, but be prepared in case of emergency. Before transporting pesticides, you should know what to do if a spill occurs. If any pesticide is spilled in or from the vehicle, take action right away to make sure the spill is cleaned up correctly.

Vehicle Safety
Never carry pesticides in the passenger section of your car, van, or truck. Hazardous vapors may be released and make the driver and other passengers ill. Pesticides may cause ill-

ness or injury if they spill on you or your passengers. It is nearly impossible to completely remove spills from the fabric of seats and floor mats. They can cause future contamination if they are not cleaned up correctly.

Never allow children, other passengers, and pets to ride with pesticides.

Never transport pesticides with food, clothing, or other things meant to be eaten by or in contact with people or animals. The risk of contamination is too high. Even small amounts of pesticide could contaminate these highly sensitive items.

Never leave your vehicle unattended when transporting pesticides in an unlocked trunk compartment or open-bed truck. You are responsible and liable if curious children or careless adults are accidentally poisoned by the pesticides. Whenever possible, transport pesticides in a locked compartment.

Transporting Pesticide Containers

Transport pesticides only in containers with intact, undamaged, and readable labels. Inspect containers before loading to be sure that all caps, plugs, and other openings are tightly closed and that there are no pesticides on the outside of the containers. Handle containers carefully to avoid rips or punctures. Anchor all containers securely to keep them from rolling or sliding. Protect paper and cardboard containers from moisture, because they become soggy and split easily when wet.

Pesticide Storage

Secure the site — Keeping out unauthorized people is an important function of the storage site.

Maintain the Storage Site

Prevent contamination — Store only pesticides, pesticide containers, pesticide equipment, and a spill cleanup kit at the storage site. Do not keep food, drinks, tobacco, feed, medical or veterinary supplies or medication, seeds, clothing, or personal protective equipment (other than personal protective equipment necessary for emergency response) at the site. These could be contaminated by vapors, dusts, or spills and cause accidental exposure to people or animals.

Keep labels legible — Store pesticide containers with the label in plain sight. Costly errors can result if the wrong pesticide is chosen by mistake. Labels should always be legible. They may be damaged or destroyed by exposure to moisture, dripping pesticide, diluents, or dirt. You can use transparent tape or a coating of lacquer or polyurethane to protect the label. If the label is destroyed or damaged, request a replacement from the pesticide dealer or the pesticide formulator immediately.

Keep containers closed — Keep pesticide containers securely closed whenever they are being stored.

Use original containers — Store pesticides in their original containers. Never put pesticides in containers that might cause children and other people to mistake them for food or drink. You are legally responsible if someone or something is injured by pesticides you have placed in unlabeled or unsuitable containers.

Watch for damage — Inspect containers regularly for tears, splits, breaks, leaks, rust, or corrosion. When a container is damaged, put on appropriate personal protective equipment and take immediate action. If the damaged container is an aerosol can, use special care to avoid accidentally releasing the pesticide into the air.

When a container is damaged:

- Use the pesticide immediately at a site and rate allowed by the label; or
- Transfer the pesticide into another pesticide container that originally held the same pesticide and has the same label still intact; or
- Transfer the contents to a sturdy container that can be tightly closed. If possible, remove the label from the damaged container and use it on the new container. Otherwise, temporarily mark the new container with the name and EPA registration number of the pesticide, and get a copy of the label from the pesticide dealer or formulator (whose telephone number is usually on the label) as soon as possible; or
- Place the entire damaged container and its contents into a suitable larger container. Consider this option carefully, however. Many times the label on the leaking container becomes illegible. The pesticide is useless and becomes a disposal problem unless you know the name and registration number and can get a copy of the label.

Prevent Pesticide Fires

Some pesticides are highly flammable; others do not catch fire easily. The labeling of pesticides that require extra precautions often will contain a warning statement in either the "Physical/Chemical Hazards" section or the "Storage and Disposal" section. Pesticides that contain oils or petroleum-based solvents are the ones most likely to contain these warning statements. Some dry products also present fire and explosion hazards.

Disposal

Pesticide users are responsible for correctly dealing with empty pesticide containers, excess usable pesticides, and waste materials that contain pesticides or their residues. For information on disposal options available in your local area, contact your state or tribal pesticide authority.

Spill Management

A spill is any accidental release of a pesticide. As careful as people try to be, pesticide spills can and do occur. The spill may be minor, involving only a dribble from a container, or it may be major, involving large amounts of pesticide or pesticide-containing materials such as wash water, soil, and absorbents.

You must know how to respond correctly when a spill occurs. Stopping large leaks or spills is often not simple. If you cannot manage a spill by yourself, get help. Even a spill that appears to be minor can endanger you, other people, and the

environment if not handled correctly. Never leave a spill unattended. When in doubt, get assistance. You can get help from Chemtrec (Chemical Transportation Emergency Center) by calling 1-800-424-9300. This number is for emergencies only.

The faster you can contain, absorb, and dispose of a spill, the less chance there is that it will cause harm. Clean up most spills immediately. Even minor dribbles or spills should be cleaned up before the end of the work day to keep unprotected persons or animals from being exposed.

A good way to remember the steps for a spill emergency is the "three C's": Control, Contain, Clean up.

Control the Spill Situation

Protect yourself — Put on appropriate personal protective equipment before contacting the spill or breathing its fumes.

Stop the source — If a small container is leaking, place it into a larger chemical-resistant container, such as a plastic drum or bag. If a spray tank is overflowing, stop the inflow and try to cap off the tank. If a tank, hopper, or container has burst or has tipped over and is too heavy to be righted, you will not be able to stop the source.

Protect others — Isolate the spill site by keeping children, other unprotected people, and animals well back. Rope off the site if necessary. If you suspect the spill contains a highly volatile or explosive pesticide, you may need to keep people back even farther. Warn people to keep out of reach of any drift or fumes. Do not use road flares or allow anyone to smoke if you suspect the leaking material is flammable.

Stay at the site — Do not leave the spill site until another knowledgeable and correctly protected person arrives. Someone should be at the spill site at all times until the spill is cleaned up.

Contain the Spill

Confine the spill — As soon as the source of the leak is under control, move quickly to keep the spill in as small an area as possible. Do everything you can to keep it from spreading or getting worse. For small spills, use containment snakes to surround the spill and keep it confined. For larger spills, use a shovel, a rake, or other tool or equipment to make a dike of soil, sod, or absorbent material.

Protect water sources — Keep the spill out of any body of water or any pathway that will lead to water, such as a ditch, floor drain, well, or sinkhole. If the spilled pesticide is flowing towards such an area, block it or redirect it.

Absorb liquids — Liquid pesticide spills can be further contained by covering the entire spill site with absorbent materials such as spill pillows, fine sand, vermiculite, sawdust, clay, kitty litter, shredded newspaper, or absorbent pads.

Cover dry materials — Prevent dry, dusty pesticide spills, such as dusts, powders, or granules, from becoming airborne by covering them with a sweeping compound or a plastic covering or by very lightly misting the material with water. Do not mist too much, because water may release the pesticidal action or may cause the pesticide to form clumps and be unusable.

Clean Up

After you have contained the spill, you must pick up the spilled material and decontaminate the spill site and any contaminated items or equipment.

Clean up the spill — For spilled liquid pesticides, sweep up the absorbent material containing the pesticide and place it into a heavy-duty plastic drum or bag. Keep adding the absorbent material until the spilled liquid is soaked up and removed.

Spills of dry pesticides should be swept up for reuse if possible. Avoid contaminating the spilled materials with soil or other debris, so it can be used in the usual application equipment and will not clog the nozzles or hopper openings. However, if the dry spill has become wet or full of debris, it must be swept up and placed in a heavy-duty plastic drum or bag for disposal.

Decontaminate the spill site — Once you have collected as much of the spilled material as possible, decontaminate the spill site as well as you can. Do not hose down the site with water, unless the spill is on a containment tray or pad.

If the surface on which the pesticide has spilled is nonporous, such as sealed concrete, glazed ceramic tile, or no-wax sheet flooring, use water (or the chemical listed on the label to dilute the pesticide) and a strong detergent to remove the residues of the spill from the surface. Do not allow any of the wash solution to run off the site being cleaned. Place fresh absorbent material over the wash solution until it is all soaked up. Then sweep up the absorbent material and place it in a plastic drum or bag for disposal as an excess pesticide.

If the surface upon which the pesticide has spilled is porous, such as soil, unsealed wood, or carpet, you may have to remove the contaminated surface and dispose of it as an excess pesticide. Depending on the size of the spill and the toxicity of the pesticide, however, sometimes the site can be successfully neutralized.

Neutralize the spill site — The labeling of a few pesticides will instruct you to neutralize a spill of that pesticide. Sometimes an authority, such as the pesticide manufacturer or Chemtrec, will also instruct you to neutralize the spill site. Follow the instructions carefully.

Neutralizing a spill often consists of mixing full-strength bleach with hydrated lime and working this mixture into the spill site with a coarse broom. Fresh absorbent material is then spread over the spill site to soak up the neutralizing liquid. This material is swept up and placed in a plastic drum or bag for disposal. You may be instructed to repeat the process several times to make sure that the site is thoroughly neutralized.

Soil is sometimes neutralized by removing and disposing of the top 2 to 3 inches and then neutralizing the remaining soil. You may be instructed to mix activated charcoal into the soil or to cover the spill site with 2 or more inches of lime and cover the lime with fresh topsoil.

Sometimes you may be instructed to cover minor spills with activated charcoal. The activated charcoal can adsorb or tie up enough pesticide to avoid adverse effects to plants and animals that contact the soil in the future. However, activated charcoal is not effective for large spills.

Decontaminate equipment — Clean any vehicles, equip-

ment, and personal protective equipment that were contaminated by the spill or during the containment and cleanup process. Use a strong mixture of chlorine bleach, dishwasher detergent, and water to clean the vehicles and equipment. Wash personal protective equipment thoroughly, following manufacturers' instructions and the guidelines in the personal protective equipment unit of this manual. Remember particularly that porous materials, such as brooms, leather shoes, and clothing, cannot be cleaned effectively if they are thoroughly saturated with pesticide. They should be discarded.

Decontaminate yourself — As soon as you are finished with the spill and equipment cleanup, wash yourself thoroughly with detergent and water. Wash any part of your skin that might have been exposed, and always wash your face, neck, hands, and forearms.

Spill Follow-up

For all large spills and any spills that take place off your property, consider keeping records of your containment and cleanup activities and your conversations with authorities and the public about the spill. Photographs help to document any damage as well as the cleanup process.

Spill Kit

Keep a spill cleanup kit immediately available whenever you handle pesticides or their containers. If a spill occurs, you will not have the time or the opportunity to find all of the items.

The kit should consist of:

- Telephone numbers for emergency assistance;
- Sturdy gloves, footwear, and apron that are chemical-resistant to most pesticides, such as barrier-laminate gear;
- Protective eyewear;
- An appropriate respirator, if any of the pesticides require the use of one during handling activities or for spill cleanup;
- Containment "snakes" to confine the leak or spill to a small area;
- Absorbent materials, such as spill pillows, absorbent clay, sawdust, pet litter, activated charcoal, vermiculite, or paper to soak up liquid spills;
- Sweeping compound to keep dry spills from drifting or wafting during cleanup;
- A shovel, broom, and dustpan (foldable brooms and shovels are handy, because they can be carried easily);
- Heavy-duty detergent;
- A fire extinguisher rated for all types of fires;
- Any other spill cleanup items specified on the labeling of any products you use regularly; and
- A sturdy plastic container that will hold the quantity of pesticide from the largest pesticide container being handled and that can be tightly closed.

All of these items can be stored in the plastic container and kept clean and in working order until a spill occurs.

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Personal Protective Equipment

Philip Koehler and Robert Belmont

Introduction

Personal protective equipment (PPE) is clothing and devices that are worn to protect the human body from contact with pesticides or pesticide residues. To prevent or reduce exposure to pesticides, you need to wear personal protective equipment. You are legally required to follow all personal protective equipment instructions that appear on the label or in labeling. Personal protective equipment includes such items as coveralls or protective suits, footwear, gloves, aprons, respirators, eyewear, and headgear. Ordinary shirts, pants, shoes and other regular work clothing usually are not considered personal protective equipment, although the pesticide labeling may require you to wear specific items of work clothing during some activities.

Pesticide labeling lists the minimum personal protective equipment you must wear while handling the pesticide. Sometimes the labeling lists different requirements for different activities. For example, more personal protective equipment may be required for mixing and loading than for application.

Chemical-resistant Personal Protective Equipment

Some pesticide labeling requires you to wear chemical-resistant personal protective equipment. You must select a material that will be resistant for the period of time that you will be exposed to the pesticide. Most chemical-resistant personal protective equipment items are made of plastic or rubber, but these materials are not equally resistant to all pesticides and in all circumstances.

Choosing Chemical-resistant Materials

Always read the pesticide labeling to see if it tells you what materials are resistant to the pesticide product. When you must select a chemical-resistant material, there are some general guidelines to follow. Cotton, leather, canvas, and other absorbent materials are not chemical resistant, even to dry formulations. Powders and dusts sometimes move through cotton and other woven materials as quickly as wet formulations and may remain in the fibers even after three launderings. Do not use hats that have a cloth or leather sweatband, and do not use cloth or cloth-lined gloves, footwear, and aprons. These materials are difficult or impossible to clean after pesticide gets on them, and they are too expensive to be disposed of after each use.

Chemical-resistant suits and hoods — The best choice of

materials for chemical-resistant suits and hoods is generally:
- Rubber or plastic, such as butyl, neoprene, or polyvinyl chloride (PVC); or
- Nonwoven fabric coated with plastic or another barrier material.

Read the packaging for the suits carefully to be sure that they are "chemical resistant," "chemical protective," or "liquid proof."

Other chemical-resistant items — For other chemical-resistant items, such as gloves, footwear, aprons, and hats, you can choose from many types of materials. Any plastic or rubber material is resistant to dry pesticides and to water-based pesticides. Dry pesticides include dusts, granules, pellets, and some baits. Water-based pesticides include wettable powders, soluble powders, some solutions, dry flowables (water-dispersible granules), and microencapsulated pesticides.

The type of material that is resistant to nonwater-based liquid pesticides depends on the type of solvent used. Watch for signs that the material is not chemical resistant. Sometimes it is easy to see when a plastic or rubber is not resistant to a pesticide. The material may:
- Change color;
- Become soft or spongy;
- Swell or bubble up;
- Dissolve or become like jelly;
- Crack or get holes; and/or
- Become stiff or brittle.

If any of these changes occur, discard the items and choose another type of material.

Protecting Your Skin

The skin is the part of your body that usually gets the most exposure while you are handling pesticides. Pay particular attention to covering as much of your skin as possible. Remember that personal protective equipment protects you only if the pesticide remains on the outside of the material. Once the pesticide gets on the inside and next to your skin, the material works against you. It holds the pesticide tightly next to your skin for as long as it is worn. When this happens, more pesticide will get on your skin and cause irritation or will go through your skin and into your body.

Body Protection

Any time you handle pesticides, wear at least a long-sleeved shirt and long-legged pants. In some instances the pesticide labeling will require you to wear a coverall, a chemical-resistant suit, or a chemical-resistant apron.

Hand and Foot Protection

Pesticide handlers get by far the most pesticide exposure on their hands and forearms. As a result, most pesticide labeling will require you to wear chemical-resistant gloves at all times while handling the pesticide. Wear chemical-resistant gloves any time you may get pesticides on your hands.

Pesticide handlers also often get pesticides on their feet. Sturdy shoes and socks are sufficient to protect your feet during a few pesticide handling activities. Canvas, cloth, and leather are difficult or impossible to clean adequately, however. Consider using chemical-resistant materials when pesticides or pesticide residues, especially concentrates, may get on your footwear.

Avoid contaminating the inside of gloves and footwear — Even when you are wearing gloves and footwear, you can get pesticides on your hands and feet unless the gloves and footwear are:
- Chemical-resistant to the pesticide being handled;
- Worn correctly;
- In good condition;
- Cleaned and cared for; and
- Replaced often.

Contamination often happens when handlers remove their gloves briefly to adjust their equipment, open a pesticide container, or wipe their face, and then put the gloves on again over their contaminated hands. If you must remove your gloves during a handling activity, wash your gloves thoroughly before taking them off, and wash your hands thoroughly and dry them before you put the gloves on again.

Handlers also sometimes make the mistake of putting on footwear with contaminated hands. This may transfer the pesticide from your hands to your socks and feet.

You must keep pesticides from running down your sleeves or pants legs and into your gloves and footwear. For many jobs, you will be working some of the time with your arms raised and some of the time with them lowered. Close the glove cuff tightly outside the sleeve and put heavy-duty tape or an elastic band around the end of the glove where it meets the sleeve. Some gloves have a method of tightening the cuff to your sleeve so the pesticide cannot run down into the glove.

For jobs where your arms are mostly lowered, place sleeves outside the gloves to keep pesticides from running down the sleeves and into the gloves. Use gloves that go up over your wrist and at least halfway to your elbow. If you will be raising your arms most of the time, you may leave your gloves outside your sleeves. Fold the cuff of your gloves up towards your fingers an inch or two to catch the pesticide before it runs down your arm.

For jobs where you will be exposed to pesticides on your legs, put your pants legs outside the boots so the pesticide will not travel down your leg and collect in the boots or shoe covers.

Head and Neck Protection

If you will be exposed to pesticides from above, wear something to protect your head and neck. A chemical-resistant hood or wide-brimmed hat will help keep pesticides off your head, neck, eyes, mouth, and face. Plastic "safari" hats with plastic sweatbands are a good choice. They are relatively cool in hot weather. Other more flexible hats and hoods are also available in chemical-resistant materials. Many chemical-resistant jackets or coveralls can be purchased with attached protective hoods.

Protecting Your Eyes

When the pesticide labeling requires you to wear protective eyewear, wear goggles, a face shield, or safety glasses with shields at both the brow and sides. Eyes are very sensitive to the chemicals in some pesticide formulations, especially concentrates, and temporary blindness caused by an accident may delay or prevent self-treatment. Eyes also readily absorb some pesticides.

Shielded safety glasses are a good choice in many handling situations because they are comfortable, do not cause fogging or sweating, and give good eye protection for many exposure situations. However, if you will be applying mists, fogs, or aerosols indoors or in any other situation where you will be enveloped in a spray, mist, or dust, wear goggles that fit tightly against your face.

Either goggles or shielded safety glasses can be worn with a half-face respirator. Full-face respirators are supplied with their own face shield, so additional eye protection is not required.

Protecting Your Respiratory Tract

The respiratory tract — the lungs and other parts of the breathing system — is much more absorbent than the skin. You must wear a respirator when the pesticide labeling directs you to do so. Even if the labeling does not require it, you should consider wearing a respiratory protective device:

- If you are in an enclosed area and the pesticide you are handling has a labeling precautionary statement such as "do not breathe vapors or spray mist," or "harmful or fatal if inhaled"; or
- If you will be exposed for a long time to pesticides that are in or near your breathing zone.

Some pesticide labeling lists the type of respirator you should wear when handling the product. Other labeling requires the use of a respirator, but does not specify the type or model to be used. When the pesticide labeling requires you to use a respirator, you must wear one that is approved by NIOSH and MSHA.

Studies have shown that many pesticide handlers do not use respirators correctly and so are not being well protected. Before you use a respirator, you should be trained in the correct procedures for selecting, fitting, cleaning and sanitizing, inspecting, and maintaining respiratory protective equipment.

Air-Purifying Respirators

In most situations where pesticide handlers need to use a respirator, some type of air-purifying respirator provides enough protection. Air-purifying respirators will not protect you from fumigants, from extremely high concentrations of vapor, or when the oxygen supply is low.

Functions of air-purifying respirators — Air-purifying respirators remove contaminants from the air in two ways:

- By filtering dusts, mists, and particles; and
- By removing gases and vapors.

Sometimes you will need only a respirator that filters dusts and mists from the air; at other times, you will need one that removes gases and vapors as well.

Wear a dust/mist-filtering respirator if the pesticide labeling tells you to or if you will be exposed to pesticide dusts, powders, mists, or sprays in your breathing zone. Wear a respirator that also removes vapors if the pesticide labeling tells you to or if you will be exposed to gases or vapors in your breathing zone.

Styles of air-purifying respirators — Air-purifying respirators are of three basic styles:

- dust/mist masks, which usually are shaped filters that cover the nose and mouth to filter out dusts, mists, and particles;
- devices consisting of a body and one or more cartridges that contain air-purifying materials; and
- devices consisting of a body and a canister that contains air-purifying materials.

Cartridges may contain either dust/mist-filtering material or vapor-removing material. For pesticide-handling tasks where vapor removal is needed, a prefilter must be used with the vapor-removing cartridge. The prefilter removes dusts, mists, and other particles before the air passes through the vapor-removing cartridge.

A canister contains both dust/mist filtering and vapor-removing material. Canisters contain more air-purifying material than cartridges. They last much longer and may protect you better in situations where the concentration of gas or vapor in the air is high. They are also much heavier and more uncomfortable to wear.

Selecting and using dust/mist-filtering devices — Dust/mist-filtering masks and cartridges are approved by NIOSH and MSHA. You must wear one that has their stamp of approval. Nonapproved filters are not as protective and are not acceptable.

Pesticide handlers must wear dust/mist-filtering masks or cartridges with NIOSH/MSHA approval number prefix TC-21C.

When you wear a dust/mist filter — either a mask, cartridge, or prefilter — you will have more trouble breathing as more dusts, mists, and other particles become trapped in the filter material. When breathing becomes too difficult, replace the filter. Eight hours of use is usually the limit for these filters. During continual use, you may need to change filters twice a day, or even more in dusty or dirty conditions. Do not use a dust/mist mask when the pesticide will completely soak the mask and be held close to the skin and breathing passages. Replace the mask if it gets soaked or loses its shape.

Selecting and using vapor-removing devices — Vapor-removing devices are rated by NIOSH for the types of gases and vapors they will remove. For pesticide handling tasks where vapor protection is needed, NIOSH requires that an organic-vapor-removing material and a pesticide prefilter be used.

Pesticide handlers must use either:

- A cartridge approved for organic vapor removal plus a prefilter approved for pesticides (NIOSH/MSHA approval number prefix for both is TC 23C); or
- A canister approved for pesticides (NIOSH/MSHA approval number prefix is 14G).

When you wear a vapor-removing respirator, remember that vapor-removing materials gradually lose their ability to hold more gases and vapors. The instructions on some other materials will tell you to replace them after a specific number of hours of use. If there are no instructions about replacement, change the cartridge or canister after about eight hours of use. If you notice an odor, taste, irritation, or dizziness, that is a signal that you are no longer being protected.

Fitting air-purifying respirators — Respirators fit wearers in one of two ways. Most must seal tightly to the face; others are loose-fitting.

Face-sealing respirators must form a tight seal against your face to be effective. Otherwise, pesticides can leak in around the edges. People with beards cannot wear this style of respirator because a tight seal cannot be formed through the hair. These respirators must be fitted to each wearer and are not interchangeable among handlers.

Dust/mist masks are face-sealing respirators. They fit over your nose and mouth and have a clip that you press around the bridge of your nose to help form a seal. Most cartridge and canister respirators are also face-sealing respirators. Full-face styles form and keep a tight seal better than half-face styles.

Many pesticide handlers are not adequately protected while wearing face-sealing cartridge and canister respirators because they often break the seal by pulling the respirator away from their face to get temporary relief from the heat, sweat, itching, or difficult breathing. Once the seal is broken in the exposure area, the respirator's ability to protect you is greatly reduced. Face-sealing cartridge and canister respirators are most useful for short-term tasks.

Disposables and Reusables

Personal protective equipment items should be either disposable or easy to clean and sturdy enough for repeated use.

Disposables

Disposable personal protective equipment items are not designed to be cleaned and reused. Discard them when they become contaminated with pesticides.

Reusables

Some personal protective equipment that you buy may be designed to be cleaned and reused several times. However, do not make the mistake of reusing these items when they are no longer protecting you. Most protective eyewear and respirator bodies, facepieces and helmets are designed to be cleaned and reused. These items may last many years if they are good quality and are maintained correctly.

Maintaining Personal Protective Equipment

When you finish an activity where you are handling pesticides or are exposed to them, remove your personal protective equipment right away. Wash the outside of your gloves with detergent and water before you remove them. Consider washing the outside of other chemical-resistant items before you remove them also. This helps you avoid contacting the contaminated part of the items while you are removing them and helps keep the inside surface uncontaminated. If any other clothes have pesticides on them, change them also. Determine whether the items should be disposed of or cleaned for reuse.

Place reusable items in a plastic bag or hamper away from your other personal clothes and away from the family laundry. Place disposables in a separate plastic bag or container. The pesticides remaining on your personal protective equipment, work clothing, and other work items could injure persons who touch them. Do not allow children or pets near them. Do not allow contaminated gloves, boots, respirators, or other equipment to be washed in streams, ponds, or other bodies of water.

Clean all reusable personal protective equipment items between uses. Even if they were worn for only a brief period of exposure to pesticides during that day, wash them before you wear them again. Pesticide residues that remain on the personal protective equipment are likely to continue to move slowly through the personal protective equipment material, even chemical-resistant material. If you wear that personal protective equipment again, pesticide may already be on the inside next to your skin. Also, personal protective equipment that is worn several times between launderings may build up pesticide residues. The residues can reach a level that can harm you, even if you are handling pesticides that are not highly toxic.

Washing Personal Protective Equipment

Wash pesticide-contaminated items separately from uncontaminated clothing and laundry. Otherwise, the pesticide residues can be transferred onto the other clothing or laundry and can harm you or your family.

Washing procedure — Follow the manufacturer's instructions for cleaning chemical-resistant items. If the manufacturer instructs you to wash the item but gives no detailed instructions, or offers no cleaning instructions at all, follow the procedure below. Some chemical-resistant items that are not flat, such as gloves, footwear, and coveralls, must be washed twice — once to thoroughly clean the outside of the item and a second time after turning the item inside out. Some chemical-resistant items, such as heavy-duty boots and rigid hats or helmets, can be washed by hand using hot water and a heavy-duty liquid detergent. They should be dried and aired as directed below.

The best procedure for washing nonchemical-resistant items, such as cotton, cotton/polyester, denim, canvas, and other absorbent materials, and most chemical-resistant items is:

- Rinse in a washing machine or by hand.
- Wash only a few items at a time so there will be plenty of agitation and water for dilution.
- Wash in a washing machine, using a heavy-duty liquid detergent and hot water for the wash cycle.
- Rinse twice using two entire rinse cycles and warm water.
- Use two entire machine cycles to wash items that are moderately to heavily contaminated.
- Run the washer through at least one additional entire cycle without clothing, using detergent and hot water, to clean

the machine after each batch of pesticide-contaminated items and before any other laundry is washed.

Drying procedure — Hang the items to dry, if possible. It is best to let them hang for at least 24 hours in an area with plenty of fresh air. Even after thorough washing, some items still may contain pesticides. When the items are exposed to clean air, remaining pesticide residues move to the surface and evaporate. You may wish to buy two or more sets of equipment at a time so you can leave one set airing in a clean place while you are using the other set. Do not hang items in enclosed living areas, because pesticides that remain in the items may evaporate and expose people or animals in the area.

Using a clothes dryer is acceptable for fabric items if it is not possible to hang them to dry. However, over a period of time the dryer may become contaminated with pesticide residues.

Maintaining Eyewear and Respirators

Wash goggles, face shields, shielded safety glasses, and respirator bodies and facepieces after each day of use. Use a detergent and hot water to wash them thoroughly. Sanitize them by soaking for at least two minutes in a mixture of 2 tablespoons of chlorine bleach in a gallon of hot water. Rinse thoroughly to remove the detergent and bleach. Dry thoroughly or hang them in a clean area to dry.

Pay particular attention to the head bands. Head bands made of absorbent materials should be replaced with chemical-resistant head bands. After each day of use, inspect all head bands for signs of wear or deterioration and replace as needed.

Store respirators and eyewear in an area where they are protected from dust, sunlight, extreme temperatures, excessive moisture, and pesticides or other chemicals. A zip-closable sturdy plastic bag works well for storage.

Respirator maintenance is especially important. Inspect your respirator before each use. Repair or replace it whenever any part shows sign of wear or deterioration.

If you remove your respirator between handling activities:

- Wipe the respirator body and face piece with a clean cloth.
- Replace caps, if available, over cartridges, canisters, and prefilters.
- Seal the entire respirator in a sturdy, airtight container, such as a zip-closable plastic bag. If you do not seal the respirator immediately after each use, the disposable parts will have to be replaced more often. Cartridges, canisters, prefilters, and filters will continue to collect impurities as long as they are exposed to the air.

At the end of any work day when you wore a reusable respirator:

- Remove the filter or prefilter. Most filters should be discarded. A few are designed to be washed and reused.
- Take off the cartridges or canisters. Discard them or, if still usable, replace their caps and seal them in an airtight container, such as a zip-closable plastic bag.
- Clean and store respirator as directed above.
- Discard disposable respirators according to manufacturer's instructions. Do not try to clean them.

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Harmful Effects and Emergency Response

Philip Koehler and Robert Belmont

Most pesticides are designed to harm or kill pests. Because some pests have systems similar to the human system, some pesticides also can harm or kill humans. Fortunately, humans usually can avoid harmful effects by avoiding being exposed to pesticides.

Humans may be harmed by pesticides in two ways: they may be poisoned or injured. Pesticide poisoning is caused by pesticides that harm internal organs or other systems inside the body. Pesticide-related injuries usually are caused by pesticides that are external irritants.

Exposure

When a pesticide comes into contact with a surface or an organism, that contact is called a pesticide exposure. For humans, a pesticide exposure means getting pesticides in or on the body. The toxic effect of a pesticide exposure depends on how much pesticide is involved and how long it remains there.

Types of Exposures

Pesticides contact your body in four main ways:

- Oral exposure (when you swallow a pesticide);
- Inhalation exposure (when you inhale a pesticide);
- Ocular exposure (when you get a pesticide in your eyes); or
- Dermal exposure (when you get a pesticide on your skin).

Avoiding Exposure

Avoiding and reducing exposures to pesticides will reduce the harmful effects from pesticides. You can avoid exposures by wearing appropriate personal protective equipment, washing exposed areas often, and keeping your personal protective equipment clean and in good operating condition.

Causes of Exposure

One of the best ways to avoid pesticide exposures is to avoid situations and practices where exposures commonly occur.

Oral exposures often are caused by:

- Not washing hands before eating, drinking, smoking, or chewing;

- Mistaking the pesticide for food or drink;
- Accidentally applying pesticides to food; or
- Splashing pesticide into the mouth through carelessness or accident.

Inhalation exposures often are caused by:
- Prolonged contact with pesticides in closed or poorly ventilated spaces;
- Breathing vapors from fumigants and other toxic pesticides;
- Breathing vapors, dust, or mist while handling pesticides without appropriate protective equipment; or
- Inhaling vapors present immediately after a pesticide is applied; for example, from drift or from reentering the area too soon, and using a respirator that fits poorly or using an old or inadequate filter, cartridge, or canister.

Dermal exposures often are caused by:
- Not washing hands after handling pesticides or their containers;
- Splashing or spraying pesticides on unprotected skin or eyes;
- Wearing pesticide-contaminated clothing (including boots and gloves);
- Applying pesticides in windy weather;
- Wearing inadequate personal protective equipment while handling pesticides; or
- Touching pesticide-treated surfaces.

Eye exposures often are caused by:
- Splashing or spraying pesticides in eyes;
- Applying pesticides in windy weather without eye protection;
- Rubbing eyes or forehead with contaminated gloves or hands; or
- Pouring dust, granule, or powder formulations without eye protection.

Harmful Effects

Pesticides can cause three types of harmful effects: acute effects, delayed effects, and allergic effects.

Acute Effects

Acute effects are illnesses or injuries that may appear immediately after exposure to a pesticide (usually within 24 hours). Acute effects usually are obvious and often are reversible if appropriate medical care is given promptly.

Pesticides cause four types of acute effects:
- Acute oral effects;
- Acute inhalation effects;
- Acute dermal effects, and
- Acute eye effects.

Acute oral effects — Your mouth, throat, and stomach can be burned severely by some pesticides. Other pesticides that you swallow will not burn your digestive system but will be absorbed and carried in your blood throughout your body and may cause you harm in various ways.

Acute inhalation effects — Your entire respiratory system can be burned by some pesticides, making it difficult to breathe. Other pesticides that you inhale may not harm your respiratory system, but are carried quickly in your blood throughout your whole body, where they can harm you in various ways.

Acute dermal effects — Contact with some pesticides will harm your skin. These pesticides may cause your skin to itch, blister, crack, or change color. Other pesticides can pass through your skin and eyes and get into your body.

Acute eye effects — Some pesticides that get into your eyes can cause temporary or permanent blindness or severe irritation. Other pesticides may not irritate your eyes, but pass through your eyes and into your body.

Delayed Effects

Delayed effects are illnesses or injuries that do not appear immediately (within 24 hours) after exposure to a pesticide or combination of pesticides.

Allergic Effects

Allergic effects are harmful effects that some people develop in reaction to substances that do not cause the same reaction in most other people.

Types of allergic effects — Some people are sensitized to certain pesticides. After being exposed once or a few times without effect, they develop a severe allergy-like response upon later exposures. These allergic effects include:
- Systemic effects, such as asthma or even life-threatening shock;
- Skin irritation, such as rash, blisters, or open sores; and
- Eye and nose irritation, such as itchy, watery eyes and sneezing.

Signs and Symptoms of Harmful Effects

Watch for two kinds of clues to pesticide-related illness or injury. Some clues are feelings that only the person who has been poisoned can notice, such as nausea or headache. These are symptoms. Others clues, like vomiting or fainting, can be noticed by someone else. These are signs.

Many of the signs and symptoms of pesticide poisoning are similar to signs and symptoms of other illnesses you might experience, such as the flu or even a hangover. Examples of signs of pesticide-related illness or injury include:

External irritants cause:
- Redness, blisters, rash, and/or burns on skin; and
- Swelling, a stinging sensation, and/or burns in eyes, nose, mouth, and throat.

Pesticide poisoning may cause:
- Excessive sweating, chills, and/or thirst;
- Chest pains;
- Difficult breathing; and
- Cramps in your muscles or aches all over your body.

Responding To A Poisoning Emergency

Local Emergency Response

The local phone number to dial for emergency response is _____. Ask your certified operator for the phone number and keep it with you at all times. It must be posted and available to you according to state law.

Get medical advice quickly if you or any of your fellow workers have unusual or unexplained symptoms starting at work or later the same day. Do not let yourself or anyone else get dangerously sick before calling your physician or going to a hospital. It is better to be too cautious than too late. Take the pesticide container (or the labeling) to the physician. Do not carry the pesticide container in the passenger space of a car or truck.

First Aid for Pesticide Poisoning

First aid is the initial effort to help a victim while medical help is on the way. If you are alone with the victim, make sure the victim is breathing and is not being further exposed to the pesticide before you call for emergency help. Apply artificial respiration if the victim is not breathing. Do not become exposed to the pesticide yourself while you are trying to help.

The best first aid in pesticide emergencies is to stop the source of pesticide exposure as quickly as possible. In an emergency, look at the pesticide labeling, if possible. If it gives specific first aid instructions, follow those instructions carefully. If labeling instructions are not available, follow these general guidelines for first aid:

Pesticide on skin:

- Drench skin and clothing with plenty of water. Any source of relatively clean water will serve. If possible, immerse the person in a pond, creek, or other body of water. Even water in ditches or irrigation systems will do, unless you think they may have pesticides in them.
- Remove personal protective equipment and contaminated clothing.
- Wash skin and hair thoroughly with a mild liquid detergent and water. If one is available, a shower is the best way to completely and thoroughly wash and rinse the entire body surface.
- Dry victim and wrap in blanket or any clean clothing at hand. Do not allow to become chilled or overheated.
- If skin is burned or otherwise injured, cover immediately with loose, clean, dry, soft cloth or bandage.
- Do not apply ointments, greases, powders, or other drugs in first aid treatment of burns or injured skin.

Pesticide in eye:

- Wash eye quickly but gently.
- Use an eyewash dispenser, if available. Otherwise, hold eyelid open and wash with a gentle drip of clean running water positioned so that it flows across the eye rather than directly into the eye.
- Rinse eye for 15 minutes or more.
- Do not use chemicals or drugs in the rinse water. They may increase the injury.

Inhaled pesticide:

- Get victim to fresh air immediately.
- If other people are in or near the area, warn them of the danger.
- Loosen tight clothing on victim that would constrict breathing.
- Apply artificial respiration if breathing has stopped or if the victim's skin is blue. If pesticide or vomit is on the victim's mouth or face, avoid direct contact and use a shaped airway tube, if available, for mouth-to-mouth resuscitation.

Pesticide in mouth or swallowed:

- Rinse mouth with plenty of water.
- Give victim large amounts (up to 1 quart) of milk or water to drink.
- Induce vomiting only if instructions to do so are on the labeling.

Procedure for inducing vomiting:

- Position victim face down or kneeling forward. Do not allow victim to lie on his back, because the vomit could enter the lungs and do additional damage.
- Put finger or the blunt end of a spoon at the back of victim's throat or give syrup of ipecac.
- Do not use salt solutions to induce vomiting.

Do not induce vomiting:

- If the victim is unconscious or is having convulsions.
- If the victim has swallowed a corrosive poison. A corrosive poison is a strong acid or alkali. It will burn the throat and mouth as severely coming up as it did going down. It may get into the lungs and burn there also.
- If the victim has swallowed an emulsifiable concentrate or oil solution. Emulsifiable concentrates and oil solutions may cause death if inhaled during vomiting.

Additional Resources

Harmful Effects and Emergency Response Tutorial

This text is part of the UF/IFAS *Basic Pesticide T*raining manual (SM-59) which is intended to provide intermediate training to pest control operators. The manual was adapted from a larger manual, *Applying Pesticides Properly*, which was developed by Ohio State University in cooperation with the Cooperative Extension Service, U.S. Department of Agriculture, and the Office of Pesticide Programs, U.S. Environmental Protection Agency.

Pesticides in the Environment

Philip Koehler and Robert Belmont

Introduction

The environment is everything that is around us. It includes not only the natural elements that the word "environment" most often brings to mind, but also people and the man-made components of our world. Neither is the environment limited to the outdoors — it also includes the indoor areas in which we live and work. Anyone who uses a pesticide — indoors or outdoors, in a city or in the country — must consider how that pesticide will affect the environment.

The user must ask two questions:

- How will this pesticide affect the immediate environment at the site where it is being used?
- What are the dangers that the pesticide will move out of the use site and cause harm to other parts of the environment?

Pesticides can harm all types of environments if they are not used correctly. Responsible pesticide users know and follow good practices that achieve effective pest control with very little risk of environmental damage. Pesticide product labeling statements are intended to alert you to particular environmental concerns that a pesticide product poses.

Sources of Contamination

When environmental contamination occurs, it is the result of either point-source or non-point-source pollution. Point-source pollution comes from a specific, identifiable place (point). A pesticide spill that moves into a storm sewer is an example of point-source pollution. Most pesticide contamination results from point sources, such as:

- Wash water and spills produced at equipment cleanup sites;
- Improper disposal of containers, water from rinsing containers, and excess pesticides;
- Pesticide storage sites where leaks and spills are not correctly cleaned up; and
- Spills that occur while mixing concentrates or loading pesticides into application equipment.

These kinds of tasks are involved with nearly every pesticide use, whether the pesticide is applied outdoors or in or around an enclosed structure.

Sensitive Areas

Sensitive areas are sites or living things that are easily injured by a pesticide.

Sensitive areas outdoors include:

- Areas where ground water is near the surface or easily accessed (wells, sinkholes, porous soil, etc.);
- Areas in or near surface water;
- Areas near schools, playgrounds, hospitals, and other institutions;
- Areas near the habitats of endangered species;
- Areas near apiaries (honeybee sites), wildlife refuges, or parks, and
- areas near ornamental gardens, food or feed crops, or other sensitive plantings.

Sensitive areas indoors include:

- Areas where people — especially children, pregnant women, the elderly, or the sick — live, work, or are cared for;
- Areas where food or feed is processed, prepared, stored, or served;
- Areas where domestic or confined animals live, eat, or are otherwise cared for; and
- Areas where ornamental or other sensitive plantings are grown or maintained.

Sometimes pesticides must be deliberately applied to a sensitive area to control a pest. These applications should be performed by persons who are well trained about how to avoid causing injury in such areas.

Pesticide Movement

Pesticides that move away from the release site may cause environmental contamination. Pesticides move away from the release site both indoors and outdoors and may cause harm in both environments. Pesticides move in several ways, including:

- In air, through wind or through air currents generated by ventilation systems,
- In water, through runoff or leaching; and
- On or in objects, plants, or animals (including humans) that move or are moved off-site.

Air

Pesticide movement away from the release site in the air is usually called drift. Pesticide particles, dusts, spray droplets, and vapors all may be carried off-site in the air. People who mix, load, and apply pesticides outdoors usually are aware of the ease with which pesticides drift off-site. People who handle pesticides indoors may not realize how easily some pesticides move off-site in the air currents created by ventilation systems and by forced-air heating and cooling systems.

Particles and droplets — Lightweight particles, such as dusts and wettable powders, are easily carried by moving air. Granules and pellets are much heavier and tend to settle out of air quickly. Small spray droplets also are easily carried in air currents. High-pressure and fine nozzles produce very small spray droplets that are very likely to drift. Lower pressure and coarse nozzles produce larger droplets with less drift potential.

The likelihood that pesticide particles and spray droplets will drift off-site depends partly on the way they are released. Pesticides released close to the ground or floor are not as likely to be caught up in air currents as those released from a greater height. Pesticides applied in an upward direction are the most

likely to be carried on air currents.

Vapors — Pesticide vapors move about easily in air. The labeling of volatile pesticides often includes warning statements that the pesticide handler should heed. Any time you release a volatile pesticide in an enclosed area, consider the hazards not only to yourself and to fellow workers, but also to people, animals, and plants that are in or near the release site or that may enter the area soon after the release.

Water

Pesticide particles and liquids may be carried off-site in water. Pesticides can enter water through:

- Drift, leaching, and runoff from nearby applications;
- Spills, leaks, and back-siphoning from nearby mixing, loading, storage, and equipment cleanup sites; and
- Improper disposal of pesticides, rinsates, and containers.

Most pesticide movement in water is across the treated surface (runoff) or downward from the surface (leaching). Runoff and leaching may occur when:

- Too much liquid pesticide is applied, leaked, or spilled onto a surface; or
- Too much rainwater, irrigation water, or other water gets onto a surface containing pesticide residue.

Runoff water in the outdoor environment may travel into drainage ditches, streams, ponds, or other surface water where the pesticides can be carried great distances off-site. Pesticides that leach downward through the soil in the outdoor environment sometimes reach the ground water.

On or In Objects, Plants, or Animals

Pesticides can move away from the release site when they are on or in objects or organisms that move (or are moved) off-site. Pesticides may stick to shoes or clothing, to animal fur, or to blowing dust and be transferred to other surfaces. When pesticide handlers bring home or wear home contaminated personal protective equipment, work clothing, or other items, residues can rub off on carpeting, furniture, and laundry items and onto pets and people.

Harmful Effects on Nontarget Plants and Animals

Nontarget organisms may be harmed by pesticides in two ways:

- The pesticide may cause injury by contacting the nontarget organism directly; or
- The pesticide may leave a residue that causes later injuries.

Harmful Effects From Direct Contact

Pesticides may harm nontarget organisms that are present during a pesticide application. Poorly timed applications can kill bees and other pollinators that are active in or near the target site. Pesticides may harm other wildlife, too. Read the warnings and directions on the pesticide labeling carefully to avoid harming nontarget organisms during a pesticide application.

Drift from the target site may injure wildlife, livestock, pets, sensitive plants, and people. For example, drift of herbicides can damage sensitive nearby plants, including crops, forests, or ornamental plantings. Drift also can kill beneficial parasites and predators that are near the target site.

Harmful Effects From Residues

A residue is the part of a pesticide that remains in the environment for a period of time following application or a spill. Pesticides usually break down into harmless components after they are released into an environment. The breakdown time ranges from less than a day to several years. The rate of pesticide breakdown depends mostly on the chemical structure of the pesticide active ingredient.

Persistent pesticides leave residues that stay in the environment without breaking down for long periods of time. These pesticides are sometimes desirable because they provide long-term pest control and may reduce the need for repeated applications. However, some persistent pesticides that are applied to or spilled on soil, plants, lumber, and other surfaces or into water can later cause harm to sensitive plants or animals, including humans, that contact them.

When using persistent pesticides, consider whether their continued presence in the environment is likely to harm plants and animals. Sometimes animals can be harmed when they feed on plants or animals that have pesticide residues on or in them.

Harmful Effects on Surfaces

Sometimes surfaces are harmed by pesticides or pesticide residues. Some surfaces may become discolored by contact with certain pesticides. Other surfaces may be pitted or marked by contact with some pesticides. Some pesticides can corrode or obstruct electronic systems or metal. Sometimes a pesticide will leave a visible deposit on the treated surface.

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Special Environmental Concerns

Philip Koehler and Robert Belmont

Introduction

Concerns about wildlife and the environment are becoming more important in decisions about which pesticides will be registered and what they may be used for. Two environmental concerns are receiving particular attention:

- Protection of ground water; and
- Protection of endangered species.

Federal and state efforts to protect ground water and endangered species are resulting in new instructions and limitations for pesticide handlers. Whether you apply pesticides indoors or outdoors, in an urban area or in a rural area, you must become aware of the importance of protecting these two vital national resources. Pesticides that are incorrectly or accidentally released into the environment — either during application or during other handling activities, such as mixing, loading, equipment cleaning, storage, transportation, or disposal — pose a threat to ground water and endangered species.

Protecting Groundwater

Groundwater is water located beneath the earth's surface. Usually, it is located in rock and soil. It moves very slowly through irregular spaces within otherwise solid rock or seeps between particles of sand, clay, and gravel. Surface water may move several feet in a second or a minute. Groundwater may move only a few feet in a month or a year. If the groundwater is capable of providing significant quantities of water to a well or spring, it is called an aquifer. Pesticide contamination of aquifers is very troubling, because these are sources of drinking, washing, and irrigation water.

Pesticide Contamination of Groundwater

When water that is moving downward from the surface contains pesticides — or comes into contact with them as it moves — the pesticides may be carried along with the water until they eventually reach the groundwater.

Five major factors determine whether a pesticide will reach groundwater:

- The practices followed by pesticide users;
- The presence or absence of water on the surface of the site where the pesticides are released;
- The chemical characteristics of the pesticides;
- The type of soil in the site where the pesticides are released; and
- The location of the ground water — its distance from the surface and the type of geological formations above it.

By being aware of these considerations, you can handle pesticides in ways that will make the potential for groundwater contamination less likely.

Practices for Pesticide Users

The best way to keep from contaminating groundwater is to follow labeling directions exactly. Be sure to note whether the labeling requires you to take any special steps to protect groundwater. In addition, remember the following:

- Avoid using more pesticide than the labeling directs.
- Consider whether your application method presents any special risks. For example, soil injection of some pesticides may not be wise when ground water is close to the surface.
- Take precautions to keep pesticides from back-siphoning into your water source.
- Whenever possible, locate mix-load sites and equipment-cleaning sites at least 100 feet from surface water or from direct links to ground water. If you must locate one of these work sites near a water source, use methods such as dikes, sump pits, and containment pads to keep pesticides from reaching the water.
- Do not contaminate groundwater through improper disposal of unused pesticides, pesticide containers, or equipment and container rinse water. Dispose of all pesticide wastes in accordance with local, state, tribal, and federal laws.

The Applicator's Role

Some pesticides or certain uses of some pesticides may be classified as restricted use because of groundwater concerns. As an applicator, you have a special responsibility to handle all pesticides safely in and near use sites where groundwater contamination is particularly likely. Take extra precautions when using techniques that are known to be likely to cause contamination of groundwater, such as chemigation and soil injection.

When a pesticide product has been found in groundwater or has characteristics that may pose a threat of contamination of groundwater, the pesticide product labeling may contain statements to alert you to the concern.

Protection of Endangered Species

An endangered species is a plant or animal that is in danger of becoming extinct. There are two classifications of these plants and animals in danger — "endangered species" and "threatened species." The term "endangered species" is used here to refer to the two classifications collectively. Scientists believe that some pesticides may threaten the survival of some of America's endangered species if they are used in the places where these plants and animals still exist.

A federal law, the Endangered Species Act, requires the U.S. Environmental Protection Agency (EPA) to ensure that endangered species are protected from pesticides. EPA's goal is to remove or reduce the threat that pesticide use poses to endangered species. Reaching this goal will require some limitations on pesticide use. These limitations usually will apply only in the currently occupied habitat or range of each endangered species at risk. Occasionally the limitations will apply where endangered species are being reintroduced into a habitat they previously occupied.

Habitats, sometimes called "critical habitats," are the areas of land, water, and air space that an endangered species needs for survival. Such areas include breeding sites; sources of food, cover, and shelter; and surrounding territory that gives room for normal population growth and behavior.

Limitations on Pesticide Use

Read all pesticide labeling carefully to find out whether the use of that product requires you to take any special steps to protect endangered species. The label may direct you to an-

other source for the details about what you must do. When limitations do apply, they usually will be in effect only in some specific geographic locations. Use of a particular pesticide is usually limited in a particular location when:

- The site is designated as the current habitat of an endangered species, and
- The endangered species that uses the site might be harmed by the use of the pesticide within (or close to) its habitat.

Habitats of Endangered Species

The U.S. Fish and Wildlife Service is responsible for identifying the current habitat or range of each endangered species. For aquatic species, the restricted habitat often will include an additional zone around the body of water to keep any drift, runoff, or leachate in the watershed from reaching the water.

The U.S. Fish and Wildlife Service is attempting to identify the habitats as accurately as possible so that pesticide use will need to be limited only in locations where it is absolutely necessary. For this reason, limitations on pesticide use may apply on one property, while a similar adjoining property may not have these limitations.

The Applicator's Role

Pesticides have the potential to harm living organisms, including endangered species:

- Pesticides can kill endangered plants and animals directly.
- Pesticides in the habitat of the endangered organisms can disrupt or destroy their sources of food and shelter.
- Pesticide application, drift, runoff, and leachate can contaminate water ingested by or inhabited by endangered organisms.
- Some pesticides can build up to dangerous levels in endangered predators that feed on plants or animals exposed to pesticides.

As an applicator, you have a clearly defined legal responsibility to protect endangered species against the hazards posed by pesticides. Careful use of pesticides in and around the key habitat areas will help these fragile plants and animals to survive, and it also may prevent some important pesticides from being removed from the market.

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Nonpesticidal Components of an IPM Program

It would be difficult to develop a list of only those products appropriate for use in a School IPM program because IPM is a thinking process, and different products are appropriate in different situations. This section lists products that some pest management professionals might find helpful. None of the products listed contains traditional pesticides. Many of the products listed are tools used to monitor pests, help exclude pests from structures, or other various mechanical devices. A pest management technician new to IPM might not be aware of the options available when attempting to monitor or exclude pests. This section is intended to aid the pest management professional in obtaining such products.

Nonpesticide Product Manufacturers and Distributors

Birds

Bird Barrier
(800) 503-5444 or (310) 793-1733
bbsales@birdbarrier.com
Audio-Visual Deterrents — Electronic devices, figures, etc.
Bird-Flite — Bird deterrent
Bird Shock — Electric bird deterrent
Bird Site Cleaning Products — Remove glues, droppings, etc.
Bird Traps — Catch and release
Birdwire — Bird deterrent
Coil — Bird deterrents
Daddi Long Legs — Bird deterrent
Rejex-it — Liquid repellents
StealthNet — Bird exclusion

Bird-Be-Gone
Stephanie A. Fitzpatrick
Marketing and Sales
24362 Via Madrugada
Mission Viejo, CA 92692
(800) 392-6915
OR
(949) 472-3122
FAX: (949) 472-3116
www.birdbgone.com
nobirds@birdbgone.com
Bird deterrents

Bird-X, Inc.
300 N. Elizabeth St.
Chicago, IL 60607
(800) 662-5021
(312) 226-2473
BirdGard — Bird repeller
Bird-Lite — Bird repeller
BirdNet — Bird deterrent
Bird-Proof — Gel or liquid
BirdXPeller — Bird repeller
B-X Safety Solvent — Repellent remover
GooseChase — Goose repellent
Irri-Tape — Bird deterrent
Pigeon Hawk — Bird deterrent
Spikes — Bird deterrent
Super Bird Xpeller — Bird distress calls
Terror Eyes — Bird repeller

Cat Claw, Inc.
PO Box 5250
Johnstown, PA 15904
(800) 832-2473
Fax: (800) 732-0380
www.catclaw.com or www.sweets.com
Cat Claw — Bird deterrent

Ecopic Volt
725 S. Adams #126
Birmingham, MI 48009
(248) 647-0505
Fax: (248) 647-7811
Ecopic Volt — Bird deterrent

Nixalite of America, Inc.
1025 16th Avenue
East Moline, IL 61244
Toll Free: (888) 624-1189
Fax: (888) 624-1196
Nixalite@qconline.com
www.nixalite.com/
Nixalite Models — Bird deterrents

Cockroaches

AgriSense
PO Box 674
Wabasso, FL 32970
Phone/Fax (561) 589-6762
Pwiii@aol.com
Behavior Modifying Compounds — Pheromones
Lo-Line and Detector — Sticky traps

Atlantic Paste & Glue Co., Inc.
4-53rd Street
Brooklyn, NY 11232
(718) 492-3648
(800) 458-7454
Fax: (718) 439-0039
Insect Trap and Monitor — Tapered slope
Insect Trap and Monitor — Thigmotropic design

Bell Laboratories, Inc.
3699 Kinsman Blvd.
Madison, WI 53704
(608) 241-0202
Fax: (608) 241-9631
www.belllabs.com
Trapper LTD — Captures mice, cockroaches, insects

Insects Limited, Inc.
(800) 992-1991
German Cockroach Pheromone Trap

Flies

Actron Inc., Gardner International
PO Box 55655
Santa Clarita, CA 91385
(800) 866-8887 (toll free in USA only)
(805) 287-3335
Fax: (805) 287-3339
flymaster@actroninc.com
FlyFinder — Fly paper on a roll
Insect Light Traps and Electrocutors — 12 different models

Advantage Traps
(803) 561-1329
Fly Banquet — Fly attractant
Fly Trap — Dual entry

AgriSense
PO Box 674
Wabasso, FL 32970
Phone/Fax (561) 589-6762
Pwiii@aol.com
Dome Trap and Wasp & Fly Lure — Wasp and fly traps
EFM Fly Board and Long-Life Fly Lure — Accessories

Anderson Environmental Systems
(800) 992-6339
Diamond V — Wall sconce and insect light trap
Natural Catch Plus + DF5000 — Fruit fly and sewer fly control

Atlantic Paste & Glue Co., Inc.
4-53rd Street
Brooklyn, NY 11232
(718) 492-3648
Fax: (718) 439-0039
Toll Free: (800) 458-7454
catchmaster@worldnet.att.net
Spider Web Fly Glue Trap — By the sheet

Farnam Companies, Inc., Pest Control Division
PO Box 34820
Phoenix, AZ 85067-4820
(800) 234-2269
Catch 'N' Pitch — Disposable fly trap
Fly Inn — Flying insect trap
Fly Relief — Disposable fly trap
Musca-Doom — Disposable fly trap
Musca-Stik — Sticky fly trap
Musca-Terminator — Fly traps

Gilbert Industries, Inc.
5611 Krueger Drive
Jonesboro, AR 72401
(800) 643-0400
Fax: (870) 932-5609
gilbertinc@worldnet.att.net
Fly Traps — Electrocuting light traps
Flytraps — Glueboard light traps

Insects Limited, Inc.
(800) 992-1991
House and Fruit Fly Systems — Pheromone kit

Paraclipse, Inc.
2271 29th Avenue East
PO Box 686
Columbus, NB 68602-0686
(402) 563-3625
Fax: (402) 564-2109
Insect Inn IV — Light trap

Pest West
(800) 843-6334
Fax: (770) 985-8273
bandw@mindspring.com
Electronic Fly Killers and Sticky Trap Units

Woodstream
An EKCO Group Company
Lititz, PA 17543
www.victorpest.com
(717) 626-2125
Fly Magnet — Bait and traps
Mosquito Barrier — Spray

Whitmire Micro-Gen Research Laboratories, Inc.
3568 Tree Court Industrial Blvd.
St. Louis, MO 63122
(800) 777-8570
Fax: (800) 977-1087
www.wmmg.com
Vector Fly Systems — Light traps
Vector Junior — Fly trap

Fleas

Farnam Companies, Inc., Pest Control Division
PO Box 34820
Phoenix, AZ 85067-34820
(800) 234-2269
Carpet Powder — Flea control

Whitmire Micro-Gen Research Laboratories, Inc.
3568 Tree Court Industrial Blvd.
St. Louis, MO 63122
(800) 777-8570
Fax: (800) 977-1087
www.wmmg.com
Ultralight Flea Trap — Light and glue trap

Rodents

AgriZap, Inc.
1860 Eastman Ave, Suite 111
Ventura, CA 93003
Toll Free: (888) DEAD-RAT [(888) 332-3728]
International: (805) 654-0657
Fax: (805) 654-1390
http://www.ratzapper.com
sales@ratzapper.com
Rat Zapper — Electrocutes rodents

Anderson Environmental Systems
(800) 992-6339
Metal-Gard — Rodent control equipment protection

Atlantic Paste & Glue Co., Inc.
4-53rd Street
Brooklyn, NY 11232
(718) 492-3648
Fax: (718) 439-0039
Toll Free: (800) 458-7454
catchmaster@worldnet.att.net
48r Rat Tray — Glue trap
72MB-PBM —Mouse glue board
Giant Rat Board — Glue trap
Rodent Barn — Rat and mouse glue board

Bell Laboratories, Inc.
3699 Kinsman Blvd.
Madison, WI 53704
(608) 241-0202
Fax: (608) 241-9631
www.belllabs.com
Protecta MC — Multiple and single catch trap
Protecta Pest Monitor — Rodents and insects
Trapper Glue Board — Mouse trap
Trapper LTD — Captures mice, cockroaches, insects

Kness Mfg. Co., Inc.
Hwy 5 South
PO Box 70
Albia, IA 52531-0070
(515) 932-7846
Toll Free: (800) 247-5062
Fax: (515) 932-2456
www.kness.com
Mini-Mouser — Multiple catch mouse trap
Tip-Trap — Live capture mousetrap

Whitmire Micro-Gen Research Laboratories, Inc.
3568 Tree Court Industrial Blvd.
St. Louis, MO 63122
(800) 777-8570
Fax: (800) 977-1087
www.wmmg.com
Mouse Master — Multiple catch mouse trap

Stored Product Pests

AgriSense
PO Box 674
Wabasso, FL 32970
Phone/Fax (561) 589-6762
Pwiii@aol.com
Behavior Modifying Compounds — Pheromones

Insects Limited, Inc.
(800) 992-1991
Stored Product Pest Pheromone Kits

Trece, Inc.
(800) 992-6339
Storgard Flit-Trak M2 — Stored product pest trap

Whitmire Micro-Gen Research Laboratories, Inc.
3568 Tree Court Industrial Blvd.
St. Louis, MO 63122
(800) 777-8570
Fax: (800) 977-1087
www.wmmg.com
Allure Insect Trapping System — Pheromone trap

Termites

Diversified Plastics, Inc.
Larry Hiner — VP Sales & Marketing
PO Box 1612
Sand Spring, OK 74063-1612
(800) 245-2597
Fax: (918) 245-0775
E-Z Access II — Inspection and treatment door

Etex Ltd.
http://www.Etex.Ltd.com
Etex 1 @ aol.com
Electro-Gun — Electronic control

Lorien Instruments, Inc.
PO Box 700
Divide, CO 80814
(719) 687-0411
Fax: (719) 687-2500
Toll Free: (888) 658-8030
Protek II — Helps prevent drilling through pipes and conduit

P.I.M. Development, Inc.
PO Box 6305
Kaneohe, HI 96744
(808) 247-4922
Fax: 235-5903
Snap On Baseboards — Termite inspection

Really Innovations
Cocoa Main
4050 West Highway 520
Cocoa, FL 32926
(407) 631-2414

Atlanta Service Center
4818 Fulton Industrial Blvd.
Atlanta, GA 30345
(404) 699-7668

Orlando Service Center
1000 West Amelia
Orlando, FL 32805
(407) 425-5525
Sales, Parts & Service: (800) 940-8024
PCO Moisture Meter — Termite detection

Termi-Mesh Hawaii, Inc.
1406 Colburn Street, Suite 201C
Honolulu, HI 96817
(808) 843-1968
Fax: (808) 843-0100
Termi-Mesh —Termite barrier (Florida and Hawaii only)

Yellowjackets, Hornets and Bees

AgriSense
PO Box 674
Wabasso, FL 32970
Phone/Fax (561) 589-6762
Pwiii@aol.com
Dome Trap and Wasp & Fly Lure — Wasp and fly traps

Farnam Companies, Inc., Pest Control Division
PO Box 34820
Phoenix, AZ 85067-4820
(800) 234-2269
Trap-A-Jack — Yellowjacket trap

Insects Limited, Inc.
(800) 992-1991
Yellowjacket Pheromone Kit

Sector Diagnostics
602 Kailua Road Suite 201
Kailua, HI 96734
(808) 526-3772
Fax: (808) 262-0587
Toll Free: (888) 303-3772
Sector@lava.net
www.termatrol.com
Thermatrol Bulk Pack — Detection station
Thermatrol C-Thru — Detection station
Thermatrol Tools — Replacement monitors, keys and soil auger

Woodstream
An EKCO Group Company
Lititz, PA 17543
(717) 626-2125
www.victorpest.com
Poison-Free Wasp and Hornet Killer

Miscellaneous

Atlantic Paste & Glue Co., Inc.
4-53rd Street
Brooklyn, NY 11232
(718) 492-3648
Fax: (718) 439-0039
Toll Free: (800) 458-7454
Insect Trap and Monitor — Thigmotropic design

B & G Equipment Co.
(800) 544-8811
bgequip.com
Pro Vacuum — Lightweight vacuum

Bell Laboratories, Inc.
3699 Kinsman Blvd.
Madison, WI 53704
(800) 323-6628
Glue Boards and Traps — Rodent and insect control and monitoring
Protecta Pest Monitor — Rodents and insects
Trapper LTD — Captures mice, cockroaches, insects
Trapper Monitor and Insect Trap

BioQuip Products, Inc.
17803 LaSalle Ave.
Gardena, CA 90248
(310) 324-0620
Fax: (310) 324-7931
Insect Resistant Coverall — Clothing
Pocket Magnifiers
Stereo Microscopes

Bird-X, Inc.
300 N. Elizabeth St.
Chicago, IL 60607
(800) 662-5021
(312) 226-2473

Certified Pest Control Operators Association of Florida
(954) 724-8806
Pesticide Application Signs

Crusader Mfg., Inc.
Acorn Environmental Systems
2334 Benjamin Street NE
Minneapolis, MN 55418
(612) 781-3169
Fax: (612) 781-8675
Orange Degreaser — Cleanser
Walkabout Backpack — Vacuum

D & S Specialty Products, Inc.
(800) 820-1980
dsspec@sprynet.com
Access and Exclusion Tools — For birds, bats and rodents
Nuisance Animal Control — Bird and rodent catch and release traps

Gateway Industrial Products, Inc.
PO Box 95
Elyria, OH 44036
(800) 701-4782
Bug Barrier — Screens and doors
Strip Doors and Bulk PVC

Insect-O-Cutor
U.S. (770) 939-2835
Canada (519) 442-2988
Insecto@mindspring.com
Insect Attraction Lamps —Replacement bulbs
Insect Electrocutors — High performance
Insect Electrocutors — Energy efficient

Insects Limited, Inc.
(800) 992-1991
Webbing Clothes Moth Pheromone Kit

PMC Specialties Group, Inc.
501 Murray Road
Cincinnati, OH 45217
(800) 543-2466
Rejexit — Taste aversion product

Sealeze Corporation
8000 White Pine Road
Richmond, VA 23237
(800) 446-7325
Fax: (800) 448-2908
Brush Weatherseal — Pest exclusion
Therm-l-Brush — Door seals

Temp-Vent Corp.
PO Box 2030
Shelby, NC 28151
(704) 482-0324
Toll Free: (800) 525-3271
Power Temp-Vent — Vent closure

Zoecon
(800) 248-7763
Insect Monitoring Trap — Glue board

Appendix I: School IPM Organization Directory

This information was provided by Tom Green of the IPM Institute of North America, Inc., and is accurate as of December 2000.

Send listings, additions or updates to ipminstitute@cs.com.

Organizations listed under state headings may have resources available and applicable to users outside of the state.

Note: No effort has been made to screen entries and no endorsement is implied. The user bears all responsibility for verifying the accuracy and propriety of information obtained from Web sites, publications, etc.

NATIONAL

Government/University/Extension

UNIVERSITY OF FLORIDA, Dr. Philip Koehler, Urban Pest Specialist, Entomology and Nematology Department, Bldg. 970, Natural Area Drive, Gainesville, FL 32611-0640, (352) 392-2484, Fax (352) 846-1500, Email: pgk@gnv.ifas.ufl.edu

Applicator training; advice to schools districts and pest management professionals; sample/model IPM documents (e.g., contracts, policies); E-mail list server; Web site: http://schoolipm.ifas.ufl.edu/ including pest management techniques from national authorities, downloadable presentations, how to start an IPM program and sample documents.

US EPA, Office of Pesticide Programs, Biopesticides and Pollution Prevention Division, MC 7511C, 1200 Pennsylvania Ave. NW, Washington, DC 20460, (703) 308-8272, Fax (703) 308-7026

Citizen's Guide to Pest Control and Pesticide Safety (EPA Pub # 730-K-95-001, September 1995); Pest Control in the School Environment: Adopting IPM (EPA Pub # 735-F-93-012, August 1993); order free of charge through EPA's National Service Center for Environmental Publications at 1-800-490-9198 or at http://http://www.epa.gov/ncepihom/ center.

Nongovernmental, nonprofit organizations

BEYOND PESTICIDES/NATIONAL COALITION AGAINST THE MISUSE OF PESTICIDES (NCAMP), Kagan Owens, Program Director, 701 E Street, S.E., Suite 200, Washington, DC 20003, (202) 543-5450, Fax (202) 543-4791, Email: kowens@beyondpesticides.org.

Resources for parents, activists, school administrators on the hazards of school pesticide use and their alternatives; model school policies and laws; resources on IPM, pesticide bans and right-to-know programs on local, state and federal level; information on pesticide poisoning incidents and how to document; membership; quarterly newsletter: *Pesticides and You*; monthly publication: *Technical Report*; annual national pesticide conference; Web site: http://www.beyondpesticides.org.

CENTER FOR HEALTH, ENVIRONMENT AND JUSTICE, Deb Benyik, Children's Health Coordinator, PO Box 6806, Falls Church, VA 22040, (703) 237-2249, E-mail: dbenyik@chej.org

Site-specific technical assistance to communities with environmental problems; publications: *Gold Standard*, school IPM guidelines, an effort of the "Poisoned Schools: Childproofing Our Communities" campaign, comprised of local, state and national children's environmental health activist groups; newsletter: *Everyone's Backyard*; membership; Web site: http://www.childproofing.org.

HEALTHY SCHOOLS NETWORK INC., Claire Barnett, Executive Director, 773 Madison Avenue, Albany, NY 12208, (518) 462-0632, Email: Healthyschools@aol.com

Kick the Pesticide Habit, 8 pp. guide for parents and others in the school community linking child environmental health research and school facility information to practical steps

schools can take to pest-proof facilities and reduce pesticide use; advocacy for improved school facility conditions and practices; assistance for parents of allergic, asthmatic, and chemically sensitive students; peer and technically reviewed guides, fact sheets, packets on a variety of indoor environmental problems in institutions serving children on cleaning products, access to public information, renovation vs health, health & safety committees, molds, carpeting, and more; Web site: http://www.hsnet.org.

IPM INSTITUTE OF NORTH AMERICA, INC., Dr. Thomas Green, President, 1914 Rowley Ave., Madison, WI 53705, (608) 232-1528, FAX (608) 232-1530, Email: ipminstitute@cs.com.

IPM certification; membership; newsletter; *IPM Standards for Schools*, 124 pp. School IPM checklist with more than 700 IPM practices and 250 resources for schools implementing IPM including model documents, how-to resources for planning, communication, pesticide risk management, non-chemical controls for school buildings and grounds; IPM verifier training; Web site: http://www.ipminstitute.org including IPM Standards in html and PDF formats and brand name list of least-impact pest control options.

ALABAMA

Government/University/Extension

IPM ALABAMA PROGRAM, School IPM Coordinator, Alabama IPM in Schools Project, 207 Extension Hall, Auburn University, Alabama 36849, (334) 844-6390

Applicator training (through the Alabama Pest Control Association); advising to schools, PCOs, any other interested groups; model IPM program; newsletters tailored for schools; Web site: http://www.aces.edu/schoolipm.

CALIFORNIA

Government/University/Extension

SCHOOL IPM PROGRAM, Department of Pesticide Regulation, California Environmental Protection Agency, 830 K Street, Sacramento, CA 95814-3510, (916) 324-4100, Fax (916) 324-4088, Email: schools@empm.cdpr.ca.gov

IPM Guidebook and web-based resources on IPM and pesticides for schools, parents, teachers; training-the-trainers in school districts; assessing IPM adoption assessment; model school sites development; California legislation requires annual parental notification, parental advisory of individual pesticide applications upon request and posting of pesticides applications with record keeping; Web site: http://www.cdfa.ca.gov/.

Nongovernmental, nonprofit organization

BIO-INTEGRAL RESOURCE CENTER, William Quarles, Executive Director, PO Box 7414, Berkeley, CA 94707; 510/524-2567; Fax 510/524-1758, Web Site: http://plant.cdfa.ca.gov/biocontrol/, Email: birc@igc.org

Membership; training programs; newsletters; *IPM Practitioner*, *Common Sense Pest Control Quarterly* and more than 100 publications on IPM and reduced-risk pest control; IPM school manual; IPM curriculum; 52-page reduced-risk product list.

COMMUNITY IPM COUNCIL, Phil Boise, IPM/Agronomy Programs Manager, 930 Miramonte Dr., Santa Barbara CA 93109, (805) 963-0583 x150, Fax (805) 962-9080, Email: Pboise@rain.org

IPM training; conference and program development for schools, municipalities, professional landscape and communities. Web site: http://www.grc.org.

CONNECTICUT

Government/University/Extension

UNIVERSITY OF CONNECTICUT, Dr. Richard A. Ashley, IPM Coordinator, Department of Plant Science, 1376 Storrs Road, U-67, Storrs, CT 06269-4067, (860) 486-3438, Fax (860) 486-4562, Email: rashley@uconn.edu

Resources for commercial growers, home gardeners, and school administrators; IPM information for turf, invasive species, weeds; online IPM homestudy courses and publications ordering; Web site: http://www.canr.uconn.edu/ipm.

FLORIDA

Government/University/Extension

UNIVERSITY OF FLORIDA, Dr. Philip Koehler, Urban Pest Specialist, Entomology and Nematology Department, Bldg 970, Natural Area Drive, Gainesville, FL 32611-0640, (352) 392-2484, Fax (352) 846-1500, Email: pgk@ufl.edu

Applicator training; advice to schools districts and pest management professionals; sample/model IPM documents (e.g., contracts, policies); E-mail list server; Web site :http://www.ifas.ufl.edu/~schoolipm/ including pest management techniques, downloadable presentations, how to start an IPM program and sample documents.

IOWA

Government/University/Extension

IOWA STATE UNIVERSITY, Pest Management & the Environment, Dr. Mark H. Shour, 109 Insectary, Ames, IA 50011, (515) 294-5963, Fax (515) 294-8027, Email: mshour@iastate.edu

Applicator training; advice to schools districts and pest management professionals.

ILLINOIS

Government/University/Extension

SCHOOL IPM TECHNICAL RESOURCE AND INFORMATION CENTER, Entomology Department, Purdue University, Mr. Al Fournier, School IPM Coordinator, 1158 Smith Hall, West Lafayette, IN, 47907-1158, (765) 496-7520, Fax (765) 494-0535, Email: al_fournier@entm.purdue.edu

Advice to schools, pest management professionals in Indiana and Illinois via hotline (1-887-668-8IPM); workshops for school administrators, staff, pest control professionals; pilot programs operating in three model school districts and four childcare facilities.

Nongovernmental, nonprofit organization

SAFER PEST CONTROL PROJECT (SPCP), Jessica Bullen, Program Associate, 25 E. Washington, Suite 1515, Chicago, IL 60602, (312) 641-5575, Fax: (312) 641-5454, Email: jbullen@bpichicago.org

Resources for parents, teachers, and schools on IPM; sample IPM materials including sample notification and model policy; newsletter; IPM Handbook and comic book about IPM (English and Spanish); workshops on residential, garden, and school IPM; Web site: www.spcpweb.org.

INDIANA

Government/University/Extension

SCHOOL IPM TECHNICAL RESOURCE AND INFORMATION CENTER, Entomology Department, Purdue University, Mr. Al Fournier, School IPM Coordinator, 1158 Smith Hall, West Lafayette, IN, 47907-1158, (765) 496-7520, Fax (765) 494-0535, Email: al_fournier@entm.purdue.edu

Advice to schools, pest management professionals in Indiana and Illinois via hotline (1-887-668-8IPM); workshops for school administrators, staff, pest control professionals; pilot programs operating in three model school districts and four childcare facilities.

MAINE

Government/University/Extension

MAINE DEPT OF AGRICULTURE, FOOD AND RURAL RESOURCES, Dr. Kathleen Murray, IPM Entomologist, 28 State House Station, Augusta, ME 04333, 207-287-7616, Fax (207) 624-5065, Email: Kathy.Murray@state.me.us

Advising to parents, schools, pest management professionals; model IPM policy; publications: *What's Bugging Our Schools? Pest Concerns and Pesticide Use in Maine Public Schools: Report of the School Integrated Pest Management Survey*, *Maine School IPM Outdoor Turf and Pest Management Guide*; workshops: On-Site Training Program, a three-hour presentation to school staff and administrators on IPM objectives and how to develop and implement an IPM program in schools.

MAINE BOARD OF PESTICIDES CONTROL, Gary Fish, 28 State House Station, Augusta, ME 04333, (207) 287-2731, Fax 207-287-7548, Email: gary.fish@state.me.us

Applicator licensing and certification; consulting/advising to parents, schools, pest management professionals; newsletter; publications (pamphlets, fact sheets); workshops and conferences (Turf IPM, Structural IPM, Ornamental IPM and other one-day seminars offered annually); Web site: www.state.me.us/agriculture/pesticides

UNIVERSITY OF MAINE COOPERATIVE EXTENSION PEST MANAGEMENT OFFICE, Dr. Jim Dill, IPM Coordinator, 491 College Avenue, Orono, ME 04469, (207) 581-3880, Fax (207) 581-3881, Email: jdill@umext.maine.edu

Applicator training; applicator certification; consulting/advising to parents, schools, pest management professionals; publications (pesticide applicator training manuals, insect and disease fact sheets); workshops/conferences (various pest management workshops offered); insect and plant disease diagnostic service; Web site: www.umext.maine.edu/topics/pest.htm.

MARYLAND

Government/University/Extension

MARYLAND DEPARTMENT OF AGRICULTURE, Pesticide Regulation Section, Mary Ellen Setting, Chief or Ed Crow, Program Coordinator, 50 Harry S. Truman Parkway, Annapolis, MD, 21401, (410) 841-5710, Fax (410) 841-2765, Email: settingm@mda.state.md.us and crowea@mda.state.md.us

Regulatory and reference materials: regulations, regulation summaries, sample notices, sample IPM plan, IPM Guidelines, Contracting Guidelines, IPM training manual, supplemental manual on IPM principles and practices,

Yellowjackets and IPM, establishing action thresholds, IPM information sheets; Website: www.mda.state.md.us.

MASSACHUSETTS

Government/University/Extension

UMASS EXTENSION, School IPM Program, Reginald Coler, Coordinator, Department of Entomology, Fernald Hall, University of Massachusetts, Box 32410, Amherst, MA 01003-2410. (413) 577-3976, FAX (413) 545-5858, Email: rcoler@ent.UMass.edu

Applicator training; advising and workshops for schools, pest management professionals.

MINNESOTA

Government/University/Extension

MINNESOTA DEPARTMENT OF AGRICULTURE, Jean Ciborowski, Integrated Pest Management Program Coordinator, Agricultural Development Division, 90 West Plato Boulevard, St. Paul, MN 55107-2094, (651) 297-3217, Fax (651) 297-7678, Email: jeanne.ciborowski@state.mn.us. Applicator certification contact person: John Wagner, Agronomy and Plant Protection Division, (651) 297-7122, Email: john.wagner@state.mn.us

Publications: *IPM Overview*, *Ant Management in Schools*, *Cockroach Management in Schools*, *Small Fly Management in Schools*, *Wasp and Bee Management Around Schools*, *Rat and Mouse Management in Schools*, *Weed Management on School Grounds and Athletic Fields*, *Join Our Pest Patrol — A Backyard Activity Book For Kids — An Adventure in IPM*; Web site: http://www.mda.state.mn.us/IPM/default.htm.

UNIVERSITY OF MINNESOTA EXTENSION SERVICE, Dean Herzfeld, Minnesota Health, Environmental, and Pesticide Safety and Pesticide Applicator Training Coordinator, 495 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108, (612) 624-347, Fax (612) 625-9728, Email: deanh@umn.edu

Applicator training manuals plus a wide range of pest management publications and training; Web sites: Health, Environmental, and Pesticide Safety at http://www.extension.umn.edu/pesticides, Community and School IPM at http://www.extension.umn.edu/pesticides/IPM/ipmhome.htm, Pesticide Applicator Training at http://www.extension.umn.edu/pesticides/pat/mnpat.html.

Minnesota's Parents' Right-to-Know Act dealing with pesticide application at schools Web site:
http://www.revisor.leg.state.mn.us/slaws/2000/c489.html#a7.

MINNESOTA DEPARTMENT OF HEALTH, model school pesticide application notices, school compliance and related information Web site: http://www.health.state.mn.us/divs/eh/esa/hra/notification.html.

MINNESOTA DEPARTMENT OF CHILDREN FAMILIES AND LEARNING maintains a searchable database listing pesticides and their EPA toxicity category at http://cfls.state.mn.us/pesticide.

MONTANA

Government/University/Extension

MONTANA STATE UNIVERSITY, Will Lanier, IPM Assistant, 422 Leon Johnson Hall, Bozeman, Montana, 59717, (406) 994-5690, (406) 994-6029, Email: wlanier@montana.edu

Applicator training; advice to schools, pest management professionals; sample/model IPM documents; e-mail list server; Web site: http://IPM.montana.edu including pest management techniques from national authorities, downloadable presentations, how to start an IPM program and sample documents, lesson plans for middle school science teachers to incorporate school IPM into science classes.

NEW JERSEY

Government/University/Extension

RUTGERS COOPERATIVE EXTENSION Pest Management Office, Dr. George Hamilton, 93 Lipman Drive, Rutgers University, New Brunswick, NJ 08901, (732) 932-9801, Fax (732) 932-729, Email: hamilton@aesop.rutgers.edu

Applicator training; advising to schools and pest management professionals; IPM certification criteria, sample/model IPM documents (e.g., contracts, policies).

Nongovernmental, nonprofit organization

NEW JERSEY ENVIRONMENTAL FEDERATION, Jane Nogaki, IPM Program Coordinator, 223 Park Avenue, Marlton, NJ 08053, (856)767-1110, Fax (856)768-6662, Email: janogaki@eticomm.net

IPM advising to parents, teachers, schools; model notification and IPM policies; IPM training workshops for lawn care, schools, urban settings; listing of NJ schools using IPM; materials on lawn care, indoor pest control, mosquito control; Web site: www.cleanwateraction.org/njef.

NEW YORK

Government/University/Extension

CORNELL COMMUNITY IPM PROGRAM, Lynn Braband, Extension Associate, New York State Agricultural Experiment Station, Geneva, NY 14456-0462, (800) 635-8356, (315) 787-2408, Fax (315) 787-2360, Email: lab45@cornell.edu; LONG ISLAND: Dr. Jody L. Gangloff, IPM Area Specialist, Cornell Cooperative Extension, 1425 Old Country Road, Bldg. J, Plainview, NY 11803, (516) 454-0900 ext. 270, Fax (516) 454-0365, Email: jlg23@cornell.edu

Applicator training; advising to schools and pest management professionals; funding for school IPM projects; newsletter; publication: *IPM Workbook for New York State Schools*; workshops; demonstration and applied research projects; Web site: http://www.nysaes.cornell.edu/ipmnet/ny/urban/ includes *IPM Workbook for New York State Schools* and several other publications.

OHIO

Government/University/Extension

OHIO STATE UNIVERSITY IPM PROGRAM, Margaret F. Huelsman, Extension Associate, 1991 Kenny Road, Columbus, OH 43210, (614) 688-8431, Fax (614) 292-9783, Email: huelsman.16@osu.edu

Applicator training; advising to parents, schools, pest management professionals; sample/model IPM documents; workshops: How to get a school IPM program started in your school district (Spring 2001); Web site: http://www.ag.ohio-state.edu/~ipm.

Nongovernmental, nonprofit organizations

RURAL ACTION SAFE PEST CONTROL PROGRAM, Heather Cantino, Coordinator, 33 Cable Lane, Athens, OH 45701, (740) 594-3338, Fax (740) 593-3228, http://www.ruralaction.org/ipm.html, Email: aa734@seorf.ohiou.edu

Services to Midwest/Appalachia/Ohio; advising to schools, pest management professionals, IPM advocates; sample IPM documents including teacher education materials, IPM principles and implementation guidelines, pest prevention checklists, home safe pest control strategies; workshops/presentations for school officials, teachers, and parents on IPM rationale, methods, techniques, implementation goals and process; Web site: http://www.ruralaction.org/ipm.html, including downloadable sample documents.

PENNSYLVANIA

Government/University/Extension

PENNSYLVANIA DEPARTMENT OF AGRICULTURE, Lee B. Bentz, IPM Coordinator, 2301 N. Cameron St., Harrisburg, PA 17110-9408, (717) 772-5204, Fax (717) 783-3275, Email: lbentz@state.pa.us; Dr. Ed Rajotte, IPM Coordinator, The Pennsylvania State University, 501 ASI, University Park, PA 16802, (814) 863-4641, Fax (814) 865-3048, Email: egrajotte@psu.edu

Advice to school districts and pest management professionals; sample IPM documents (e.g., contracts, policies); publications: *Common Household Insects*, *Pyramid of IPM Tactics for Schools*; video: *Insects and Spiders and Mites, Oh My!*, quarterly newsletter; workshops for teachers; Web site: http://paipm.cas.psu.edu/.

TENNESSEE

Government/University/Extension

UNIVERSITY OF TENNESSEE AGRICULTURAL EXTENSION SERVICE, Karen M. Vail, Urban Entomologist, Entomology and Plant Pathology Department, 218 Plant Science Building, 2431 Center Drive, Knoxville, TN 37996, (865) 974-7138, Fax (865) 974-8868, Email: kvail@utk.edu

Advising to parents, schools, and pest management professionals; sample IPM documents (e.g., contracts, policies); publications: *Suggested Guidelines for Managing Pests in Tennessee's Schools: Adopting Integrated Pest Management* (PB1603), *Integrated Pest Management of Landscapes* (PB 1639); workshops/conferences for school officials, pest management professionals and school plant managers; Web site: http://www.utextension.utk.edu/pbfiles/pb1603.pdf.

TEXAS

Government/University/Extension

TEXAS AGRICULTURAL EXTENSION SERVICE, Dr. Michael Merchant, Associate Professor and Extension Urban Entomologist, TexasA&M University Center, 17360 Coit Road, Dallas, TX 75252-6599, (972) 231-5362, Fax (972) 952-9632, E-mail: m-merchant@tamu.edu

IPM Coordinator training; applicator training; CEU training; advice to schools districts and pest management professionals; sample/model IPM documents (e.g., contracts, policies); publications: *Pest Control in Texas Schools. Adopting Integrated Pest Management*. B-6015; ABCs of IPM video training modules for school districts, includes an introductory video on IPM for schools; IPM posters.

WASHINGTON

Government/University/Extension

WASHINGTON STATE UNIVERSITY PUYALLUP, Carrie R. Foss, Pesticide Education, and Dr. Art Antonelli, Extension Entomologist, 7612 Pioneer Way, E. Puyallup, WA 98371-4998 (253) 445-4577 and (253) 445-4545, Fax (253) 445-4569, E-mails: cfoss@wsu.edu and antonell@wsu.edu

WASHINGTON STATE DEPARTMENT OF AGRICULTURE, Dr. Dan Suomi, Agricultural Chemical Specialist, PO Box 42589, Olympia, WA 98504, (360) 902-2044, Email: dsuomi@agr.wa.gov.

Nongovernmental, nonprofit organization

WASHINGTON TOXICS COALITION, Cheryl Holzmeyer, Healthy Schools Campaign Coordinator, 4649 Sunnyside Ave. N, Suite 540-East, Seattle, WA 98103, (206) 632-1545 x11, Fax (206) 632-8661, Email: cholzmeyer@watoxics.org

Advising to parents, school districts, and others seeking to reduce pesticide use in schools; membership; sample/model IPM documents (e.g., contracts, policies); newsletter: Alternatives; reports and fact sheets including *Toxic by Design: Why We Need to Reduce Pesticide Use NOW*, *Healthy Homes for Healthy Kids*, *Weed Wars: Pesticide Use in Washington Schools*, and others including a series designed for professional landscapers; Toxics Hotline (800) 844-SAFE; Web site: http://www.watoxics.org including *Seven Steps to Reducing Pesticide Use in Schools*, and a model least-toxic IPM policy.

WEST VIRGINIA

Government/University/Extension

WEST VIRGINIA DEPARTMENT OF AGRICULTURE, Pesticide Regulatory Programs, Dr. Peggy K. Powell, Certification/Compliance Assistance Supervisor, 1900 Kanawha Blvd East, Charleston, WV 25305-0190, (304) 558-2209, Fax (304) 555-2228, Email: ppowell@ag.state.wv.us

Applicator training and certification; advising to parents, schools and pest management professionals; West Virginia Title 61, Series 12J *Rules for IPM Programs in Schools and Day Care Centers*; bulletins and fact sheets.

WISCONSIN

Government/University/Extension

WISCONSIN DEPARTMENT OF AGRICULTURE, TRADE, AND CONSUMER PROTECTION, Brian Becker, School IPM Specialist, PO Box 8911, Madison, WI 53708-8911, (608) 224-4547, Fax (608) 224-4656, Email: brian.becker@datcp.state.wi.us

Applicator certification; advising and workshops for schools; School Integrated Pest Management Manual for Wisconsin's Schools; Web site: http://ipcm.wisc.edu/programs/school/table.htm including *School IPM Manual*.

UNIVERSITY OF WISCONSIN, Department of Horticulture, Dr. John Stier, Asst. Professor, 1575 Linden Drive, Madison, WI 53706, (608) 262-1624, Fax (608) 262-4743, Email: jstier@facstaff.wisc.edu; Department of Entomology, Karen Delahaut, IPM Outreach Specialist, 1630 Linden Drive, Madison, WI 53706, (608) 262-6429, Fax: (608) 262-3322, Email: kadelaha@facstaff.wisc.edu; Dr. Chris Williamson, Turfgrass Entomologist, 1630 Linden Drive, Madison, WI 53706, (608) 262-4608, Fax (608) 262-3322, Email: rewillie@entomology.wisc.edu; Phil Pellitteri, Insect Diagnostician and Indoor Pest Specialist, 1630 Linden Drive, Madison, WI 53706, (608) 262-6510, Fax (608) 262-3322, Email: pellitte@entomology.wisc.edu

Applicator training (Turf and Landscape category 3.0 and Structural Pest Control category 7.1); advising and workshops for schools and pest management professionals; Web site http://ipcm.wisc.edu/programs/school/; including Wisconsin's *School Integrated Pest Manual* with sample IPM documents.

Compiled by: Thomas A. Green, Ph.D., President, IPM Institute of North America, Inc., 1914 Rowley Ave., Madison, WI 53705 USA (608) 232-1528 (608) 232-1530 (fax), Email: ipminstitute@cs.com, http://www.ipminstitute.org

Appendix II: United States Poison Control Centers

This list was provided to NPTN in part by:
The American Association of Poison Control Centers
3201 New Mexico Ave., NW Suite 310
Washington, DC 20016

Following are the names and addresses of poison centers in the United States, with emergency telephone numbers. This list is current as of February 1996. Centers in **bold type** with an asterisk currently meet certification criteria established by the American Association of Poison Control Centers (AAPCC). Certification by the AAPCC requires that poison centers be staffed by registered nurses, be open 24 hours a day, and serve a large enough area of population.

ALABAMA

Alabama Poison Center, Tuscaloosa *
Area: Tuscaloosa area and nearby counties of Alabama
408-A Paul Bryant Drive
Tuscaloosa, AL 35401
Emergency Phone: (800) 462-0800 (AL only); (205) 345-0600

Regional Poison Control Center *
Area: Alabama state
The Children's Hospital of Alabama
1600 - 7th Ave. South
Birmingham, AL 35233-1711
Emergency Phone: (800) 292-6678 (AL only); (205) 933-4050

ALASKA

Anchorage Poison Control Center
Area: Alaska state
3200 Providence Drive
PO Box 196604
Anchorage, AK 99516-6604
Emergency Phone: (800) 478-3193 (AK only), (907) 261-3193

ARIZONA

Arizona Poison and Drug Information Center *
Area: Arizona state, except Phoenix
Arizona Health Sciences Center; Rm. 1156
1501 N. Campbell Ave.
Tucson, AZ 85724
Emergency Phone: (800) 362-0101 (AZ only); (602) 626-6016

Samaritan Regional Poison Center *
Area: Maricopa county (Phoenix)
Good Samaritan Regional Medical Center
1111 E. McDowell - Ancillary 1
Phoenix, AZ 85006
Emergency Phone: (800) 362-0101 (AZ only); (602) 253-3334

ARKANSAS

Arkansas Poison and Drug Information Center
Area: Arkansas state
University of Arkansas for Medical Sciences
4301 W. Markham Street - Slot 522
Little Rock, Ar 72205
Emergency Phone: (800) 376-4766; (800) 641-3805 (TDD)

Southern Poison Center, Inc.
Area: East Arkansas
847 Monroe Avenue, Suite 230
Memphis, TN 38163
Emergency Phone: (800) 288-9999 (TN only); (901) 528-6048

CALIFORNIA

California Poison Control System- Fresno/Madera *
Area: Fresno/Madera
Valley Children's Hospital
9300 Valley Children's Place
Madera, CA 93638-8762
Emergency Phone: (800) 876-4766 (CA only)

Los Angeles Regional Drug & Poison Information Center
Area: Southern California
LAC & USC Medical Center
1200 N. State Street, Room 1107 A&B
Los Angeles, CA 90033
Emergency Phone: (800) 876-4766 (CA Only)

California Poison Control System- Sacramento *
Area: Northeast California
UC Davis Medical Center-HSF Room1024
2315 Stockton Blvd
Sacramento, CA 95817
Emergency Phone: (800) 876-4766 (CA Only)

California Poison Control System- San Diego *
Area: San Diego County and Imperial County
UCSD Medical Center
200 West Arbor Drive
San Diego, CA 92103-8925
Emergency Phone: (800) 876-4766 (CA Only)

California Poison Control System — San Francisco
Area: Del Norte, Humboldt, Mendocino, Sonoma, Napa, Marin, San Francisco, Contra Costa,
Alameda, and San Mateo counties only
San Francisco General Hospital
1001 Potrero Avenue, Room 1E86
San Francisco, CA 94110
Emergency Phone: (800) 876-4766 (CA Only)

Santa Clara Valley Regional Poison Center
Area: Monterey, San Benito, San Luis Obispo, Santa Clara, and Santa Cruz counties only
Valley Health Center, Suite 310
750 South Bascom Ave.
San Jose, CA 95128
Emergency Phone: (800) 662-9886 (CA only); (408) 885-6000

University of California, Irvine, UC Irvine Regional Poison Control Center
Area: Inyo, Mono, Orange, San Bernardino and Riverside counties only
101 The City Drive, Rte. 78
Irvine, CA 92668
Emergency Phone: (800) 544-4404

COLORADO

Rocky Mountain Poison and Drug Center *
Area: Colorado state
8802 E. 9th Avenue
Denver, CO 80220-6800
Emergency Phone: (800) 332-3073 (CO only outside metro); (303) 629-1123 (Denver metro)

CONNECTICUT

Connecticut Poison Control Center *
Area: Connecticut state
University of Connecticut Health Center
263 Farmington Avenue
Farmington, CT 06030-5365
Emergency Phone: (800) 343-2722 (CT Only); (860) 679-3456

DELAWARE

Poison Information Center
Medical Center of Delaware
Wilmington Hospital
501 West 14th Street
Wilmington, DE 19899
Emergency Phone: (302) 655-3389

The Poison Control Center *
Area: Delaware state
3535 Market Street, Suite 985
Philadelphia, PA 19104-3309
Emergency Phone: (800) 722-7112; (215) 386-2100

DISTRICT OF COLUMBIA

National Capital Poison Center *
Area: Washington, DC and surrounding metro
3201 New Mexico Avenue, NW, Suite 310
Washington, DC 20016
Emergency Numbers: (202) 625-3333; (202) 362-8563 (TTY)

FLORIDA

Florida Poison Information Center — Jacksonville *
Area: Northern and eastern coastal areas of Florida
University Medical Center
University of Florida Health Science Center-Jacksonville
655 West Eighth Street
Jacksonville, FL 32209
Emergency Numbers: (800) 282-3171 (FL only); (904) 549-4480

Florida Poison Information Center — Miami *
Area: Miami and nearby counties of Florida
University of Miami School of Medicine
Department of Pediatrics
PO Box 016960 (R-131)
Miami, FL 33101
Emergency Numbers: (800) 282-3171 (FL only); (305) 585-5253

The Florida Poison Information Center & Toxicology Resource Center *
Area: Tampa area and nearby counties
Tampa General Hospital
Post Office Box 1289
Tampa, FL 33601
Emergency Phone: (800) 282-3171 (Florida); (813) 253-4444 (Tampa)

GEORGIA

Georgia Poison Center *
Area: Georgia state
Hugh Spalding Children's Hospital
Grady Health System
80 Butler Street SE
PO Box 26066
Atlanta, GA 30335-3801
Emergency Phone: (800) 282-5846 (GA only); (404) 616-9000; (404) 616-9237 (TDD)

Interstate Center - Palmetto Poison Control Center
University of South Carolina
College of Pharmacy
Columbia, SC 29208
Emergency Phone: (800) 922-1117 (Central Savannah River area of Georgia only)

HAWAII

Hawaii Poison Center
Kapiolani Medical Center for Women and Children
1319 Punahou Street
Honolulu, HI 96826
Emergency Phone: (808) 941-4411

IDAHO

Rocky Mountain Poison and Drug Center *
8802 E. Ninth Avenue
Denver, CO 80220-6800
Emergency Phone: (800) 860-0620 (ID only)

Idaho Poison Center
Area: Idaho state
3092 Elder Street
Boise, Idaho 83705
Emergency Phone: (208) 334-4570; (800) 632-8000 (ID only)

Interstate Center — Spokane Poison Control Center
St. Luke's Hospital
South 711 Cowley
Spokane, WA 99202
Emergency Phone: (800) 572-5842 (Northern Idaho only)

ILLINOIS

Illinois Poison Center *
222 S. Riverside Plaza, Suite 1900
Chicago, IL 60606
Emergency Phone: (800) 942-5969 (IL Only)

BroMenn Poison Control Center
Area: Normal and nearby counties of Illinois
BroMenn Regional Medical Center
Franklin at Virginia
Normal, IL 61761
Emergency Phone: (309) 454-6666

Chicago & Northeastern Illinois Regional Poison Control Center
Area: Chicago and Northeast counties of Illinois
(Rush Poison Control Center)
Rush-Presbyterian-St. Luke's Medical Center
1653 W. Congress Parkway
Chicago, IL 60612
Emergency Phone: (800) 942-5969 (northeastern IL only); (312) 942-5969

Central and Southern Illinois Regional Poison Resource Center
St. John's Hospital
800 East Carpenter Street
Springfield, IL 62769
Emergency Phone: (800) 252-2022 (IL only); (217) 753-3330

Interstate Center-Cardinal Glennon Children's Hospital Regional Poison Resource Center
1465 South Grand Blvd.
St. Louis, MO 63104
Emergency Phone: (800) 366-8888 (western IL only)

INDIANA

Indiana Poison Center *
Area: Indiana state
Methodist Hospital
Clarian Health Partners
I-65 & 21st Street
Indianapolis, IN 46206-1367
Emergency Phone: (800) 382-9097 (IN only); (317) 929-2323; (317) 929-2336 (TTY)

Interstate Center — Kentucky Regional Poison Center of Kosair Children's Hospital
PO Box 35070
Louisville, KY 40232-5070
Emergency Phone: (502) 589-8222 (southern Indiana only)

IOWA

Iowa Poison Center
St. Luke's Regional Medical Center
Area: west third of Iowa
St. Luke's Regional Medical Center
2720 Stone Park Boulevard
Sioux City, IA 51104
Emergency Phone: (800) 352-2222; (712) 277-2222

Poison Control Center
Department of Pharmaceutical Care
The University of Iowa Hospitals & Clinics, CC101 GH
200 Hawkins Drive
Iowa City, IA 52242
Emergency Phone: (800) 272-6477 (IA Only)

Interstate Center — The Poison Center
Children's Memorial Hospital
8301 Dodge Street
Omaha, NE 68114
Emergency Phone: (800) 955-9119

KANSAS

Mid-America Poison Control Center
Area: Kansas state
University of Kansas Medical Center
3901 Rainbow Boulevard, Room B-400
Kansas City, KS 66160-7231
Emergency Phone: (800) 332-6633 (KS Only); (913) 588-6633; (913) 588-6639 (TDD)

Interstate Center - Cardinal Glennon Children's Hospital
Regional Poison Center
1465 South Grand Blvd.
St. Louis, MO 63104
Emergency Phone: (800) 366-8888 (Topeka, KS Only)

KENTUCKY

Kentucky Regional Poison Center of Kosair Children's Hospital *
Area: Kentucky state
Medical Towers South, Suite 572
234 East Gray Street
Louisville, KY 40202
or
PO Box 35070
Louisville, KY 40232-5070
Emergency Phone: (800) 722-5725 (KY only); (502) 589-8222

LOUISIANA

Louisiana Drug and Poison Information Center *
Area: Louisiana state
University of Louisiana at Monroe
College of Pharmacy
Sugar Hall
Monroe, LA 71209-6430
Emergency Phone: (800) 256-9822 (LA only); (318) 362-5393

MAINE

Maine Poison Control Center
Area: Maine state
Maine Medical Center
22 Bramhall Street
Portland, ME 04102
Emergency Phone: (800) 442-6305 (ME only); (207) 871-2950

MARYLAND

Maryland Poison Center *
Area: Maryland state
University of Maryland at Baltimore
20 North Pine Street
Baltimore, MD 21201
Emergency Phone: (800) 492-2414(MD only); (410) 706-7701; (410) 706-1858 (TDD)

National Capital Poison Center *
Area: D.C. and surrounding metro area
3201 New Mexico Avenue, NW, Suite 310
Washington, DC 20016
Emergency Numbers: (202) 625-3333; (202) 362-8563 (TTY)

MASSACHUSETTS

Massachusetts Poison Control System *
Area: Massachusetts state
300 Longwood Ave.
Boston, MA 02115
Emergency Phone: (800) 682-9211 (MA and RI Only); (617) 232-2120

MICHIGAN

Spectrum Health Regional Poison Center *
Area: Eastern Michigan and peninsula
1840 Wealthy, S.E.
Grand Rapids, MI 49506-2968
Emergency Phone: (800) 764-7661 (MI Only); (800) 356-3232 (TTY)

Regional Poison Control Center *
Area: Southeast and Thumb area of Michigan
Children's Hospital of Michigan
4160 John R. Harper Professional Office Building
Suite 616
Detroit, MI 48201
Emergency Phone: (800) 764-7661 (MI Only); (313) 745-5711

Marquette General Hospital Poison Center
Area: Western Michigan
420 W. Magnetic Street
Marquette, MI 49855
Emergency Phone: (800) 562-9781; (906) 225-3497

Bronson Poison Center
Bronson Methodist Hospital
252 East Lovell Street
Kalamazoo, MI 49007
Emergency Phone: (800) 442-4112 (MI Only); (616) 341-6409

Interstate Center - Poison Information Center of Northwest Ohio
Medical College of Ohio Hospital
3000 Arlington Avenue
Toledo, OH 43614
Emergency Phone: (800) 589-3897 (S.E. Michigan Only)

MINNESOTA

Hennepin Regional Poison Center *
answers calls from general public and medical professionals
Hennepin County Medical Center
701 Park Avenue
Minneapolis, MN 55415
Emergency Phone: (800) POISON 1 (MN and SD Only); (612) 347-3141; Petline: (612)
337-7387; (612) 904-4691 (TTY)

PROSAR International Poison Control Center
answers calls for contracts and Minnesota Worker Right-To-Know
1295 Bandana Blvd., Suite 335
St. Paul, MN 55108
Emergency Phone: (888) 779-7921

North Dakota Poison Information Center
Area: Northwestern Minnesota
MeritCare Medical Center
720 4th Street North
Fargo, ND 58122
Emergency Phone: (800) 732-2200 (ND, MN, SD only); (701) 234-5575

MISSISSIPPI

Mississippi Regional Poison Control Center
Area: Mississippi State
University of Mississippi Medical Center
2500 North State Street
Jackson, MS 39216
Emergency Phone: (601) 354-7660

Southern Poison Center, Inc.
Area: North Mississippi
847 Monroe Avenue, Suite 230
Memphis, TN 38163
Emergency Phone: (800) 288-9999 (TN only); (901) 528-6048

MISSOURI

Cardinal Glennon Children's Hospital Regional Poison Center *
Area: Missouri state
1465 S. Grand Blvd.
St. Louis, MO 63104
Emergency Phone: (800) 366-8888 (MO Only); (314) 772-5200

Children's Mercy Hospital Poison Control Center
Area: Western Missouri, Eastern Kansas
2401 Gillham Road
Kansas City, MO 64108
Emergency Phone: (816) 234-3430

Interstate Center - The Poison Center
8301 Dodge Street
Omaha, NE 68114
Emergency Phone: (800) 955-9119

MONTANA

Rocky Mountain Poison and Drug Center *
Area: Montana state
8802 E. 9th Avenue
Denver, CO 80220-6800
Emergency Phone: (800) 525-5042 (MT Only)

Interstate Center - Spokane Poison Center
St. Luke's Hospital
South 711 Cowley
Spokane, WA 99202
Emergency Phone: (800) 572-5842 (Western MT Only)

NEBRASKA

The Poison Center *
Area: Nebraska state
8301 Dodge Street
Omaha, NE 68114
Emergency Phone: (800) 955-9119 (NE & WY Only); (402) 354-5555 (Omaha)

NEVADA

Rocky Mountain Poison & Drug Center *
8802 E. 9th Avenue
Denver, CO 80220-6800
Emergency Phone: (800) 446-6179 (NV Only)

Oregon Poison Center *
Oregon Health Sciences University
3181 SW Sam Jackson Park Road
Portland, OR 97201
Emergency phone: (503) 498-8968

Washoe Poison Center
Washoe Medical Center
77 Pringle Way
Reno, NV 89520-0109
Emergency Phone: (702) 328-4129

NEW HAMPSHIRE

New Hampshire Poison Information Center
Area: New Hampshire state
Dartmouth-Hitchcock Medical Center
One Medical Center Drive
Lebanon, NH 03756
Emergency Phone: (800) 562-8236 (NH only); (603) 650-8000

NEW JERSEY

New Jersey Poison Information and Education System *
Area: New Jersey state
201 Lyons Avenue
Newark, NJ 07112
Emergency Phone: (800) 764-7661 (NJ Only)

NEW MEXICO

New Mexico Poison and Drug Information Center *
Area: New Mexico state
University of New Mexico
Health Sciences Library, Room 125
Albuquerque, NM 87131-1076
Emergency Phone: (800) 432-6866 (NM only); (505) 272-2222

NEW YORK

Central New York Poison Control Center *
Area: Central New York state
750 East Adams Street
Syracuse, New York 13210
Emergency Phone: (800) 252-5655 (NY Only); (315) 476-4766

Finger Lakes Poison Center *
Area: Finger Lakes region of New York
University of Rochester Medical Center
601 Elmwood Avenue
PO Box 321
Rochester, NY 14642
Emergency Phone: (800) 333-0542; (716) 275-3232; (716) 273-3854 (TTY)

Hudson Valley Regional Poison Center *
Area: Eastern Part of New York, from New York City to Canadian Border
Phelps Memorial Hospital Center
701 North Broadway
Sleepy Hollow, NY 10591
Emergency Phone: (800) 336-6997 (NY Only); (914) 366-3030

Long Island Regional Poison Control Center *
Area: Long Island area of New York
Winthrop University Hospital
259 First Street
Mineola, NY 11501
Emergency Phone: (516) 542-2323; (516) 663-2650; (516) 924-8811 (TDD Suffolk); (516)
747-3232 (TDD Nassau)

New York City Poison Control Center *
Area: New York City
N.Y.C. Department of Health
455 First Avenue
Room 123, Box 81
New York, NY 10016
Emergency Phone: (800) 210-3985; (212) 340-4494; (212) P-O-I-S-O-N-S; (212)V-E-N-E-N-O-S; (212) 689-9014 (TDD)

Western New York Regional Poison Control Center *
Area: Western New York
219 Bryant Street
Buffalo, NY 14222
Emergency Phone: (800)888-7655 (NY Western Regions Only); (716) 878-7654

Interstate Center - Northwest Regional Poison Center
St. Vincent Health Center
232 West 25th Street
Erie, PA 16544
Emergency Phone: (800) 822-3232 (S.W. NY Only)

NORTH CAROLINA

Carolinas Poison Center *
Area: Charlotte and nearby counties of North Carolina
Carolinas Medical Center
5000 Airport Center Parkway, Suite B
PO Box 32861
Charlotte, NC 28232-2861
Emergency Phone: (800) 84-TOXIN (1-800-848-6946); (704) 355-4000

NORTH DAKOTA

North Dakota Poison Information Center
Area: North Dakota state
MeritCare Medical Center
720 4th Street North
Fargo, ND 58122
Emergency Phone: (800) 732-2200 (ND, MN, SD only); (701) 234-5575

OHIO

Akron Regional Poison Center
Area: Northeast Ohio
One Perkins Square
Akron, OH 44398
Emergency Phone: (800) 362-9922; (330) 379-8562

Central Ohio Poison Center *
Area: Central Ohio
700 Children's Drive, Room L032
Columbus, OH 43205
Emergency Phone: (800) 682-7625 (OH Only); (614) 228-1323; (614) 228-2272 (TTY)

Cincinnati Drug & Poison Information Center *
Area: Southwest Ohio
Regional Poison Control System
2368 Victory Parkway, Suite 300
Cincinnati, OH 45206
Emergency Phone: (800) 872-5111 (OH only); (513) 558-5111

Greater Cleveland Poison Control Center
Area: Cleveland & surrounding metro area
11100 Euclid Avenue
Cleveland, OH 44106-6010
Emergency Phone: (888) 231-4455 (OH Only); (216) 231-4455

Medical College of Ohio Poison & Drug Information Center
Area: Northwest Ohio
3000 Arlington Avenue
Toledo, OH 43614
Emergency Phone: (800) 589-3897 (Ohio 419 area code only); (419) 381-3897 (Toledo local only)

OKLAHOMA

Oklahoma Poison Control Center
Area: Oklahoma state
940 NE 13th Street, Room 3512
Oklahoma City, OK 73104
Emergency Phone: (800) 764-7661 (OK Only); (405) 271-5454

OREGON

Oregon Poison Center *
Area: Oregon state
Oregon Health Sciences University
3181 SW Sam Jackson Park Road
Portland, OR 97201
Emergency Phone: (800) 452-7165 (OR only); (503) 494-8968

PENNSYLVANIA

Central Pennsylvania Poison Center *
Area: Central Pennsylvania
Penn State Geisinger Health System
Milton S. Hershey Medical Center
MC H043 PO Box 850
500 University Drive
Hershey, PA 17033-0850
Emergency Phone: (800) 521-6110; (717) 531-6111; (717) 531-8335 (TTY)

The Poison Control Center *
Area: Southeast Pennsylvania & Lehigh Valley
3535 Market Street, Suite 985
Philadelphia, PA 19104-3309
Emergency Phone: (800) 722-7112; (215) 386-2100

Pittsburgh Poison Center *
Area: Western Pennsylvania
3705 Fifth Avenue
Pittsburgh, PA 15213
Emergency Phone: (412) 681-6669

RHODE ISLAND

Regional Center for Poison Control and Prevention Services *
Area: Massachusetts and Rhode Island
300 Longwood Avenue
Boston, MA 02115
Emergency Phone: (617) 232-2120

SOUTH CAROLINA

Palmetto Poison Center
Area: South Carolina state
College of Pharmacy
University of South Carolina
Columbia, SC 29208
Emergency Phone: (800) 922-1117 (SC Only); (803) 777-1117; (803) 765-7359; (706) 724-5050

SOUTH DAKOTA

Hennepin Regional Poison Center *
Hennepin County Medical Center
701 Park Avenue
Minneapolis, MN 55415
Emergency Phone: (800) POISON 1 (MN & SD Only); (612) 347-3141;
(612) 904-4691 (TTY)

McKennan Poison Center
Area: South Dakota state
Box 5045
800 E. 21st Street
Sioux Falls, SD 57117-5045
Emergency Phone: (800) 952-0123 (SD Only); (800) 764-7661; (800) POISON-1

St. Luke's Poison Center
Area: Southeast South Dakota
St. Luke's Regional Medical Center
2720 Stone Park Boulevard
Sioux City, IA 51104
Emergency Phone: (712) 277-2222; (800) 352-2222

TENNESSEE

Middle Tennessee Poison Center *
Area: Middle Tennessee
The Center for Clinical Toxology
501 Oxford House
1161 21st Avenue South
Nashville, TN 37232-4632
Emergency Phone: (800) 288-9999 (TN Only); (615) 936-2034 (Greater Nashville); (615)
936-2047 (TDD)

Southern Poison Center
Area: Western and Eastern Tennessee
847 Monroe Avenue, Suite 104
Memphis, TN 38163
Emergency Phone: (800) 288-9999 (TN only); (901) 528-6048

TEXAS

Central Texas Poison Center *
Scott and White Memorial Hospital
2401 South 31st Street
Temple, TX 76508
Emergency Phone: (800) 764-7661 (POISON1); (254) 724-7401

North Texas Poison Center *
Texas Poison Center Network
Parkland Health & Hospital System
5201 Harry Hines Blvd.
PO Box 35926
Dallas, TX 75235
Emergency Phone: (800) 764-7661 (TX Only)

South Texas Poison Center *
The University of Texas Health Science Center
Forensic Science Building, Room 146
Department of Surgery
7703 Floyd Curl Drive
San Antonio, TX 78284-7849
Emergency Phone: (800) 764-7661 (TX Only)

Southeast Texas Poison Control *
The University of Texas Medical Branch
3.112 Trauma Building
Galveston, TX 77555-1175
Emergency Phone: (800) 764-7661 (TX Only)

West Texas Regional Poison Center *
Thomason Hospital
4815 Alameda Avenue
El Paso, TX 79905
Emergency Phone: (800) 764-7661 (TX Only)

Texas Panhandle Poison Center
1501 S. Coulter
Amarillo, TX 79175
Emergency Phone: (800) 764-7661 (TX Only)

UTAH

Utah Poison Control Center *
Area: Utah state
410 Chipeta Way, Suite 230
Salt Lake City, UT 84108
Emergency Phone: (800) 456-7707 (UT only); (801) 581-2151

VERMONT

Vermont Poison Center
Area: Vermont state
Fletcher Allen Health Care
111 Colchester Avenue
Burlington, VT 05401
Emergency Phone: (877) 658-3456 (Toll free); (802) 658-3456

VIRGINIA

Blue Ridge Poison Center *
Area: Central & Western Virginia
University of Virginia Health System
Box 437
Charlottesville, VA 22908
or
PO Box 800774
Charlottesville, VA 22908-0347
Emergency Phone: (800) 451-1428 (VA Only); (804) 924-5543

National Capital Poison Center *
Area: Northern Virginia
3201 New Mexico Avenue, NW, Suite 310
Washington, DC 20016
Emergency Numbers: (202) 625-3333; (202) 362-8563 (TTY)

Virginia Poison Center *
Area: Eastern and Central Virginia
Medical College of Virginia Hospitals
Virginia Commonwealth University
PO Box 980522
Richmond, VA 23298-0522
Emergency Phone: (800) 552-6337 (VA Only); (804) 828-9123

WASHINGTON

Washington Poison Center *
Area: Washington state
155 NE 100th Street, Suite 400
Seattle, WA 98125-8012
Emergency Phone: (800) 732-6985 (WA Only); (206) 526-2121; (206) 517-2394 (TDD); (800)
572-0638 (TDD WA Only)

Spokane Poison Center
St. Luke's Hospital
South 711 Cowley
Spokane, WA 99202
Emergency Phone: (800) 572-5842 (Eastern WA, Northern ID, Western MT and NW Oregon Only)

Mary Bridge Poison Center
Mary Bridge Children's Hospital
317 South K Street
PO Box 5299
Tacoma, WA 98405-0987
Emergency Phone: (800) 542-6319 (WA Only); (206) 594-1414

WEST VIRGINIA

West Virginia Poison Center *
Area: West Virginia state
3110 MacCorkle Ave. SE
Charleston, WV 25304
Emergency Phone: (800) 642-3625 (WV only)

WISCONSIN

Children's Hospital of Wisconsin Poison Center
PO Box 1997
Milwaukee, WI 53201
Emergency Phone: (800) 815-8855 (WI only); (414) 266-2222

University of Wisconsin Hospital & Clinics Poison Control Center
600 Highland Avenue, F6/133
Madison, WI 53792
Emergency Phone: (800) 815-8855 (WI Only); (608) 262-3702

WYOMING

The Poison Center *
Area: Wyoming state
Children's Center
8301 Dodge St.
Omaha, NE 68114
Emergency Phone: (800) 955-9119 (NE & WY); (402) 354-5555

* Certification by the American Association of Poison Control Centers requires that poison centers be staffed by registered nurses, be open 24 hours a day, and serve a large enough area of population.

Appendix III: Educational Presentations – Video Based

The ABCs of IPM

A Video-based Pest Management
Training Program for Schools

The ABCs of IPM video set is a comprehensive training program for school employees. It has been carefully developed and reviewed by Texas A & M University experts in the fields of entomology and pest management. While emphasizing the "how-to's" of pest control these videos also help sell the Integrated Pest Management (IPM) concept to school faculty, staff and administrators.

The complete package includes five videotape modules that provide instruction, content, illustrations, and examples focused on pertinent IPM topics. Each module consists of a 15 minute videotape plus a User's Guide. The Guides supplement the tapes and include pre- and post-tests, note-taking outlines, questions for discussion and additional resources. Module overviews and learning objectives help orient viewers and training facilitators to the purpose and intent of each video.

The five modules include:

1. **Introduction.** Defines IPM and explains the process of putting an IPM program to work in schools.
2. **Structural Pest Control.** General pest management recommendations for schools. "How-to's" of applying IPM to the most common pest problems found in non-food handling areas of schools.
3. **Food Handling Areas.** Pest control in food handling areas is explained using a four-step approach.
4. **Bids and Contracts.** Overviews steps for securing the services of a commercial IPM provider.
5. **The Administrative Challenge.** Explains the importance of a clear IPM policy, the benefits of an IPM plan, and the crucial role of an IPM Coordinator.

Additional modules coming in 1998 include **IPM for Landscapes** and **Pesticide Selection and Safety**. Purchasers of the training package will be notified when additional modules become available.

To order, complete this form and send with prepayment to:
Texas Agricultural Extension Service
Distribution and Supply
PO Box 1209
Bryan, TX 77806-1209

Name _____
Address _____
City _____
State _____ _____ Zip _____
Phone: (_____) _____

Price: individual modules — $35; complete five-module set — $150. (Buy the complete set and save $25!)

Quantity _____
Title _____
Unit Price _____

Total Price:
Merchandise Total _____
Shipping & Handling _____
Total _____

Shipping fees (to U.S. addresses)

Single Tape (for example: Introduction, Module 1)	$4
Complete Set (Modules 1-5)	$5
Additional Single Tapes	add $1
Additional Complete Sets	add $2

Prepayment must be made in cash, check or money order payable to the "Texas Agricultural Extension Service." No credit card orders accepted.

Please allow two weeks for delivery. Discounts may be available for larger orders. For more information, call (972) 952-9204.

Appendix IV: Related World Wide Web Sites, By Subject

Integrated Pest Management Resources

Alabama IPM in Schools:
http://www.aces.edu/schoolipm/
Buggy Software:
http://www.ifas.ufl.edu/~ent1/software/fasulo.htm
Department of Defense Armed Forces Pest Management Board:
http://www.afpmb.org/
Entomology Index of Internet Resources — Iowa State University:
http://www.ent.iastate.edu/list/
IPM in New York State Communities:
http://www.nysaes.cornell.edu:80/ipmnet/ny/urban/
IPM Alabama — Auburn University:
http://www.aces.edu/department/ipm/
IPM in Schools — Pennsylvania State University:
http://paipm.cas.psu.edu/schools/schoolIPM.html
IPM Institute of North America:
http://www.ipminstitute.org/
Minnesota Helps — Community, Urban and Schools IPM:
http://www.crc.agri.umn.edu/~mnhelps/ipmhome.htm
The Pennsylvania IPM Program:
http://www.cas.psu.edu/docs/casdept/IPM/index.html
Pesticide Education Resources — University of Nebraska-Lincoln:
http://ianrwww.unl.edu/ianr/pat/ephome.htm
Urban Integrated Pest Management — North Carolina State University:
http://ipmwww.ncsu.edu/urban/cropsci/toc.html
Urban Integrated Pest Management — University of Florida:
http://hammock.ifas.ufl.edu/en/en.html
Urban Integrated Pest Management — University of Illinois:
http://ipm.uiuc.edu/urban/index.html
Wisconsin's School Integrated Pest Management Manual:
http://ipcm.wisc.edu/programs/school/default.htm

Land Grant University Entomological Resources

Alabama — Auburn University Department of Entomology:
http://www.ag.auburn.edu/dept/ent/ent.html
Alaska — University of Alaska:
http://www.alaska.edu/
Arizona — University of Arizona Department of Entomology:
http://ag.arizona.edu/ENTO/entohome.html
Arkansas — University of Arkansas Department of Entomology:
http://www.uark.edu/depts/entomolo/
California — University of California,Davis, Department of Entomology:
http://entomology.ucdavis.edu/
California — University of California, Riverside, Department of Entomology:
http://www.entomology.ucr.edu/
Colorado — Colorado State University Department of Entomology:
http://www.colostate.edu/Depts/Entomology/ent.html
Connecticut — University of Connecticut:
http://www.uconn.edu/
Delaware — Delaware State University:
http://www.dsc.edu/
Florida — University of Florida Department of Entomology:
http://www.ifas.ufl.edu/~entweb/entomolo.htm
Georgia — University of Georgia Department of Entomology:
http://entomology.ent.uga.edu/
District of Columbia — University of the District of Columbia:
http://www.udc.edu/
Guam — University of Guam College of Agriculture and Life Sciences:
http://uog2.uog.edu/cals/
Hawaii — University of Hawaii:
http://www.hawaii.edu/

Idaho — University of Idaho Department of Plant, Soil and Entomological Sciences:
http://www.uidaho.edu:80/pses/
Illinois — University of Illinois Department of Entomology:
http://www.life.uiuc.edu/Entomology/home.html
Indiana — Purdue University Department of Entomology:
http://www.entm.purdue.edu/
Iowa — Iowa State University Department of Entomology:
http://www.ent.iastate.edu/
Kansas — Kansas State University Department of Entomology:
http://www.oznet.ksu.edu/entomology/
Kentucky — University of Kentucky Department of Entomology:
http://www.uky.edu/Agriculture/Entomology/enthp.htm
Louisiana — Louisiana State University Department of Entomology:
http://www.lsu.edu/guests/wwwent2/
Maine — University of Maine Pest Management Office:
http://www.umext.maine.edu/topics/pest.htm
Maryland — University of Maryland Department of Entomology:
http://www.entomology.umd.edu
Massachusetts — University of Massachusetts Department of Entomology:
http://www.umass.edu/ent/index.html
Michigan — Michigan State University Department of Entomology:
http://www.ent.msu.edu/
Minnesota — University of Minnesota Department of Entomology:
http://www.ent.agri.umn.edu/
Mississippi — Mississippi State University Department of Entomology & Plant Pathology:
http://www.msstate.edu/Entomology/ENTPLP.html
Missouri — University of Missouri Department of Entomology:
http://forent.insecta.missouri.edu/
Montana — Montana State University Department of Entomology:
http://scarab.msu.montana.edu/
Nebraska — University of Nebraska Department of Entomology:
http://ianrwww.unl.edu/ianr/entomol/entdept.htm
Nevada — University of Nevada:
http://www.unlv.edu/
New Jersey — Rutgers State University Department of Entomology:
http://www-rci.rutgers.edu/~insects/
New Mexico — New Mexico State University:
http://www.nmsu.edu/
New York — Cornell University:
http://www.cornell.edu/
North Carolina — North Carolina State University Extension Entomology:
http://www.ces.ncsu.edu/depts/ent/extent.htm
North Dakota — North Dakota State University Department of Entomology:
http://www.ndsu.nodak.edu/entomology/
Ohio — Ohio State University Department of Entomology:
http://iris.biosci.ohio-state.edu/osuent/home.html
Oklahoma — Oklahoma State University Department of Entomology and Plant Pathology:
http://www.ento.okstate.edu/
Oregon — Oregon State University:
http://www.orst.edu/
Pennsylvania — Pennsylvania State University Department of Entomology:
http://www.ento.psu.edu/
Puerto Rico — University of Puerto Rico:
http://www.upr.clu.edu/
Rhode Island — University of Rhode Island Cooperative Extension Service:
http://www.edc.uri.edu/
South Carolina — Clemson University Department of Entomology:
http://entweb.clemson.edu/
South Dakota — University of South Dakota:
http://www.usd.edu/
Tennessee — University of Tennessee Entomology & Plant Pathology Department:
http://funnelweb.utcc.utk.edu/~epp/
Texas — Texas A&M University - Department of Entomology:
http://entowww.tamu.edu/
Utah — Utah State University - Department of Biology:
http://www.biology.usu.edu/
Vermont — University of Vermont Cooperative Extension Service:
http://ctr.uvm.edu/ext/
Virginia — Virginia Polytechnic Institute and State University Department of Entomology:
http://www.ento.vt.edu/
Washington — Washington State University Department of Entomology:
http://entomology.wsu.edu/
West Virginia — West Virginia University College of Agriculture, Forestry and Consumer Sciences:
http://www.caf.wvu.edu/academics.html
Wisconsin — University of Wisconsin Department of Entomology:
http://www.entomology.wisc.edu/
Wyoming — University of Wyoming:
http://www.uwyo.edu

Pest Control and Identification

Buggy Software — University of Florida:
http://www.ifas.ufl.edu/~ent1/software/fasulo.htm
Bureau of Entomology and Pest Control, Florida Department of Agriculture and Consumer Services:
http://doacs.state.fl.us/~aes-ent/
Entomology Index of Internet Resources — Iowa State University:
http://www.ent.iastate.edu/list/
Head Lice Information — Harvard School of Public Health:
http://www.hsph.harvard.edu/headlice.html
Featured Creatures — University of Florida:
http://www.ifas.ufl.edu/~insect/
Florida Agricultural Information Retrieval System:
http://hammock.ifas.ufl.edu/
Florida Medical Entomology Lab:
http://WWW.IFAS.UFL.EDU/~VEROWEB/
Georgia Pest Control Handbook:
http://www.ces.uga.edu/Agriculture/entomology/96pch.html
Imported Fire Ant Survey Site:
http://ceris.purdue.edu/napis/pests/ifa/index.html
John A. Mulrennan, Sr. Public Health Entomology Research and Education Center:
http://pherec.org/
Maryland Department of Agriculture — Mosquito Control Section:
http://www.mda.state.md.us/geninfo/genera9.htm
Mosquito Genomics WWW Server:
http://klab.agsci.colostate.edu/index.html
National Food Safety Database:
http://www.foodsafety.ufl.edu/index.html
National Pest Management Association's Homeowner Discussion Forum:
http://www.pestworld.org/cgi-bin/ubbcgi/Ultimate.cgi
PestWeb — an industry portal:
http://www.pestweb.com/
Structural Pest Control Division — North Carolina Department of Agriculture:
http://www.agr.state.nc.us/str-pest/
Texas Structural Pest Control Board:
http://www.state.tx.us/agency/472.html
Structural Pest Control Publications — North Carolina Department of Agriculture and Consumer Services:
http://www.agr.state.nc.us/str-pest/pubs/index.htm
Urban Integrated Pest Management — University of Florida:
http://hammock.ifas.ufl.edu/en/en.html

Pesticide Resources

Alaska Pesticide Control Regulations:
http://www.state.ak.us/local/akpages/ENV.CONSERV/title18/aac90ndx.htm
American Association of Pesticide Safety Educators:
http://aapse.ext.vt.edu/
EXTONET — Extension Toxicology Network:
http://ace.ace.orst.edu/info/extoxnet/
EXTONET — Unique Sensitivity of Children:
http://ace.orst.edu/info/extoxnet/faqs/senspop/child.htm
Hawaii Pesticide Information Retrieval System:
http://pestworld.stjohn.hawaii.edu/cfdocs/test/hpirs.htm
Indiana Pesticide Regulations:
http://www.law.indiana.edu/
Indiana Pesticide Use and Application Regulations:
http://www.law.indiana.edu/
Maine Board of Pesticide Control:
http://www.state.me.us/agriculture/pesticides/
Material Safety Data Sheets — Cornell University:
http://msds.pdc.cornell.edu/msdssrch.asp
Material Safety Data Sheets — How To Find Them:
http://www.ilpi.com/msds/index.html
National Pesticide Telecommunications Network — Oregon State University:
http://ace.ace.orst.edu/info/nptn/
Pennsylvania Pesticide Urban Initiative:
http://urbanpested.cas.psu.edu/index.html
Pesticide Education Resources — University of Nebraska-Lincoln:
http://ianrwww.unl.edu/ianr/pat/ephome.htm
Pesticide Information Program — Clemson University:
http://entweb.clemson.edu/pesticid/
Responsible Industry for a Sound Environment:
http://www.pestfacts.org/
South Carolina Regulatory and Public Service Programs:
http://drpsp.clemson.edu/
U.S. Environmental Protection Agency (EPA):
http://www.epa.gov
U.S. Environmental Protection Agency (EPA) — Integrated Pest Management in Schools:
http://www.epa.gov/pesticides/ipm/
U.S. Environmental Protection Agency (EPA) — Office of Prevention, Pesticides, and Toxic Substances:
http://www.epa.gov/opptsfrs/home/opptsim.htm
U.S. Environmental Protection Agency (EPA) — Office of Pesticide Programs:
http://www.epa.gov/pesticides/
U.S. Environmental Protection Agency (EPA) — Pesticide Safety Programs:
http://www.epa.gov/pesticides/safety/

U.S. Environmental Protection Agency (EPA) — Spray Drift of Pesticides:
http://www.epa.gov/pesticides/citizens/spraydrift.htm
Virginia Department of Agriculture and Consumer Services — Office of Pesticide Services:
http://www.vdacs.state.va.us/index.html
Washington State Pesticide Page:
http://pep.wsu.edu/
West Virginia Pesticide Regulatory Programs:
http://www.state.wv.us/agriculture/Departments_Descriptions/Plant_Industries_Division/plant_industries_division.html
Wisconsin Pesticide Use Reporting and Reduction Project:
http://www.wsn.org/pesticides/

State Departments of Education

Alabama Department of Education:
http://www.alsde.edu/
Alaska Department of Education:
http://www.educ.state.ak.us/
Arizona Department of Education:
http://www.ade.state.az.us/
Arkansas Department of Education:
http://arkedu.state.ar.us/
California Department of Education:
http://goldmine.cde.ca.gov/
Colorado Department of Education:
http://www.cde.state.co.us/
Connecticut Department of Education:
http://www.state.ct.us/sde/
Delaware Department of Education:
http://www.doe.state.de.us
District of Columbia Public Schools:
http://www.k12.dc.us/
Florida Department of Education:
http://www.firn.edu/doe/doehome.htm
Georgia Department of Education:
http://www.doe.k12.ga.us/
Hawaii Department of Education:
http://www.k12.hi.us/
Idaho Department of Education:
http://www.sde.state.id.us/Dept/
Illinois Board of Education:
http://www.isbe.state.il.us/
Indiana Department of Education:
http://ideanet.doe.state.in.us/
Iowa Department of Education:
http://www.state.ia.us/educate/depteduc/
Kansas Department of Education:
http://www.ksbe.state.ks.us/Welcometext.html
Kentucky Department of Education:
http://www.kde.state.ky.us/
Louisiana Department of Education:
http://www.doe.state.la.us/
Maine Department of Education:
http://janus.state.me.us/education/homepage.htm
Maryland Department of Education:
http://www.msde.state.md.us/
Massachusetts Department of Education:
http://www.doe.mass.edu/
Michigan Department of Education:
http://www.mde.state.mi.us/
Minnesota Department of Children, Families and Learning:
http://www.entomology.umn.edu/
Mississippi Department of Education:
http://www.mdek12.state.ms.us/
Missouri Department of Elementary and Secondary Education:
http://www.dese.state.mo.us/
Montana Office of Public Instruction:
http://www.metnet.mt.us/
Nebraska Department of Education:
http://www.nde.state.ne.us/
Nevada Department of Education:
http://www.nsn.k12.nv.us/nvdoe/
New Hampshire Department of Education:
http://www.state.nh.us/doe/
New Jersey Department of Education:
http://www.state.nj.us/education/
New Mexico Department of Education:
http://sde.state.nm.us/index.html
New York Department of Education:
http://www.nysed.gov/
North Carolina Public Schools:
http://www.dpi.state.nc.us/
North Dakota Department of Public Instruction:
http://www.dpi.state.nd.us/
Ohio Department of Education:
http://www.ode.state.oh.us/
Oklahoma Department of Education:
http://www.sde.state.ok.us/
Oregon Department of Education:
http://www.ode.state.or.us/
Pennsylvania Department of Education:
http://www.pde.psu.edu
Rhode Island Department of Education:
http://ridoe.net/
South Carolina Department of Education:
http://www.state.sc.us/sde/
South Dakota Department of Education and Cultural Affairs:
http://www.state.sd.us/state/executive/deca/deca.htm
Tennessee Department of Education:
http://eppserver.ag.utk.edu/default.html
Texas Education Agency:
http://www.tea.state.tx.us/

Utah Office of Education:
http://www.usoe.k12.ut.us/
Vermont Department of Education:
http://www.state.vt.us/educ/
Virginia Department of Education:
http://www.pen.k12.va.us/go/VDOE/
Washington Superintendent of Public Instruction:
http://www.k12.wa.us/
West Virginia Department of Education:
http://wvde.state.wv.us/
Wisconsin Department of Public Instruction:
http://www.dpi.state.wi.us/
Wyoming Department of Education:
http://www.k12.wy.us/wdehome.html

State Departments of Health

Alabama Department of Public Health:
http://www.alapubhealth.org/
Alaska Department of Public Health:
http://www.hss.state.ak.us/dph/dph_home.htm
Arizona Department of Health Services:
http://www.hs.state.az.us/
Arkansas Department of Health:
http://health.state.ar.us/
California Department of Health Services:
http://www.dhs.cahwnet.gov/
Colorado Department of Public Health:
http://www.cdphe.state.co.us/cdphehom.asp
Connecticut Department of Public Health:
http://www.state.ct.us/dph/
Delaware Health and Social Services:
http://www.state.de.us/dhss/irm/dhss.htm
Florida Department of Health:
http://www.doh.state.fl.us/
Florida Department of Health — Statewide Public Health Information Network:
http://www.doh.state.fl.us/
Georgia Division of Public Health:
http://www.ph.dhr.state.ga.us/
Hawaii Department of Health:
http://www.hawaii.gov/health/
Idaho Department of Health and Welfare:
http://www2.state.id.us/dhw/hwgd_www/home.html
Illinois Department of Public Health:
http://www.idph.state.il.us/
Indiana State Department of Health:
http://www.state.in.us/doh/index.html
Iowa Department of Public Health:
http://idph.state.ia.us/
Kansas Department of Health and Environment:
http://www.ink.org/public/kdhe/
Kentucky Health Services Cabinet:
http://cfc-chs.chr.state.ky.us/
Louisiana Department of Health and Hospitals:
http://www.dhh.state.la.us/
Maine Bureau of Health:
http://www.state.me.us/dhs/boh/index2.htm
Maryland Department of Health and Mental Hygiene:
http://www.dhmh.state.md.us/
Massachusetts Department of Public Health:
http://www.state.ma.us/dph/
Michigan Department of Community Health:
http://www.mdch.state.mi.us/
Minnesota Department of Health:
http://www.health.state.mn.us/
Mississippi Department of Health:
http://www.msdh.state.ms.us/msdhhome.htm
Missouri Department of Health:
http://www.health.state.mo.us/
Montana Department of Public Health and Human Services:
http://www.dphhs.state.mt.us/
Nebraska Health and Human Services System:
http://www.hhs.state.ne.us/
Nevada State Health Division:
http://www.state.nv.us/health/
New Hampshire Department of Health and Human Services:
http://www.dhhs.state.nh.us/
New Jersey Department of Health & Senior Services:
http://www.state.nj.us/health/
New Mexico Department of Health:
http://www.health.state.nm.us/website.nsf/frames?ReadForm
New York Department of Public Health:
http://www.health.state.ny.us/
North Carolina Department of Health and Human Services:
http://www.dhr.state.nc.us/DHR/
North Dakota Department of Health:
http://www.ehs.health.state.nd.us/ndhd/
Ohio Department of Health:
http://www.odh.state.oh.us/
Oklahoma Department of Health:
http://www.health.state.ok.us/
Oregon Department of Human Resources — Health Division:
http://www.ohd.hr.state.or.us/
Pennsylvania Department of Health:
http://www.health.state.pa.us/
Rhode Island Department of Health:
http://www.health.state.ri.us/
South Carolina Department of Health and Human Services:
http://www.dhhs.state.sc.us/
South Dakota Department of Health:
http://www.state.sd.us/state/executive/doh/
Tennessee Department of Health:
http://www.state.tn.us/health/

Texas Department of Health:
http://www.tdh.texas.gov/
Utah Department of Health:
http://hlunix.ex.state.ut.us/
Vermont Department of Health:
http://www.state.vt.us/health/
Virginia Department of Health:
http://www.vdh.state.va.us/
Washington State Department of Health:
http://www.doh.wa.gov/
West Virginia Department of Health and Human Resources:
http://www.wvdhhr.org/bph/index.htm
Wisconsin Department of Health & Family Services:
http://www.dhfs.state.wi.us/
Wyoming Department of Health:
http://wdhfs.state.wy.us/WDH/default.htm

Health Information

California Environmental Protection Agency:
http://www.calepa.ca.gov/
California Environmental Protection Agency — Chemical Ingredients Database:
http://www.cdpr.ca.gov/docs/monster/monster.htm
California Environmental Protection Agency — Department of Pesticide Regulation:
http://www.cdpr.ca.gov/
California Environmental Protection Agency — Office of Environmental Health Hazard Assessment:
http://www.oehha.org/
California Environmental Protection Agency — Product/Label Database:
http://www.cdpr.ca.gov/docs/label/labelque.htm
California Environmental Protection Agency — Search the Pesticide Registration Numbers Book:
http://www.cdpr.ca.gov/cgi-bin/wais.pl
Center for Disease Control (CDC) and Prevention:
http://www.cdc.gov/
Cockroach Allergens — New England Journal of Medicine:
http://www.nejm.org/content/1997/0336/0019/1356.asp
Florida Department of Environmental Protection:
http://www.dep.state.fl.us/
Illinois Environmental Protection Agency:
http://www.epa.state.il.us/
Kentucky Department of Environmental Protection:
http://www.nr.state.ky.us/nrhome.htm
National Pediculosis Association:
http://www.headlice.org/
Maine Department of Environmental Protection:
http://www.state.me.us/dep/mdephome.htm
Massachusetts Department of Environmental Protection:
http://www.state.ma.us/dep/dephome.htm
New Jersey Department of Environmental Protection:
http://www.state.nj.us/dep/index.html
Ohio Environmental Protection Agency:
http://www.epa.state.oh.us/
Pennsylvania Department of Environmental Protection:
http://www.dep.state.pa.us/
South Carolina Department of Health and Environmental Control:
http://www.state.sc.us/dhec/

Pest Control Associations

American Association of Pesticide Safety Educators:
http://aapse.ext.vt.edu
American Mosquito Control Association:
http://www.mosquito.org
Certified Operators of Southwest Florida:
http://www.certifiedbug.com/
Certified Pest Control Operators Association of Florida, Inc.:
http://www.pestweb.com/cpco/
Certified Pest Control Operators of Georgia:
http://www.cpcoofga.com/
Delaware Pest Control Association:
http://www.opca.net/
Florida Mosquito Control Association:
http://www.floridamosquito.org/
Florida Pest Control Association:
http://www.fpca.org/
Georgia Pest Control Association:
http://www.pestweb.com/gpca/
Kansas Pest Control Association:
http://www.cjnetworks.com/%7Ekspesco
Louisiana Pest Control Association:
http://www.lpca.org/
Michigan Mosquito Control Association:
http://www.mimosq.org/
Mosquito and Vector Control Association of California:
http://mosqnet.ucdavis.edu/
National Pest Management Association:
http://www.pestworld.org/
New England Pest Control Association:
http://www.nepca.org
New Jersey Mosquito Control Association:
http://www-rci.rutgers.edu/~insects/njmca.htm
New Jersey Pest Control Association:
http://www-rci.rutgers.edu/~insects/njpca.htm
North Carolina Mosquito & Vector Control Association:
http://ipmwww.ncsu.edu/NCMVCA/
Northeastern Mosquito Control Association:
http://www.nmca.org/
Northwest Mosquito & Vector Control Association:
HTTP://WWW.NWMVCA.ORG/
Oregon Pest Control Association:
http://www.opca.org

Pest Control Operators of California:
http://www.pcoc.org/
Professional Association of Pest Control Operators — Texas:
http://www.satxbiz.com/papso/
Professional Lawn Care Association of America:
http://www.plcaa.org
Texas Mosquito Control Association:
http://www.texasmosquito.org/
Texas Pest Control Association:
http://www.texaspest.org
Utah Mosquito Abatement Association:
http://www.umaa.org/
Washington State Pest Control Association:
http://www.wspca.org

School-related Sites

National PTA Health and Safety Programs:
http://www.pta.org/programs/hlthwelf.htm
Nationwide Directory for IPM in Schools:
http://www.epa.gov/reg5foia/pest/matilla/ipm_dir.html

Fun WWW Sites

The Adventures of Banph — Ant Knight:
http://www.banph.com/
Entomological Society of America — Kids' Page:
http://www.entsoc.org/educate.htm
EPA Student and Teacher Sites:
http://www.epa.gov/pesticides/kids.htm
Florida 4-H Bug Club — in English and Spanish:
http://bugweb.entnem.ufl.edu/bugclub/
The Insect Question?:
http://www.ent.iastate.edu/mailinglist/bugnet/question.html
Katerpillars and Mystery Bugs — University of Kentucky:
http://www.uky.edu/Agriculture/Entomology/ythfacts/entyouth.htm
Orkin Insect Zoo:
http://www.mnh.si.edu/museum/VirtualTour/Tour/Second/InsectZoo/
Wendell's Yucky Bug World:
http://www.yucky.com/