SECTION 5

Selecting Least-hazardous Pest Control Practices

5.1 Criteria for Selecting Least Hazardous Pest Control Practices

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

- Least hazardous to human health.
- Least disruptive of natural controls in landscape situations.
- Least toxic to non-target organisms.
- Most likely to be permanent and prevent recurrence of the pest problem.
- Easiest to carry out safely and effectively.
- Most cost-effective in the short and long term.
- Appropriate to the weather, soils, water, and the energy resources of the site and the maintenance system.

5.1.1 Least Hazardous to Human Health

It is particularly important around children to take the health hazards of various strategies into consideration. Hazard refers to the extent and type of negative effects of the strategy in question.

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. Cockroach baits manage cockroach populations much more effectively than aerosol sprays.

5.1.2 Least Disruptive of Natural Controls

In landscape settings, try to avoid killing off the natural enemies that aid in controlling pest organisms. Unfortunately, and for a number of reasons, natural enemies are often 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. For help in determining this, see the resources listed in **Appendix G**.

5.1.3 Least Toxic to Non-Target Organisms

The more selective the control, the less harm there will be to non-target organisms in the environment.

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 soil 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.*

5.1.4 Most Likely to Be Permanent and Prevent Recurrence of the Pest Problem

Finding treatments that meet this specification 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, mice, and other pests.
- Cleaning gutters and directing their flow away from the building to prevent moisture damage.
- Installing a sand barrier around the inside edge of a foundation to prevent termites from crawling up into the structure.
- Applying an insect growth regulator to prevent fleas from developing in an area with chronic problems.

5.1.5 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, mask, and goggles. In hot weather, people are often 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 hazardous materials.

5.1.6 Most Cost-Effective in the 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 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. IPM frequently costs less than, or about the same, as conventional chemically based programs, once the program is in place (see section 2.9.2 for a discussion on "Assessing Cost-Effectiveness").

In addition, parental and community concern about the use of conventional pesticides may make *any* use of pesticides 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, prepare policy statements and other pest management duties. These costs should also be factored into the pest control equation.

5.1.7 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. UCCE Master Gardeners are available in many counties for local planting recommendations. Look in the Yellow Pages under Government or go to http://ucanr.org/ to find the local County Cooperative Extension Office.

5.2 Timing Treatments

Treatments must be timed to coincide with a susceptible stage of the pest and, if 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 ground squirrels using traps or bait stations, it is usually best to focus control in mid-May through mid-July, as native vegetation and food sources are drying. In some areas, ground squirrels aestivate (summer sleep) during the hottest summer months (mid-July through August). This is a poor time to attempt control. Fall is also a good time for baiting as ground squirrel foraging activity peaks in September and October prior to hibernation.

5.2.1 Spot Treatments

Treatments, whether pesticides or non-hazardous 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 hazardous materials can be kept to a minimum.

5.3 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 ingenious pest managers develop new solutions to old problems every day.

5.3.1 Education

Education is a cost-effective pest management strategy. Information that will help change people's behaviors—particularly how they store food and dispose of garbage—plays an invaluable part in managing pests like cockroaches, ants, flies, yellow jackets, 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 hazardous treatments for innocuous organisms. Teaching children about IPM will have a long-term effect on the direction of pest management as these students grow up to become consumers, educators, policy makers, and researchers. See **Appendix O** for training and licensing opportunities and **Appendix F** for IPM-related curricula and resources for the classroom.

5.3.2 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 eliminate pest habitat. For example, buildings designed without exterior horizontal ledges will reduce pigeon problems. Inside, heavy-duty, stainless steel wire shelving mounted on rolling casters helps reduce roach habitat and facilitates cleanup of spilled food. For more information, a guide to pest management through prevention, "Pest Prevention: Maintenance Practices and Facility Design," can be located on the DPR School IPM Web site at www.cdpr.ca.gov/schoolipm.

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. Fixing any leaks has the added benefit of saving 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.

5.3.3 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 or failing to give them proper care. Healthy plants are likely to have fewer insect, mite, and disease problems. It is very important that the person responsible for the school landscaping knows (or is willing to learn) about the care required by the particular plants at the school.

Designing/Redesigning of Landscape Plantings

- Choose the right plant for the right spot and choose 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 and zinnias.
- Diversify landscape plantings. A pest can devastate the entire area when large areas are planted with a single species of plant.

5.3.4 Physical Controls

Vacuuming

A heavy-duty vacuum with a special filter fine enough to screen out insect effluvia (one that filters out particles as small as 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 and can capture adult fleas, their eggs, and pupae. A vacuum used outside can be used to collect spiders, box elder bugs, and cluster flies.

Trapping

Traps play an important role in least-hazardous 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.

Barriers

Barriers can be used to exclude pests from buildings or other areas. Barriers can be as simple as a window screen to keep out flying and crawling insects or sticky barriers to exclude ants from trees. Barriers that are more complicated include electric fences to keep out deer and other vertebrate wildlife and L-shaped footings in foundations to exclude rodents.

Heat and Cold

Commercial heat treatments can be used to kill wood-destroying pests such as termites. A propane weed torch can be used to kill weeds coming up through cracks in pavement. Freezing can kill trapped insects such as yellowjackets before emptying traps, kill clothes moths, and kill the eggs and larvae of beetles and moths that destroy grain.

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.

5.3.5 Biological Controls

Biological control uses a pest's natural enemies to attack and control the pest. We use the word "control" rather than "eliminate" because biological control usually implies that a few pests must remain to feed the natural enemies. The exception to this is a separate category of biological control called microbial control, which includes the use of plant and insect pathogens. Microbial controls are generally used like conventional chemical pesticides to kill as many pests as possible. Biological control strategies include conservation, augmentation, and importation.

Conservation

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 non-target organisms.
- Time the 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.

Augmentation

This strategy artificially increases the numbers of biological controls in an area. This can be accomplished by planting flowering plants (also called insectary plants) to provide pollen and nectar for the many beneficial insects that feed on the pest insects or purchasing beneficials from a commercial insectary. Examples of the best-known commercially available natural enemies include lady beetles, lacewings, predatory mites, and insect-attacking nematodes. These are but a very small part of the large and growing number of species now commercially available for release against pests. Learning when to purchase and release them and how to maintain them in the field should be emphasized in any landscape pest management program. See the DPR Publication "Suppliers of Beneficial Organisms in North America" for commercial suppliers of biocontrol organisms (available online at http://www.cdpr.ca.gov/ under *News and Publications*).

Importation

People often ask if parasites or predators can be imported from another country to take care of a particularly disruptive pest in their area. It is true that the majority of pests we have in North America have come from other parts of the world, leaving behind the natural enemies that would normally keep them in check. "Classical" biological control involves searching for these natural enemies in the pest's native area and importing these natural enemies into the problem area. This is not a casual venture: it must be done by highly trained specialists in conjunction with certain quarantine laboratories approved by the United States Department of Agriculture. Permits must be obtained and strict protocols observed in these laboratories. Once the imported natural enemies become established in their new home, they usually provide permanent control of the pest. Patience is needed, however, because establishment of the natural enemies can take several years.

5.3.6 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. Non-target organisms are much less likely to be affected because these microbial pesticides selectively attack pests.

The most well known microbial insecticide is *Bacillus thuringiensis*, or B.t. The most widely sold strain of B.t. 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.

5.3.7 Least-Hazardous Chemical Controls

The health of school occupants 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. There are many chemical products to choose from that are relatively benign to the larger environment and at the same time effective against target pests. To find out whether a specific pesticide product is exempt from the right-to-know requirements of the Healthy Schools Act, see **Appendix B**.

"Least-hazardous" 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 non-target organisms. There are many least-hazardous products being registered in California, including materials such as the following:

- Pheromones and other attractants.
- Insect growth regulators (IGRs).
- Repellents.
- Desiccating dusts.
- Pesticidal soaps and oils.
- Some botanical pesticides.

Pheromones

Animals emit substances called pheromones that act as chemical signals. The sex pheromones released by some female insects advertise their readiness to mate and can attract males from a great distance. Other pheromones act as alarm signals.

A number of pheromone traps and pheromone mating confusants are now commercially available for some insect pests. Most of the traps work by using a pheromone to attract the insect into a simple sticky trap. The mating confusants flood the area with a sex pheromone, overwhelming the males with stimuli and making it very difficult for them to pinpoint exactly where the females are.

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. These hormones do not affect us since humans and other mammals don't metamorphose as insects do.

Repellents

Some chemicals repel insects or deter them from feeding on treated plants. For example, a botanical insecticide extracted from the neem tree (*Azadirachta indica*) can prevent beetles and caterpillars from feeding on treated rose leaves. Current research shows that neem has a very low toxicity to mammals. A number of neem products are currently available but as with all pesticides, it is important to use them according to label instructions to ensure success and safety.

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. 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: always use a dust mask and goggles during application.

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 fishponds. 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 may 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: it as 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

Although botanical pesticides are derived from plants, they are not necessarily better or safer 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" have been synthesized in the laboratory, and are much more long lasting and powerful than the pyrethrins. Pyrethroids are toxic to fish and other aquatic invertebrates. Neem, another botanical pesticide, is discussed previously 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 pesticides.

5.4 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. See **Appendix H**, the

Recommended Readings section of this manual, for other reference materials on pesticides. **Appendix G**, Pesticide Information Resources, lists organizations that provide information on pesticide toxicity. You will find links to MSDS sites on the California School IPM Web site at www.cdpr.ca.gov/schoolipm. Some pesticide products are exempt from the recordkeeping, notification, and posting requirements of the Healthy Schools Act. Use the worksheet "Pesticides exempted from Healthy Schools Act right-to-know requirements" (**Appendix B**) to determine if a specific product is exempt. DPR's School HELPR Web page is a guide to choosing the optimal pest management action, depending on the situation. In addition, there are some pesticides that are prohibited from use in schools. See http://apps.cdpr.ca.gov/schoolipm/school_ipm_law/prohibited_prods.pdf to view the list of pesticide products prohibited from use in schools and child care facilities.

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

5.4.1 Safety

This means safety for humans (especially children), pets, livestock, and wildlife, as well as safety for the overall environment. Read the pesticide label. Pesticide labels contain information to protect your health. Every label displays a "signal word" that indicates the level of acute (immediate) toxicity of the formulated pesticide product. See **Box 5-1** for explanations of the signal words. Questions to ask about safety are:

- What is the acute (immediate) and chronic (long-term) toxicity of the pesticide?

  Acute toxicity is the toxicity of the chemical after a single or limited exposure. It is measured by the lethal dose (LD_{50}) or the lethal concentration (LC_{50}) which causes death in 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}/LC_{50} value, the more poison it takes to kill the target animals and the less toxic the pesticide. In other words, a high LD_{50}/LC_{50} value equals low toxicity. The LD_{50}/LC_{50} does not reflect any effects from long-term exposure that may occur at doses below those used in short-term studies.

  Chronic toxicity refers to potential health effects from exposure to low doses of the pesticide for long periods. Chronic effects can be carcinogenic (cancer-causing), mutagenic (causing genetic changes), or teratogenic (causing birth defects). Sources of information on health effects of pesticides are provided in **Appendix G** or online at www.cdpr.ca.gov/schoolipm.

- 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?

Box 5-1: Definitions of signal words for pesticides

Federal law and the acute toxicity data determine the signal words and precautionary statements that must appear on pesticide labels (40 Code of Federal Regulations 156.10). Always read pesticide labels thoroughly before using and be sure to follow label directions. Misuse of any pesticide is not only illegal, but may create a dangerous situation.

The signal word (see below) indicates the most severe level of anticipated acute (immediate) toxicity of the formulated pesticide product to humans based on at least one of five to six tests conducted with laboratory animals. The chronic (long-term) toxicity is not indicated on the label. Note that chronic toxicity may be important for pesticide products used frequently. You can obtain chronic toxicity information from several reputable sources such as U.S. EPA (http://www.epa.gov/iris) or the National Pesticide Information Center (http:/npic.orst.edu). Pesticide labels typically bear the warning "Keep out of reach of children."

Signal Word	**Toxicity category**	**Precautionary statements by toxicity category** Oral, inhalation or dermal toxicity	 Skin and eye local effects
Danger — Poison Danger	I	Fatal (poisonous) if swallowed [inhaled or absorbed through skin]. Do not breathe vapors [dust or spray mist]. Do not get in eyes, on skin, or on clothing. [Front panel statement of practical treatment required]	Corrosive, causes eye and skin damage [or skin irritation]. Do not get in eyes, on skin, or on clothing. Wear goggles or face shield and rubber gloves when handling. Harmful or fatal if swallowed. [Appropriate first aid statement required].
Warning	II	May be fatal if swallowed [inhaled or absorbed through skin]. Do not breathe vapors [dust or spray mist]. Do not get in eyes, on skin, or on clothing. [Appropriate first aid statement required].	Causes eye [and skin] irritation. Do not get in eyes, on skin, or on clothing. Harmful if swallowed. [Appropriate first aid statement required].
Caution	III	Harmful if swallowed [inhaled or absorbed through skin]. Avoid breathing vapor [dust or spray mist]. Avoid contact with skin [eyes or clothing]. [Appropriate first aid statement required].	Avoid contact with skin, eyes or clothing. In case of contact, immediately flush eyes or skin with plenty of water. Get medical attention if irritation persists.
[No signal word]	IV	[No precautionary statements required]	[No precautionary statements required]

If no signal word occurs on the label, then the product has the lowest toxicity category or contains active ingredients that are exempt from federal and California registration; however, it may cause slight skin or eye irritation.

Products you select must be registered or exempted from registration*. Note that some products are neither registered nor exempted, and are, therefore, illegal to use. If chemical control is necessary, select legal products with no signal word or with caution as a signal word when available.

For information about products exempt from registration, see* **Appendix B *and California Notice to Registrants 2000-6, which is available on our Web site at www.cdpr.ca.gov under Programs and Services, Pesticide Registration Branch.*

5.4.2 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.

5.4.3 Effectiveness

This issue is not as straightforward as it might seem since it depends on how effectiveness is being evaluated. For example, a pesticide can appear to be very effective in laboratory tests because it kills 99 percent of the test insects. In field tests under more realistic conditions, however, it may also kill 100 percent of the pest's natural enemies. This will lead to serious pest outbreaks later.

5.4.4 Endurance

A pesticide may have been effective against its target pest at the time it was registered, but if the pest problem is now recurring frequently, it may be a sign that the pest has developed resistance to the pesticide, in other words, that the pesticide has lost its endurance.

5.4.5 Speed

A quick-acting, short-lived, more acutely toxic material might be necessary in emergencies; a slow acting, longer lasting, less-hazardous 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 hazardous organophosphate.

5.4.6 Cost

This is usually measured as cost per volume of active ingredient used. Some of the newer, less-hazardous microbial and botanical insecticides and insect growth regulators may appear to be more expensive than some older, more hazardous pesticides. The newer materials, however, 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.

5.5 Pesticide Use, Disposal, and Storage

In California, pesticide use, disposal, and storage are governed by laws in the California Food and Agricultural Code (FAC) and regulations in Title 3 of the California Code of Regulations (CCR). The laws and regulations concerning pesticide use have become increasingly complicated over the past few years. See the Pesticide Safety Information Series N in **Appendix P** for more detailed information regarding pesticide use in California schools. Pesticide applicators in schools must follow state and federal laws regarding pesticide use, disposal and storage in addition to following the requirements of the Healthy Schools Act.