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Pesticide Education Program

Massachusetts Core Supplement

Revised November 2014.

To be used with the Pesticide Applicator Training
CORE MANUAL, 3rd Edition

The chapters in this supplement are intended to expand your knowledge of topics that are mentioned in the Core Manual. There are learning objectives with each chapter. Expect to be tested on this document.

If you have any questions regarding the content of this document please contact the UMass Extension Pesticide Education Program at nclifton@umass.edu

Chronic Health Risks of Pesticides

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Department of Entomology, April 29, 1986
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January 2014

Learning objectives:

- First read Chapters 5 & 6 in the Core Manual (3rd edition)
- Define the following terms: mutagen, oncogen, carcinogen, teratogen, neurotoxin
- Explain why chronic health effects are more difficult to diagnose than acute health effects
- List the resources where you can find information about the chronic health effects associated with the pesticides that you are using.

Chronic health effects are problems that develop over a relatively long period of time, following either one significant exposure that initiates a problem, such as cancer or following a series of small exposures, which accumulate in some manner and result in the development of a disease or disorder. In contrast, acute toxicity is poisoning from a single dose over a much shorter duration of time as might be received, for example, in an accidental spill of a pesticide concentrate. The acute health effect occurs very soon (within 24 hours) after exposure. Recognition of chronic health effects and development of scientific methods to screen chemicals for such effects have been slower to develop than was the case for acute toxicity. Consequently less is known about chronic health risks and there are more areas of disagreement on how to conduct and interpret such tests.

A number of different problems are grouped under the term chronic health risks. Among the major ones are:

Mutagenicity

This is the ability of a substance or an agent to cause mutations, that is, changes to genes or chromosomes. Such changes are almost always harmful. Tests to detect such effects are varied, ranging from tests on cells (bacteria, or cell lines from mammalian tissues) to tests on whole animals such as mice. It is believed that chemicals that can cause mutations are more likely to be ones that can also cause cancers. Since mutation testing is much faster and cheaper than whole animal lifetime cancer testing, it is used as a quick first screen for new compounds.

Oncogenicity & Carcinogenicity

Oncogenicity is the ability of a chemical to cause abnormal growths or tumors in tissues. Whereas the health hazards of some growths may be slight for example, warts or other benign growths, other growths such as certain brain tumors may be life threatening. Carcinogenicity is the ability of a substance or agent to produce malignant tumors. Testing chemicals for their ability to cause tumors is done by administering daily doses of the test substance to animals, often rodents, for their entire lifetime and then dissecting them carefully to detect the presence of tumors in the animals' tissues. A rodent carcinogenicity study typically takes 2-3 years to complete. Pesticide companies are required to submit test data on oncogenicity from several animal species.

Given the complexity of human health, genetics, diet, as well as exposures to substances in the environment, it is not always possible to diagnose the exact cause for a cancer or tumor. Consequently it is not usually possible to state that any given person's cancer is directly attributed to a particular chemical exposure. It is possible however, to say that increased exposure to certain substances increases risks and that the exposure of a large number of people will result in an increase in the number of cases of cancer.

There are currently over 70 pesticide active ingredients considered known, likely, or probable human carcinogens on the Massachusetts Department of Agricultural Resources (MDAR) website (www.mass.gov/eea/agencies/agr/pesticides under School IPM). This list is provided by the USEPA. These ingredients include the insecticides carbaryl and pyrethrins, the fungicides chlorothalonil and maneb, and the herbicides acifluorfen and diuron. Under the Massachusetts *Act to Protect Children and Families from Harmful Pesticides* passed in 2000, pesticide products that contain these active ingredients may not be used in and around schools, daycare facilities, and after school programs.

Teratogenicity

Teratogenicity is the ability of a substance to cause abnormal growth or deformity in developing fetuses, (e.g., "birth defects"). These effects are screened by administering doses of the chemical to female test animals at various stages in their pregnancies and observing the numbers of miscarriages and defective offspring versus what would normally be expected. Various test animals such as rodents, rabbits, dogs and monkeys are used. Effects are usually considered significant if they occur at doses not toxic by themselves to the mother. Birth defects occurring at doses toxic to the mothers are felt to be less meaningful because the direct poisoning of the mother is associated with reduced food intake and other processes directly harmful to the fetuses by themselves. Testing for such effects is a standard part of pesticide registration, although data gaps may exist for older chemicals.

Neurotoxicity

This refers to gradual damage to basic nerve structure, such as degeneration of the nerve sheath. It does <u>not</u> refer to reversible effects such as reduction of cholinesterase levels. The chicken is the test animal ordinarily used for neurotoxicity tests.

Other Effects

In addition to the health effects just discussed, a number of others may also be caused by exposure to chemicals. These include adverse impacts on the endocrine system; that can include harm to reproductive systems (such as, reduced sperm production or sperm motility in men). Exposure to some substances may also cause damage to organs such as the liver damage (hepatotoxicity) and kidney damage (nephrotoxicity). Overexposure to pesticides could also compromise the immune system (immunotoxic) or lead to direct toxic injury or death of the fetus (fetotoxic). Blood disorders (referred to as hemotoxic effects) and respiratory disorders can also be caused by exposure to some pesticides.

Chronic health risks are likely to remain a source of uncertainty for the foreseeable future because of the difficulty in obtaining direct evidence relevant to impacts on human health. Positive results in test animals should be used as indicators of chemicals that may pose risks. Firm proof that a pesticide causes human disease is likely to be lacking. Applicators can obtain specific information about what is known about chronic health effects for the pesticides that they are using by looking at the pesticide label, the chemical safety data sheets, and variety of creditable sources including the National Pesticide Information Center (npic.orst.edu) and U.S. EPA Pesticides Program.

Cholinesterase Testing Information

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with Special Thanks to the *Cholinesterase Task Force
Revised March 1989, January 2014

Learning Objectives:

- First read Chapter 7 in the Core Manual (3rd edition).
- Define the terms cholinesterase, organophosphate, and carbamate.
- Determine whether you should have the cholinesterase levels in your blood monitored.
- Describe how to handle an exposure incident involving organophosphates or carbamates.

What are Cholinesterases?

Cholinesterases are enzymes found in humans, insects, and other species that are necessary for normal function of the nervous system. Certain insecticides such as organophosphates (chlorpyrifos, malathion, etc.) and carbamates (carbaryl, propoxur, etc.) can block and inhibit theses enzymes.

How much exposure to cholinesterase blocking pesticides does it take to make you sick?

The amount of pesticide exposure necessary to make you sick depends on the type of product, the potency of the active ingredient, and the amount of exposure, e.g. whether you are handling a concentrated or diluted mixture. The greater the exposure (high dose), the greater the effect. Effects may range from no observable effects to severe illness/symptoms requiring hospitalization. Severe poisoning can lead to coma and death.

The onset of symptoms occurs anywhere from exposure to 12 hours following exposure. The symptoms of acute poisoning include nausea, vomiting, diarrhea, tightness in the chest, excessive sweating, rapid heartbeat, cramps, restlessness, headache and confusion. Poisoning with organophosphates or carbamates can resemble drunkenness, a head cold, or the flu, so be sure to bring a copy of the label and/or product safety data sheet to the emergency room with you.

When you follow label directions and wear the appropriate protective clothing you reduce the chances of poisoning by cholinesterase inhibiting pesticides.

Why Monitor Cholinesterase Levels?

The purpose of regularly measuring your cholinesterase activity level (i.e. monitoring your level) is to establish a baseline for normal activity and be alerted to any drop in enzyme levels before they reach values low enough to make you sick. Changes in your cholinesterase levels can be detected in the absence of symptoms. In addition, antidotes that counteract the acute symptoms of cholinesterase poisoning are available. By monitoring cholinesterase levels, workers can be removed from exposure before symptoms occur. Natural recovery normally occurs when exposure stops.

Who should be monitored?

People who regularly use organophosphates and carbamates insecticides should be monitored prior to the beginning of a spray season to establish a baseline of activity. Subsequent testing should occur regularly during the season as directed by their physician. Frequent testing may be advisable for cases of heavy use, spills, and accidents. At the end of the season, a follow-up test should be done to assure that your levels are back to baseline.

If you are inadvertently exposed to cholinesterase inhibiting insecticides you should remove contaminated clothing, wash the affected area of skin well with soap and water, and contact your physician immediately.

Where and how can you have monitoring done?

If you regularly handle cholinesterase-inhibiting pesticides you should see your physician or an occupational medical physician and explain how you are potentially exposed to these compounds. The physicians will then request that a blood sample be drawn to monitor cholinesterase levels and the appropriate laboratory test be done.

Cholinesterases are present in the plasma and the red blood cells. Chemicals that inhibit cholinesterase enzymes can differentially inhibit plasma and red blood cell enzymes, so both levels should be determined. The lab results along with your medical history will be interpreted by your physician and a recommendation will be made regarding further exposure.

Emergency First Aid

-remove contaminated clothing
-wash area well with soap and water
-contact physician
-bring a copy of the label and this sheet with you (do not bring the pesticide container)
-for more information call
Mass. Poison Information Center 1-(800)-222-1222

Mass. Pesticides Program (617)-626-1720
*Special Thanks to: Karen Barnes, RN; Ann-Marie Burke, Dept. of Public Health; Judith Marquis, Ph.D.; Louis Pepper, MD; & Leah Weiss, Dept of Public Health

Protecting Honey Bees from Pesticides*

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Revised by Natalia P. Clifton and Dr. Patricia Vittum, UMass Extension
January 2014

Learning objectives

- First read Chapter 10 in the Core Manual (3rd edition)
- List plants and/or sites where you may see bees foraging.
- Identify the primary section on the label where bee toxicity information is located.
- Compare pesticide formulations that are more toxic to bees to formulations that are less toxic to bees.
- Discuss how temperature can affect the impact of pesticides on bees.
- Define the phrases *bees are actively visiting* and *bees are visiting* that are found on pesticide labels.
- Describe why neonicotinoid insecticides pose a risk to bees.
- Recognize the "Bee" icon used on some labels for the neonicotinoid insecticides.

Introduction

Honeybees are essential for pollination of many crops such as cranberries, apples and other fruits & vegetables. Honeybee pollination services are the basis of livelihood for a number of apiculturists in New England. In addition, many more people keep bees as hobbyists, having one or two hives on their property. County beekeeper associations exist in all Massachusetts counties and can be consulted about bee colony locations. Membership is not required of beekeepers, so County Associations will not know the locations of all hives.

Bees forage up to several miles searching out concentrations of flowers, plants shedding pollen and/or producing nectar. Each year pesticide applications kill honeybee colonies in Massachusetts. Some of these kills could have been foreseen and avoided. The sub-lethal effects of a pesticide exposure can lead to disorientation that can affect how well the bee can navigate, forage for food, and return to the colony safely. You, the pesticide applicator, have a responsibility to prevent such impacts on bees. To do so, you need to understand the circumstances leading to negative impacts on bees and the actions you can take to avoid them.

*The primary focus of this supplement is honey bees. However it is important to note that native pollinators, such as bumble bees, butterflies, flies, and hummingbirds, are also significant sources for pollination of crops, landscape plants, native plants, and backyard vegetable and fruit gardens. Additional information about native pollinators can be found in the Resources section of this supplement.

Major Poisoning Factors. What Are The Main Contributing Factors Leading To Bee Poisoning Problems?

1. Bloom - Severe bee poisoning problems almost always involve the contamination of blooming plants with insecticides (and sometimes fungicides). This provides the first line of defense on short-blooming crops such as tree fruits. We do not recommend any insecticide applications during the blooming period and many are specifically prohibited on the label. Also avoid spraying blooming weeds that are growing in orchards or in fallow areas adjacent to crops. Many bee kills have resulted from foraging on contaminated blooming weeds. In landscape and lawn settings, avoid applying insecticides when flowering ground cover is in bloom. Tree spray work must not be done to ornamentals such as flowering crabapples when they are in bloom. Likewise, shade trees such as maples, oaks and locust must not be sprayed when they are in bloom or pollen shed. Flowers of such trees may be relatively inconspicuous but may still be very attractive to bees. Plants in pollen shed, such as corn, are also attractive to bees and must be considered as if in flower.

2. Toxicity of the pesticide to bees. Bees tend to be more susceptible to pesticide poisoning than many target pest insects. Information about bee toxicity for a specific pesticide will be found in the *Environmental Hazards* section of the pesticide label. If you want to avoid using pesticides that are highly toxic to bees, you can refer to lists that rank pesticides from being highly toxic to being relatively nontoxic to bees.[1]

3. Residual action - Residual action of a chemical is a key factor determining its safety to pollinators. Any insecticide which loses it toxicity within a few hours can probably be applied when the bees are not actively foraging with reasonable safety. However, many chemicals are expressly designed to provide pest control for days or weeks. Such compounds are called residual pesticides; examples include azinphos methyl (Guthion™) and permethrin (found in several lawn and landscape insecticide/miticides). These compounds remain hazardous to bees for many days if bees visit sprayed surfaces.

4. Formulation - Different formulations of pesticides often vary significantly in their toxicity to bees. Dusts are much more hazardous than sprays, and wettable powders usually provide a significantly longer toxic hazard than emulsifiable concentrates because the dry particles such formulations produce cling better to the body hair of foraging bees. The most hazardous type (to bees) of formulation is microencapsulation, where the active ingredient is encased in tiny nylon-type plastic capsules. The main reasons why microencapsulated pesticides are so hazardous to bees are: (1) the capsules have a special tendency to adhere to bees because of their size and electrostatic charge; and (2) when contaminated pollen is stored in the beehive combs, it remains toxic to bees from one season to the next. Some pesticides, such as carbaryl (Sevin™) may be available in several different formulations for the same purpose. For example Sevin XLR™, a liquid formulation of carbaryl, is believed to be less hazardous to bees than the wettable powder formulation of Sevin™.

[1]Clemson University. 2012. How to Protect Honeybee from Pesticides A Guide for Beekeepers Department of Pesticide Regulation Publication, Bulletin 5 clemson.edu/public/regulatory/pesticide_regulation/bulletins/

5. Drift of Chemical - Drift of spray or dust applications can greatly increase bee-poisoning problems. Even when the target crop/site is not blooming or is unattractive to bees, drift onto adjacent weeds or fields may lead to serious losses. As noted above, drift onto blooming weeds

or shrubbery in fallow areas or beneath the crop/site is a major source of bee kills. Cutting or mowing of the weeds is recommended to reduce the problem.

6. Timing - Timing of applications is obviously related to the previous factors. We often can apply insecticides when the crop/plant is not blooming. We can apply the least hazardous formulations during late evening when controls are required during the blooming period. Some pesticide labels will have specific language that prohibits not only a pesticide application during bloom but maybe several days before bloom.

7. Temperature. Honey bees can become active and forage at temperatures as low as 55F. Also temperature has a significant modifying effect on the bee-poisoning hazard of a pesticide. f temperatures following treatment are unusually low, residues of the crop may remain toxic to bees up to twenty times as long as following normal temperatures. Conversely, if abnormally high temperatures occur during late evening or early morning, bees may forage actively on the treated crops during these times. At very high temperatures (over 90 F) bees may forage less for pollen and nectar and more for water to cool the hive. Puddles of spray, if available, may be a source of injury to bees foraging for water.

8. Strength of colony. The strength of a honeybee colony has a definite effect on bee poisoning losses. Large colonies usually suffer greater losses than small colonies, because more foragers are exposed to the pesticide residues while flying outside of the hive.

9. Distance from treated fields. Honeybee mortality is inversely proportional to the distance of colonies from treated fields/areas. The most severely damaged colonies will be those immediately adjacent to the fields/areas where insecticides are being applied. However, during a dearth of pollen and nectar, bees have been severely poisoned at up to 5 miles from the treatment area.

Bee Toxicity Information on Pesticide Labels

EPA evaluates a pesticide for toxicity to pollinators if it is used outdoors. This information will be found in the *Environmental Hazards* section of the pesticide label. Below are two examples. Note in Figure 1, the statement, "Do not apply….while **bees are actively visiting** the treatment area." This refers to bees that you see on the plants. In Figure 2, note the statement, "Do not apply…if **bees are visiting** the treatment area." This statement applies to bees that are on the plants as well as bees that may visit the plants after treatment and this indicates that the pesticide has "extended residual toxicity" for bees.

Figure 1.

> **ENVIRONMENTAL HAZARDS**
> This pesticide is toxic to fish, aquatic invertebrates, and mammals. Do not apply directly to water or to areas where surface water is present or to intertidal areas below the mean highwater mark. Drift and runoff may be hazardous to aquatic organisms in neighboring areas. Do not contaminate water when disposing of equipment washwater or rinsate.
> This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area.

Figure 2.

> **Environmental Hazards**
> This product is toxic to fish, aquatic invertebrates, small mammals, birds and bees. Do not apply directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark. Drift and runoff from treated areas may be hazardous to aquatic organisms in water adjacent to treated areas. Do not contaminate water when disposing of equipment washwaters or rinsate. This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.

Neonicotinoid insecticides were first registered in the United States in the mid 1990s. These insecticides have a relatively low mammalian toxicity and were considered a good alternative to the more toxic organophosphate and carbamate insecticides. However, unlike organophosphate and carbamate insecticides that tend to degrade relatively quickly in the environment, neonicotinoids are persistent and even as they degrade, they continue to remain toxic to bees.

One of the first neonicotinoid insecticides was imidacloprid, the primary active ingredient in the product Merit™. Other neonicotinoids include clothianidin, dinotefuran, and thiamethoxam. Currently neonicotinoids are the most commonly used class of insecticides in the United States. They are found in products to control bed bugs, to manage fleas and ticks on pets, to manage termites, and to manage a wide range of insects and insect relatives on fruit, vegetable, turf, landscape, and structural settings.

Users of these insecticides should be aware of the risks of the neonicotinoids to bees. Bees can come in contact with these insecticides through direct exposure during spraying, as residuals on foliage and other surfaces, and as contaminants in nectar and pollen.

The U.S. EPA introduced a label change for insecticides that contain one or more of the neonicotinoids in order to protect bees. The bee icon (see below) will be place in the *Environmental Hazards* section of the pesticide label. There will be further instructions concerning bees in the *Directions for Use* section on the label.

Poisoning Prevention. How Can You Protect Bees From Pesticide Poisoning?

1. Read and follow all directions on the pesticide label regarding toxicity to bees. If there is reference to bee toxicity in the *Environmental Hazards* section of the label, there are likely to be further instructions regarding bees in other sections of the pesticide label.

2. Apply pesticides when bees are not actively foraging/visiting plants. Many insecticides can be applied in late evening, night or early morning with relative safety to bees. This timing is typically from 6 p.m. to 7 a.m. in northern states and 8:30 p.m. to 4 a.m. in southern states. Anthers on corn tassels actively shed pollen during the morning; short-residual materials can be applied from 2 p.m. to midnight with minimal hazard to bees.

3. Do not treat crops/plants in bloom. Do not allow sprays to drift onto adjacent crops or inter plantings that are in bloom. Be especially careful when treating a bee-pollinated crop.

4. Become familiar with state regulations concerning the protection of pollinators. □ Massachusetts there are additional requirements for notifying apiaries if a bee toxic pesticide is being applied to blooming fruit trees or blooming field crops (alfalfa, clover,

and trefoil). The specific requirements are listed in 333 CMR 13.07(2) of the Massachusetts Pesticide Regulations.

5. Minimize pesticide drift. When blooming weeds and foraging bees occur in the field edges, avoid drift of pesticides onto these areas.

6. Choose the least hazardous formulation of a pesticide.

7. Modify spray programs in relation to weather conditions. Insecticides should not be applied when unusually cold temperatures are expected that night, because the residues will remain toxic to bees which enter the field the following day. Stop spray applications when temperatures rise and bees begin entering the field in early morning.

8. Do not treat during hot evenings when honeybees are clustered on the outside of the hives. Delay applications until midnight or later and after the bees have entered the hives.

9. Know where bee colonies are in your area. Contact beekeepers if you intend to make a pesticide application that may kill bees. Cooperation between beekeepers and pesticide applicators is essential to reduce bee kills from pesticides. Contact your area or county beekeeper association to learn if beekeepers are maintaining hives in your area.

10. Do not place unmarked honeybee colonies adjacent to fields or orchards, which are likely to be treated. Beekeepers should put their name, address, and phone number or approved identification number on hives. Use print large enough to be read at some distance.

11. Find ways to enhance the health of bees and other pollinators. There are many organizations that are raising the awareness of the importance of pollinators and the variety of issues that impact the health of pollinators. See Resources section.

Information for this supplement comes from the following publications/websites

1. Johansen, C.A. 1977. Pesticides & Pollinators. Ann. Rev. Ent. 22:177-92.
2. Johansen, C.A. 1981. Protection of Pollinating Bees, a Self struction Manual. Coop. Ext. Publication EB0901, Washington State Univ. Pullman, Washington.
3. National Research Council Canada. 1981. Pesticide-Pollinator teractions. NRCC Pub. No. 18471, Ottawa.
4. Wilson, W.T. et al. 1980. Beekeeping in the United States. USDA Handbook No. 335. U.S. Gov't Printing Office, Wash., D.C.
5. Pollinator Protection - EPA Actions to Protect Pollinators epa.gov/opp00001/ ecosystem/pollinator/risk-mgmt.html

Resources

Pollinator Protection - EPA Actions to Protect Pollinators
epa.gov/opp00001/ ecosystem/pollinator/risk-mgmt.html

USDA Report on the National Stakeholder Conference on Honey Bee Health, National Honey Bee Health Stakeholder Conference Steering Committee. 2013.
http://www.ars.usda.gov/news/docs.htm?docid=15572

Pesticide Task Force of the North American Pollinator Protection Campaign (NAPPC)
Pollinator.org/nappc

Pesticide Environmental Stewardship – Pollinator Protection
pesticidestewardship.org/PollinatorProtection

The Xerces Society for vertebrate Conservation
http://www.xerces.org/pollinator-conservation/

Integrated Pest Management

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Learning Objectives

- First read Chapter 13 in the Core Manual (3rd edition)
- Define the term Integrated Pest Management (IPM)
- Give reasons why you should practice IPM
- Describe the purpose of monitoring
- Define the terms assessment, action threshold, economic injury level, economic threshold and zero threshold
- Describe how forecasting is used to manage pests
- Be familiar with the different cultural control, physical control and mechanical strategies
- Describe how natural enemies can manage pests
- Define the three types of biological control: introduction, augmentation, and conservation
- Be familiar with the different chemical control options including reduced risk, biological, microbial, biochemical, and minimum risk pesticides
- Describe the roles that record keeping, communication and education can have in implementing an IPM program
- Be familiar with the terms found in the glossary section on pages 21 & 22.

Introduction

This supplemental publication was prepared to provide generic IPM information to those seeking to become a certified and/or licensed pesticide applicator in Massachusetts. This information addresses changes in the Massachusetts Pesticide Control Act (Chapter 132 B of the Massachusetts General Laws), which became effective on November 1, 2000. In particular, the changes require that "each examination shall include an evaluation of the applicant's competence with respect to the use of Integrated Pest Management (IPM)".

The goals of this publication are: to define Integrated Pest Management (IPM), to describe the benefits and essential elements of its use, to outline pertinent IPM examples in various settings and to provide an overall level of general knowledge necessary to implement IPM.

History

Since the advent of modern pest control chemicals in the 1940's traditional methods of pest control typically involved periodic applications of pesticides whether or not pests were present and were in numbers sufficient to cause economic or other losses. This approach resulted in several problems, including: development of insect, disease and weed pest resistance to the chemicals used; outbreaks of previously minor pests; and environmental contamination. □ addition, substantial concern arose about the possibility that pesticides could be causing adverse effects on public health.

Beginning in the 1950's and continuing to the present day, University-based scientists and others began to develop a new approach to pest control, now known as Integrated Pest Management or IPM. Although IPM had its roots in agriculture crop protection for sites as diverse as apple orchards and sweet corn fields, IPM concepts and principles have now been applied to such non-agricultural settings as golf courses, schools, homes, and restaurants.

Consequently, specific definitions of PM vary greatly depending on which setting it is being applied to.

A Definition

This publication will use the definition cited in the Massachusetts Pesticide Control Act. **Integrated Pest Management or IPM** is a "comprehensive strategy of pest control whose major objective is to achieve desired levels of pest control in an environmentally responsible manner by combining multiple pest control measures to reduce the need for reliance on chemical pesticides; more specifically, a combination of pest controls which addresses conditions that support pests and may include, but is not limited to, the use of monitoring techniques to determine immediate and ongoing need for pest control, increased sanitation, physical barrier methods, the use of natural pest enemies and a judicious use of lowest risk pesticides when necessary."

Practicing Integrated Pest Management or IPM

IPM can reduce the quantity of chemical pesticides entering the environment and can save money. IPM is based on taking preventive measures, monitoring pest problems, assessing pest numbers, and choosing appropriate actions. Corrective action, such as applying a pesticide, is only taken if pest numbers reach levels (action thresholds) which indicate that damage will occur. The action threshold for a pest and its associated damage may be different depending on the situation. For example, the damage may be economic in crop systems – will the damaged caused by the pest reduce the yield significantly? Damage may be based on aesthetics in landscapes – how many spider mites can be on a plant before the client notices and complains? Finally, pest "damage" may be related to public health issues – now that West Nile virus has been detected in Massachusetts, how much effort should go into controlling the mosquitoes that spread the disease? Many different tactics are used in IPM, including such things as cultural practices, biological control agents, physical and mechanical controls, and chemical pesticides.

The term **integrated** refers to the use of different tactics to avoid, minimize, and prevent a pest problem. These tactics are integrated into a system that improves the effectiveness of each method. IPM integrates information that comes from different disciplines, such as disease information from plant pathologists, weed information from weed scientists, and insect information from entomologists. For example, in a non-IPM spray program for apples, fungicides used to control apple scab might have a negative impact on the biological control agents of plant feeding mites. Similarly, in a non-IPM spray program for lawns, chinch bugs are control by insecticides that may have a negative impact on biological control by predators, such as big-eyed bugs. In an IPM system, the use of certain pesticides, that affect natural predators such as big-eyed bugs or predatory mites, would be avoided.

Pests are unwanted organisms that are a nuisance to people or domestic animals, and can cause injury to humans, animals, plants, structures, and possessions. Pests can include insects and other arthropods, plant diseases (including fungi, bacteria and viruses), vertebrates (such as rodents and birds), and weeds.

Management is the process of making decisions in a systematic way to keep pests from reaching unacceptable or intolerable levels. Small populations of pests often can be tolerated; total eradication often is not necessary or possible. However, there are settings in which the tolerance for a pest or its associated damage may be zero - for example, insects or vertebrates in a hospital. Proper management depends on **information.** In an IPM system, information is usually obtained from a regular and thorough site inspection called **monitoring**.

Why Practice IPM?

Why should you even consider IPM when chemical pesticides so often succeed at controlling pests? Here are some reasons for having a broader approach to pest management than just the use of chemicals.

Keep a Balanced Ecosystem

Every ecosystem, made up of living things and their non-living environment, has a balance; the actions of one creature in the ecosystem usually affect other organisms in that system. The introduction of chemicals into an ecosystem can upset this natural balance by destroying certain species and allowing others (sometimes pests themselves) to dominate. *Beneficial insects* and insect relatives such as the ladybird beetle (ladybug), lacewing larvae, tiny non-stinging wasps, or spiders, all of which consume pests, can be killed by pesticides; thereby, leaving few natural mechanisms of pest control. Pesticide use can sometimes lead to **pest resurgence**, whereby pests are initially controlled but later increase in numbers that then require additional pesticide applications. The use of pesticides can also lead to **secondary pest outbreaks** where the *natural enemies* of a species are destroyed allowing another pest whose population has been low historically to reach outbreak levels. For example, spraying carbaryl (Sevin™) for insects in orchards may kill mite predators, thereby leading to outbreaks of spider mites. Natural enemies can be destroyed in other settings as well. For example, spraying carbaryl (Sevin™) for insects on oak trees may kill natural enemies that help keep oak leaf skeletonizer in check, thereby leading to potentially damaging populations of that insect.

Pesticides Can Be Ineffective

Chemical pesticides sometimes are ineffective because pests can become resistant to their effects. Over 600 cases of *pesticide resistance* have been documented to date from all classes of pests; including, weeds such as common lamb's-quarters, insects such as cockroaches, house fly, Colorado potato beetle, Indian meal moth, vertebrates such as Norway rat, and diseases such as apple scab. Furthermore, pests may survive because the chemical does not reach them, is washed off, is applied at an improper rate, or is applied at the wrong time during the life cycle.

IPM Is Not Difficult

Although some of the terms and ideas may be new to you, practicing PM is not difficult. You will have done much of the "work" for an IPM approach if you have identified the pest, determined the source and cause of the problem, noted the extent of the damage, and used this information to decide on the action to take. Your action decision could include a chemical solution or a non-chemical one. This thinking process is the same one used in IPM.

IPM Is Cost Effective

IPM can save money by avoiding losses due to pests, and avoiding unnecessary pesticide expense whether in an agricultural or non-agricultural setting. For example, onion growers who followed IPM recommendations in 1987 saved more than $23 an acre in insecticide costs. Golf course superintendents who replace fungicides with organic fertilizers or composts can save up to $1500 every time a fungicide is not applied. Applicators are able to save on sprays because the calendar is not the basis for spraying; the need is.

In agricultural settings where pest pressure is high, pesticide reduction may or may not result, but PM can provide a better quality crop. Connecticut sweet corn growers using PM had less caterpillar damage after switching to an PM program, and experienced an average increased profit of $227 per acre.

In non-agricultural settings such as buildings, IPM programs have resulted in lower costs than traditional pest control programs. For example, once non-chemical tactics such as repairing structural problems and sealing cracks are completed, a resulting reduction in pesticide use will usually result in lower costs. Over time, indoor IPM programs can become cost effective via the benefits such as improved work environments, reduced energy costs, and reduced building maintenance.

However, cost effectiveness is not based purely on the price of a gallon or pound of a pesticide. Even where pest pressure is high, an IPM program would consider using low-risk control tactics such as applying *microbial pesticides* for mosquito control. Although the use of a *microbial pesticide* may be more expensive than another pesticide, the result is less risk to humans and less impact and disruption to the environment.

Promote a Safer and Healthier Environment

We have much to learn about the persistence of chemicals both in the indoor and outdoor environment, and their effect on living creatures. For outdoors, more cases of contaminated groundwater and surface waters occur each year, and disposal of containers and unused pesticides still pose challenges for applicators. Even though long-term documentation of the effects of all pesticides is still unavailable, it is generally agreed that using fewer pesticides means that there will be less risk to surface water and groundwater, and less hazard to wildlife and humans. doors, building occupants may be exposed to chemical pesticides through the air or by direct contact with treated surfaces. Since the preventive aspects of IPM can result in fewer pests, they may also lead to less pesticide use. Fewer pesticides often mean lower exposure and/or risks to occupants from misapplications, spills, etc.

Maintain a Good Public Image

Public outcry about the presence of pesticide residues on produce has raised pesticide applicator awareness of the level of public concern about pesticides. Consumers are pressuring food stores, which in turn are pressuring growers, for produce that has been grown with as few pesticides as possible. Growing food, using integrated pest management, can help allay public concerns. Structural pest management professionals making recommendations for improvements in sanitation, clutter reduction, and/or structural modifications, minimize the need for chemical control and can also benefit by favorable public attitudes to their efforts.

Required by Certain Regulations

In response to concerns about pesticide use and potential overuse, many states have enacted regulations, which require the use of IPM in certain circumstances. Throughout the country, states are requiring schools to develop IPM plans and require IPM contracts with professional pest managers.

In Massachusetts, schools, day care centers, and school age child care programs are required to adopt and implement an Integrated Pest Management plan for both indoor (by November 1, 2001) and outdoor areas. Municipalities in many areas have specific contract requirements mandating IPM for town buildings and roads. In Massachusetts, state facilities can only use approved IPM contractors. In sensitive areas such as groundwater recharge zones, some pesticides may be limited to use only under an IPM plan. Also, IPM plans are required for vegetation management along roads, power lines and other rights-of-way.

Essential Elements of IPM

The essential elements of IPM are monitoring of pests, assessment of pest numbers, use of multiple control measures (e.g. cultural controls, biological controls, and chemical controls), record keeping and evaluation, and communication and education.

1. Monitoring is a key element of IPM. The results of a monitoring program provide important information to determine the need for control actions, as well as a way to assess whether control actions actually worked.

- Monitoring pests involves:
- regular checking of the area;
- early detection of pests;
- proper identification of pests;
- identification of the effects of biological control agents.

Regular checking of a warehouse, bakery, restaurant, field, greenhouse, golf course, or other areas, and *early detection of pests* can function together like an early warning system for pests, helping to avoid or prevent a pest problem. For example, checking around a structure in the spring for the nest building activities of wasps (i.e. yellow jackets) may prevent the need for using pesticides later in the summer as well as preventing a potential health problem. More recently, the use of *pheromone* (natural insect scents) *traps* has become a common IPM technique to detect the presence and activity periods of certain pests, such as various stored product pests and has even been used as a control measure in some agricultural crops.

Proper identification of pests is an important prerequisite to handling problems effectively. Identification is important because certain management practices may control one species but not the other. Ants and termites look similar as winged adults, but the methods of their management are very different.

Correct identification allows a pest manager to manage the real source of the problem and avoid merely treating the symptoms (or controlling non-pests). For example, the woods cockroach behaves and looks like indoor breeding roaches but is only an occasional intruder from the outside requiring little or no control.

Unless the pest is identified, the management program may have the wrong pest as its target. Identification allows a pest manager to determine the best course of action to solve a pest problem and avoid negative impacts to non-target organisms, particularly if you:

- use a pesticide that is specific to the pest;
- control the pest effectively during the most susceptible stage of its life cycle; or
- consider the use of a non-chemical control.

Identifying the effects of biological control means knowing which creatures are helpful and determining if pests have been affected by the *beneficial organisms*. Sometimes pests are naturally kept in check, and at other times the pest populations sharply increase.

2. Assessment is the process of determining the potential for pest populations to reach an **action threshold** or an intolerable level. Is a grower likely to suffer financially? Is the pest likely to transmit a disease? There are important differences between the assessment of crop pests and urban pests. IPM treatment decisions are often based on certain thresholds.

The **economic injury level** is the number of pests which cause damage (loss of yield or quality) that is equal to the cost required to control the pest. A grower does not want a pest to cause damage, but he/she also does not want to spend money in treating the pest if it is not going to cause much damage. Spending $100 to treat a pest that is only going to cause $50 in damage is not good business. Therefore, treatment must be applied when it is anticipated that the economic injury level is going to be exceeded. The **economic threshold** is the highest point a pest population can reach without risk of its reaching the economic injury level. Economic injury levels are dependent on many factors, including value of the crop, stage of the crop, the amount of damage the pest makes, and the cost of a specific treatment. These factors have been calculated and estimated for a number of pests on several crops. However, when precise information is not available for all the factors required for calculation of an economic threshold, the highest tolerable pest level is often calculated and presented as the pest **action threshold**.

It is often virtually impossible to determine the "value" of some crop or settings. How much is a putting green on a golf course worth? How much is a cockroach-free school cafeteria worth? Urban pest thresholds are often related to aesthetics or health concerns rather than economic considerations. Where health concerns or individual sensitivities exist, the tolerable level for a certain pest may be *zero*. A *zero threshold* forces action even if only one pest has been detected. *Zero thresholds* exist in hospitals, food production, warehousing, and retail facilities.

The advantage in using thresholds is that if a pest has not reached the threshold level, there is no risk of economic loss and, therefore, there is no need to spray. Once pest numbers have reached the threshold level, action is justified. The costs of control will be less than the estimated losses that the pests would cause if left uncontrolled.

Forecasting, an assessment process, can help you determine if weather conditions will be favorable for the development of diseases and insect pests. For example, by using environmental information, such as periods when leaves remain wet (wetting periods), apple growers can predict when apple scab development occurs and spray only when conditions are favorable for the disease.

Growers who have kept *good records* of pests in previous years can use these records to help determine if problems such as weeds, insects, and diseases are likely to reoccur. For example, they might be able to apply the most effective herbicides at the proper time for early control of a problem.

3. Action (Control Methods) Once the number of pests reaches an action threshold, steps (actions) need to be taken to control or minimize the impact of the pest. Below are several tools that can be use as control measures.

a. Cultural Controls are those methods that change the environment of the pest, making it less favorable. In an agricultural setting, *plowing*, *crop rotation, removal of infected plant material, sanitation of greenhouse equipment, removal of pest harborages*, and effective *manure management* are all cultural practices that are employed to deprive pests of a comfortable habitat. In an indoor setting, *clutter reduction* and *proper cleaning practices* are cultural practices that discourage pest survival. Outdoor practices such as *proper planting* and *pruning techniques* and selecting *insect* or *disease resistant varieties* are also effective cultural techniques.

Pest-resistant plant varieties are less susceptible than other varieties to certain insects and diseases. Use of such resistant varieties often means that growers or pest management professionals do not need to apply as many pesticides as they would with susceptible varieties. Apple growers can save up to eight fungicide applications a year by growing scab-resistant apples such Liberty and Freedom cultivars. Farmers growing alfalfa and wheat also keep several pests at bay by planting resistant varieties. Plant breeders have developed many flower crops that are resistant to one or more insect pests. Turf managers can suppress common surface feeding insect pests by using *endophytic* grass and seed mixtures. Arborists can recommend new birch varieties within the landscape that are tolerant of borers.

Management of urban pests is improved when sanitation programs are implemented, pest harborages are eliminated, and garbage pickup frequency is increased. Flying insect pests can be reduced when lights, that do not attract insects, such as high-pressure sodium-vapor lamps, are installed. Removing tree stumps and lumber scraps (which are prime food sources for subterranean termites) from construction sites, can prevent problems with these pests.

Cultural controls also include practices which are sometimes classified as **physical controls** or **mechanical controls.** These include *structural modifications* and *barriers* which prevent pests from entering a building or infesting a crop. By preventing support timbers from soil contact, damage from several different wood destroying pests can be avoided. Wood absorbs moisture and is more susceptible to attack by carpenter ants and termites when in direct contact with the soil. mproving water drainage is also an important cultural control measure for urban pests.

Physical barriers such as netting over small fruits and screening in greenhouses can prevent pest problems. Vegetable crops may be covered with spun-bonded polyester to prevent moths and flies from laying their eggs in crops. Physical barriers are extremely important in termite, housefly, and rodent management. Screens, metal shielding, and door sweeps should be maintained to prevent pest infestation. Other physical controls include *light traps, sticky traps, multiple-catch and snap mousetraps, heat and cold treatments, electrical current,* and simple physical removal of the pest via *handpicking or vacuuming.*

Cultural controls are often simple and inexpensive but they usually must be applied in advance of a pest problem in order to be effective. Advanced planning is important. Therefore, once an IPM plan is implemented, these *preventive measures* can be used annually and/or seasonally to reduce the buildup of pests.

b. Biological Control is the use of **natural enemies** (biological control agents) to help manage pests. Biological control agents include *predators* (e.g. ladybird beetles and other beetles, fly larvae, adult wasps, ants), *parasites* (e.g. nematodes and specialized flies and wasps) and diseases (especially bacteria, fungi and viruses). There are three types of biological control: *introduction*, *augmentation* and *conservation*.

Introduction refers to the release of natural enemies of pests into new areas or regions. Introduction of natural enemies is carried out under government regulations to insure that these introduced natural enemies do not themselves become pests. Many of our pests originally came from different continents. These include the multi-colored Asian ladybird beetle, Gypsy moth, the imported cabbageworm, the Japanese beetle, and the European corn borer, among others. When these pests were imported, their natural enemies were left behind. By collecting natural enemies from the region where the pest originated, and then introducing these natural enemies in the "new" location, pest populations can be reduced and stabilized. An introduced parasitic fly and a fungus have successfully reduced Gypsy moth populations in community settings. Numbers of alfalfa weevil, previously a significant pest in alfalfa, have dropped following the introduction of a parasitic wasp. Studies are currently being conducted on the use of parasitic wasps to control the lily leaf beetle, a serious pest in landscapes.

Augmentation is the addition of (usually native) natural enemies directly into a system to reduce pest numbers. Many biological control agents are commercially available for augmentation. Predatory mites are released into orchards and strawberry fields to reduce spider mite numbers. Parasitic nematodes are applied to cranberry bogs to control root weevils. Ladybird beetles are commonly released in greenhouses to control aphids. Augmentation includes both **inoculative releases**, in which small numbers of beneficial insects are released over a period of time, which reproduce to become effective against pests, and **inundative releases** in which high numbers of beneficial insects are released.

The most important biological control method in agriculture is **conservation**. This is a selection of methods which preserve and encourage natural enemies that are already present. In agriculture, conservation methods include providing *refuges* for natural enemies, planting food crops, pruning and spraying in alternate rows, planting *cover crops*, managing water use, and applying pesticides selectively. Conservation is being recognized and practiced increasingly in a variety of settings, such as mosquito control. For example, open marsh water management (OMWM) has been successful in Massachusetts by allowing predators, such as fish, to feed upon salt marsh mosquitoes. To conserve natural enemies, pesticides with low toxicity to natural enemies must be selected and they should be applied in a manner to reduce natural enemy exposure. Leaving a low population of pests in the field also encourages natural enemies; since, when their prey is eliminated, natural enemies do not remain in the area for long.

It is important to remember that biological control is part of a biological system. In order for it to work effectively, a stable environment must be provided. Disturbances to the system such as wide temperature and moisture fluctuations or pesticide applications may reduce the probability for successful biological control. Biological control also takes time, so the practitioner must plan releases in advance. Also, because biological control is a dynamic system, it does not completely eliminate pests, but can reduce them to low levels.

c. Chemical Control - Pesticides are important and commonly used tools in IPM. However, they must be used in an appropriate and timely manner to help the PM system to function. This requires first determining whether a pesticide is needed and then selecting one that best fits the management program.

In recent years, there has been a movement to register active ingredients that are considered *reduced risk pesticides*. These reduced risk pesticides include *biological pesticides*. **Biological pesticides** include **microbial pesticides** (microorganisms such as fungi and bacteria formulated as pesticides) and **biochemical pesticides** which include *pheromones* (natural insect scents), *insect and plant growth regulators* (to affect the growth and molting process), and hormones.   Other reduced risk pesticides include *petroleum oils* (to suffocate insects, mites and their eggs), *repellents* (widely used in vertebrate management) and *soaps* (specifically formulated and tested as insecticides and herbicides). A new category of pesticides, that has yet to be widely used, is called *minimum risk pesticides.*   Active ingredients that are included in this category are corn oil, mint oil, garlic, peppermint, and white pepper. When considering which pesticides to use, it is important to note that the efficacy of some of these "new" pesticides are unknown.

Certain pesticides can provide immediate results in reducing pest populations. However, because of their toxicity and potential environmental impact, and because they are disruptive to the biological system, they should be used as a control measure when no other strategies will bring the pest population under the threshold.

Like all control actions, pesticides should be selected that are effective in controlling the pest, least disruptive to natural enemies, least hazardous to human health and least damaging to the general environment. These pesticides are likely to have a narrow host range, have low mammalian toxicity, and breakdown quickly in the environment. Additionally, pesticides of a similar mode of action should not be applied repeatedly, so as to prevent pests from developing pesticide resistance.

4. Record keeping involves the systematic storing and retrieval of IPM information. While federal and/or state law requires pesticide application records, in most situations the collection and use of other information can improve decision-making and provide more effective control. For example, the results from a monitoring program will indicate what a pest population looks like at various points in time. More extensive records can provide indications of increasing or decreasing numbers of pests or natural enemies, which could influence a decision about the treatment. In agriculture, weather records, coupled with pesticide application and pest sampling records, could indicate how well a specific pesticide performed in a certain situation. This **evaluation** could be useful in future seasons. A similar evaluation for a facility or athletic field can be made by tracking pesticide use patterns and other control strategies that may indicate that additional tactics are necessary.

5. Communication and Education involve having informed individuals available to report pest problems or conditions conducive to these problems. Examples include scouts in a cranberry bog and food service workers in a cafeteria. In addition, these individuals can educate and train others to understand the essential elements of IPM in order to involve them in the IPM program. Invariably, communication and education can play a role in the overall success of any IPM program.

An Overview

All of the components of an PM approach can be grouped into four major steps.

1. taking preventive measures (cultural practices, communication, and education) to avoid pest buildup,
2. monitoring,
3. assessing the pest situation, and
4. determining the best action to take (record keeping).

1) Once an integrated pest management approach is adopted, **preventive measures** can be taken that will reduce or slow the development of pest populations. For agricultural settings, these preventive measures include cultural controls such as crop rotation, pest resistant plant varieties, alternating planting dates, pruning, and sanitation. In a non-agricultural setting, preventive measures include adopting facility designs that will deter the development of pest populations. For example, positioning equipment off the floor in a commercial kitchen can insure easier and more thorough cleaning, using better construction methods can deter termite attack and infestation, and convincing consumers to use insect-proof containers for food or window screens in their homes, can be considered to be preventive measures. Communication and education are important since your customer and/or client can be an integral part of success of these preventive measures.

2) Monitoring occurs throughout the season or year. This is done by looking or sampling regularly for the appearance of insects, weeds, diseases, rodents, and other pests. Regular sampling, in both agricultural and non-agricultural settings, means using devices, such as *sticky* and/or *pheromone* traps, to detect pests.

3) Assessment also occurs throughout the season or year. An action threshold has to be determined for each pest that is identified through the monitoring process.

4) Determining the best course of action. If a pest reaches the action threshold, a control measure should be implemented. Accurate records will help to determine which control measures are appropriate. In IPM, control measures should be selected that are:

- least disruptive to natural enemies
- least hazardous to human health
- least damaging to the general environment
- most likely to result in permanent reduction of pests
- most cost-effective in the short- and long-term

In many IPM programs, cultural control strategies are employed first, biological control options are used next, and pesticides are used only as a last resort.

In summary, an IPM approach means that pest management professionals and growers use multiple tactics to prevent pest buildups, including monitoring pest populations, assessing the damage, making informed management decisions, and keeping in mind that pesticides should be used judiciously, after other alternatives have been tried. Ultimately, the IPM strategy serves agriculture, the environment, and human health as the most logical means to manage pests effectively, while using the least amount of chemical necessary.

Glossary Section

Biochemical pesticides: Pesticides that are naturally occurring substances that control pests by usually non-toxic mechanisms. Biochemical pesticides include substances, such as pheromones, hormones, natural plant regulators, natural insect growth regulators, and enzymes.

Biological pesticides: Pesticides that include naturally occurring and genetically engineered microorganisms (microbial pesticides), genetically engineered plants that produce their own pesticides (plant-pesticides), and naturally occurring compounds that are not toxic to the target pest (biochemical pesticides).

Biological Control: Pest control without the use of chemicals. Parasites, predators, diseases, etc., are used to control pests

Chemical Pesticide: Term used to describe a pesticide which is a chemical rather than a parasite, virus or some other type of pest killer.

Economic threshold: The point of pest infestation where application of a control measure would return more money that the cost of the control procedure.

Harborage: An area or site that pests find suitable to live such as cluttered and/or unclean places

Insect growth regulators: Pesticides that disrupt the molting, maturing from pupal stage to adult, or other life processes of insects.

Juvenile hormones: Natural insect chemicals that keep the earlier stages of an insect from changing into the normal adult form.

Microbial pesticides: Pesticides that contain microorganisms, such as bacteria, fungi, viruses, and protozoa, as the active ingredient. These pesticides can be applied like chemical pesticides in the form of dusts and spray mixtures.

Minimum risk pesticides: Chemical pesticides classified by the EPA as exempt materials under 40 CFR 152.25. The active ingredients covered by this exemption include, cedar oil, citronella, corn gluten meal, dried blood, garlic, mint oil, thyme and white pepper. Most of these active ingredients come from plants. Others come from animals (dried blood and putrescent whole egg solids), metals (zinc metal strips) or chemical compounds like sodium chloride (common salt).

Monitoring: Regular checking and identification of pests and effects of biological control.

Multiple catch trap: A mechanical device that attracts certain kinds of pests, such as mice, that can automatically reset and can catch many pests.

Natural Enemies: The predators and parasites which exist in the environment and attack pest species.

Nematode: A tiny, hair-like worm that causes damage by feeding on roots or other plant parts.

Parasite: A plant or animal that harms another living plant or animal (called the host) by living or feeding on or in it. Sometimes parasites are helpful to man by attacking and controlling pests which could injure crops or animals. These parasites are forms of biological control.

Pesticide Resistance: Genetic abilities developed by pest populations that enable them to resist the effects of certain types of pesticides that are toxic to other members of that species.

Predator: An organism that attacks, kills and feeds on other animals or insects.

Pheromones: Chemicals emitted by an organism to influence the behaviors of other organisms of the same species.

Pheromone traps: A device that contains a pheromone that is used to attract, trap, or kill a target pest.

Plant growth regulators: Substances (excluding fertilizers or other plant nutrients) that alter the expected growth, flowering, or reproduction rate of plants.

Reduced risk pesticides: Pesticides that contain active ingredients that pose reduce risk to human health, reduce risk to non-target organisms, reduce potential for contamination of the environment, and/or broadens adoption of IPM or makes it more effective.

Refuge: A place where beneficial insects are sheltered.

Repellent: A pesticide that keeps or drives insects or other pests away from the plant, animal, or surface treated.

Sticky traps: A non-chemical device that has a sticky surface which catches pests. It is used as a monitoring tool to confirm the presence and identity of pests.

Additional References

f you are interested in obtaining more information about PM for specific sites and/or crops, there are many publications available at the UMass Extension Bookstore (413) 545-2717, www.umassextensionbookstore.com

Licensing Requirements, General Use Pesticide, & Restricted Use Pesticides

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January 2014 (revised November 2014)

Learning objectives:

- First Read Chapter 14 in Core Manual (3rd edition)

- Define and understand the differences between applicator license, private certification, commercial certification and dealer license.
- Define the phrase "*under the direct supervision of a certified applicator*".
- Understand the roles of the U.S. EPA and Massachusetts Department of Agricultural Resources (MDAR) in registering pesticides.
- Describe the difference between a Federal Restricted Use Pesticide and a State Restricted Use Pesticide

Massachusetts Pesticide Licenses

Applicator License (a.k.a Core License): This license is required to use *general use* pesticides on the property of another for hire or as part of your current job duties on the property of your employer or land leased by your employer. Someone who has an applicator license may also use pesticide products classified a *restricted use pesticides* (RUPs) as long as they are working "*under the direct supervision of an appropriately-certified applicator*". The definition of "*under the direct supervision of a certified applicator*" is found in Massachusetts Pesticide Regulations Section 2.03(4) Definitions.

> "***Under the direct supervision of a certified applicator***"*, unless otherwise prescribed by its labeling, a pesticide shall be considered to be applied under the direct supervision of a certified applicator if it is applied by a competent person acting under the instructions and control of a certified applicator who is available if and when needed, and who is responsible for the pesticide applications made by that person, even though such certified applicator is not physically present at the time and place the pesticide is applied.

Private Certification: This license is required to use *restricted use* pesticides on an agricultural operation. A private certified applicator may also provide "*direct supervision*" to the other employees on the farm who maintain an Applicator's License.

Commercial Certification: This license is required to use *restricted use* pesticides on the property of another for hire. An applicator who maintains Commercial Certification may provide "*direct supervision*" for other employees who maintain an Applicator's License.

Dealer License: This license is required to sell products classified as *Restricted Use Pesticides* to appropriately Certified pesticide applicators.

*The Pesticide Board in the Massachusetts Department of Agricultural Resources has been reviewing this definition. There may be additional requirements associated with "*direct supervision*" in the future.

General Use Pesticide, Restricted Use Pesticides, & Pesticide Product Registration

The U.S. Environmental Protection Agency is responsible for registering pesticides that can be used in the United States. The majority of pesticide products registered by the U.S. EPA are registered as *general use pesticide*s. General use pesticides are commonly referred to as "over-the-counter pesticides." When there is a concern about a pesticide product such as high toxicity or impacts on the environment, the U.S. EPA may register and classify the product as a "*Restricted Use Pesticide (RUP)*". The pesticide label of these products are required to bear the words "**Restricted Use Pesticide**" in a prominent place on the front panel of the pesticide label.

After a pesticide product is registered by the U.S. EPA, the pesticide manufacturing company has to register the product in every individual state where they plan to distribute and sell their product. Every state has the ability to further regulate and restrict the use of pesticides within their state. Massachusetts can determine that a particular pesticide product will be reclassified and registered as a "*State Restricted Use Pesticide (SRUP)*", even though the U.S. EPA has registered it for "*general use*." Products that are reclassified and registered in Massachusetts as "*State Restricted Use Pesticides*" will **not** have the words, "**Restricted Use Pesticide**", on the pesticide label.

You must be an appropriately Certified Applicator (commercial or private) in Massachusetts to purchase and use any product classified by the federal government as a *Restrict Use Pesticide (RUP)* and/or Massachusetts *State Restricted Use Pesticide (SRUP)*. Such products may also be used by an individual whom maintains a valid Massachusetts pesticide Applicator License only under certain conditions of "*direct supervision by an appropriately-certified applicator*".

The Massachusetts State Restricted Use Pesticide List

The following criteria identify which pesticides are registered as State Restricted Use pesticides in Massachusetts as of **January 2014**. The criteria do not include those pesticides registered in Massachusetts as federally restricted use pesticides. Please refer to the Massachusetts Department of Agricultural Resources website (www.mass.gov/eea/agencies/agr/pesticides under the pesticide product registration) for a current list of State Restricted Use Pesticide products.

As a general guide, the pesticide active ingredients described below are classified as State Restricted Use pesticide pursuant to Massachusetts Pesticide Board Subcommittee actions.

1. All agricultural and non-cropland pesticide uses of products containing one or more of the following ingredient(s): (H-herbicide, I-insecticide, F-fungicide). These active ingredients have characteristics that can lead to leaching and possible groundwater contamination. They are listed on the Massachusetts Groundwater Protection List.

acifluorfen (H)	dimethanamid (H)	folpet (F)	pronamide (H)
bentazon (H)	dinotefuran (I)	kresoxim-methyl (F)	sedaxane (F)
bromacil (H)	disulfoton (I)	lindane (I)	simazine (H)
chlorothalonil (F)	diuron (H)	MCPA (H)	sulfentrazone (H)
cyflufenamid(F)	flufenacet (H)	methoxyfenozide (I)	terbufos (I)
cyproconazole (F)	fluopyram (F)	metolachlor (H)	thiamethoxam (I)
dacthal (DCPA) (H)	fluthiacet-methyl (H)	metribuzin (H)	triticonazole (F)

2. **All products containing 2,4-dichlorophenoxyacetic acid (2,4-D) in concentrations of 20% or greater** because of concerns for unreasonable risks to human health with the use of products with higher concentrations.

If you have any questions as to whether or not a specific pesticide product is registered in Massachusetts and/or classified as restricted use in Massachusetts, please contact the Pesticide Program Product Registration Specialist at (617) 626-1720.

Additional Legal Processes Affecting Pesticide Use in Massachusetts

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January 2014

Learning objectives:

- First read Chapter 14 in Core Manual (3rd edition)
- Define the terms Special Local Needs (SLNs) registrations and Emergency Exemptions (a.k.a. FIFRA Section 18)
- Explain the purpose of consumer information bulletins.
- dentify the location and/or types of pesticide applications that require consumer information bulletins.

State pesticide regulatory authority, as derived from state and federal pesticide law & regulation, is used in Massachusetts in several ways to increase pest control effectiveness by allowing uses of pesticides not on the labels of federally registered products. The principal types of such state actions are special local needs registrations (SLNs), emergency exemptions (Sect. 18) and experimental use permits (EUP's). In addition, existing state pesticide regulations are interpreted through advisory policy statements intended to clarify the state Dept. of Agricultural Resources (MDAR) enforcement expectations. Applicators, commodity groups, and registrants need to be familiar with these processes.

Special Local Needs Registrations (SLN a.k.a FIFRA section 24-(C)). Federally registered pesticide products are limited to use on sites and at rates as described on their labels. The Federal government recognizes that some pest problems of local significance may not be effectively addressed by such federally labeled products. When this is the case, the state is given the authority to issue, with the consent of the product registrant, a supplemental SLN or "24-C labeling" that adds the missing use to the label of an appropriate federal product. All SLN registrations are also subject to Federal review by the U.S. EPA. An in-state commodity expert, usually a University Extension leader must verify that the need is genuine and in the interest of a significant agricultural industry or other user group. The Massachusetts Department of Agricultural Resources (MDAR) must develop appropriate labeling and review the use for potential hazards and then, after acceptance by the registrant of the parent label, the 24-C label may be adopted. This SLN registration stays in effect so long as its registration is maintained at both the Federal (U.S. EPA) and State (MDAR) agency levels. SLN registrations may not be issued for chemicals not in federally registered products or for crop sites in which there is no federally established tolerance for the chemical in question.

Emergency Exemptions (Sect. 18's). When crop losses or health risks threaten, demanding immediate control efforts for which there are no effective federally registered products, the state has the power to authorize emergency use of appropriate unregistered pesticides. These emergency uses are NOT registrations and are subject to Federal review and final approval by U.S.EPA. There are four types of emergency exemptions. If the problem can be foreseen by a few months or more, a Specific Exemption request is made by the state to EPA, which reviews the request and approves or denies it with such restrictions and reporting requirements, as it deems necessary. If the problem is totally unforeseen and immediate action is needed, the state may act immediately on a Crisis Exemption simultaneously notify U.S. EPA of its actions and working with the Federal government to address the outstanding regulatory issues. A Section 18 is good only for a single use season or until a specified date. Other emergency exemptions include Quarantine Exemptions and Public Health Exemptions. The state seeks to an exemption only for very serious problems since such actions are undertaken via the authority granted to the governor and such actions may have significant legal ramifications. Review of such requests are first assessed by the Massachusetts Department of Agricultural Resources

Experimental Use Permits (EUP). Work done within Massachusetts under an EPA experimental use permit (EUP) requires a state EUP as well. Such permits are issued for large scale testing (1/4 acre or more of outdoor space or greater than 100 square feet of greenhouse bench space) for the purposes of developing information needed for pesticide registration. MDAR issues such permits and can be contacted for details concerning when EUPs are required.

Advisory Policy Statements. To explain the requirements of state pesticide regulations as they apply to specific problems or types of work, MDAR has written a series of advisory statements. These statements are not intended to add any new requirements to existing regulations but rather to make clear the agency's views on what does and does not constitute a violation that the agency would treat as a pesticide misuse. Guidelines are currently available on sign posting for lawn care specialists, use of pesticides in primary recharge areas (Zone II) of public drinking water wells, use of pesticides in occupied rooms and the mixing loading and storage of pesticides. These documents are available on the MDAR website.

Consumer Information Bulletins. These are documents that pesticide applicators must give to their customers before pest management services occur. These documents are designed to provide information to the customer and may include

- Purpose of the pesticide application on the lawn, school, home.
- Description of integrated pest management and other ways of minimizing pesticide use
- Describe ways to minimize exposure to pesticides
- Describe how the customer is notified before pesticide applications
- Describe the information that should be left with the customer after pesticide application
- List the contact information for questions or problems the customer may have.

There are consumer information bulletins for pesticide applications made to lawns, trees, indoor areas, and schools, daycare facilities and after school programs. There are additional consumer information bulletins for application of termiticides and for managers of buildings. These documents are available on the MDAR website.

Occupational Safety and Health Act and Safety Data Sheets

Natalia P. Clifton, UMass Extension Pesticide Education Program
University of Massachusetts-Amherst, January 2014

Learning Objectives:

- First read Chapters 17, 18, 20 and Appendix B in Core Manual (3rd edition)
- Describe the goals of the Occupational Safety and Health Act (OSHA).
- Describe your employer's responsibility regarding Hazard Communication in the Workplace
- Explain the differences between MSDS and SDS.
- Describe how the information found on pesticide labels differs from MSDS/SDS.
- Explain why pesticide applicators should read and understand the MSDS/SDS.

The Occupational Safety and Health Act of 1970 is a law regulated by the Occupational Safety and Health Administration (OSHA) under the U.S. Department of Labor. The goal of the law is "to assure safe and healthful working conditions for working men and women". There are many hazards in the workplace such as falls, sprains, burns, exposure to chemicals, or other accidents. Employers are required to identify hazards in the workplace and take steps to minimize those hazards for their employees. Employers will use a combination of chemical product labeling, material safety data sheets (MSDS provided by chemical manufacturer) and employee training to explain the chemical hazards in the workplace.

In 2012, the Hazard Communication Standard of OSHA was revised in order to "to be consistent with the provisions of the United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS)." Under this revision, the terminology of material safety data sheet (MSDS) was changed to safety data sheet (SDS). Although the function of the SDS is the same as a MSDS, there is now a standard 16-section format for each SDS. Safety data sheets will include information about the chemical identification, hazards, first-aid measures, fire-fighting measures, handling and storage, exposure control/personal protection, and toxicological information. The transition to the "new" format is required to be completed by June 1, 2015. Therefore there will be a mix of "old MSDS" and "new SDS" until June 2015.

The use of pesticides in the workplace is regulated by U.S. EPA under Federal Insecticide Fungicide and Rodenticide Act (FIFRA). Pesticide users are required to comply with pesticide labels as well as accompanying labeling. EPA considers the MSDS/SDS to be part of the pesticide labeling. Employers are required to obtain and supply MSDS/SDS to their employees for all pesticide products. Pesticide users (the employees) are required to comply with the MSDS/SDS. It is advised that all pesticide applicators have copies of safety data sheets in their company vehicles for each of the pesticides they are transporting. This is to ensure that they have access to these important documents at all times for both reference purposes as well as emergency situations.

Safety data sheets can provide important information that is not always found on the pesticide label. This may include additional guidelines for personal protective equipment and use (Section 8). Provisions for emergencies such as fires and spills are addressed under Section 5 and Section 6, respectively. Section 11 covers the toxicological information for the pesticide including; routes of exposure, symptoms of poisoning, LD_{50}, and immediate, delayed, and chronic health effects. Safety Data Sheets standard format includes the following sections:[1]

Section 1, Identification includes product identifier; manufacturer or distributor name, address, phone number; emergency phone number; recommended use; restrictions on use.
Section 2, Hazard(s) identification includes all hazards regarding the chemical; required label elements.
Section 3, Composition/information on ingredients includes information on chemical ingredients; trade secret claims.
Section 4, First-aid measures includes important symptoms/ effects, acute, delayed; required treatment.
Section 5, Fire-fighting measures lists suitable extinguishing techniques, equipment; chemical hazards from fire.
Section 6, Accidental release measures lists emergency procedures; protective equipment; proper methods of containment and cleanup.
Section 7, Handling and storage list precautions for safe handling and storage, including incompatibilities.
Section 8, Exposure controls/personal protection lists OSHA's Permissible Exposure Limits (PELs); Threshold Limit Values (TLVs); appropriate engineering controls; personal protective equipment (PPE).
Section 9, Physical and chemical properties lists the chemical's characteristics.
Section 10, Stability and reactivity list chemical stability and possibility of hazardous reactions.
Section 11, Toxicological information includes routes of exposure; related symptoms, acute and chronic effects; numerical measures of toxicity.
Sections 12 through 16 are regulated under Federal and State pesticide laws
Section 12, Ecological information*
Section 13, Disposal considerations*
Section 14, Transport information*
Section 15, Regulatory information*
Section 16, Other information, includes the date of preparation or last revision.

*Note: OSHA will not be enforcing Sections 12 through 15(29 CFR 1910.1200(g)(2)).
[1]OSHA Quick Card Hazard Communication Safety Data Sheets
https://www.osha.gov/Publications/HazComm_QuickCard_SafetyData.html

Because of the changes to SDS there maybe some inconsistencies between the pesticide label and the SDS. For example, the signal words (Caution, Warning, Danger) on the pesticide label may be different on the safety data sheets. Safety data sheets are intended to be consistent with Global Harmonization labeling and therefore use different criteria for signal word selection. Pictograms will also start appearing on safety data sheets. Here are a few pictograms and their meanings. (page 28)

Exclamation Mark

Irritant (skin and eyes)
Skin Sensitizer
Acute Toxicity (harmful)
Narcotic Effects
Respiratory Tract Irritant

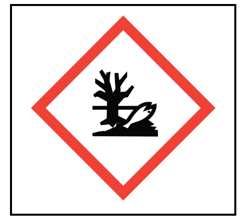
Health Hazard

Carcinogen
Mutagenicity
Reproductive Toxicity
Respiratory Sensitizer
Target Organ Toxicity

Corrosion

Skin Corrosion
Burns
Eye Damage
Corrosive to Metals

Environment



Aquatic Toxicity