General Knowledge: Integrated Pest Management (IPM)

Integrated Pest Management (IPM) Learning Objectives

THIS CHAPTER IS PART OF THE GENERAL KNOWLEDGE REQUIRED FOR BOTH PRIVATE AND NON-PRIVATE CERTIFIED APPLICATORS GENERAL EXAM.

After studying this section, you should be able to:

- ✓ **Define the concept of Integrated Pest Management (IPM).**
- ✓ **List the principles of IPM.**
- ✓ **Describe IPM Action Thresholds and explain how they are used.**
- ✓ **List the five major groups of IPM control strategies and provide several examples of how each would be used in an IPM program.**

What is Integrated Pest Management (IPM)?

Integrated Pest Management (IPM) is a long-term management strategy that uses a combination of tactics to reduce pests to tolerable levels with the lowest cost to the pest manager and minimal effect on the environment. IPM integrates prevention, cultural practices, mechanical and/or physical pest controls, biological pest controls **and** chemical pest controls to prevent and suppress pests. The goal of IPM is to reduce, in an economical way, the adverse impacts of pest control on human health, the environment and non-target organisms. IPM is based on and uses scientifically sound strategies. Problems associated with widespread pesticide use, such as pest resurgence, pest resistance and secondary pest outbreaks, are minimized by using IPM.

Integrated Pest Management (IPM) combines prevention, cultural, mechanical/ physical, biological and chemical pest control methods to formulate effective pest management plans.

The concept of Integrated Pest Management is nothing new and is widely implemented on field crops and orchards throughout the world. Implementation in the urban environment presents special challenges. Urban IPM, or pest control programs that incorporate reduced use of pesticides in homes, private and commercial landscapes, golf courses and structural settings, is an expanding field with increased support from university and industry research.

Principles of IPM

- **Identify the pest.**
- **Monitor the pest population.**
- **Establish an action threshold.**
- **Evaluate control options.**
- **Implement control options.**
- **Monitor results.**

For pest identification help, go to

http://ipm.ucanr.edu

Select tactics that will be most effective, most economical and have the least impact on non-target species and the environment.

Principles of Integrated Pest Management (IPM)

1. **Pests, their hosts and beneficial organisms must be positively identified.** The pest problem and associated plant or animal species must be correctly identified. If you can't identify the pest, collect samples and submit them to University of Nevada, Reno Extension or the Nevada Department of Agriculture for identification. Many university websites have photo galleries to help identify pests. The University of California Statewide Integrated Pest Management website at http://ipm.ucanr.edu has good information. Once the pest is identified, determine the pest's life cycle, growth cycle and reproductive habits. Pest managers should also be able to identify all life stages of beneficial organisms, such as the lady bird beetle, an insect predator.

2. **Establish monitoring guidelines for each pest species.** Routine monitoring of both pests and natural enemies (beneficial species) is a critical part of IPM. Methods of monitoring include visual inspection, pheromone and sticky traps, and sweep nets. Document and track both pest and beneficial organism population numbers. The ratio of natural enemies (usually insects) to pests should be considered before a pesticide is applied.

3. **Establish an action threshold for the pest**. A fundamental concept of IPM is that a certain number of individual pests can and should be tolerated. Thresholds may be based on many things, such as pest numbers or percent damage. Will the pest cause unacceptable damage to the value or appearance of the plant, crop or animal? When working with structural pests, how will the pest affect the structure and those who use the structure? **What will happen if no action is taken?** These types of questions help to establish the action threshold for a particular pest in a given situation. Action thresholds are usually divided into four categories: economic, aesthetic, emotional and human health and safety.

   The **economic threshold** is defined as the pest population level that produces damage equal to the cost of treatment. The threshold is the pest density, or population level, at which a control application should be made. Economic thresholds are commonly used in agricultural crop production. The economic thresholds for most agricultural commodities, including production horticulture, are fairly well understood, and IPM programs have been developed for many agricultural crops around the world. In an agronomic setting, a single crop is grown over a large area with a relatively uniform climate pattern. The number of pests associated with the crop is usually limited. Each pest has been studied in relation to the crop and the prevailing environment, and IPM strategies are developed for its control.

Urban landscapes and structural settings are judged on their appearance and whether or not the presence of a pest presents a health or safety issue. The aesthetics and healthful condition of an individual plant or animal, a whole landscape or a structure may be affected by pests. The presence of pests and their damage, though not serious, may be intolerable or annoying to some, yet readily accepted by others. Urban IPM strategies are developed with less emphasis on economic thresholds, unless the soundness of the structure or liability concerns for a client are involved. It is often the appearance of a pest or the damage it causes that triggers control actions. This is called the **aesthetic threshold**. The aesthetic threshold varies from person to person, making it difficult to establish control criteria for most landscape pests. Each property or situation my have a different aesthetic threshold.

Sometimes, the action threshold is based solely on the emotions of the property owner. This is referred to as an **emotional threshold**. For many people, a single mouse, cockroach or spider is unacceptable. Many people fear pests, and this triggers their need to implement control actions.

Action thresholds are low when **human health and safety** are at risk. The action threshold for poisonous black widow spiders would likely be lower than the threshold for other spiders. Action thresholds are likewise low for arthropods that transmit disease, such as ticks that transmit Lyme disease or mosquitoes that transmit West Nile virus.

4. **Evaluate and implement control tactics.** Select tactics that will be most effective, most economical and have least impact on non-target species and the environment. In agriculture and urban landscapes, decisions based on action thresholds should also take into account the presence of natural enemies. Select controls that will impact beneficial organisms as little as possible while suppressing the pest. If a pesticide is the selected management tool, beneficial enemies (usually insects) will likely also be killed.
5. **Monitor, evaluate and document the results.** This allows you to make adjustments to improve the effectiveness of future pest control strategies.

Pest Thresholds:

Economic: Point at which the pest infestation causes enough economic damage to justify the cost of treatment.

Aesthetic: Point at which the infestation causes enough visual damage to justify treatment.

Emotional: Point at which the pest infestation causes enough emotional trauma to justify treatment.

Human health and safety: Point at which the pest infestation causes enough health or safety concerns to justify treatment.

Integrated Pest Management (IPM) Methods

Integrated Pest Management (IPM) uses a wide range of pest control methods that will provide control in a cost-effective manner. IPM also seeks to minimize potential risks to humans, animals (pets, livestock and wildlife), and the environment. Most effective pest control plans include two or more control methods. Control methods can be divided into five basic groups: prevention, cultural controls, mechanical or physical controls, biological controls and chemical controls.

Prevention: Prevention strategies seek to prevent pest infestations or minimize the conditions that contribute to pest infestations.

For plants, one of the most effective prevention strategies is to select plant varieties that are adapted to and will flourish in Nevada's challenging climate. Plants that are not subject to environmental stresses are less susceptible to disease or other pest problems. If a poorly adapted plant is selected for a landscape, it will be difficult to overcome the stresses imposed on the plant or control the pest problems that arise as a result. Choosing plants that will do well in existing site conditions can help to prevent pest problems.

Another prevention strategy for plants is to choose pest-resistant plant varieties. Selecting plants based on their resistance to pests is essential for effective landscape IPM. Host plant resistance is the ability of the plant to tolerate pests without damage to the plant itself. For example, selecting a Norway maple (*Acer platanoides*) instead of a silver maple (*Acer saccharinum*) or boxelder tree (*Acer negundo*) will help avoid problems with boxelder bugs. Boxelder bugs do not prey on Norway maples, but both silver maple and boxelder trees are preferred hosts for the bug.

Before purchasing or planting, inspect all new stock to make sure diseases, insects, weeds and other pests are not present. Do not purchase, and refuse to accept, plant material with obvious disease, insect or cultural problems. Remove weeds from nursery containers before you place them in a landscape.

Rotating crops can help disrupt disease or insect infestation cycles. Choosing disease, weed and other pest-free plants, seed, mulch and other garden amendments will also aid in preventing a pest problem.

Selecting structural materials and products that eliminate habitat or food for pests is a prevention strategy for structural pests. Many new materials (steel and plastic) are not eaten by pests, nor can they become a habitat for them.

Successful pest control management considers all the potential control methods:

- **Prevention**
- **Cultural**
- **Physical/ mechanical**
- **Biological**
- **Chemical**

Prevention is generally the least expensive control strategy

Cultural controls: Cultural controls are the practices or strategies we use to grow and maintain healthy plants and animals. Cultural practices, such as proper fertilizer application, watering, soil management, sanitation and site selection can influence the health of plants and, therefore, the frequency and severity of pest problems. Good sanitation practices are imperative to prevent many insect and vertebrate infestations in homes, warehouses and other structures. Livestock operations require that the animals be maintained in healthy conditions with adequate food and water. Healthy animals, like healthy plants, are better able to resist pest infestations. Relatively small changes in cultural practices can have significant impacts on pest populations.

Proper fertilization and appropriate watering can promote healthy plant growth, which makes plants less susceptible to pest problems. Improper fertilizer and watering, either too much or too little, can stress plants and may encourage pests. Managing soil to improve water- and nutrient-holding capacity and maintain pH within the range from 6.0 to 8.0 will also aid plant health. Healthy plants are less susceptible to pest problems. Selecting appropriate planting sites also helps to ensure plants will survive and thrive. A plant under stress is more susceptible to pest problems.

Proper fertilization and appropriate watering promote healthy plant growth, reducing the plant's susceptibility to pest infestation.

For crops or gardens, rotating plantings can help break the pest cycle. Diseases and insect pest cycles can be disrupted by this simple, time-honored cultural practice. The use of companion plantings can also interrupt the pest cycle, acting as a barrier to protect the desired crops or plantings.

Another cultural control that can aid plants is to avoid unintended injury. Avoiding mechanical damage can greatly improve a plant's survival and reduce potential pest problems. Wounds in trees caused by string trimmers, mowers or tillage equipment can induce stress and shorten the life of trees by making them susceptible to both insects and diseases. Pruning wounds created at the wrong time of year can make a tree more susceptible to insect and/or disease infestations. For example, pruning black locust trees when locust borers are active in late summer and early fall creates wounds that may attract egg-laying females.

Good sanitation can help to prevent many pest infestations. Remove disease- or insect-infested plant materials from the vicinity of susceptible plants. Pick up fallen fruit, as diseases and/or insect pests may overwinter in them, leading to re-infestation the following year. Prune out dead or diseased plant parts or remove entire diseased plants before pests spread to adjacent plants. Regular cleaning and disinfecting of gardening equipment, particularly pruning tools, is also recommended to prevent the spread of some landscape diseases.

Good sanitation can prevent many pest infestations.

Eliminate food and water sources for pests.

Eliminate shelter sites for pests.

Changing the temperature, light or humidity are cultural factors that can reduce the incidence of pest infestations in storage structures, greenhouses and other facilities.

Changing the environment is another cultural control method to discourage or eliminate pests. All animals need three things to survive: food, water and shelter. Insect, rodent and bird pests are no different than other animals. Manipulating the environment can prevent or discourage them. This approach is most appropriate when dealing with pests in and around homes, agricultural buildings and other facilities, such as schools and hospitals. Good sanitation within and around structures is critical in controlling pests. This eliminates habitat and food sources for most pests. Good sanitation, especially manure management, aids in reducing the incidence of pest infestations in or on animals.

Eliminate food and water sources for pests:

- Regularly empty trash cans and replace liners to reduce insect and rodent pest problems.
- Store seed and pet and livestock feed in secure, pest-proof containers.
- Routinely sweep and mop kitchen floors and food preparation areas.
- Repair leaking pipes.
- Wring out and dry floor mops.
- Clean out rain gutters to allow proper drainage.
- Keep floor drains clean.
- Destroy crop residues to reduce insect and disease pests.
- Empty containers that collect rain or irrigation water.

Eliminate shelter sites for pests:

- Seal entry points, including holes, cracks and other openings where insects and rodents enter structures.
- Use door sweeps to prevent pests from entering under doors.
- Keep doors closed.
- Eliminate clutter, including trash, brush and debris or leaf piles where pests hide and nest.
- Install bird spikes, netting or other barriers to prevent birds from nesting, feeding or roosting.
- Empty containers that collect rain or irrigation water.

Changing the temperature, light or humidity are cultural factors that can reduce the incidence of pest infestations in storage structures, greenhouses and other facilities.

Physical/mechanical controls: Physical or mechanical control strategies are those methods that reduce pest infestations by disrupting the pests or providing a physical barrier to prevent the pest from infesting an area.

One of the simplest methods of physical or mechanical pest control is hand-picking insects or hand-pulling weeds. This removes the pest from the host plant or site. This method works best in situations where the pests are visible and easily accessible.

Physical or mechanical disruption of pests also includes such methods as mowing, hoeing, tilling or cultivating. Another method of physical disruption is washing. A strong spray of water may interrupt the life cycle of many insect pests while causing little damage to the host plants or the surrounding environment. In many cases, reducing pests by mowing, cultivating, hoeing or trimming can provide an alternative to using pesticides in the landscape. Reducing direct competition from weeds through careful tillage or mulching around the base of plants can enhance the life and appearance of the plants.

Physical barriers, such as fences, netting, sticky barriers, plastic mulches, row covers, plant cages and paper or plastic tree collars, can help prevent or at least deter pests. Caulking around windows, doors, and utility line access holes and screening entrances, vents, and access ports does much to keep structural pests out of a building. Do not bring pest-laden items, such as storage boxes, old furniture, plants and soil, stored products, etc., into a structure without first inspecting them for pests and controlling them.

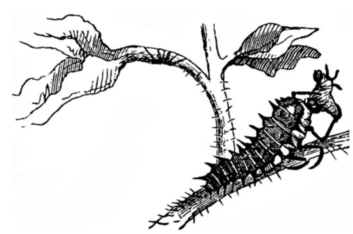
Traps are another physical or mechanical method used to control pests. Types of traps include mechanical traps, such as mouse traps, sticky traps and light traps. Some traps contain pheromones that attract and trap pests using scents. Another method uses trap crops. These are crops intentionally planted to attract pests away from economic crops or desired plants. The trap crop is sacrificed to protect the other crops.

Biological controls: Biological pest control is the use of a living organism to control another living organism. The importance of using biological control agents to control insect and disease pests is often overlooked. Biological agents of landscape pests include:

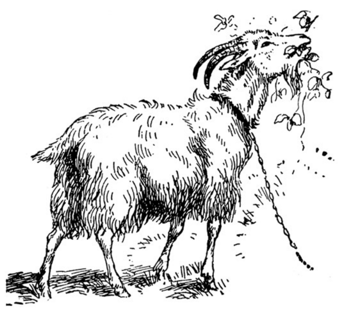
- **Predators:** Common arthropod predators of insects include lacewings, predatory mites, minute pirate bugs, lady bird beetles and spiders. Either the adult and/or immature stage may prey on insect pests, so it is important to properly identify all the life stages of predator arthropods. Some predatory arthropods have greater impacts on pest populations than others. Vertebrate pest management should include the use of natural enemies. Examples include predators, such as hawks, owls and

Mechanical controls include hoeing.

Trap crops are planted to attract pests away from economic crops or desired plants.



Lady bird beetle larva.



Grazing animals, such as this goat can slow the spread of weeds.

Biological control may be obtained by conservation, augmentation or importation of the control species.

coyotes, that prey on rodents. Natural enemies can be found in all habitats including landscapes, aquatic sites, crop land and surrounding areas.

- **Parasites:** The life cycle of insect parasites develops in or on an insect host. The parasite feeds on body fluids or organs, usually killing the host. Common parasites include wasps, flies and nematodes. Most are specialized in their choice of a host.
- **Weed Feeders:** Insects, grazing animals and some fish, such as grass carp, consume plant leaves, stems, seeds, flowers and fruits. Insects are often specific to a single species of weed, while grazing animals and fish feed on a broader array of vegetation. Weed feeders seldom eradicate an infestation. However, they are useful in slowing the spread of weeds.
- **Pathogens:** Weeds, arthropods and vertebrate pests can be infected by pathogens, including viruses, bacteria and fungi. When environmental conditions are favorable for the pathogen, a disease outbreak can occur which may decimate the pest population. This same principle applies to disease outbreaks in all species, including humans. Most pathogens are specific to certain groups of plants or animals. A pathogen commonly found in soil is *Bacillus thuringiensis,* or "Bt." Bt is a bacterium that is effective at controlling insects in their larval stage. There are two common commercial varieties: kurstaki (Btk), which controls caterpillars and israelensis (Bti) which controls mosquitoes, black flies, and fungus gnats. Bt products are considered safe to humans and other non-target organisms.

Biological control may be accomplished in one or a combination of several ways:

- **Conservation**: This is the process of using, protecting and encouraging existing populations of natural enemies. Examples of conservation include avoiding the use of insecticides when beneficial insect populations are high or providing nesting or roosting sites for birds of prey. Conservation is the most cost-effective form of biological control.
- **Augmentation:** This occurs when more individuals are added to an already existing population of biocontrols at a site. For instance, many species of predator and weed-feeding insects can be collected in the field or raised commercially and may be released to increase existing populations to a level where they are effective against the pest.
- **Importation:** This method relies on introducing a population of beneficial organisms not currently present to a given site. This is often done to

manage nonnative pest species, such as the noxious weeds saltcedar and leafy spurge, or insect pests like the Russian wheat aphid.

The Nevada Department of Agriculture, in cooperation with USDA – Animal Plant Health Inspection Service (APHIS) and Plant Protection and Quarantine (PPQ) is using biological controls to manage several pests in Nevada. Russian wheat aphid (*Diuraphis noxia*), a recently introduced insect, is a serious pest of barley, wheat and other small grains. Parasitic wasps, syrphid flies and different species of lady bird beetles have been released experimentally with the hope that they will contribute to the control of this damaging aphid. Attempts to control the noxious weed leafy spurge (*Euphorbia esula*) have included beneficial insects. Three species of flea beetle and a midge species have been released in Nevada to decrease the population of this weed to manageable levels.

Chemical controls: Chemical controls include pesticides applied to manage pests. More information on types of pesticides can be found in the previous chapter of this manual. Pesticides should be viewed as a last-resort treatment to prevent significant damage to plants in the landscape, as a viable and possibly necessary treatment for agricultural commodities, or to protect human health. Pesticides are important tools, but they should be used only when necessary and in conjunction with other management tools. The development of a pest problem often signals poor management practices, so a review of the management protocols and cultural practices for a given landscape, field or property should be made prior to applying pesticides.

In the urban environment, the tendency is to use pesticides as preventative measures to ensure “perfect” landscapes. Pesticide use for this purpose is based on perceived threats from pests, but many times no actual pest has been identified and no damage is visible. Not only is this pesticide application philosophy expensive and unnecessary, but it may also have significant environmental consequences. For example, overapplication of weed-and-feed-type products on lawns can have serious effects on adjacent ornamental plants, particularly trees planted in or adjacent to turf.

The use of pesticides for structural and institutional pest control must first consider the potential exposure to the residents of the building, as well as potential health effects. When inside a structure, pesticides tend to break down more slowly than when in the outdoor environment, so residual effects must be considered. This limits the number and type of pesticides that are available for such applications. These products are highly regulated.

For further information on biological controls, go to USDA-APHIS Plant Health Biological Control Program, https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/biological-control-program.

IPM recognizes that pesticides have a role in pest control strategies, but they are not the only pest control option and should only be used when other options are not effective.

Why Use Integrated Pest Management (IPM)?

An effective Integrated Pest Management (IPM) program will help reduce pest resistance, pest resurgence and secondary pest outbreaks.

Effective Integrated Pest Management programs have successfully reduced unnecessary pesticide applications, as well as the total number of applications made in a season or to structures. This has resulted in reduced pest control costs and may prevent some of the adverse effects of total reliance on pesticides, including pest resurgence, secondary outbreaks and pesticide resistance.

Pest Resistance: When a pesticide is effective against a pest or group of pests, it may be overused. Under these circumstances, the pest population may become resistant to the specific pesticide or pesticides with similar modes of action. This happens because naturally resistant individuals who survive the pesticide application may pass the resistance on to their offspring. The resistant offspring survive while the nonresistant offspring die. This eventually results in an entire population composed of resistant individuals. The pesticide is no longer effective, causing applicators to increase rates and application frequencies, which in turn leads to increased resistance and increased environmental hazards due to overapplication of pesticides. Currently, hundreds of pests have developed resistance to one or more pesticides. Common pest species that have demonstrated resistance include houseflies, mites, aphids, cockroaches and common mallow, a weed often found in lawns and gardens.

Resurgence: Pesticides, both synthetic and so-called “natural” materials, can do more harm than good because they often destroy the natural enemies of a pest. Although natural enemies may be few in number, when they are present, they help to control a certain percentage of the pest population. If the existing natural enemies are destroyed by pesticides, you lose this benefit. Following a pesticide application, pest populations can rebound much more rapidly than their predators, particularly those with multiple generations per year. Their numbers may quickly outdistance the ability of the predators to help control them. The pest population may quickly increase to greater numbers than before the pesticide application was made. Pest resurgence can result in a “pesticide treadmill,” which occurs when applications of pesticides are followed by pest resurgence, followed by pesticide applications made at a higher rate, followed by pest resurgence, and so on. This pattern adds to pesticide resistance problems.

Secondary Pest Outbreaks: An organism that usually does little damage when left alone may suddenly become a problem if pesticide applications destroy its natural enemies. A well-documented example of secondary pest outbreak can occur when broad-spectrum pesticides, such as carbaryl, organophosphates or acephate, are used for the control of aphids or coddling moth on apple trees. Along with a decrease in the targeted pest population, there is a decrease in the natural enemies of mites and, consequently, a serious increase in the mite population. Recommendations on the labels of many orchard-spray products suggest mixing a miticide (a pesticide designed to kill mites) with a broad-spectrum insecticide, to help control the predicted surge in mites. The mites existed before but were being kept in check by natural enemies. The broad-spectrum pesticide releases the secondary pest from control by their natural enemies and allows them to become dominant pests.

Conclusion

Ideally, an Integrated Pest Management program considers all available pest control actions, including no action. IPM is not a substitute for good horticultural practices in agricultural fields or the landscape. Nor is it a substitute for selecting the most pest-resistant or tolerant materials. IPM does not advocate the complete avoidance of pesticides. It recognizes that pesticides have a continuing role to play in conjunction with and in support of other pest control strategies. However, the applicator should consider the proper timing of applications and use spot spraying to promote the most effective control with the least amount of chemical.

By reducing our reliance on pesticides in home gardens, agricultural fields, public health applications, structures, and parks and recreation areas, we lower the amount of pesticides introduced into the environment. We also reduce the potential for the applicator and others to be harmed by continued exposure to chemicals. In addition, with judicious use of pesticides, we can extend the useful life of some beneficial chemicals by reducing the buildup of pest resistance.

For more information, go to A Green Industry Professional's Guide to Integrated Pest Management (IPM), University of Nevada, Reno Extension Special Publication SP-17-14 at https://naes.agnt.unr.edu/PMS/Pubs/2020-2326.pdf. A hard copy of this publication is available at the Washoe County Extension office at 4955 Energy Way, Reno, Nevada.

Unless otherwise noted, all line drawings are from Clipart ETC, Florida's Educational Technology Clearinghouse, University of South Florida, http://etc.usf.edu/clipart/index.htm.

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Updated in 2023 by M. Hefner, University of Nevada, Reno Extension and B. Allen and R. Saliga, Nevada Department of Agriculture

Ideally, an Integrated Pest Management program considers all available pest control options, including no action.

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