Chapter
7

INTEGRATED PEST MANAGEMENT

The goal of pest management is to manage pests effectively, economically, and safely. Insects, weeds, plant diseases, slugs, birds, and mammal pests can be managed using Integrated Pest Management (IPM). With IPM, you only need to reduce pest numbers below a damaging level. It is not necessary to eliminate all pests.

The IPM approach was first developed for agricultural pests. Since the 1980s, it has been successfully applied to:

- Landscape pests
- Forestry pests
- Structural pests
- Home and garden pests

IPM helps decrease the need for chemical pesticides. This reduces costs and environmental risks.

Learning Objectives

Completing this chapter will help you to:

- **Define Integrated Pest Management and describe the parts of an IPM program.**
- **Know why correct identification and knowledge of pest biology is crucial when managing pests.**
- **Know the role of monitoring in pest management and give examples of common methods.**

Learning Objectives, cont'd.

- **Describe injury and action thresholds and know the difference between them.**
- **Describe five categories of pest treatments and give examples.**
- **Know the factors to consider when choosing pest treatments.**
- **Know the importance of evaluating pest management results.**

Principles of Integrated Pest Management

IPM is a decision-making process that helps to prevent pest problems. With IPM programs, all information and treatment methods are considered in order to manage pests. This should be effective, affordable, and safe for the environment. Elements of any IPM program include:

1. **Prevention**: Organisms are kept from becoming problems by planning and managing ecosystems.
2. **Identification**: Pests and beneficial organisms are identified.
3. **Monitoring**: Pest and beneficial organism's populations are watched, as well as pest damage, and the environment.
4. **Injury and Action Decision**: Injury and action thresholds are used to know when to treat pests.
5. **Treatments**: Treatments (or a combination) are used, including cultural, biological, physical, mechanical, behavioural, or chemical methods. The goal is to control pests with little impact on the environment.
6. **Evaluation**: The effectiveness of pest management plans are considered.

Advantages of IPM include:

- Long-term answers to pest problems
- Protecting environmental and human health by reducing pesticide use
- Reducing harm to beneficial organisms
- Preventing creation of pesticide resistant pests
- Providing a way to manage pests when pesticides cannot be used

Elements of an IPM Program

Prevention

Prevention is a key step in IPM. IPM prevents problems by changing the way crops, ornamentals, buildings, or other sites are managed. Avoiding pests is often cheaper and gives better results in the long run. Waiting until problems occur can create a reliance on treatments. Preventing pest problems protects plants with no treatment cost. If prevention does not eliminate pests, their numbers are at least lower. This makes them easier to control.

Cultural or physical controls (described later) can be considered preventive. You might choose disease resistant plant species to avoid some disease problems. Sanitation is a big part of prevention. An example would be cleaning a warehouse to deny food and water to rodents.

Identification

Not all plant damage or decline is caused by pests. Crops, ornamentals, lawns, and other plants can be damaged by extreme heat, cold, or wind. They can also be damaged by physical injuries from equipment, lack of nutrients, human activity, or pet urine. Many types of pest damage look the same, but controls for individual pests can vary. You must know what the problem is before choosing a treatment. When a pest is identified, you must find information on its biology and life cycle.

To plan an IPM program, find out:

- When pests will be present
- What they eat
- Where they hide
- The stages of life that are easiest to control
- What natural enemies exist

Beneficial organisms (e.g., insects) are often mistaken for pests when found on damaged plants. They are actually there to prey on the pests that cause damage. You must be able to recognize beneficial organisms before deciding if treatments are required. For example, if enough lady beetles are present in aphid colonies, a pesticide may not be needed to control the aphids.

Understanding the biology of pests and beneficial organisms can help in making pest management decisions:

- Knowing the life cycle and growth stages of a pest allows you to target treatments to times when the pest is most exposed. This is important if the treatment only works for a short time, or during certain stages of the pest's life.

- Knowing the rate of reproduction for a pest can help when choosing the time and number of treatments. Pest species that have only one generation a year tend to grow more slowly than species with many generations each season.

- Knowing the rate of reproduction for beneficial organisms helps in deciding if the beneficial organisms will be able to control the pest population naturally, or if a different treatment will be needed. Some species have one generation per year. Others have many.

- Understanding pest behavior can help in choosing the time and place of treatment. Some pests are only active at certain times of the day or in certain places. Knowing this allows you to target pest management efforts.

Identify Pests and Beneficial Species

Applicators can learn to identify common weeds, insects, vertebrate pests, and plant diseases. It is ideal to have a sample of the pest, to make sure that it is identified correctly. This may not always be possible. Some pests (e.g., plant diseases) are often identified by the damage or symptoms they cause.

If a pest cannot be identified you can seek the help of someone with more experience, or a professional.

Some provinces have government or private diagnostic laboratory services to identify pests. This usually involves a fee.

Identification and biology of pests and beneficial organisms can be learned from:

- Identification guides, reference books, and government or scientific publications
- Government or private pest monitoring services
- Representatives or technicians from pest management or pesticide companies
- Government pest management specialists
- Universities and colleges
- The Internet and other electronic resources

Monitoring

Crops, ornamentals, buildings or other sites can be checked, or monitored, for the presence of pests. Monitoring gives the information needed to make sound decisions on managing pests. Regular monitoring makes it possible to tell where pests are, the size of the population, and if it is increasing or decreasing. This helps when deciding whether treatments are needed, and the most effective time and place.

A pest monitoring program consists of:

- A series of regular inspections and counts, or estimates, of the size of the pest population
- Written records of observations and the counts found during each inspection

Monitoring can be as simple as keeping regular notes of monthly visual inspections. It can be as complex as performing detailed, weekly count in which the size of the pest population is estimated.

It is important to do a good job when monitoring pests. A good monitoring program can reduce the need for pest treatments and save money. It may also provide early warning that problems are beginning. The earlier the problems are found, the easier they are to address.

Monitoring can be used to:

- Tell if pests are present and in what numbers
- Find pest damage or symptoms of disease
- Look for weather conditions (temperature or humidity) that favour the development of the pest (including plant diseases)
- Look for the life stages of the pest that are most responsive to treatment
- Tell the growth stage or health of a host plant or animal
- Tell if beneficial organisms are present and in what numbers
- Identify what can be changed to improve the effectiveness of the treatment or prevent future pest problems

There are many types of monitoring methods and tools. Methods include visual inspections and counting and measuring methods.

Visual Inspections

A visual inspection is the most basic way to monitor for pests. Visual inspections are:

- Close and careful examinations to see what pests are present
- Done when and where they are needed
- Recorded in writing

Visual inspections take less time than counts, but the information that is found can be limited. There are no numbers that can be compared from one inspection to the next. The same person should be responsible for doing visual inspections of a site each time. The value of the notes taken during this time depends on the experience and judgment of the monitor.

Visual inspections are useful to:

- Check for the presence of pests or pest damage
- Check for the presence or absence of beneficial organisms.
- Find large problem sites (e.g., weedy patches or infected crop areas).
- Find conditions that promote pest problems (e.g., entry points for rats in warehouses).
- Check plant health and other site characteristics.

Counting and Measuring Methods

Counting and measuring pest populations provide more detailed information than visual inspections. Counts can be compared from week-to-week or year-to-year. The value of the results does not depend on the judgment of the person doing the monitoring. The monitor needs to be trained in taking samples and doing counts. The compiled information can then be used to make pest management decisions.

Common methods to monitor include counting:

- Insects or damaged areas on samples of plant parts
- Pests found in a measured area (e.g., the number of weeds or insects in a square metre of turf)
- Insects, rodents, or fungus spores caught in traps
- Crop insect pests caught in sweep nets
- Pests knocked into beating traps from tapping tree trunks or limbs
- Days or hours with weather conditions that favour plant disease

Counting is useful to:

- Estimate the size and spread of a pest population
- Compare records between sites or dates
- Establish injury levels and action thresholds
- Evaluate the effect of treatments on pest populations

Sampling Theory

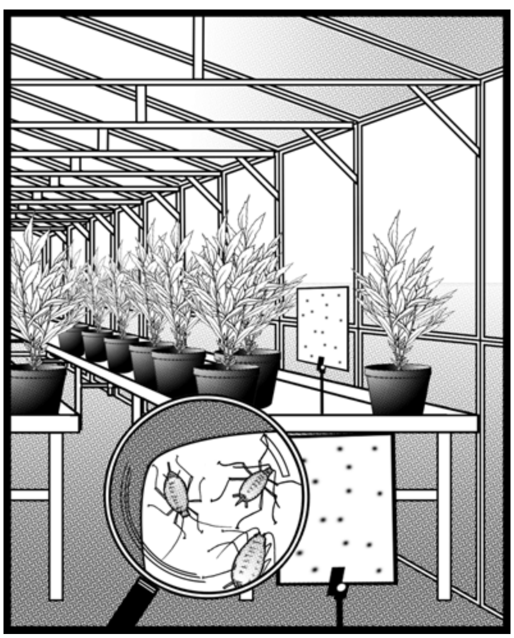

Figure 7-3

Counting methods often involve taking samples (e.g., using sticky traps in a greenhouse and counting the number of pest insects found on them, or selecting measured areas of turf and counting the number and types of weeds present). The goal is to take enough samples to get a good estimate of pest numbers in the whole area. Estimate quality depends on **sample size** and **sample randomness**.

SAMPLE SIZE

The greater the number of samples counted, the more likely it is that the results will give a good estimate. Ten to fifty samples are often required. There is a limit to how many samples can be taken. Before monitoring, you must decide how many samples are needed for accuracy.

To determine the number of samples needed:

1. Take 10 samples. Count the number of pests (or signs of damage, or beneficial organisms, etc.). Add up the total and divide by 10 to get the average.

2. Take 40 samples, count the same way, and calculate the average.

3. Compare the two averages. If they are within 10–20% of one another, it is likely that taking 10 samples will be enough. This shows that the results did not change that much when more samples were taken.

4. If there is a large difference (greater than 20%) between the two averages, it means that 10 samples are not enough. Try the average of 15, 20, or more samples until a number is found that gives a result similar to that of 40 samples.

This method of estimation is more useful in situations (e.g., landscapes) where a rough estimate of a pest population will do. It may not be accurate enough to monitor some crop pests. In that case, injury and action thresholds may need to be determined. (See Ch. 7: Injury and Action Thresholds).

SAMPLE RANDOMNESS

It is necessary to take random samples. This ensures that results reflect the entire site and are not influenced by the person doing the sampling. Random sampling means picking samples by chance. You do not look first and decide which samples to collect. Random sampling is just as important as getting enough samples. This allows a more accurate estimate of the pest situation. If samples are not random, the pest situation can appear better or worse than it really is.

A sampling plan is used to ensure that samples are random. Decide on a sample plan ahead of time and stick to it. Sampling plans include:

- Laying a grid pattern on a map and choosing where samples will be taken on the grid
- Taking samples at points that have been planned in advance (e.g., every fifth plant in a row) or at one-metre intervals along a line drawn between two points

A visual inspection is not random. It is focused on places where pests are most likely to be. This does not reflect the whole pest situation. It is not possible to compare counts from non-random sampling with those of random sampling. The same methods must be used each time to compare results.

Frequency of Monitoring

The way in which you monitor should depend on the pest and type of site. Monitoring for insects is often done weekly. It should be done during a time when damage is expected. Weeds in turf might be counted only once or twice a year. Checks for fungal diseases on plants may be needed every few days during warm, humid weather. If records are kept, the information can be used in the future to pinpoint the best time to look for specific pests. This keeps costs down by not monitoring when pests are not likely to be present.

Injury and Action Thresholds

With IPM, a few pests can be tolerated. It is only necessary to take action when pest numbers reach a certain level. This level is called a threshold.

Injury Threshold

The injury threshold is the level at which pest numbers are high enough to cause unacceptable injury or damage. The injury level is the maximum number of pests that can be tolerated.

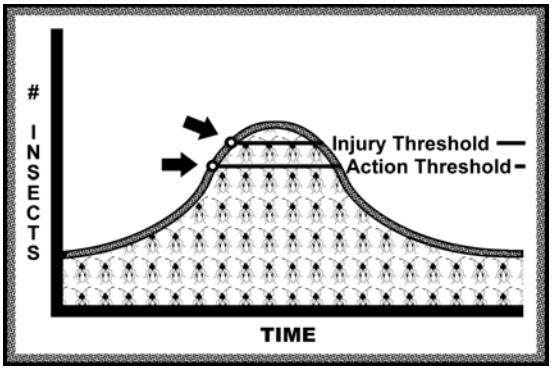

Figure 7-1: Action and Injury Thresholds

Action Threshold

The action threshold is the point at which treatment should take place to prevent the pest population from reaching injury threshold. The action threshold will differ with the type of treatment. It depends on how the treatment works.

For pesticides that act quickly, the action threshold might be just before a pest population reaches the injury threshold level. For slower treatments such as the use of biological controls, the action threshold should occur earlier when pest numbers are lower. The action threshold can also be determined for a time when most of the pests are in a treatable stage (e.g., larval stage for insects).

With aphids, for example, the action threshold for bringing in aphid predators (biological control) would be when the aphid population is low. This is because predators need time to reproduce and control the aphids. The action threshold for chemical control using a pesticide would occur when the aphid population is higher. A pesticide acts immediately, and a larger population of aphids can be controlled more quickly than if a biological control option was chosen.

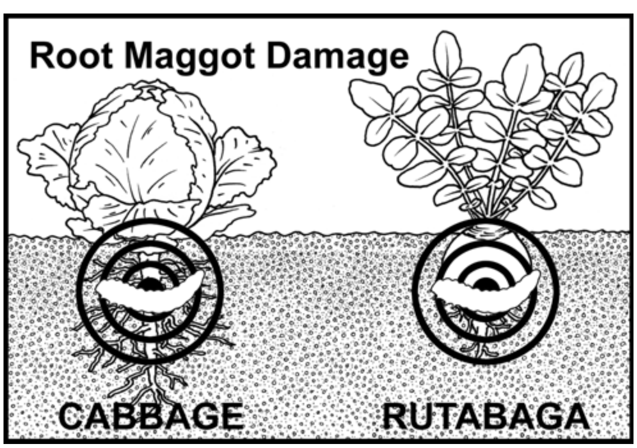

Figure 7-2: Thresholds may be different for some pests based on the type of crop damage it causes. Because the root is the marketable portion of the rutabaga, it has a lower action threshold for cabbage root maggot damage than cabbage, where the root is not marketed.

Injury and action thresholds have been well studied and established for some crops. These take the cost of treatments and crop value (both yield and quality) into account. This is used to determine if the cost of treatment is justified. Few injury thresholds have been established for landscape ornamentals. For these, injury thresholds depend on how easy it is to see the damage. Injury thresholds also depend on how much damage people are willing to accept. For some structural pests, such as rodents in food processing plants, there is no tolerable level of pest population. Injury and action threshold are not as important for these situations as prevention and monitoring.

To help in defining injury and action thresholds, information may be available from:

- Government and scientific texts
- Pest management experts
- Universities or colleges
- Grower organizations

Threshold information may not always be available. It may be necessary to begin by estimating damage based on previous experience or on the expectations of clients or site users. By keeping good records and evaluating the IPM program each year, it is possible to refine and improve thresholds over time.

Treatments

All available information is used in an IPM program to select the best treatments. Two or more treatments are often used together. Most treatments fall into one of the following groups:

- Cultural
- Mechanical/Physical
- Biological
- Behavioural
- Chemical

Figure 7-3: Customers have a different tolerance level for pests. They are not always willing to accept the treatments that best fit an IPM program.

Cultural Control

Cultural controls disrupt the pest or host life cycle. This makes the environment less suited to support the pest. Some of these treatments are also considered preventive. Cultural controls keep pests from developing or spreading.
Cultural controls include:

- Rotating crops to stop or slow the growth of a pest's population, such as avoid nematodes and soil-borne plant diseases
- Using optimum growing conditions to produce healthy plants
- Using sanitation (for example, alternate hosts for pests can be removed. Breeding and overwintering sites can be cleaned up.)
- Choosing pest resistant cultivars or species

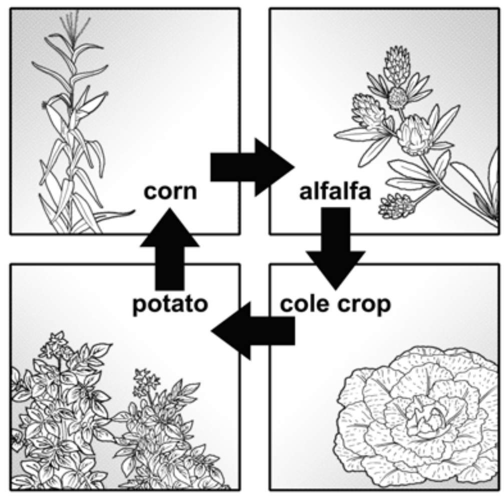

Figure 7-4: Crop rotation over a number of years can reduce pest problems for some or all of the crops being grown.

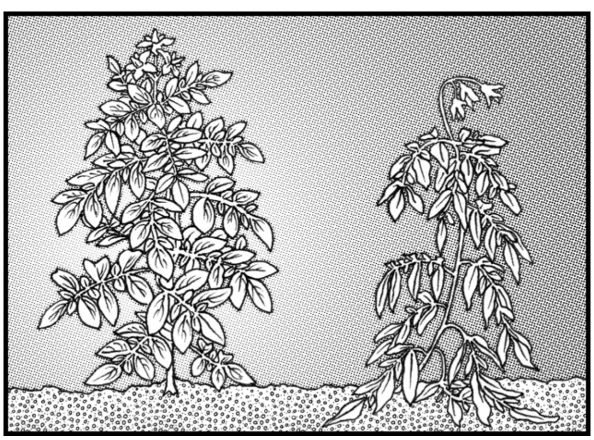

Figure 7-5: Pest resistant and pest susceptible cultivars. On the left a potato plant that is resistant to the disease affecting the potato plant on the right.

Mechanical/Physical Control

Figure 7-6: Agricultural tilling kills weeds either in a crop or before a crop is planted.

Although some textbooks may separate physical and mechanical controls, there are many similarities. These treatments use equipment, devices, barriers, or extreme temperatures to reduce pests. Mechanical/physical controls include:

- Mechanical cultivation of soil to kill weeds or over-wintering insects
- Mowers and brushing equipment for plant control
- Traps for insects, rodents, molluscs, or other pests
- Screens, plants collars, netting, or other barriers
- Vacuum equipment for pests in field crops or buildings
- Freezers to control pests in stored products
- Flame, hot water, or infrared light for weed control
- Noisemakers or other pest-repelling devices

Biological Control

Biological control involves the use of a living natural enemy of a pest. Some are sold commercially for release in large numbers. Beneficial insects are used to control pests in greenhouse vegetables and outdoor crops. There are many kinds of organisms used as biological controls. These include disease organisms, mites, birds, and animals.

Biological controls include:

- Releasing predatory or parasitic insects to attack insect or weed pests
- Conserving natural predators and parasites

- Using grazing animals to control weeds
- Using disease organisms to control insects or weeds

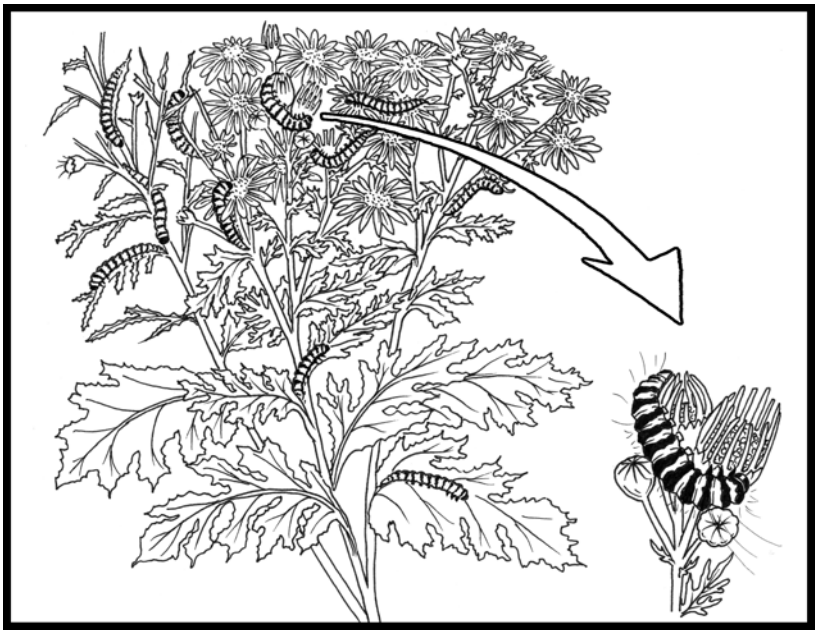

Figure 7-7: The cinnabar moth is used to control tansy ragwort, a weed in pastures, rangelands and along roadsides.

Biological controls are registered as pesticides in Canada by the Pest Management Regulatory Agency.

The use of parasite and predator insects (and all biological controls) requires a good understanding of biology. Release must be planned for the right time. Most biological controls are highly perishable, so they need to be handled with care and must be released soon after being received. Most species are effective on one or a few species of pests. They may only provide good control under certain conditions (temperature, humidity, length of day) or on certain crops.

Behavioural Control

For this type of treatment, a pest's natural behaviour is used to suppress the population. Behavioural controls include:

- Releasing insect pheromones. (These are chemicals produced by insects to send signals to others over a large area. Sex pheromones can be used to confuse male insects and disrupt mating.)
- Using pheromones, plant attractants, or other lures to attract pests to traps or toxic baits
- Releasing sterile male insects to prevent pests from reproducing (e.g., codling moth)

Chemical Control

A pesticide is designed to kill, control, repel, attract, or manage pests. Any product that claims to do this is a pesticide under the *Pest Control Products Act* and Regulations. Chemicals that act as plant growth regulators, plant defoliants, or plant desiccants are also pesticides.

Pesticides are grouped by their properties. They can be:

- Selective
- Non-selective
- Residual
- Persistent in the environment
- Quick to break down (non-persistent)

Selective pesticides are toxic to some species, with little or no effect on other species.

Non-selective pesticides are toxic to a range of species. Beneficial organisms and non-target life can be harmed.

Residual pesticides remain effective on a treated surface or area for some time after application.

Persistent pesticides remain active for months or years before breaking down. Some persistent pesticides can build up in animal or plant tissues.

Non-persistent pesticides do not remain active in the environment for more than a year. They often break down into inactive compounds within days or weeks.

Pesticide Resistance

Overuse of some pesticides can result in pest populations that are resistant to them. This is often noticed when the usual application rate or timing of a pesticide fails to provide control.

Resistant pest populations develop when a few individuals survive a pesticide application because of a genetic difference. When these pests reproduce, they pass on resistant genes to their offspring. When the same pesticide is used over and over, it kills the susceptible insects, leaving the resistant insects behind to breed. The entire population is soon made up of pesticide resistant individuals.

When a pesticide application does not work, some applicators may then try maximum label rates. This increased selection pressure can speed up the development of resistance.

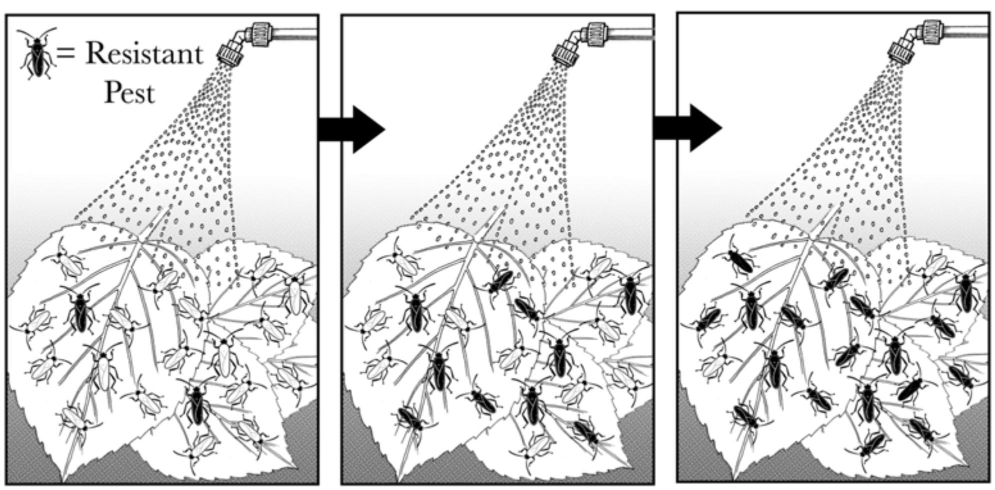

Figure 7-8: Pesticide resistance increases with repeated applications.

A pest population that becomes resistant may not be able to be controlled with pesticides. Pest populations that have developed resistance to one pesticide may also resist other pesticides with similar chemical properties. The use of registered pesticides should be managed to prevent or slow pest resistance. This will allow pesticides to remain effective as pest control agents for a longer time.

Pest populations that have developed resistance to one pesticide may also be resistant to other related pesticides.

Pesticide resistance can be avoided or slowed by:

- Using pest prevention methods when possible
- Using a number of treatments (particularly non-chemical)
- Using pesticides only when monitoring shows they are needed (e.g., waiting until action thresholds have been reached)
- Alternating pesticides from different chemical groups so that no single group of pesticide is used over and over

Environmental Considerations for Treatments

Figure 7-9: Consider all environmental conditions before spraying!

Observing environmental conditions at, or near, a proposed treatment site can help when making decisions. Environmental conditions can affect the safety and effectiveness of a treatment. Wind speed and temperature are important when using chemical (pesticide) treatments. Weather can also affect biological or other non-chemical treatments.

Environmental conditions include:

- **Temperature** - A beneficial organism such as a parasite may require a certain temperature to reproduce quickly and control a pest. Some pesticides lose their effectiveness or break down quickly at extreme temperatures.

- **Relative Humidity** - Some plant diseases do not develop when relative humidity is low. Other plant diseases do not develop when relative humidity is high. Some herbicides are less effectiveness when relative humidity is high; others, when it is low.

- **Precipitation** - Rain can reduce pesticide effectiveness by washing it off a treated surface. Wet conditions can increase the effectiveness of parasitic nematodes used to control root pests.

- **Air movement** - Winds can spread pests. They can also carry pesticides or biological control insects away from the application site.

- **Sensitive areas** - A chemical control may not be advised or allowed if there are fish-bearing waters nearby.

- **Topography** - Steep land can discourage the use of some types of application equipment as well as physical or mechanical equipment. Valleys can have wind patterns that interfere with the use of insect pheromones as behavioural controls.

Treatment Selection

The aim of IPM is to prevent unacceptable damage and treatments that are not needed. Choosing the right treatment (or combination) requires some thought. Treatments should only be used if experience and monitoring information shows that pest numbers are likely to increase to the injury threshold.

Always check pesticide labels for precautionary statements on environmental conditions that will affect how a pesticide works. Package labels on biological controls usually have information on conditions that will harm the organisms. Environmental conditions needed for the best effect are also stated.

Applying the same treatment over and over can stop pests from causing damage. However, it:

- Is expensive
- Promotes pesticide resistance
- Harms non-target species
- Can cause environmental damage

To decide if a treatment is wise, benefits must be weighed against costs and potential problems. Information is needed to select the best treatment. This can include:

- Information on the pest's biology, natural enemies, and preferred hosts
- Monitoring records
- Injury and action thresholds
- Local environmental conditions
- Treatment characteristics

Monitoring records are used with injury and action thresholds to determine timing of treatments. Selected treatments should:

- Be less hazardous to humans
- Be less toxic or damaging to non-target life and the environment
- Produce long-term results
- Prove to be cost-effective over time

In an IPM program, it is common to use several treatments together to control pests. Combined treatment methods are often more effective than using only one method. Even if the effect of each method is small, they can add up to adequate control. If a pesticide is to be used, it must be compatible with other treatments. Some less toxic or non-residual pesticides can be used shortly before using biological controls.

Information on pest treatment methods includes:

- Books and periodicals (government and scientific texts, pest management industry journals, and trade magazines)
- Pest management representatives (pest management firms, technicians and industry associations, product suppliers, and pest monitoring service firms)
- Government pest experts
- Universities and colleges
- The Internet and other electronic resources

Keeping Treatment Records

You must keep detailed records of all treatments, including the type of treatments chosen, dates of treatment and weather conditions at the time of the treatment as well as shortly after it. Records should provide a detailed history of pest problems encountered and treatment results.

Records are useful for:

- Evaluating different treatments
- Comparing pesticides
- Fine-tuning equipment settings (e.g. pump pressure, nozzle types and travel speed of application equipment)
- Planning pesticide re-entry times and harvest dates
- Solving problems that come up after treatment (e.g., failed treatments, crop or property damage, and liability issues)
- Planning future treatments

Treatment records for pesticide applications should include the following:

- Applicator's name (license or certificate number, if it applies)
- Date, time, and location of application
- Target pest(s)
- Pesticide (Product name and PCP Act number)
- Rate of application and amount used
- Type of application equipment and settings
- Weather and other conditions that can affect the application
- Preharvest interval (where applicable)
- Environmental effects, problems, or safety issues that arise
- Evaluation of treatment effect

Information on insects, diseases, weeds, and vertebrate pests can be found in specific study manuals.

Evaluation of Pest Management Results

The effectiveness of any IPM program must be evaluated. You should note whether pest management results were achieved, and how the program could be improved.

An IPM program can be evaluated using

- Noting any changes, including preventive actions that can avoid future problem
- Changing injury and action thresholds in light of experience
- Planning for seasonal pest infestations
- Tracking the costs and benefits of a pest management program
- Visual inspections or counts of pests and non-target organisms before and after treatments.
- Post-treatment data versus pre-treatment monitoring records.
- Treatment records (methods, dates, times, rates, costs, etc).
- Feedback from clients or site users.
- Possible pest management improvements and preventive actions that can be taken.

Communication

Communication is important when developing and putting an IPM program in place. A large amount of information must be taken into account and applied to solve a pest problem.

Local pest experts, government employees, trade associations, and other IPM practitioners work to gather local experience and information.

Workers on farms or workers in businesses involved in pest management must communicate with each other. As well details of the IPM program and its goals should be made clear to these workers. There should also be some method to relay needs and observations to employers or supervisors. Everyone should clearly understand his/her role if an IPM program is to succeed.

It is important to pass along IPM information to customers and to promote the benefits of an IPM program to potential or future clients, and the general public.

Clients should know what needs to be done, and why. This will help to address their concerns and promote customer satisfaction.

Summary

Integrated Pest Management (IPM) programs use all available information and treatment methods to manage pest populations. This should be effective, inexpensive, and environmentally sound. IPM is based on the idea that it is often only necessary to keep pest numbers at acceptable levels. The entire population need not be eliminated. An IPM approach improves long-term pest management. Pesticide use and costs are often reduced. IPM includes:

- Prevention
- Identification
- Monitoring
- Injury and action thresholds
- Treatments
- Evaluation

Prevention is the key because it keeps pests from causing problems. This avoids damage and saves money.

Correct identification is needed for choosing proper monitoring and treatment. You must know what the problem is before choosing methods to monitor and treat it.

Monitoring provides information needed to make sound decisions on pest management. This information comes from visual inspections or counting and measuring methods. Regular counts or measurements provide numbers that can be compared over time, regardless of who does the monitoring. Enough random samples must be taken to get a good estimate of the pest population.

In IPM programs, it is often only necessary to act when pest numbers reach a high level (threshold). This involves:

- The injury threshold - The maximum tolerable pest population
- The action threshold - When treatment should take place to prevent the pest population from reaching injury threshold

Treatments are needed when experience and monitoring results show that pest numbers are likely to reach the injury threshold.

Summary, cont'd.

In an IPM program, two or more treatments can be used in a coordinated approach. Treatments can be grouped as follows:

- Cultural controls disrupt pest life cycles or make the environment less suited for survival.

- Mechanical and physical controls use equipment or devices, barriers, or temperatures to reduce pest populations.

- Biological controls are living natural enemies of a pest. These include insects, disease organisms, birds, and other animals.

- Behavioural controls use a pest's natural behaviour to suppress the population.

- Chemical controls include most pesticides. Active ingredients are naturally derived or synthesized. They are used to kill, attract, repel, or alter the growth of pests.

Pesticides are often grouped as selective or non-selective. They can be residual, persistent, or quick to break down. A major problem with overuse of pesticides is the development of resistant populations. Careful management of pesticides slows the development of resistance. This allows pesticides to remain effective if needed.

Treatments should be:
- Least hazardous
- Likely to produce long-term results
- Cost-effective over time

Environmental conditions should be taken into account before applying treatments. These can affect safety and effectiveness. Detailed treatment records must be kept. These provide a record of pest problems and treatments. Treatment records can be used to plan improvements and answer questions after treatment.

An IPM program must be evaluated for effectiveness. Ways to prevent pest problems and improve the program should be identified. Communication between all involved in an IPM program is important.

Self-test Questions

Answers are located in Appendix A of this manual.

1. What are the advantages of using an IPM program?

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

2. Why is prevention key to an IPM program?

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3. Monitoring is used in an IPM program to:

   a. Discover if pests are present and in what numbers
   b. Find pest damage or symptoms of disease
   c. Determine if beneficial organisms are present
   d. All of above
   e. **a** and **b** only

4. Explain the difference between injury threshold and action threshold.

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5. List five treatments used for pest control. Give one example of each.

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6. Why is communication important in an IPM program?

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7. A monitoring program should take enough samples to get the most accurate estimate of the pest population. **True or False?**

8. Visual inspections include counting the number of pests on plants. **True or False**?

9. In an IPM program, only one treatment is used for a given pest problem. **True or False**?

References for Further Reading

Books:
Common Sense Pest Control. 1991. W. Olkowski, S. Daar and H. Olkowski. The Taunton Press.715 pp. Bio-Integral Resource Center, P.O. Box 7414, Berkeley, CA 94707 Tel: 510-524-2567 Fax: 510-524-1758 www.birc.org

IPM Journal:
IPM Practitioner. Bio-Integral Resource Center, P.O. Box 7414, Berkeley, CA 94707 Tel: 510-524-2567 Fax: 510-524-1758 www.birc.org

IPM Training:
Nova Scotia Agricultural College, Centre for Continuing and Distance Education, PO Box 550, Truro, NS B2N 5E3 Tel: 902 893-6666 Fax: 902-895-5528 www.nsac.ns.ca/cde/coursedes.htm

Pest Identification and Disease Diagnosis Services:
Wildwood Labs, 53 Blossom Drive, Kentville, Nova Scotia B4N 3Z1 Tel: 902-679-2818 Fax: 902-679-0637 Email: info@wildwoodlabs.com Web: http://www.wildwoodlabs.com