INTEGRATED PEST MANAGEMENT

Adapted from the ***Integrated Pest Management Handbook***
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Pest management has evolved over the last 75 years. There has been a gradual progression from spraying pesticides on a regular schedule to a system called Integrated Pest Management (IPM). IPM is the selection, integration and implementation of pest control based on predicted economic, ecological and sociological consequences. IPM seeks to include a combination of biological, physical and chemical methods into a cohesive scheme designed to provide long-term protection.

This system was conceived in the 1950's when it was first realized that insects and plant diseases were developing immunity to chemical pesticides at an alarming pace. IPM replaces the "see and spray" and "calendar-based spray" approaches to pest management. Emphasis is placed instead on prevention. Problems are identified and treated in a manner least disruptive to the environment. There are five components of Integrated Pest Management: prevention, diagnosis, research, monitoring and decision-making.

Prevention consists of several aspects:

1. Design-
    a. Select plants that are adapted to the site (soil, climate, etc.).
    b. Design landscapes to utilize species diversity and minimize monocultures.
    c. Space plants properly to encourage air circulation.

2. Health of the soil-
    a. Add organic matter if needed.
    b. Minimize soil compaction.
    c. Address drainage problems before planting.

3. Health of the plants-
    a. Supply adequate water and allow time for foliage to dry before evening.
    b. Prune out disease; prune at the right time of year; prune to improve air circulation.
    c. Fertilize plants only when necessary.

4. Garden hygiene-
    a. Remove and dispose of all dead and diseased tissues.
    b. Use clean tools; sterilize if recommended.

5. Resistance-
    a. Choose resistant varieties when available.

6. Promote beneficial insects-
    a. Maintain nectar and cover plants to encourage populations.

Diagnosis consists of properly identifying the cause or causes of the damage. See the chapters that follow on insects, diseases and abiotic problems. Avoid diagnosing plant problems over the phone. Have the client bring a sample in or visit the site for proper diagnosis.

Once the pest has been diagnosed then the research begins. Learn the life cycle and development stages of the pest. How a pest lives and reproduces will greatly assist control efforts. At what stage does the pest damage the plant? At what stage is the pest most vulnerable to control? When are the pests at the threshold level that damage to the plant needs to be controlled? Low levels of damage are normally tolerated.

Monitoring is the next step in the integrated approach to pest management. Check the seasonal development of key pests on a weekly basis. Traps can be placed out to catch pests to monitor emergence and population levels.

Keep track of weather conditions that affect pest development, such as temperature, humidity, and precipitation. Research entomologists have developed degree-day models for many common pests that help predict the emergence of those pests in the spring. Often in the early stages of development pests are most vulnerable.

At the decision making step a management plan is developed based on the biological information known about the pest. Alternative control methods are utilized in the plan including: mechanical and cultural techniques, biological control and least toxic pesticides. As a last resort more toxic chemical controls are used.

IPM Management Decision Steps:

1. Identify the pest problem.
2. Determine whether or not the pest is at a threshold level (a high enough level to actually harm the plants).
3. Find out what the pest's vulnerable stages are.
4. If spraying is deemed necessary, choose the best materials for the specific pest and time of season.

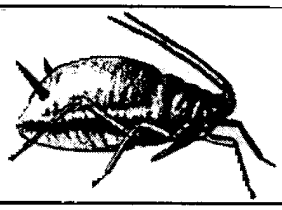
Alternative control methods

Mechanical and cultural techniques include practices such as cultivation, spraying with water, using barriers or covers. Techniques vary depending on the pest involved. Biological control methods use a natural enemy or substance to control a pest including the use of predatory or parasitoid insects, microbial insecticides, and pheromone traps to name a few. Least toxic pesticides are products such as insecticidal soaps, horticultural oil sprays, and insecticides derived from plant extracts. For more information on the various alternative control methods available consult reference materials and see Chapters 7 and 8 (Disease and Insects).

On the following page is an example of an integrated approach to aphid control:

Aphids

Aphids, actual size 1/10 - 1/8" in length



TYPES	DESCRIPTION	HOST(S)
APPLE	Yellow-green	Apple, hawthorn, mountain ash, crabapple.
BEAN	Black	Beans, beets, cucumber, carrots, lettuce, etc.
BLACK CHERRY	Large, shiny black	Cherries, plumb, wild mustards
BLACK WILLOW	Orange	Willow
BOX ELDER / MAPLE	Green	*Acer* species
ELM LEAF	Pale yellow, whitish fluff	Elm
GIANT CONIFER	Reddish-brown	Pines, spruces, firs
GIANT WILLOW	Large, purple black	Willow
GREEN PEACH	Green	Fruit trees, vegetables, and flowers
LEAF-CURL ASH	Yellow-green, whitish fluff	Ash
LEAF-CURL PLUM	Shiny yellow-green	Plumb
PETIOLE-GALL	Pale green	Poplars, cottonwoods
POTATO	Pink and green	Rose, nightshade family, vegetables, flowers, weeds
ROSE	Pink and green	Rose
ROSY APPLE	Black	Apple, pear, mountain ash

DESCRIPTION: Very small (1/10 to 1/8 inch long), pear-shaped, soft-bodied insects ranging in color from light green through dark green, and pinkish to black. Aphids cluster on stems and/or undersides of leaves and produce "honeydew", a sugary mixture that is fed upon by ants and many of the aphids' natural enemies. Aphids move very slowly, if at all, and often appear to be attached to the plant surface by their sucking mouthparts. Young aphids, or nymphs, are wingless. Adults can be winged or wingless, depending on the species, environment, and time of season. There are many different kinds of aphids, most of which are specific to particular species, or genera, of plants. However, there are some aphids that attack many species of plants. Different species of aphids are often present at different times of the season.

LIFE CYCLE: Aphids overwinter as shiny, black eggs on twigs, budscales, and bark. Female aphids hatch from these over-wintering eggs and give birth to live nymphs, all female, by parthenogenic reproduction (no fertilization by male aphids). Since mating is not required for parthenogenic reproduction, aphids can appear very quickly and build up large populations rapidly. A single female can produce 60-100 nymphs during its 20 to 30 day lifetime. Nymphs start to reproduce 6 to 10 days after birth. Winged male aphids are produced in the fall (mainly due to changing light conditions), and mating occurs. Fertilized females then lay over-wintering eggs, generally on or near their preferred food source. When conditions become unfavorable (too hot, too dry, leaf tissue no longer succulent, decreased leaf nitrogen levels, over crowding), winged adults are produced. These winged adults are capable of flying off to more favorable food sources. Fortunately, they are weak flyers!

CONTROLS:

CULTURAL Aphid outbreaks are encouraged by cool, wet spring weather because their populations increase more rapidly than their natural enemies in this climate. Aphid outbreaks may also occur if controls used to treat other pests harm aphid predators (i.e., syrphid fly and lacewing larvae, ladybird beetles). Certain controls are more toxic to predators than others (see treatment options). Excessive fertilization, especially nitrogen, causes plants to maintain succulent growth, and may encourage aphid population

developments. Use less soluble nitrogen fertilizers (ammonium or urea-based forms or compost). Avoid pruning that encourages early spring growth. On aphid-susceptible species, prune in late spring after aphids arrive and prune a little at a time. Stop pruning before the end of July so you don't encourage a fall flush of growth.

MONITORING Check aphid populations regularly; appropriate control methods vary by season. During aphids' dormant season, check for eggs (in late winter) to decide if a dormant control will be required. Check ten twigs per tree. If 30 to 50% have eggs, a dormant oil treatment may be helpful. In early spring, check ten terminal shoots weekly; look especially at leaf undersides. If 25-50% of the terminals on young trees and shrubs are infested, some control may be required. Older, large trees can usually tolerate 50% or more terminal infestation before control is necessary. Check for predators. If predators are present at a ratio of 1:5, control is usually not required. If leaf curling is occurring already, treat immediately, especially on aphid-susceptible species like plum and green ash.

BIOLOGICAL Syrphid fly and lacewing larvae, gall midges (Aphidoletes), and ladybird beetles are effective aphid eaters. Evaluating several predators, researchers in Colorado found that lacewings were the best predators under hot conditions, and ladybeetles and Aphidoletes did best under cool temperatures. Overall, Aphidoletes was the best aphid predator of green peach aphid (Gerace, 1999). Aphid populations are also decreased by fungus disease and parasites.

Diseased or parasitized aphids turn brown, puff up and stick to leaves.

MECHANICAL Yellow sticky traps are useful to catch winged aphids, particularly in indoor growing situations, as long as populations are not too high. Sticky traps may catch some predator species as well as aphids.

In certain cases, using a silver or foil mulch under crop plants can confuse flying aphids that are searching for hosts. The silvery, reflective surface is thought to disrupt their sense of direction. When growing squashes or cucumbers, you may get somewhat the same effect by using silver-leafed varieties.

PHYSICAL Washing with soapy water (with a dispenser attached to the hose) can knock some aphids off plants and reduce populations if done repeatedly. Washing may also enhance conditions for fungus diseases that attack aphids. Prune out infested terminals.

CHEMICAL *Insecticidal Soap* is only effective on soft-bodied insects. It has a short activity period. Repeat applications as needed. Avoid application in direct sun or at temperatures >85° F. Soap can burn foliage of tender plants. Wait 48 hours after application before releasing predators.

Two percent horticultural oil (Sunspray or Volck Supreme Spray) should not be applied in direct sun and/or at temperatures >85-90° F or <40° F. It may burn leaves, especially of sensitive or drought-stressed plants. Wait 48 hours after application before releasing predators.

BOTANICAL Neem oil (Margosan-O, Bioneem, Greentight, or Azatin) is best applied 2-3 times in succession, 7-10 days apart. Spray in the evening. It has a short activity period. Repeat applications!

Pyrethrum/Pyrethrin works best if combined with insecticidal soap: add 1/2 to 1 Tbsp. per gallon. Spray in the evening. This botanical has an extremely rapid breakdown rate, especially in sunlight. It also has a very short activity period. Repeat applications and spot spray if possible. It can harm predators and parasites.

Chemical control methods

Using Pesticides

If you reach the “"last resort” and have to use a hard pesticide option, there are several things you need to know to use pesticides safely and responsibly.

First, read the label.

THE LABEL

The label tells how to safely and correctly use the pesticide. The label, when properly followed, provides protection for applicators, consumers, fish, and wildlife.

IDENTIFIES THE CHEMICAL HAZARDS

First, the label identifies the chemicals in the container. The contents are listed in a standard form so that you know exactly what you are applying. Mistaken uses of chemicals can cause crop injury, poor control, or illegal residues. The crop may be unfit for market, making you, the applicator, legally responsible for any losses.

Single words are used on most labels to state the toxicity of the pesticide to humans. The label also lists the protective equipment needed for proper handling and use of the chemical. This may include masks, gloves, respirators, etc.

REGISTERED USES

The label lists the uses for the pesticide as approved by the Environmental Protection Agency (EPA). If the intended use is not on the label, the product should not be used. You are legally responsible for any accident or crop loss that results from using materials that are not approved. Certain formulations of a particular pesticide may be intended for a specific use only: for example, livestock. The label for this formulation may list only the uses for livestock even though the pesticide is also registered for other uses. Generally, however, any non-labeled use is a misuse, and the applicator may be taken to court.

RECOMMENDED DOSES

Recommended doses and directions for applying approved uses also appear on the label. These suggestions can be helpful to you because they state the maximum dosages permitted by law. However, local conditions **may not require maximum doses** to achieve good control of the pest. You should use no more pesticide than needed.

COMPATIBILITY

The label will usually state which other chemicals can be mixed with the pesticide. Often other pesticides or fertilizers can be combined with the pesticide for one application. Sometimes the chemicals cannot be mixed without destroying their effectiveness. Check on compatibility before you mix.

PHYTOTOXICITY

The label will tell whether injury to plants is likely. Some plants are more sensitive than others to pesticide chemicals. The injury to the plants can range from slight burning to death of the plant. Choose a pesticide that is not phytotoxic to the target plant.

LABEL LAW

The information found on the label has passed strict government requirements. The label itself, not just the pesticide product, must be registered by the EPA before it is used. EPA reviews and approves each statement that is on the label. The toxicity warnings come from tests required by the government. The pesticide and the label are registered by EPA only when the applicators, consumers, fish, and wildlife will be protected. If the label statements are carefully followed, no illegal residues will be found on any crop. Getting a single pesticide ready for registration and use usually costs the chemical company $7-10 million dollars.

WHAT'S ON THE PESTICIDE LABEL?

1. **NAME and ADDRESS of the CHEMICAL COMPANY.**
2. **TRADE NAMES:** These almost always are on the label in large print and may not be used in the "active ingredient" section. Such names as SEVIN, AMIBEN, or ETHREL are trade names.
3. **LIST of all the ACTIVE INGREDIENTS**

    a. **Official Common Name:** well-known name accepted by the Pesticide Regulation Division of EPA. Laws require that officially-approved common names - not the chemical name - appear in the "active ingredient" section of the label. Not all pesticides have an official common name. Examples of common names are CARBARYL, CHLORAMBEN, and ETHEPHON.
    b. **Chemical Name:** A scientific name telling the contents or formula of the actual poison. When an accepted common name is not available, the chemical name must be used in the "active ingredient" section of the label. However, if the chemical name is too long and complex, another name describing the poison is allowed.

4. **TYPE OF PESTICIDE**: insecticide, herbicide, fungicide, etc.
5. **KIND OF FORMULATION**: dusts, wetable powders, granules, sprays, baits, pressurized cans (bug bombs), emulsifiable concentrates.
6. **EPA REGISTRATION NUMBER**
7. **STORAGE and DISPOSAL PRECAUTIONS**
8. **HAZARD STATEMENTS:** All pesticides labels carry the statement "Keep Away from Children." Pesticides have been grouped into categories according to their toxicity to animals, people, and environment. Special words on the label tell which category they are in.

    a. *CATEGORY I - HIGHLY TOXIC:* Danger - Poison printed in red and a skull and crossbones must be on the label for these. Such labels also have direction for handling, plus an antidote statement, as well as the sentence "Call a Physician Immediately."
    b. *CATEGORY II- MODERATELY TOXIC:* Warning is the special word which must be on the label for moderately-toxic products. Directions on how to handle the pesticide must also appear. These are still dangerous pesticides, even in small amounts.
    c. *CATEGORY III - SLIGHTLY TOXIC*: Caution must be on all labels for slightly toxic materials. Instructions for avoiding the main danger are also required.
    d. *CATEGORY IV - RELATIVELY NON-TOXIC:* No signal word is required for relatively non-toxic products but other precautions might appear. Even in this group there is no pesticide which is completely safe.
9. **DIRECTIONS FOR USE:**
    a. How to protect the crop;
    b. How to apply the chemical;
    c. How to control the pest;
    d. Compatibility.
10. **NET CONTENTS**

Second, compare the toxicity of pesticide options. LD 50 comparisons refer to the "Lethal Dose" of a pesticide required to kill 50% of the experimental organisms (usually rats). LD 50 comparisons are made in kilograms of pesticide per milligram of body weight of the experimental organism. **The lower the LD 50 number, the more toxic the pesticide is.** Where ranges are given it is because different formulations of the same pesticide can have different toxicities. Read the label to know for sure how toxic a pesticide is.

References

Missoula County Master Gardener Manual: Sustainable & Organic Horticulture Production. Atthowe H. Missoula County Extension Service.

Insect Pest Management Guidelines for California Landscape Ornamentals. Koehler C.S. 1987. University of California Extension Publication # 3317.

Chapter Review

A. What are the basic principles of Integrated Pest Management?_____

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B. List the five main components in an IPM program. _____

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C. What information is found on a pesticide label?_____

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D. List two types of mechanical or cultural control methods.

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E. What is a biological control method?_____

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