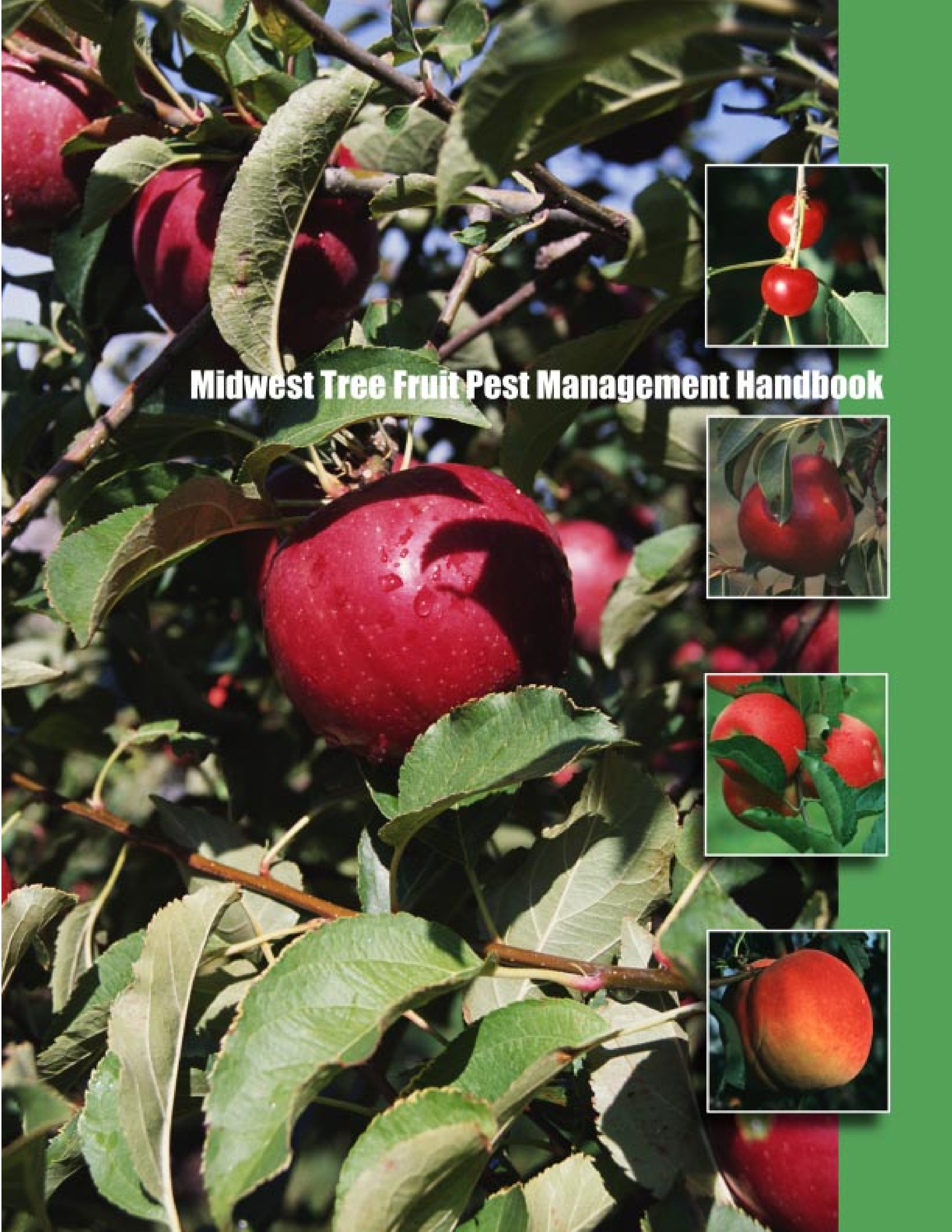
Midwest Tree Fruit Pest Management Handbook



Midwest Tree Fruit Pest Management Handbook

Edited by

R.T. Bessin
University of Kentucky

P.S. McManus
University of Wisconsin-Madison

G.R. Brown
University of Kentucky

J.G. Strang
University of Kentucky

ID-93

Prepared by

University of Illinois—Urbana, IL 61801
M. Kushad—*Horticulture*
S.M. Ries—*Plant Pathology*
R. Weinzierl—*Entomology*

Iowa State University—Ames, IA 50011
P.A. Domoto—*Horticulture*
M.L. Gleason—*Plant Pathology*
D.R. Lewis—*Entomology*

Kansas State University—Manhattan, KS 66506
F.D. Morrison—*Horticulture*
A. Erb—*Horticulture*
N.A. Tisseret—*Plant Pathology*
R. Bauernfeind—*Entomology*

University of Kentucky—Lexington, KY 40546
R.T. Bessin—*Entomology*
G.R. Brown—*Horticulture*
J.R. Hartman—*Plant Pathology*
R.T. Jones—*Horticulture*
J.G. Strang—*Horticulture*

University of Missouri—Columbia, MO 65211
B.A. Barrett—*Entomology*
P. Byers—*Horticulture (SMSU)*
M.L. Caps—*Horticulture (SMSU)*
W.H. Shaffer—*Plant Pathology*
M.R. Warmund—*Horticulture*

Ohio State University—Columbus, OH 43210
M.A. Ellis—*Plant Pathology*
F.R. Hall—*Entomology*
D.D. Miller—*Horticulture*
C. Welty—*Entomology*

Purdue University—West Lafayette, IN 47907
R.E. Foster—*Entomology*
R.A. Hayden—*Horticulture*
P.M. Hirst—*Horticulture*
P.C. Pecknold—*Plant Pathology*
S.C. Weller—*Horticulture*

University of Wisconsin—Madison, WI 53706
D.L. Mahr—*Entomology*
P.S. McManus—*Plant Pathology*
T.R. Roper—*Horticulture*

Contents

Preface

This tree fruit production guide is presented in an ongoing attempt to better serve midwestern fruit growers. Financial constraints make publication of fruit production circulars by each of the North Central states increasingly difficult. By pooling the resources and expertise of the various states, Extension specialists believe that this publication will be of better quality, with information adaptable over a wider range of climates, soil conditions, and orchard management schemes. This cooperation enables the authors to include more information at greater depth that should be of value to you, the grower.

This handbook contains information on pests, production practices, and pest management practices that should be useful over several years. Your state's spray guide, which lists pesticides for specific crops and problems, is published separately and is updated each year. This handbook should be used in conjunction with an up-to-date spray guide for your state and with the newsletters issued from your state's Cooperative Extension Service. Contact your state's Extension fruit specialist for information on newsletters.

This publication does not replace the many publications on fruit cultivars or management practices that are available from your Cooperative Extension Service. Other useful references are included in Appendix C.

Disclaimer Clause

Reference to products in this publication is not intended to be an endorsement to the exclusion of others which may be similar. Any person using products listed in this publication assumes full responsibility for their use in accordance with current directions of the manufacturer.

Legal Responsibilities for Pesticide Use

Pesticides suggested for use in this publication are registered by the Environmental Protection Agency, Pesticides Regulation Division, and are cleared for use as indicated on the individual labels. The legal limitations in the use of these pesticides should be strictly observed to prevent excessive residues in or on harvested fruit. Each grower is held responsible for the residues on fruit from his or her orchard and should follow directions carefully and observe cut-off dates and rates of application. Some of the pesticides listed may be on the EPA restricted-use list.

Introduction

Orchard Management

Economic production of high-quality fruit depends on the growers developing a system of crop management that is appropriate for each orchard. Decisions are made to manage practices such as planting, fertility, harvesting, and pruning as well as to manage the insect, disease, and weed problems that can reduce yield or quality. Diseases and insects affect fruit production throughout the Midwest, although the relative importance of the different diseases and insects varies from region to region. The information in this handbook should serve as an introduction to some of the common diseases and insects in the Midwest, but it is the responsibility of growers to know which pests are important in their orchards. Your state Cooperative Extension Service can help you identify diseases and insects and direct you to additional resources on specific problems. For current recommendations, refer to the *Commercial Tree Fruit Spray Guide*, available from your Cooperative Extension Service.

Effective management of an orchard pest problem depends on:

- Using appropriate cultural practices that will prevent or delay pests from reaching damaging levels,
- Early detection of pests and/or environmental conditions that regulate pests before serious losses occur,
- Correct diagnosis of the problem and correct identification of the pest causing it, and
- Evaluation of pest population densities to determine if economic damage is likely and if additional control measures are needed.

Diseases

The diseases described in the following sections are caused by fungi and bacteria. However, several important diseases result from infection by viruses, phytoplasmas (formerly called mycoplasma-like organisms or MLOs), and nematodes. To keep your orchard free from virus and phytoplasma diseases, purchase trees that are certified "virus-free" from reputable nurseries. Where possible, eradicate wild alternate hosts of virus and phytoplasma diseases. For example, wild chokecherry is a common host for X-disease, an important phytoplasma disease of peaches, nectarines, and cherries. Control insects, especially aphids and leafhoppers, which are common vectors of viruses and phytoplasmas. Finally, if you do your own grafting, be aware that several diseases are graft transmissible.

Integrated Pest Management (IPM) of Insects, Mites, and Diseases

Integrated pest management is a systematic way to use multiple techniques to manage orchard costs, avoid economic damage, and minimize environmental damage. It includes the use of *cultural and mechanical practices* to prevent pest outbreaks from developing; *biological control* to encourage the pest's natural enemies to survive and attack pests; and selective use of *chemical control* when cultural and biological controls are inadequate and a crop needs to be rescued from a damaging pest population. IPM maximizes applicator and environmental safety while minimizing pesticide usage and ensuring high fruit quality and yields. *Although the term "pest" means "insects" to many people, in IPM the term pest is used in a broader sense that includes disease-causing microorganisms and weeds, as well as insects, mites, birds, and mammals.*

The types of pests and their intensities vary among orchards in the Midwest. Orchards in warmer or drier climates may not have the same key pests of the same crop in a cooler or wetter climate. For that reason, IPM is not simply a "recipe" to follow. The grower must identify the important pests and deploy appropriate preventive cultural practices, monitoring, and control strategies that exploit knowledge about the pests' life cycles and their natural enemies. Additionally, as new IPM strategies are discovered, orchard IPM programs will continue to evolve by integrating new strategies into a unified program.

Disease Management as a Component of IPM

Diseases must be considered in the larger framework of whole orchard management. Most practices that promote tree health—planting on favorable sites, adequate but not excessive fertilization, and proper pruning—will improve trees' resistance to diseases. Many diseases can be managed by planting resistant cultivars. Orchard sanitation (e.g., removing diseased and dead tissues) will reduce disease pressure.

Fungicide and bactericide use is consistent with IPM, if these pesticides are used judiciously. Overuse and misapplication of pesticides are not only economically and environmentally unsound, but could lead to the development of pathogens that are tolerant of or resistant to the pesticide. For example, resistance of the apple scab pathogen to the fungicides benomyl and dodine has been documented throughout the world. Likewise, the fire blight pathogen has developed resistance to streptomycin in the Pacific Northwest and regions of Michigan and Missouri. Specific information on currently available fungicides and bactericides is provided in Chapter 6.

The number and variety of pesticides available to manage diseases and other pests of fruit crops is finite. If a pathogen becomes resistant to a product, it is unlikely that an effective substitute or alternative will be available to manage the disease. We must take steps to ensure that the limited arsenal of pesticides will be functional until effective nonchemical means of control are practical in commercial orchards. To reduce the risk of resistance developing to a pesticide: 1) use pesticides only in the framework of an IPM program; 2) minimize the number of applications; 3) do not go below or above rates given on product labels; and 4) avoid exclusive, season-long use of a single product or products with similar modes of action.

Strategies of Pest Management

Some of the strategies used in integrated pest management programs are summarized here. For specific examples of how these apply to management of specific diseases and insect pests, see the summaries at the end of the disease and insect sections within each crop chapter.

Cultural Controls

These are preventive and help to minimize infestations and infections.

When establishing a new orchard:

- Site selection,
- Variety and rootstock selection,
- Disease-free planting stock, and
- Tree density.

When maintaining an orchard:

- Pruning: remove infected or infested branches, improve tree architecture, allow quicker drying of leaves, and improve spray penetration;
- Fertility: provide plants with optimum nutrient levels;
- Timely sanitation of prunings, fruit mummies, and other orchard debris;
- Fruit thinning;
- Habitat modification: remove weeds and alternate hosts of pests; and
- Pest exclusion: use fences or nets to exclude wildlife.

Biological Controls

- Natural enemies: encourage predators, parasitoids, and antagonists that attack pests;
- Microbial pesticides: treat crops with beneficial pathogens that kill pests;
- Behavior modification: use mating disruption pheromones, traps, or poisoned feeding stimulants to prevent pest infestation.

Chemical Controls

- Conventional synthetic pesticides,
- Inorganic pesticides,
- Botanical pesticides,
- Soaps and oils, and
- Insect growth regulators.

Biological Control

Natural Enemies of Disease-causing Microorganisms

Biological control of insect pests has a long and better-known history than biological control of disease-causing microorganisms, but research in both disciplines has been increasing recently. Beneficial microorganisms that have the potential for incorporation into IPM programs include some fungi that attack pathogenic nematodes and beneficial fungi, such as *Trichoderma,* that are antagonistic to fungal crop pathogens. Although commercial biological control products have great potential for the future, they play a relatively small role in current disease management programs in midwestern orchard systems.

Types of Natural Enemies Attacking Arthropods

All insects and mites have natural enemies that attack them. Only a small percentage of the arthropod species typically found in an orchard are pests. In unmanaged orchards, it may be difficult to find some pests because they are kept under control by natural enemies. In managed orchards, natural enemies may be scarce because they are sensitive to pesticides. Natural enemies of arthropod pests in the orchard may be predators, parasitoids, or pathogens. For detailed information about natural enemies, see the publications by Mahr and Ridgeway (1993) and Henn and Weinzierl (1990) listed at Appendix C.

Predators are usually as big or larger than their prey. They consume several to many prey over the course of their development. Common predators include hover fly larvae (also called syrphid fly larvae), lacewing larvae, some lacewing adults, ground beetle adults and larvae, lady beetle adults and larvae, minute pirate bugs, damsel bugs, assassin bugs, some stink bugs, yellowjackets, and some thrips (Figure 1). Some species of mites such as *Neoseiulus (Amblyseius) fallacis* and *Zetzellia mali* are also predators.

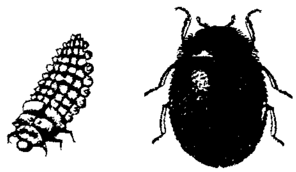
Parasites are usually smaller than their hosts. A parasite usually does not kill its host or consume large parts of its tissue. *Parasitoids* are similar to parasites, but they differ in important ways. Unlike true parasites that usually only weaken their host, parasitoid development always results in the death of the host. Parasitoids are usually about the same size as their host. Several types of wasps and flies are common parasitoids. The adult female lays eggs inside the body of the host pest, and the egg hatches into a larva that slowly consumes the body of the host. Parasitoids commonly attack soft-bodied insects, such as caterpillars, aphids, eggs, or pupae.

Beneficial pathogens are living microbial organisms that cause insects and mites to become sick and die. These include fungi, bacteria, viruses, protozoa, and nematodes. These pathogens occur naturally, particularly when the weather is warm and wet for prolonged periods. These are not the same pathogens that cause disease in plants. In fact, one advantage of beneficial pathogens is that toxicity to other organisms and humans is very low. A few commercially available microbial pesticides such as sprays contain the bacterium *Bacillus thuringiensis,* the fungus *Beauvaria bassiana,* and the nematode *Steinernema carpocapsae*.

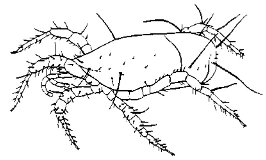
Biological Control Methods

Biological control involves conserving and encouraging naturally occurring enemies, or releasing natural enemies that have been purchased. The best way to encourage the survival of natural enemies in an orchard is to avoid exposing them to pesticides that are highly toxic to them. Some insecticides such as Guthion, Asana, Ambush, Pounce, and Sevin are toxic to a wide range of chewing and sucking insects. Some fungicides are also toxic to beneficial organisms. Natural enemies can also be conserved by choosing pesticides that are compatible with IPM, that is, that are toxic to target pests but relatively nontoxic to predators. Table 18 on page 87 shows the relative toxicity of several insecticides and miticides

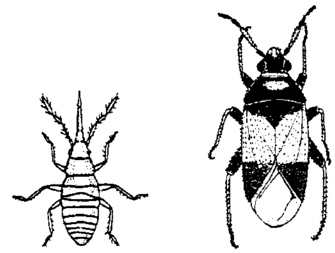
Figure 1. Arthropod predators in midwestern orchards.



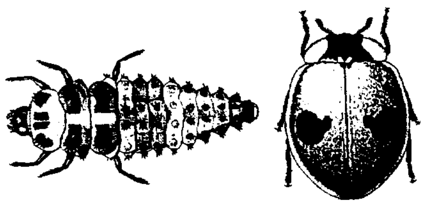
Black lady beetle larva and adult



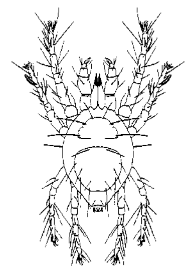
Predatory mite (Neoseiulus)



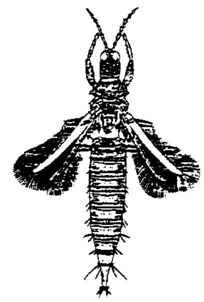
Insidious flower bug nymph and adult



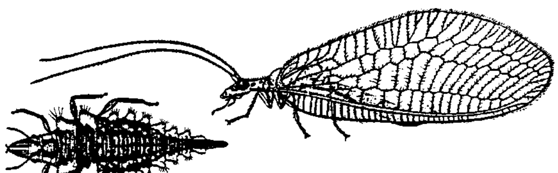
Lady beetle larva and adult



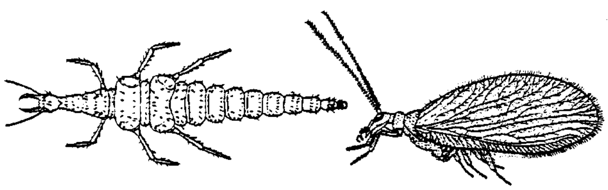
Predatory mite (Agistemus)



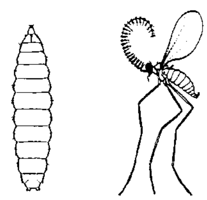
Black Hunter thrip



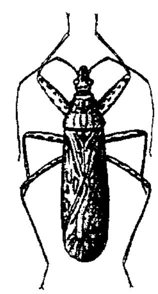
Green lacewing larva and adult



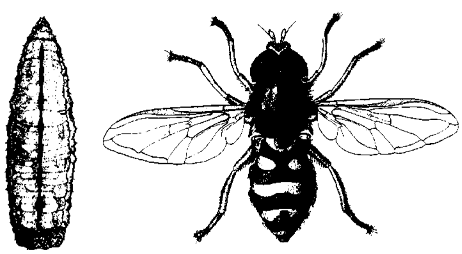
Brown lacewing larva and adult



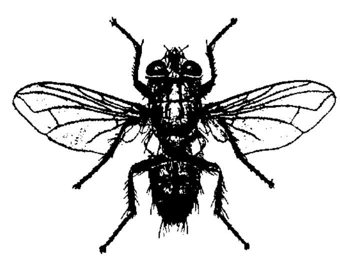
Gall midge larva and adult



Damsel bug



Hover fly larva and adult



Parasitic fly

against predatory mites. It can also be done by using the spray strategy known as alternate row middle spraying, in which some unsprayed foliage is available as a refuge for predators.

Some of the world's success stories of integrated biological and chemical control are from tree fruit, where naturally occurring predaceous lady beetles *(Stethorus punctum)* or predaceous mites *(Neoseiulus* [*Amblyseius*] *fallacis* and *Zetzellia mali)* have been important in keeping spider mites at tolerable levels. Likewise, some of agriculture's greatest disasters have resulted from the failure to use integrated management systems that rely on biological and cultural tactics as much as chemical control.

Monitoring Insects and Mites to Make Control Decisions

Action thresholds: Many crops can tolerate a certain amount of pest damage without a reduction in yield or quality. Some pests cause economic damage only when they occur in large numbers (for example, spider mites and aphids), while others are considered serious even at low levels (for example, plum curculio and apple maggot). A rescue treatment is not needed until the pest population reaches a critical density, usually referred to as a threshold or action threshold. An action threshold is the density of pests that signals the need for control if economic damage is to be avoided. Thresholds for different pests may be expressed as a number of pests per leaf or plant, per trap, or as a percentage of leaves infested.

One goal in the development of IPM programs is to have an appropriate action threshold for each pest. For example, spotted tentiform leafminer control is suggested in some areas if the average number of mines per leaf is two or greater. Rosy apple aphid control is suggested in apples if 5 percent or more of the terminals or fruit clusters are infested. Codling moth control is suggested if pheromone traps catch an average of five or more moths per week. However, growers need to wait 250 degree-days after codling moth capture before applying an insecticide (see "Insect Development and Degree-days"). While action thresholds are available for pests of some orchard crops in the Midwest, particularly apples, thresholds for pests on many crops have not been determined.

Monitoring Pests

Growers who practice IPM as part of their fruit production operation need to know how to monitor pests, especially insects and mites, because pest control decisions are based on the knowledge of *which pests* are present in their orchards, *how many* are present, *when* they are present, and how many are economically *tolerable*.

The two most common types of pest monitoring are *scouting* and *trapping*. Scouting and trapping each have their own merits. Scouting may be time consuming but can provide accurate information on the presence of the pest in its damaging stage. Trapping is easily done, but because it is often done to monitor the adult stage of pests that cause damage in the larval stage, the results may not be directly applicable to making control decisions on the larval form. Both methods should be used, where appropriate, to provide information to make management decisions. Another method of predicting when pests are likely to appear is *weather monitoring*. Development of certain fungal and bacterial diseases can be predicted by monitoring temperature, duration of leaf wetness, and rainfall. Activity of some insects can be predicted by monitoring temperatures and calculating degree-days.

Scouting means walking through the orchard and looking for pests or symptoms of their presence. The purpose of scouting is to monitor the effectiveness of preventive actions and the possible need for a rescue treatment. A representative sample of each crop is examined to determine the average infestation or infection level. The number of plant parts to examine varies according to the crop, size of the orchard, and the time of year.

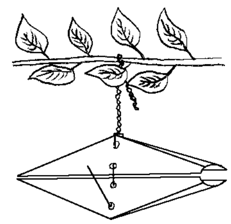
For some crops and pests, very specific scouting procedures have been developed so that a minimum number of leaves or fruit need to be examined in order to confidently make a decision about the need for applying a control measure. With a systematic sampling plan, orchards should be scouted on a regular basis, generally once a week. It is important to examine samples carefully for the presence of egg masses and small insects that may be present before the damage is evident.

Insect trapping. Traps that have the ability to catch insects are useful in some cases to reduce insect densities through mechanical control, but are most often used as a monitoring tool. Insect traps are used to determine if an insect species is present as well as to estimate the insect's density and distribution. Insects can be attracted to traps by visual appearance or by odor. Odor traps attract certain insects by using scents associated with food or mates.

Food attractant traps. Traps that use the scent of a food source are commercially available for Japanese beetle, rose chafer, and apple maggot. While these may be used for mechanical control, they can also be used for monitoring purposes. The Japanese beetle bag trap uses a food attractant to lure both the male and female beetles into the trap. This trap is so effective at attracting beetles that it can actually increase the number of beetles in the vicinity of the traps. The use of apple volatile lures greatly enhances the attractiveness of red sphere sticky traps to apple maggot flies.

Visual traps. The adult form of the apple maggot is a true fruit fly that is attracted to red spheres and yellow cards coated with sticky material. The effectiveness of these traps is enhanced when baited with apple volatile lures. Another example is white sticky traps used to monitor the tarnished plant bug.

Pheromone traps. The most common trapping method is the pheromone trap. Sex pheromones are natural scents produced by insects to attract mates. Most commercial pheromones are imitations of secretions from unfertilized adult female insects, which are used to attract male insects of the same species. The main advantage of pheromones is that they are specific to individual pest species; for example, the pheromone for the red-banded leafroller attracts only red-banded leafrollers and not the oblique-banded or fruit-tree leafrollers. Orchard pests that can be monitored with pheromone traps include codling moth, San Jose scale, red-banded leafroller, oblique-banded leafroller, fruit-tree leafroller, oriental



fruit moth, peachtree borer, lesser peachtree borer, dogwood borer, American plum borer, and spotted tentiform leafminer.

Traps used with pheromone lures come in a variety of styles and materials. One of the most common types is a wing trap. A wing trap is made of a cardboard or plastic top and a sticky cardboard bottom, held together with a wire hanger. The pheromone is impregnated on a small rubber stopper which is placed in the middle of the sticky bottom or glued to the inside of the trap top. Another style is the bucket trap, such as a Unitrap or Multi-pher trap. Bucket traps have a funnel entry system for keeping the pest from escaping. This trap does not need a sticky coating. With pheromone traps, the lures need to be replaced periodically, typically every 4 weeks, or as recommended by the manufacturer.

Insect pheromone trapping guidelines:

- Use a minimum of two traps for each pest species in representative locations.
- Monitor traps at least twice a week.
- Count and record the number of captured insects in each trap. Compare the appearance of the trapped insects with pictures or specimens of the intended target pest to be sure you are not counting other species. Remove captured insects during each visit with a wire or twig, wipe them on a paper towel or rag, and dispose of them away from the orchard.
- Record trap catches on each date in an IPM scouting log. It can help to keep a running graph of the information.
- Change trap liners (sticky cardboard bottoms) monthly, or more frequently when covered with debris. The trap often becomes less effective if too much dust or debris accumulates in the sticky layer.

- Change pheromone lures every 4 weeks (or according to manufacturer's directions). DO NOT dispose of old lures in the orchard; these will compete with the traps and cause lower trap catch numbers. It is useful to establish a pattern when changing lures, such as the first of every month.
- Store replacement lures in a freezer or refrigerator. It is best to only buy a 1-year supply at a time, but lures can be stored from one season to the next in the freezer. On each package, write the date the lures were purchased and placed in the freezer so that the oldest ones can be used first.
- If you are trapping for more than one species, change gloves or wash your hands when handling pheromones for different species to prevent cross-contamination. Minute traces of one pheromone on another can render the second completely ineffective to its target pest. Label each trap with the target pest name, and be sure to place the correct pheromone lure into the correct trap.

Weather Monitoring

The weather conditions that determine the rate of development of some diseases can be monitored to determine the optimal time to control the disease with pesticides. Temperature, leaf wetness, rainfall, and other weather factors can be measured either manually or by computer. The weather monitoring station should be located within the orchard in a location that is representative of the orchard. Weather data can then be pulled into equations or computer programs for disease development to determine management actions. Predictive models are available for apple scab and fire blight.

Insect development and degree-days. While scouting and trapping can provide information about which pest species are present at a given time, another monitoring tool of a more predictive nature is the use of temperature-based development models. Temperature plays a major role in determining the rate at which insects develop. Each insect species has a temperature range in which it feeds and develops. Below that temperature range, the insect will not develop, and above that temperature range, development will slow drastically or stop. Each insect also has an optimal temperature at which it will develop at its fastest rate. By using this relationship, you can predict the rate of development of insects. By being able to predict when an insect will appear, you can estimate when your crop is most likely to be damaged and when to intervene to prevent damage from occurring.

A method of estimating development time is called the *degree-day* method. The degree-day method can be used to predict when insects will reach a particular stage of their life cycle, if you know four things: the threshold temperature, the daily average temperature, the thermal constant, and the biofix date. Each insect species has a *threshold* temperature. Below this temperature no development of the insect occurs. The threshold temperature is 50°F for many insect species, 43°F for other species. A degree-day is the number of degrees above the threshold temperature over a 1-day (24-hour) period. For example, if the threshold temperature of an insect is 50°F and the average temperature for the day is 80°F, then 30 degree-days would have accumulated on this day (80 – 50 = 30).

The accumulation of degree-days can be used to predict when insects will hatch, pupate, and emerge as adults. By using accumulated degree-days, growers can estimate when a pest will appear in their crop, then scout for the pest and determine if treatment is needed. However, for degree-days to be used to make these predictions, researchers must have determined the number of degree-days necessary for the event to occur. This is called the *thermal constant*. The thermal constant, just like the threshold temperature, will be different for different insects and for different events in the life cycle.

The start of degree-day accumulations varies by pest species but usually is based on either a fixed calendar date or a specific biological event (biofix). The calendar date is the same each year (often January 1), but often it is necessary to keep track of degree-day accumulations for several weeks before the insect appears. The biofix is often the initiation of adult flight or peak flight as indicated by pheromone trap catches. For example, with codling moth, the biofix is the date when the fifth moth is captured at the beginning of the season.

The easiest way to calculate degree-days for a date is to subtract the threshold temperature from the average daily temperature. The average daily temperature can be determined by simply averaging the high temperature and low temperature for the date:

[(maximum temp + minimum temp) ÷ 2].

For example, if the high temperature for the day was 90°F, and the low temperature was 60°F, then the average temperature for the day would be:

75°F [(90 + 60) ÷ 2 = 150 ÷ 2 = 75)].

If the threshold temperature for an insect were 50°F, then the degree-days accumulated on this day would be 25 because 75 – 50 = 25.

Temperature extremes add variables to this simple method of calculating degree-days. To overcome these and to more accurately predict when insects will be present, use the following rules:

1. If the maximum temperature for the day is not greater than the threshold temperature, no degree-days are accumulated. For example:

   maximum daytime temperature = 45°F
   threshold temperature = 50°F.

2. If the high temperature for the day is greater than the threshold temperature but the low temperature for the day is less than the threshold temperature, then when calculating the average temperature for the day, the threshold temperature is used as the low temperature. For example:

   maximum daytime temperature = 70°F
   low daytime temperature = 45°F
   threshold temperature = 50°F.

   The threshold temperature of 50°F would be used instead of the actual low daytime temperature when calculating the average daily temperature. So the degree-day units accumulated on this day would be 10:

   [(70 + 50) ÷ 2 – 50 = 120 ÷ 2 – 50 = 60 – 50 = 10].

3. If the high temperature for the day is greater than the *optimum* temperature, the temperature at which the insect will develop at the fastest rate, then use the optimum temperature as the high temperature for the day when calculating the average temperature for the day. For example:

   maximum daytime temperature = 98°F
   optimum temperature = 95°F
   low daytime temperature = 75°F
   threshold temperature = 50°F.

   The optimum temperature of 95°F would be used instead of the actual high temperature for the day when calculating the average temperature for that day. So the degree-day units accumulated on this day would be 35:

   [(95 + 75) ÷ 2] – 50 = (170 ÷ 2) – 50 = 85 – 50 = 35].

Many of the insect pests that attack orchard crops in the Midwest have degree-day models developed to predict their development. Degree-day models are commonly used to improve the timing of insecticide applications for codling moth and San Jose scale (see Appendix A).