PEST AND DISEASE MANAGEMENT

Introduction

The damage caused by many pests can often be tolerated in a school garden. Some pests can be controlled without chemicals by washing plants with a forceful spray of water, hand picking and destroying the pests, or by using barriers.

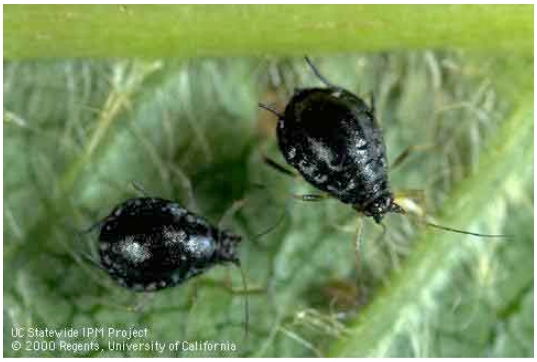
Each of the following sections on Arthropod, Mollusks, Vertebrate pests, and their Natural Enemies have a few photos of the more common garden pests. All of the photos and information are from the UC IPM website. The website has detailed information on these pests and many more. The information on the IPM website includes additional photos, Pest Identification, Life Cycle, Damage Caused by Pest, Management of Pest, and in many cases a Pest Note that can be printed out. Click this link http://www.ipm.ucdavis.edu/PMG/selectnewpest.landscape.html to go to the UC IPM Pest Index.

Arthropod Pests

The examples of arthropod pests shown here are aphids, spider mites, whiteflies, mealybugs, corn earworm, and tomato hornworm.

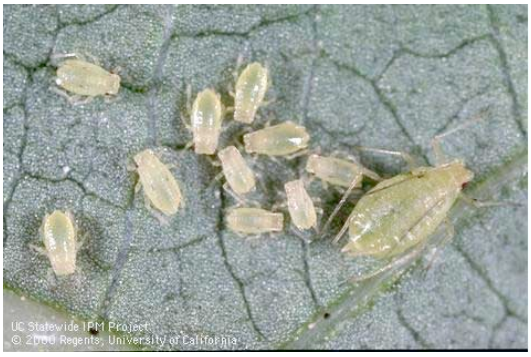
Aphids

Aphids are small, soft-bodied insects with long, slender mouth parts that they use to pierce stems, leaves, and other tender plant parts and suck out plant fluids. Almost every plant has one or more aphid species that occasionally feeds on it. Large populations cause curling, yellowing, and distortion of leaves and stunting shoots; they can also produce large quantities of a sticky exudate known as honeydew, which often turns black with the growth of a sooty mold fungus. Aphids come in a variety of colors.



Black Cherry Aphid

Rosy Apple Aphid



Green Peach Aphid

Leaf curling and distortion caused by aphids

Spider Mites

Spider mites are the most common mite pest in the garden. To the naked eye, spider mites look like tiny moving dots; however, you can see them easily with a 10X hand lens. Adult females, the largest forms, are less than 1/20 inch long. Spider mites live in colonies, mostly on the under-surfaces of leaves; a single colony may contain hundreds of individuals. The names "spider mite" and "webspinning mite" come from the silk webbing species produce on infested leaves. The presence of webbing is an easy way to distinguish them from all other types of mites.

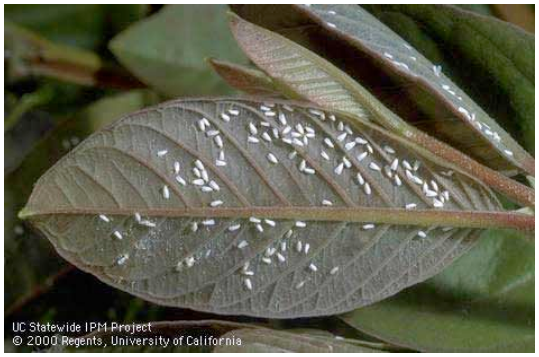
Adult Pacific Spider Mite

Leaf mottling and webbing from heavy infestation of spider mites

Whiteflies

Whiteflies are tiny, sap-sucking insects that are frequently abundant in vegetable and ornamental plantings. They excrete sticky honeydew and cause yellowing or death of leaves. Outbreaks often occur when the natural biological control is disrupted.

Whiteflies usually occur in groups on the undersides of leaves. They derive their name from the mealy, white wax covering the adult's wings and body. Adults are tiny insects with yellowish bodies and whitish wings.



Adult greenhouse whiteflies and tiny eggs

Sooty mold grows over honeydew left by a whitefly infestation on cotton

Mealybugs

Mealybugs are soft, oval, flat, distinctly segmented, and covered with a white, mealy wax that extends into spines (filaments) along the body margin and the posterior end. The species differ mainly in the thickness and length of the waxy filaments. Citrus mealybug, the most common species, has a pinkish body that is visible through the powdery wax. The filaments around its margins are not appreciably longer at the posterior end.

Mealybugs extract plant sap, reducing tree vigor, and excrete honeydew. If a cluster of mealybugs feeds along a fruit stem, fruit drop can occur. Damage is most severe in spring and fall.

Mealybug colonies

Citrus mealybugs

Crop damaged by citrus mealybug

Corn Earworm

The corn earworm may be present throughout the season but is most abundant during August and September. Larvae feed on leaves, tassels, the whorl, and within ears, but the ears are the preferred sites for corn earworm attack.


Color variations of tomato fruit worm (also called corn earworm and cotton bollworm).

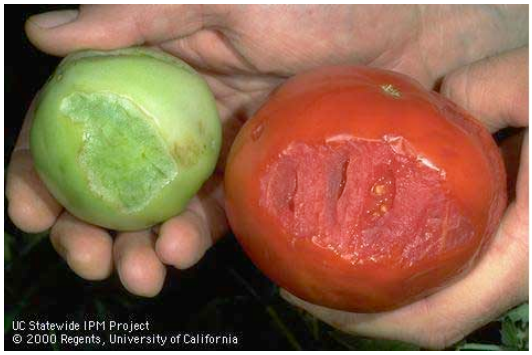
Corn earworm larva feeding on corn

Tomato Hornworm

Hornworms feed on blossoms, leaves, and fruit. At high populations they can extensively defoliate plants and scar the fruit.

Hornworm larva

Adult tomato hornworm



Tomato hornworm damage

Snails and Slugs

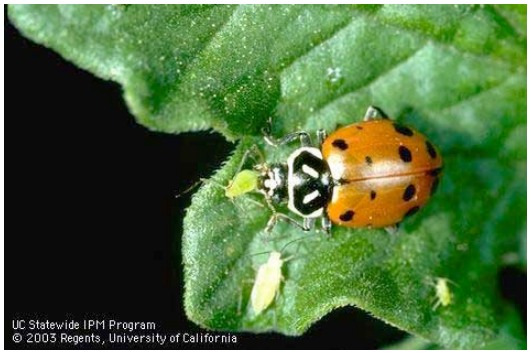
Snails and slugs are among the most bothersome pests in many garden and landscape situations. On plants they chew irregular holes with smooth edges in leaves and flowers and can clip succulent plant parts. They can also chew fruit and young plant bark. Because they prefer succulent foliage or flowers, they are primarily pests of seedlings and herbaceous plants, but they are also serious pests of ripening fruits, such as strawberries, artichokes, and tomatoes, that are close to the ground.

Brown garden snail

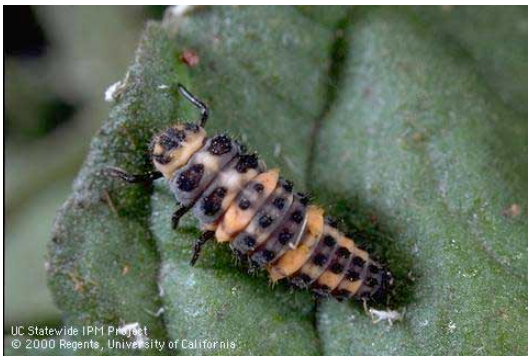
Slug crawling on ripe strawberry

Beneficial Insects – Natural Enemies
Natural enemies are organisms that kill, decrease the reproductive potential or otherwise reduce the numbers of another organism. Natural enemies that limit pests are key components of integrated pest management programs. Some of the natural enemies to encourage in your garden are the lady beetle, mealybug destroyer, and the syrphid fly. Click this link http://www.ipm.ucdavis.edu/PMG/NE/index.html to go to the UC IPM website Natural Enemies Gallery for more information on these and other beneficial insects.

Convergent Lady Beetle
Both adults and larvae of lady beetles feed primarily on aphids and occasionally on whiteflies, other soft-bodied insects, and insect eggs.

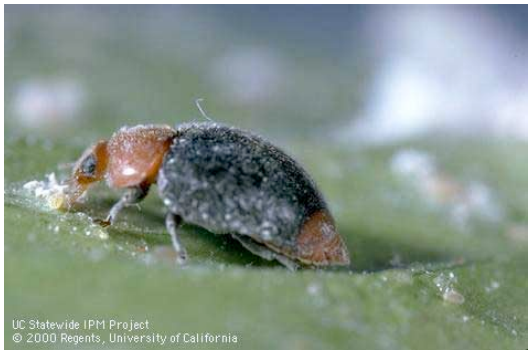


Adult convergent lady beetle feeding on aphids

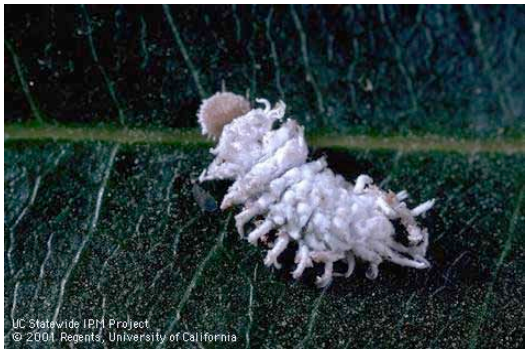


Larva of convergent lady beetle

Mealybug Destroyer
Both adults and larvae feed on exposed mealybug species and other homopterans such as the green shield scale. *C. montrouzieri* are most effective at controlling mealybugs when the mealybug population is high.



Adult mealybug destroyer

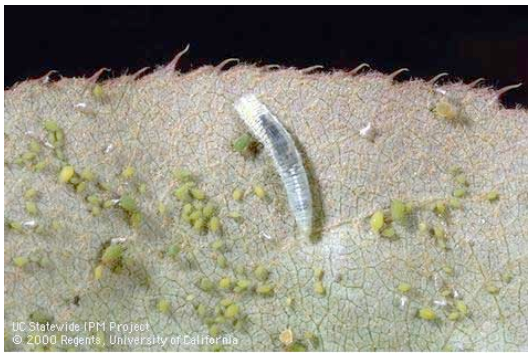


Mealybug destroyer larva feeding on citrus mealybug

Syrphid Fly

Syrphid flies are regularly found where aphids are present in agricultural, landscape, and garden habitats. Adults of this stingless fly hover around flowers, have black and yellow bands on their abdomen, and are often confused with honeybees.

Adult syrphid fly



Syrphid fly larva preying on aphids

Vertebrate Pests

Some of the most common vertebrate pests are the California Ground Squirrel, Pocket Gopher, Roof Rat, and Vole (Meadow Mouse).

California Ground Squirrel

The California ground squirrel is one of the most troublesome pests to homeowners and gardeners. Ground squirrels damage many food-bearing and ornamental plants. Particularly vulnerable are grains and nut and fruit trees such as almond, apple, apricot, orange, peach, pistachio, prune, and walnut.

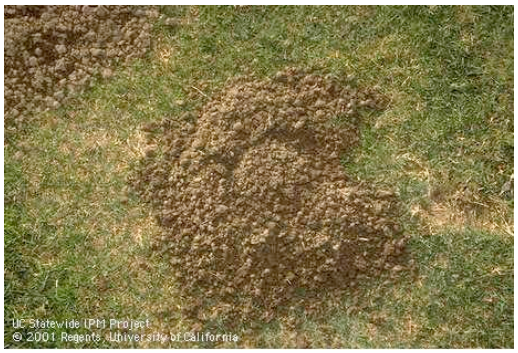
California Ground Squirrel

California Ground Squirrel burrows

Pocket Gopher

Pocket gophers are burrowing rodents that get their name from the fur-lined external cheek pouches, or pockets, which they use for carrying food and nesting materials. They are well equipped for a digging, tunneling lifestyle with powerfully built forequarters, large-clawed front paws, fine short fur that doesn't cake in wet soils, small eyes and small external ears, and highly sensitive facial whiskers to assist movements in the dark. Pocket gophers often invade yards and gardens and feed on many garden crops, ornamental plants, vines, shrubs, and trees. A single gopher moving down a garden row can inflict considerable damage in a very short time. Gophers also gnaw and damage plastic water lines and lawn sprinkler systems.

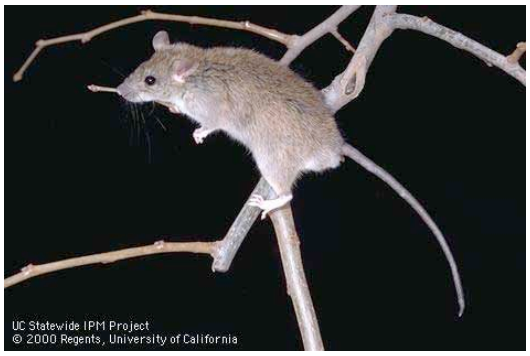
Pocket Gopher



Characteristic crescent-shaped mound and plugged burrow opening of a pocket gopher

Roof Rat

Roof Rats are some of the most troublesome and damaging rodents in the United States. They consume and contaminate food, damage structures and property, and transmit parasites and diseases to other animals and humans. They also damage garden crops and ornamental plantings.

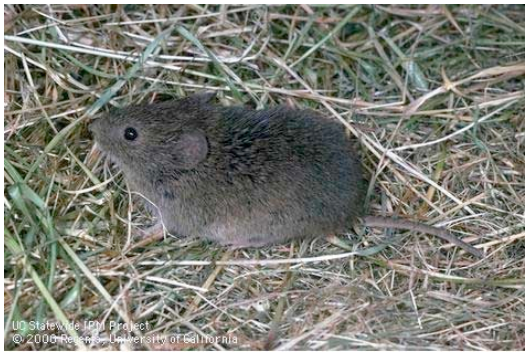


Roof Rat

Comparison of droppings, from left to right are house mouse, roof rat, and Norway rat.

Voles (Meadow Mouse)

Voles do not commonly invade homes, and should not be confused with the house mouse. Voles cause damage by feeding on a wide range of garden plants including artichoke, beet, Brussels sprouts, cabbage, carrot, cauliflower, celery, lettuce, turnip, sweet potato, spinach, and tomato. Turf and other landscape plantings such as lilies and dichondra may be damaged. Voles will gnaw the bark of fruit trees including almond, apple, avocado, cherry, citrus, and olive.



Vole

Examples of vole droppings

Plant Diseases

Disease is a cause of lowered efficiency or final breakdown in the plant's function and growth. The signs and symptoms of the disease can give a good indication of the pathogen involved, or at least the general group of the pathogen.

Sometimes it is impossible to identify the cause of a plant disease without a laboratory diagnosis. If it doesn't effect yield or quality a diagnosis is not needed.

There are three general categories of disease-causing organisms: fungal, bacterial and viral pathogens.

Fungal Pathogens
These are the most numerous of the plant pathogens and can infect the roots, stems, leaf, and flower tissues. They are often found in the soil and many times can persist from season to season between crops. Symptoms include wilts, stem rots, mildews, rusts, leaf spots, and numerous others. Fungi generally do well in cool to slightly warm conditions with lots of available water. Many times you can see the actual fungus that is causing the disease with a hand lens or the naked eye.

Bacterial Pathogens
These need a wound or some type of opening to invade the plant. This can be any type of tissue damage and primarily affects the upper parts of plants. Bacterial pathogens can be seed borne, and are sometimes found in the soil or on plant debris. Bacterial pathogens cause leaf spots, cankers, galls, and other symptoms. Transmission occurs from plant to plant, mechanically. Bacterial pathogens do well in warm, moist conditions. You cannot see the actual bacterial pathogen without a microscope.

Viral Pathogens
Viral pathogens can cause deformations, unusual elongation, discoloration, or reduced yields. They are transmitted by insects, mechanically, or by seed. The best control is to reduce the insect population.

Click this link http://www.ipm.ucdavis.edu/PMG/selectnewpest.landscape.html to go to the UC IPM website Plant Disease Index to read more and see examples of specific plant diseases.

Nematodes
These small worms are typically found in the soil which may infect the roots of most crops. Solutions are to solarize the soil with clear plastic, rotate crops, and plant resistant varieties, where available.

Click this link http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7489.html to go to the UC IPM website to read more and see examples of nematodes.

Control of Plant Pathogens

There are several good practices that will minimize infection from plant pathogens. These include the following:

- Good Sanitation - Make sure the disease-causing organisms stay out of your growing operation. If you have a disease problem, dispose of the infected material immediately. (Seal it in a plastic bag and put into the trash. Do not compost.)
- Clean Stock Plants - Start with clean material and you will minimize disease problems.
- Consistent Monitoring - Daily, weekly, or monthly. Catch disease problems early and treat where needed.
- Adequate Nutrition - Plants that are receiving adequate nutrition are less likely to suffer from disease. Fertilize regularly.

Integrated Pest Management

No garden, despite the gardener's best efforts, is immune to pests and diseases. Even a well-tended one will have destructive organisms that will fly, crawl, creep, leap, or stroll into the garden from adjacent areas. Some will even ride on the winds and air currents from miles away.

Gardens are microcosms where plants, insects, bacteria, fungi, earthworms and a host of many other organisms live and thrive. The majority of these inhabitants are law-abiding, go about their business and live in harmony with each other. Only a few are troublemakers that cause problems for the rest of the garden community. In most cases, the good guys insure the bad guys do not get out of line to cause problems. Integrated Pest Management (IPM) is an important garden practice. IPM does not eliminate garden pests but endeavors to keep pests under control and reduce their damage to a tolerable level through a variety of methods.

For many years, farmers followed the premise that the only good bug was a dead bug. Hobby gardeners also followed this premise. Many thought the introduction of miracle pesticides and laboratory chemicals, such as DDT in the '40s, was the solution to all pest problems. Armed with an arsenal of chemicals, farmers and gardeners were encouraged to spray or dust at the slightest provocation. In the '60s farmers were spraying more and more with fewer and fewer results. They did not realize that:

- Many insects developed a resistance to the pesticide.
- The creature destroyed could be a beneficial organism that attacked the pests.
- The misuse of the chemical products would cause environmental harm.

IPM is an integrated program that relies on alternative techniques for pest control and prevention of garden problems. These include: biological controls, resistant varieties, traps, barriers, crop rotation, mulch, solarization, tilling techniques, irrigation methods, pruning techniques, proper garden clean up and the limited use of pesticides when appropriate.

Pest problems, of course, will vary with region, climate, crop variety, soil type and general gardening practices. IPM is an important method of pest control in school gardens.

In the schoolyard where children are present, chemical pesticides usually cannot be used. When there is an extremely serious problem and chemical pesticides are necessary, the school pest control department must be contacted for assistance. They have trained personnel available or under contract who will inspect the problem and apply the correct product when children are not present.

Least toxic pesticides commonly available include: insecticidal soap, Neem spray and Bt (Bacillus thuringiensis). Any pesticide product used in the garden must list the crop plant to be treated and the pest being controlled.

The most important step of IPM is going out to the garden on a regular basis and systematically checking the plants for pests and symptoms of damage.

Examine the plants at least once or twice a week during the growing season

Walk through the garden turning over leaves to check for signs of insects or disease. Equipment for the monitoring program should include a notebook for keeping records, a ten power magnifying lens for viewing small insects and small plastic bags or jars for collecting samples to be identified later. This is an excellent student activity to develop observation skills and to learn how to identify insects.

1. Identify the problem

When a problem is discovered in the garden, the first step to finding a solution is to identify the nature of the problem.

What is causing the problem? Is it an insect, a soil-borne pathogen, too much or too little water, sun scald, gophers, rabbits, snails or slugs, birds or has a child stepped on the plants or pulled the plant apart?

Is the problem in one part of the garden isolated on one type of plant (e.g., cabbages) or is it also in another part of the garden (e.g., peas)?

It would be unwise to treat the whole garden for a highly localized problem. Use the notebook to record these facts. Have students go into the garden to make notes on problems they find. Click here to go to the sample IPM form that can be used to assist in collecting the evidence discovered and record the findings in a notebook.

Once the pest information is collected, have the students use several sources to research and identify the problem and learn effective methods to control it. Sources include library reference books, such as insect field guides or gardening books. Three excellent publications are:

Pests of the Garden and Small Farm, A Grower's Guide to Using Less Pesticide by The University of California, Division of Agriculture and Natural Resources, publication number 3332.

A Citizen's Guide to Pest Control and Pesticide Safety by the United States Environmental Protection Agency, publication number EPA 730-K-95-001

University of California Guide to Solving Garden and Landscape Problems on CD, publication number 4300.

In San Diego County, you may call the University of California County Cooperative Extension, Master Gardener Information Hot Line (858) 694-2860 for free advice on gardening problems. Local garden centers are also good sources for solutions to gardening problems. However, they may recommend chemicals they sell.

2. Decide how much pest control is necessary
When you find and identify a problem, select the best solution to solve it. The best solution may be washing the plant with a strong water spray from the garden hose, changing the watering schedule, spraying the plant with insecticidal soap or a botanical pesticide such as Bacillus thuringiensis, commonly known as Bt, or doing nothing. Ask yourself these questions:

- Does the garden really need to be insect free? Can you tolerate some blemished plants or fruits in your garden?
- Are beneficial insects present in the garden?
- Can you replace the plants with hardier disease resistant varieties?

3. Choose an effective option
With the information on your IPM record form gathered in Step 1 and the answers to your questions considered in step 2, determine which option you wish to choose. If you are still uncertain, research additional references or get advice from gardening professional.

4. Evaluate the results
Once a pest control method has been chosen and implemented, always allow time for it to work and then evaluate its effectiveness. Compare pre-treatment and post-treatment conditions. Is there evidence of a reduction in the number of pests?

If steps are taken to prevent pests in the first place you may not have to control them later. Garden pests seek places to live that satisfy their basic needs for moisture, food and shelter. If these conditions are reduced the pests may move on to other areas.

To make your garden less attractive to pests, take the following preventative actions:

- Have the soil tested before planting to determine if you need to adjust the pH. Most plants grow best with a pH between 6.0 and 7.5.
- Make sure your garden has good drainage. Raised beds will improve drainage especially in heavy clay soils. Add organic material (compost) to the soil before planting if the soil needs amendments.
- Select healthy plants, seedlings and seeds that are known to resist diseases and are well suited to the climate. Fertilize them well. Strong plants are more likely to survive attacks by pests.
- Plant alternate rows of different kinds of plants. Pests that prefer one type of vegetable may not move to the next row if other kinds of plants are planted in neighboring rows.
- Do not plant the same crop in the same place year after year.
- Mulch the garden with leaves, straw, grass clippings, shredded or chipped bark to keep down weeds. A weed-free garden will reduce the pest population.

- Beneficial organisms help control pests. Birds, ladybugs, spiders, green lacewings, dragonflies, centipedes, praying mantis all eat aphids, mealybugs, whiteflies and mites.
- Traps may be used to control mice, rats, gophers and squirrels. Fencing the garden with poultry wire is an effective method of keeping out rabbits.
- Compost garden waste and dead vegetation.

You may choose from many different methods as you plan your strategy for controlling garden pests. Sometimes a non-chemical method is as effective and convenient as many chemical alternatives. For many pests, total elimination is almost impossible, but it is possible to control them.

Knowing your IPM options is the key to good pest control.

Again the UC IPM website is an excellent source of information for pest identification and control utilizing Integrated Pest Management (IPM). Click this link http://www.ipm.ucdavis.edu/PMG/selectnewpest.landscape.html to go to the UC IPM Pest Index.

SAMPLE IPM RECORD FORM

DATE: _____ LOCATION IN GARDEN: _____

TIME: _____ TEMPERATURE and WEATHER:_____

	Affected Plants	Symptoms
1.		
2.		
3.		

Pest Found and Where

1. Name _____ Plant_____ Number found____

Where? ____leaves _____stem _____flowers _____fruit _____roots

2. Name _____ Plant_____ Number found____

Where? ____leaves _____stem _____flowers _____fruit _____roots

3. Name _____ Plant_____ Number found____

Where? ____leaves _____stem _____flowers _____fruit _____roots

Name of Observer _____

Figure 1 IPM