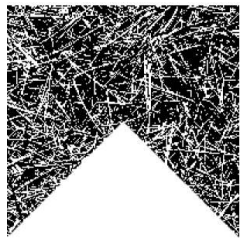


IPM



Home Garden Vegetables

Insect Control Recommendations for 2011

INSECT CONTROL

Making Your Garden Vegetables Less Susceptible to Insect Damage

Integrated pest management or IPM is the judicious use of multiple pest management tactics when pest populations reach above the action threshold. The action threshold is simply the level of pest populations at which control should be implemented to avoid damage to the crop. Action thresholds help determine both the need for control actions and the proper timing of such actions.

Homeowners and gardeners can practice IPM by using insecticides as a last resort, by employing alternative pest management strategies, and by conserving natural enemies. There are many ways to reduce or eliminate the need for insecticides; some of these are described in the sections that follow.

To stay informed about pest occurrences, management recommendations, and the latest IPM information, readers may subscribe to the "Alabama IPM Communicator" newsletter, an official publication of the Alabama IPM Center. To subscribe, please send an email to bugdoctor@auburn.edu or visit the newsletter archive at www.aces.edu/go/128.

Healthy Soil

Healthy soil will result in plants better able to resist insects and diseases. Before planting, the garden soil should be turned over and organic matter, such as manure or compost, should be added to supply essential nutrients. Organic nutrients are released slowly, in contrast to synthetic fertilizers, which provide "quick-fix" nutrients. When possible, compost should be purchased from a trusted local source; buying poor quality compost may result in insect infestations like maggots and grubs.

Companion Planting

Companion planting is the practice of strategically placing insect-repelling plants next to crops that will benefit from their repellent effects. Some plants contain or give off compounds that repel insects. For example, planting garlic among vegetables helps to deter Japanese beetles, aphids, vegetable weevils, and spider mites; basil planted near tomatoes repels tomato hornworms; and marigolds interplanted with squash or cucumbers will repel cucumber beetles and nematodes.

Beneficial Insects

Most insects encountered in nature are good bugs and have a critical role in the natural food chain. Therefore, a gar-

dener should be able to identify garden insects and determine whether they are harmful or beneficial. Table 4 provides a short list of insect predators that help seek and destroy insect pests and that are commonly seen in the garden. There are also many insect parasitoids that are too small to see individually.

Applying insecticides can destroy the natural balance by eliminating beneficial insects. Switching to one early season application of systemic insecticides to recommended garden vegetables can not only provide long-term insect control but also allow establishment of natural enemies in the beginning of the season in a new garden.

Crop Rotation

Planting vigorous vegetable varieties and using proper crop rotation are two basic IPM tactics. Planting vegetables in a different section of the garden from year to year may help reduce pest infestation by disrupting insect life cycle. Some insect pests overwinter in the garden soil and emerge in the spring and begin searching for food. If the plant they prefer to eat is located several yards away, the insect must move to the source. Many will die along the way or will fall prey to birds and other predators. Also, many vegetables remove nutrients from the soil; by rotating vegetable crops each year within the garden, the soil in a particular section will have the opportunity to rest and regenerate.

Diversified Planting

A common practice among home gardeners is to plant a single crop in a straight row. This encourages pests because it makes it easy for them to travel from one host plant to another. By intermingling different types of plants and by not planting in straight rows, an insect is forced to search for a new host plant, thus exposing it to predators. This approach also works well with companion planting.

Trap Plants

If given a choice, some insects will opt to feed on one plant type over another. For example, pickleworms prefer squash to cucumbers, and some tomato worms prefer dill over tomatoes. With a little knowledge of host preferences, you can take advantage of this by placing certain trap plants where they can lure harmful insects away from the main crop. Trap plants should be planted as early as possible and a vigorous plant variety should be used. Once the trap plants have become infested, the target insect can be picked off and dropped in

soapy water or the entire plant can be disposed of. For stink bug management, addition of early-planted trap crop (such as okra, beans, or sunflowers) followed by insecticidal or cultural pest management tactic could be beneficial. Trap plants can be planted within the main crop in rows or around the borders to attract and retain pest insects.

Barriers and Traps

Barriers and traps can be employed to capture or impede the movement of pests. A collar made of thick paper or cardboard placed around the stem of a plant and pressed into the soil an inch or so deep will prevent cutworms and other burrowing insects from getting into the soil around your plants. A board or thick piece of paper painted bright yellow and coated with a sticky substance, such as Tanglefoot®, will attract and intercept aphids, whiteflies, and other small flying insects.

Mulch

Mulching is the spreading of organic matter in the garden and around plants. It is an effective method to control weeds and serves as a refuge for predatory insects like ground beetles and spiders. Mulch also helps the soil to retain moisture, which promotes plant vigor and reduces abiotic stresses. Mulch should be added to the garden when plants are 4 to 6 inches high. Grass clippings, leaves, hay, sawdust, wood chips, and compost make excellent mulches. One drawback of using mulch may be increased numbers of slugs in the garden that feed on young and succulent plants.

Insect Sampling Techniques

Both pest and beneficial insects can be sampled by home gardeners to assess the level of insect activity before and after an insecticidal spray. Some simple techniques to frequently sample insect populations include the following:

- Yellow sticky cards: Many insects and spiders can be intercepted on colored sticky cards as they migrate long dis-

tances. Yellow sticky cards can be placed at several locations around a garden to monitor the aphid migration while white cards can be used to monitor thrips, certain bugs and beetles.

- Drop cloth/shake cloth: Gardeners can use a drop cloth spread between the rows of vegetables to gently shake off slow-moving insect pests (such as caterpillars) and beneficial arthropods for counting.
- Sweepnet sampling: Gardeners can use a sweep net for collecting insects off the plants by vigorously moving the net through crop canopy. A relatively easy way of viewing insect collection is to empty the contents of the net into a gallon-size Ziploc bag. The bag can then be frozen in a refrigerator to preserve specimens for later viewing or identification.
- Pitfall traps: Pitfall traps can be placed in the ground and are excellent for estimating the population/activity of soil-dwelling insect pests and predators (like tiger beetles, ants, etc.).

Insect Monitoring Using Pheromone Traps

Moth insect pests can be detected using pheromone traps around the garden. Research at Auburn University and elsewhere indicates that detection of the first flight of moths may indicate the need to scout crops for other life stages of the insect pest; for example, if 10 to 12 corn earworm and fall armyworm moths are found in separate pheromone traps each week, then vegetable crops should be examined immediately for larval feeding damage. To a limited extent, it may be possible to “trap out” or intercept all moths in an area using multiple traps.

Pheromone traps are available for almost all major insect pests of vegetables including corn earworm (tomato fruitworm), fall armyworm, cutworm, tobacco budworm, and squash vine borer. Pheromone traps can be purchased in bulk from vendors like Great Lakes IPM (Vestaburg, MI) or in the form of kits from Internet sites like Arbico Organics (Tucson, AZ) and Planet Natural (Bozeman, MT).

General Recommendations for Managing Soil Pests in the Garden

Many soil insect pest populations reach high numbers in grass or turf. Home gardens are often established in areas previously covered with grass. To reduce soil insect problems, thoroughly till or spade the area well in advance of planting (30 days or more) and again just before planting. This will bring soil pests up near the surface where their chances of mortality are increased.

A broadcast soil insecticide applied properly 2 weeks before planting will help to control some soil insects like cutworms, wireworms, and white grubs. See the note on applying broadcast soil insecticides at the end of Table 1 for instructions on this topic.

Systemic insecticides (imidacloprid-containing products) are now available for home gardeners; these insecticides should be used in a timely manner and early in the season so that the insecticide is not present when fruits are harvested. (Note the 21-day waiting period.) The product should be applied as a drench soon after transplanting or when the first sucking pests are noticed on leaves. A systemic insecticide also requires a few days to get absorbed and translocated throughout the vascular system of plants. For more information about proper use of the new insecticides or for IPM training,

contact a Regional Extension Agent at the local county Extension office.

Slugs

Slugs like to feed on young seedlings and succulent parts of plants. They leave a trail of mucus on the surfaces on which they crawl. Moist, humid environments favor slug development, and slugs usually overwinter in sheltered locations outdoors. Eggs are deposited in moist areas and maturity requires a year or more. Pesticide baits (e.g., metaldehyde) are minimally to moderately effective against slugs and are best applied late in the afternoon. Baiting in the fall after the first fall rains will target slugs before they can lay eggs.

The following are suggestions for minimizing slug damage to gardens:

- Spade or till garden area in the fall and again in the spring before planting.
- Using a flashlight, check the garden for active slugs around 10:00 pm. Those detected can be picked up with an old teaspoon. Place captured slugs in a container of salt; salt will kill slugs. If this activity is continued for 3 or 4 nights in a row, damage can be greatly reduced.

- Place stale beer in small cups or pans sunken in the soil so the lip of the container is slightly below ground level. Slugs are attracted to the beer; once inside, they drown. The beer should be replaced about every 3 days for best results; however, the beer must be stale to be effective. Slug populations can be greatly reduced if this method is started early in the spring and enough containers are set out.
- Use diatomaceous earth, lime, or sawdust as a barrier. Replace it after each rain.

Cutworms

Cutworms are greasy-looking caterpillars that curl into a C-shape when disturbed. They have a wide host range and can cause damage rapidly resulting in a thin crop stand. Cutworms are active only at night and remain buried below the soil surface near food plants during the day. They emerge to feed at night and often cut seedlings or small stems, causing the plants to fall over. Because grass and many weeds are preferred hosts, remove grass and weeds in the garden, and plow the soil well in advance of planting. Damage can also be prevented by placing a paper or plastic "sleeve" over the plant and pressing the bottom into the soil. Paper cups with the bottoms removed or 4-inch high sections of half-gallon paper milk cartons are ideal. Place the sections or sleeves around newly set transplants or newly emerged seedlings so that 1 inch is below ground level and 3 inches are above the ground. Tuna cans with the bottoms removed may also be used for this purpose. Some cutworm species can be monitored using insect pheromone traps, which can provide information about pest pressure in the neighborhood.

Wireworms

Wireworms are the slender, yellowish-brown, hard-bodied larvae of click beetles. They can survive deep in the soil for up

to five years and can move up to attack the seeds or young plants. Several wireworm species prefer plants in the grass family. They are usually not a problem unless the garden is planted on land that previously contained grasses or crops in the grass family. Turning over the soil in the fall and again in the spring well in advance of planting will help to reduce wireworm populations.

White Grubs

White grubs are Japanese and May beetle larvae that are dirty white in color with the tip of their abdomen more of a blue-black; they roll into a C-shape when disturbed. The mature grubs may reach 2 inches in length. They live in the soil and sometimes feed on plant roots and tubers. About the only time they are troublesome is when parts of the lawn or sod are turned under in the spring for garden use. When gardens must be planted in these areas, prepare the soil well in advance of planting. Handpicking grubs as the sod is turned over, raked, and prepared for planting is the best method of control.

Mole Crickets

Mole crickets have brown, velvety bodies with broad front legs for digging in the soil. They have large eyes and are about 1 inch long when mature. As mole crickets tunnel through the soil, they can disrupt the root system of vegetables. They may also feed on plant roots and underground stem tissue. There are no effective soil insecticides registered for use against mole crickets in vegetables. Avoid planting the garden in areas that were previously covered with grass. If any mole cricket tunnels are observed around plants, tamp the soil back down to restore support to the root system.

Managing Pests That Feed Above Ground

This section provides some non-chemical methods for management of insect pests that feed above ground. Insecticide recommendations are provided in the tables that follow.

Aphids

- Anchor aluminum foil to the soil for 1 foot around transplants to repel aphids. Slope the soil away from the plant so rain water and mud do not obscure the reflective surface. Foil may be removed after flowering.
- Make a water trap by painting a small, shallow pan bright yellow and filling it with soapy water. Place several in the garden and refill after each rain. Or paint 6- x 8-inch cards or pieces of plywood a bright yellow (Rust-Oleum 659 or Safety Yellow). Then coat them with a thin layer of a sticky substance such as Tanglefoot or Tack Trap. Attach them to the garden stakes with the cards at crop level. Replace the Tanglefoot or Tack Trap as needed.
- Repel aphids by spraying plants with a mixture of 2 tablespoons of hot red pepper, 2 garlic cloves, 1 tablespoon of liquid soap, and 1 quart of water.
- Handpick, remove, and destroy aphid colonies on plant leaves.
- Knock aphids from plants with a strong spray of water from the garden hose.
- Spray plants with insecticidal soap. Test tender plants first to ensure they are not burned by the soap solution.

- Aphids can transmit plant virus disease; remove and destroy diseased plants to delay spread of the virus to healthy plants.

Asparagus Beetles

- Plant marigolds near asparagus to repel beetles.
- Destroy and bury any plant refuse in the fall to remove overwintering sites.
- Handpick and destroy all eggs, larvae, and adults in the morning before they become active.
- Spray asparagus ferns with pyrethrin in late summer so fewer beetles will overwinter. Cut foliage off at the ground as soon as it begins to die back.

Cabbage Loopers and Cabbageworms

- Cover plants with cheesecloth or a floating row cover to prevent egg-laying.
- Handpick and destroy the worms. Green worms are much easier to spot on red-leaf cabbage varieties.
- Spray plants with *Bacillus thuringiensis* when worms are still small.
- Remove alternate host weeds such as wild mustard and shepherd's purse from the garden.
- Interplant a hot pepper plant between every two cabbage plants.

Colorado Potato Beetles

Potato beetles are infamous for insecticide resistance to synthetic pyrethroids; therefore, use insecticides sparingly and try the following alternative management methods.

- Potato beetles prefer to feed on potatoes, eggplants, and tomatoes. Rotate these preferred hosts with other crops in alternate years.
- Interplant non-host crops (e.g., beans) with preferred host crops.
- Handpick and destroy orange egg masses, which occur on the underside of leaves, reddish-brown larvae, and yellow and black striped adults. Two to three generations of the insect occur in Alabama and throughout the South.
- Place straw mulch around plants to hinder movement of the beetles.

Corn Earworms (Tomato Fruitworms)

- With no controls applied, earworms usually damage only the tips of the ears of corn. Cut off the damaged tips and the remainder can be eaten.
- If possible, avoid planting other vegetables near corn, a favorite food of corn earworms.
- Plant and harvest corn as early as possible to avoid infestations.
- Drop 0.25 teaspoon of mineral oil on the silks of each ear of corn after silks have wilted but before they begin to dry.
- Select tight-husked corn varieties for planting; this inhibits worm movement into the ear.
- Beginning at the flower stage, check upper tomato leaves once per week for the small, round, white fruitworm eggs. Spray plants with *Bacillus thuringiensis* weekly as long as eggs are detected.

Cucumber Beetles

- Plant "nonbitter" cucumber varieties; the bitter compound in cucumbers attracts the beetles.
- Cover young plants with cheesecloth or floating row covers until the vines start to run.
- Interplant cucumbers with radishes; radish seems to repel cucumber beetles. Pansies, marigolds, and nasturtiums also repel the beetles.
- Eliminate weeds in and around the garden; some weeds are hosts for bacterial wilt disease, which is spread by the cucumber beetles.

Flea Beetles

- Flea beetles are most numerous in the spring; therefore, plant susceptible crops like eggplants and radishes later in the season.
- Unless flea beetle populations are heavy, their feeding will not kill the plants nor reduce their yields; control is usually not necessary.
- Weeds bordering the garden may serve as alternate hosts. Removing weeds will reduce flea beetle populations.

Grasshoppers

- Trap grasshoppers by using a 1-quart container half filled with a 10-percent molasses and water mixture.
- Grasshopper populations are most damaging in late summer; a floating row cover can be used to protect late-season plantings.
- Fall plowing of the garden, including fence rows and garden borders, exposes the grasshopper eggs to the weather and to insect predators.

Japanese Beetles

- Avoid planting the garden near lawns or in previously grassy areas.
- Protect plants with floating row covers.

Leafhoppers

- Protect plants with cheesecloth or other fine, mesh row covering.
- Paint 6- x 8-inch boards a bright yellow (Rust-Oleum 659 or Safety Yellow). Then coat them with a thin layer of a sticky substance such as Tanglefoot or Tack Trap. Hang the boards at crop level. When the boards are filled with insects, wash and recoat them.
- Spray plants with insecticidal soap.
- Leafhoppers can transmit virus diseases; remove diseased plants to delay spread to healthy plants.

Mexican Bean Beetles

- Handpick and destroy the egg masses and beetles in early morning before they become active.
- Interplant nonhost crops like potatoes among bean plants to disrupt egg-laying.
- Soybeans are preferred by bean beetles over snap or lima beans; thus soybeans planted nearby can be used as a trap crop.

Spider Mites

- Spray plants with insecticidal soap.
- Mites don't like moist conditions. Keeping the foliage wet can deter mites, but it can also encourage plant diseases.
- Keep plants adequately watered and stress free. Do not use synthetic pyrethroid insecticides too often to avoid mite outbreaks.

Squash Bugs

- Remove and destroy any clusters of oval, orange-brown squash bug eggs.
- Remove and destroy vines and unused fruit after harvest to eliminate overwintering sites.
- Place shingles or boards near squash or pumpkin plants in spring or early summer to attract squash bugs. Then, collect and destroy the adult bugs that gather under the boards each morning.
- Nasturtiums and marigolds planted near squash plants may deter squash bugs.

Squash Vine Borers

- Cover plants with a fine mesh cloth or row cover until female flowers appear. They have a bulge between flower and stem that is absent in the male flowers.
- Squash varieties with long vines may continue to grow despite borer damage.
- Plant squash in late summer or fall to avoid heavy vine borer infestations.
- Cut open borer entry holes in the stem with a knife. Then, remove the worm and pack moist earth around the stem. This is a more labor-intensive method.

Tomato Hornworms

- Handpick worms from plants; check plants in the evening with a flashlight.
- *Bacillus thuringiensis* will be effective if sprayed when the worms are small.

- Dill planted next to tomatoes will serve as a preferred trap crop; handpick worms off the dill.
- Do not destroy hornworms that have small, white cocoons attached to their bodies. These are parasite cocoons from which small beneficial parasitic wasps will emerge.
- Turning the soil in the fall will expose hornworm pupae to weather and predators.

Bean or Cowpea Weevils

- Plant resistant, thick-hulled southern pea varieties such as AUbe or Freeze-Green.
- Plant beans as early as possible; then, turn plants under after harvest.
- Pick shell beans when they are somewhat green. Then, blanch them before freezing. This will kill weevil eggs and larvae which are seldom seen in the frozen beans.

- Before storing, heat beans in a 175°F oven for an hour. When cool, bag beans and freeze for a week. This will kill any weevil larvae or eggs; beans can then be stored at room temperature.

Whiteflies

- Whiteflies are rarely a problem in outdoor gardens. Make sure any purchased transplants are not infested with whiteflies (or other insects).
- Paint 6- x 8-inch boards a bright yellow (Rust-Oleum 659 or Safety Yellow). Then, coat them with a thin layer of a sticky substance such as Tack Trap or Tanglefoot. Hang the boards at crop level.
- Spray plants with insecticidal soap.

How To Use The Tables

In Table 1, you will find (1) the names of the vegetables grown in most home gardens in Alabama, (2) the names of the insects that are likely to attack each vegetable, (3) the common (or generic) name of the recommended insecticides, and (4) the number of days you must wait after applying each insecticide before harvesting the vegetable. This is important for the safety of anyone eating the food.

In Table 2, you will find a list of common names for each recommended insecticide along with examples of commercial formulations. The common name is present on the product package where active ingredients are listed. This table also provides common formulations of the active ingredient and the application rate or application rate range for the given formulation of that active ingredient. Rate ranges are given where active ingredients are recommended at different rates for different pests. Read the label of each product you use to make sure you are using the correct application rate for the pest you want to control. Table 2 also provides some insecticides recommended for organic or chemical-free vegetable production. Note that the list of commercial insecticidal products is not all inclusive. Please read the product label before and after purchase or use because labels may change with time.

Home garden insecticides are available as liquids and dusts and occasionally as wettable powders. Concentrated

liquid formulations must be mixed with water and applied as a spray. Some insecticides may be bought ready to use (RTU) and do not need to be mixed. They can be sprayed from the container. Dusts are also applied directly to the plants without any mixing by the home gardener.

First, check Table 1 to identify the common name of the insecticide that is recommended for the insects that are attacking your vegetables. Then look in Table 2 to find the common formulations available and recommended application rates or rate ranges if the active ingredient has different rates for different pests. Insecticides for home gardeners are almost always grouped together at stores that sell them. Locate a product that has the active ingredient you need and inspect the label to be sure that the vegetable you wish to treat is included on the label. Remember, early detection and timely application of insecticides when insects are small can help to reduce dependence on synthetic insecticides.

Refer to Table 3 for insecticide classifications, modes of action, and efficacy for controlling major insect pests of vegetables in home gardens.

Finally, Table 4 provides a list of common insect predators and Table 5 lists commercial vendors that sell beneficial insects. Follow instructions provided by the vendors for releasing natural enemies.

Table 1. Home Garden Vegetables Insecticide Recommendations

Insect	Insecticide Common Name	Number of Days to Wait from Application to Harvest	Comments
ASPARAGUS			
Aphids			
	insecticidal soap	0	No residual activity. Do not apply at temperatures above 90° F.
Asparagus Beetles, Cutworms			
	carbaryl	1	
	pyrethrin	1	
BEANS, PEAS			
Aphids			
	bifenthrin	3	
	esfenvalerate	3 (green) 21 (dry)	
	insecticidal soap	0	No residual activity
	gamma-cyhalothrin	7	
	malathion	1 (beans) 3 (peas)	
Mexican Bean Beetles, Bean Leaf Beetles, Corn Earworms, Cowpea Curculio, Stink Bugs			
	bifenthrin	3	For cowpea curculio make three applications at 5-day intervals starting when pods are 0.5 inch long.
	carbaryl	3 (fresh) 21 (dry)	Will not control stink bugs.
	esfenvalerate	3 (green) 21 (dry)	
	gamma-cyhalothrin	7	
	spinosad	3	For caterpillar pests and thrips.
Spider Mites			
	insecticidal soap	0	No residual activity
	malathion	1 (beans) 3 (peas)	Malathion provides marginal control of spider mites.
	sulfur	0	Do not use if temperature is greater than 95° F. Do not use within 3 weeks of oil spray.
BEETS			
Flea Beetles			
	carbaryl	7 (roots) 14 (tops)	
BROCCOLI, BRUSSELS SPROUTS, CABBAGE, CAULIFLOWER			
Aphids			
	bifenthrin	7	
	esfenvalerate	3	Not for use on brussels sprouts
	imidacloprid	21	Apply early in the season soon after transplanting. Also controls thrips and whiteflies.
	insecticidal soap	0	No residual activity
	gamma-cyhalothrin	1	
	malathion	3 (broccoli) 7 (others)	
	permethrin	1	

Insect	Insecticide Common Name	Number of Days to Wait from Application to Harvest	Comments
BROCCOLI, BRUSSELS SPROUTS, CABBAGE, CAULIFLOWER (cont.)			
Caterpillars (on foliage)			
	<i>Bacillus thuringiensis</i> (Dipel/Thuricide and other formulations)	0	Treat as soon as damage is found and repeat as needed. Susceptible larvae will stop feeding soon after eating treated foliage but may not die for several days.
	bifenthrin	7	
	carbaryl	3	
	esfenvalerate	3	Not for use on brussels sprouts
	gamma-cyhalothrin	1	
	permethrin	1	
	spinosad	1	For controlling cabbage looper, diamondback moth, imported cabbageworm, and leafminer. Good rotation partner with other insecticides.
Cutworms			
	bifenthrin	7	
	esfenvalerate	3	Not for use on brussels sprouts
	gamma-cyhalothrin	1	
Flea Beetles, Stink Bugs, Harlequin Bugs			
	bifenthrin	7	
	carbaryl	3	Will not control stink bugs and Harlequin bugs.
	esfenvalerate	3	Not for use on brussels sprouts
	gamma-cyhalothrin	1	
CANTALOUPE, CUCUMBER, PUMPKIN, SQUASH, WATERMELON			
Aphids			
	bifenthrin	3	
	esfenvalerate	3	
	imidacloprid	21	Apply early in the season soon after transplanting. Also controls thrips.
	insecticidal soap	0	No residual activity
	malathion	3 (pumpkin) 1 (others)	Use and registration varies with specific product. Do not apply unless leaves are dry.
	permethrin	0	
Cucumber Beetles (adults), Squash Bugs, Pickleworms, Melonworms, Rindworms			
	bifenthrin	3	Late planted crops may be heavily attacked by pickleworms and melonworms. Begin treatments at first bloom and repeat weekly as needed.
	carbaryl	3	
	esfenvalerate	3	
	imidacloprid	21	Apply early in the season soon after transplanting.
	permethrin	0	
SquashVine Borers			
	bifenthrin	3	Direct spray at base of plants. Use pheromone traps to detect moth flight and treat early with insecticide in highly infested areas.
	esfenvalerate	3	

Insect	Insecticide Common Name	Number of Days to Wait from Application to Harvest	Comments
CANTALOUPE, CUCUMBER, PUMPKIN, SQUASH, WATERMELON (cont.)			
Spider Mites			
	insecticidal soap	0	No residual activity
	malathion	3 (pumpkin) 1 (others)	Use and registration varies with specific product. Do not apply unless leaves are dry. Malathion provides marginal control of this pest.
Whitefly			
	bifenthrin	3	
	imidacloprid	21	Apply early in the season soon after transplanting.
	insecticidal soap	0	No residual activity
	pyrethrins+PBO	0	No residual activity
COLLARDS			
Aphids			
	esfenvalerate	7	
	imidacloprid	21	Apply early in the season soon after transplanting. Also controls thrips and whiteflies.
	malathion	7	Use and registration varies with specific product.
Caterpillars (on foliage)			
	<i>Bacillus thuringiensis</i> (Dipel/Thuricide and other formulations)	0	Treat as soon as damage is found and repeat as needed. Susceptible larvae will stop feeding soon after eating treated foliage but may not die for several days.
	carbaryl	14	
	esfenvalerate	7	
Flea Beetles, Harlequin Bugs, Stink Bugs			
	carbaryl	14	Does not control stink bugs.
	esfenvalerate	7	
EGGPLANT			
Aphids			
	bifenthrin	7	
	esfenvalerate	7	
	imidacloprid	21	Apply early in the season soon after transplanting.
	insecticidal soap	0	No residual activity
	gamma-cyhalothrin	5	
	malathion	3	Use and registration varies with specific product.
Colorado Potato Beetles			
	bifenthrin	7	
	carbaryl	3	
	esfenvalerate	7	
	imidacloprid	21	Apply early in the season soon after transplanting.
	gamma-cyhalothrin	5	
	permethrin	3	
	spinosad	1	Provides broad-spectrum control of many pests. Do not spray more than six times per season.

Insect	Insecticide Common Name	Number of Days to Wait from Application to Harvest	Comments
EGGPLANT (cont.)			
Flea Beetles			
	bifenthrin	7	
	carbaryl	3	
	esfenvalerate	7	
	imidacloprid	21	Apply early in the season soon after transplanting.
	gamma-cyhalothrin	5	
Lacebugs			
	bifenthrin	7	
	carbaryl	3	
Spider Mites			
	insecticidal soap	0	No residual activity
	malathion	3	Use and registration varies with specific product. Malathion provides marginal control of spider mites.
Whiteflies			
	bifenthrin	7	
	insecticidal soap	0	No residual activity
	pyrethrin+PBO	0	No residual activity
IRISH POTATOES			
Aphids			
	esfenvalerate	7	
	insecticidal soap	0	No residual activity
	malathion	0	
	permethrin	14	
Colorado Potato Beetles, Flea Beetles			
	carbaryl	7	
	esfenvalerate	7	
	permethrin	14	
	spinosad	1	Do not apply more than six times per season.
Potato Tuberworms			
	esfenvalerate	7	Treat when foliage or tuber damage is noticed. Store tubers promptly after digging to avoid tuber worm infestation in storage.
	permethrin	14	

Insect	Insecticide Common Name	Number of Days to Wait from Application to Harvest	Comments
LETTUCE, SPINACH			
Aphids			
	bifenthrin	7	For use on head lettuce only.
	insecticidal soap	0	No residual activity
	imidacloprid	21	Apply early in the season soon after transplanting. Also controls foliar thrips and whiteflies.
	gamma-cyhalothrin	1	For use on lettuce only.
	malathion	7 (head) 14 (leaf) 7 (spinach)	Use and registration varies with specific product.
Caterpillars (on foliage)			
	<i>Bacillus thuringiensis</i> (Dipel/Thuricide and other formulations)	0	Treat as soon as damage is found and repeat as needed. Susceptible larvae will stop feeding soon after eating treated foliage but may not die for several days.
	bifenthrin	7	For use on head lettuce only.
	carbaryl	14	
	gamma-cyhalothrin	1	For use on lettuce only.
	permethrin	1	
Flea Beetles, Harlequin Bugs, Stink Bugs			
	bifenthrin	7	For use on head lettuce only.
	carbaryl	14	Does not control stink bugs.
	gamma-cyhalothrin	1	For use on lettuce only.
MUSTARD GREENS			
Aphids			
	insecticidal soap	0	No residual activity
	malathion	7	Use and registration varies with specific product.
Caterpillars (on foliage)			
	<i>Bacillus thuringiensis</i> (Dipel/Thuricide and other formulations)	0	Treat as soon as damage is found and repeat as needed. Susceptible larvae will stop feeding soon after eating treated foliage but may not die for several days.
	carbaryl	14	
Flea Beetles			
	carbaryl	14	

Insect	Insecticide Common Name	Number of Days to Wait from Application to Harvest	Comments
OKRA			
Aphids			
	imidacloprid	21	Apply early in the season soon after transplanting. Also controls other small sucking insect pests.
	insecticidal soap	0	No residual activity
	malathion	1	Use and registration varies with specific product.
ONIONS			
Onion Maggots (adults)			
	gamma-cyhalothrin	14	
Thrips			
	gamma-cyhalothrin	14	
	malathion	3	Use and registration varies with specific product.
PEPPERS			
Aphids			
	bifenthrin	7	
	esfenvalerate	7	
	imidacloprid	21	Apply early in the season soon after transplanting.
	insecticidal soap	0	No residual activity
	gamma-cyhalothrin	5	
	malathion	3	Use and registration varies with specific product.
Flea Beetles, European Corn Borers			
	bifenthrin	7	
	carbaryl	3	
	cyfluthrin	7	
	esfenvalerate	7	
	imidacloprid	21	Apply early in the season soon after transplanting. Will not control borer.
	gamma-cyhalothrin	5	
	permethrin	3	
Spider Mites			
	insecticidal soap	0	No residual activity
	malathion	3	Use and registration varies with specific product. Malathion provides marginal control of spider mites.
RADISHES			
Aphids			
	esfenvalerate	7	
	insecticidal soap	0	No residual activity
	malathion	7	
Flea Beetles			
	carbaryl	7	
	cyfluthrin	0	
	esfenvalerate	7	

Insect	Insecticide Common Name	Number of Days to Wait from Application to Harvest	Comments
SWEET CORN			
Corn Earworms, Fall Armyworms, European Corn Borers			
	bifenthrin	1	Begin treatment when silks appear. Repeat at 2-day intervals with sprays directed at ears.
	carbaryl	2	
	cyfluthrin	0	
	esfenvalerate	1	
	gamma-cyhalothrin	21	
	permethrin	1	
	spinosad	1	
Flea Beetles, Cucumber Beetles			
	bifenthrin	1	
	carbaryl	2	
	cyfluthrin	0	
	esfenvalerate	1	
	gamma-cyhalothrin	21	
	permethrin	1	
Stink Bugs			
	bifenthrin	1	
	cyfluthrin	0	
	esfenvalerate	1	
	gamma-cyhalothrin	21	
	permethrin	1	
SWEET POTATOES			
Flea Beetles, Cucumber Beetles			
	carbaryl	7	
Caterpillars (on foliage)			
	<i>Bacillus thuringiensis</i> (Dipel/Thuricide and other formulations)	0	Treat as soon as damage is found and repeat as needed. Susceptible larvae will stop feeding soon after eating treated foliage but may not die for several days.
	carbaryl	7	
Sweet Potato Weevil			
	carbaryl	7	Also labeled as pre-plant dip; follow label directions.

Insect	Insecticide Common Name	Number of Days to Wait from Application to Harvest	Comments
TOMATOES			
Aphids			
	bifenthrin	1	
	cyfluthrin	0	
	esfenvalerate	1	
	imidacloprid	21	Apply early in the season soon after transplanting.
	insecticidal soap	0	No residual activity
	gamma-cyhalothrin	5	
	malathion	7	
Cutworms			
	bifenthrin	1	
	cyfluthrin	0	
	esfenvalerate	1	
	gamma-cyhalothrin	5	
Flea Beetles, Colorado Potato Beetles, Fruitworms, Hornworms, Tomato Pinworms			
	bifenthrin	1	
	carbaryl	3	
	cyfluthrin	0	
	imidacloprid	21	Apply early in the season soon after transplanting. Will control flea beetles but not caterpillars on foliage.
	esfenvalerate	1	
	gamma-cyhalothrin	5	
	permethrin	0	Do not use on varieties with fruit less than 1 inch in diameter.
Spider Mites			
	bifenthrin	1	
	insecticidal soap	0	No residual activity
	sulfur	0	Do not use if temperature is above 95° F. Do not use within 3 weeks of oil spray.
Stink Bugs, Leaffooted Bugs			
	bifenthrin	1	
	cyfluthrin	0	
	esfenvalerate	1	Weekly treatments may be needed for late season control.
	gamma-cyhalothrin	5	
Whiteflies			
	bifenthrin	1	
	imidacloprid	21	Apply early in the season soon after transplanting.
	insecticidal soap	0	No residual activity
	pyrethrins+PBO	0	No residual activity

Insect	Insecticide Common Name	Number of Days to Wait from Application to Harvest	Comments
TURNIPS			
Aphids			
	insecticidal soap	0	No residual activity
	malathion	7	Use and registration varies with specific product.
Caterpillars (on foliage)			
	<i>Bacillus thuringiensis</i> (Dipel/Thuricide and other formulations)	0	Treat as soon as damage is found and repeat as needed. Susceptible larvae will stop feeding soon after eating treated foliage but may not die for several days.
	carbaryl	7 (roots) 14 (tops)	
Flea Beetles			
	carbaryl	7 (roots) 14 (tops)	

NOTE: Applying Broadcast Soil Insecticides

Slugs and **snails** can be controlled in home gardens with a 2% methaldehyde bait. Consult the label for specific vegetables on which it may be used. The bait is applied to the soil surface and should not contact foliage or edible parts of the plant.

Infestations of some **soil dwelling pests**, such as **cutworms**, **armyworms**, and **crickets** can be controlled with 2% carbaryl (Sevin). Combination baits of carbaryl and methaldehyde are also available. Many soil dwelling pests can also be controlled in all vegetable crops by applying bifenthrin granules (0.115%) prior to planting at the rate of 1 pound of product per acre. Work the bifenthrin granules into the top 4 to 6 inches of soil.

Active ingredients available in some commercial products labeled for **fire ant** control in home gardens include spinosad (Fertilome Come and Get It !, Safer Brand Fire Ant Bait, and Green Light Fire Ant Control With Conserve), pyriproxyfen (Esteem Ant Bait), and (S)-methoprene (Extinguish Professional Fire Ant Bait). Approximate time required for the active ingredients to give noticeable results are as follows: spinosad, 2 to 4 weeks; pyriproxyfen, 6 to 8 weeks; and (S)-methoprene, 8 to 12 weeks.

No general use insecticides provide control of **leafminer** larvae inside leaves. Leafminer problems are frequently caused by overuse of insecticides. Hand-pick mined leaves.

Table 2. General Use Insecticides for Conventional and Organic Vegetable Production

Insecticide	Formulations	Application Rates on Labels ¹	Examples of Products
<i>Bacillus thuringiensis</i> (Bt)	Dipel liquid and dusts Thuricide liquid Bt worm killer Other formulations	Follow label directions. Rates vary with Bt concentration.	Bonide Dipel 150 Dust Bonide Thuricide Concentrate
bifenthrin	0.3% liquid	1.5 oz./gal. of water. Wet plants thoroughly, but avoid runoff.	Ortho Bug B Gon Max Lawn and Garden Insect Killer (various sizes)
	0.115% granule	1lb./500 sq.ft.	Ortho Bug B Gon Max (Insect Killer for Lawns)
carbaryl	23.7% liquid	Follow label directions. ²	Fertilome Carbaryl Garden Spray
	0.126% RTU ³	Spray until surface is wet.	GardenTech Sevin Ready-to-Use Bug Killer (in various sizes)
	5% dust	0.25-1 lb./1,000 sq.ft. ²	GardenTech Sevin 5% Dust
	2% granule	2.25 lb/1,000 sq.ft	GardenTech Sevin Lawn Insect Granules
cinnamaldehyde	30% cinnamaldehyde	0.85 oz./gal. of water	Cinnamite (Mycotech)
cyfluthrin	0.75% liquid	1 T/gal. of water	Bayer Advanced Multi-Insect Killer
esfenvalerate	0.425% liquid	2 T/gal. of water	Ortho Bug B Gon Multi-Purpose Insect Killer Monterey Bug Buster
garlic juice (Repellent)	99.3% garlic extract	Consult product label.	Garlic Barrier AG+ ⁶
insecticidal soap	Insect killing soap 49.2%	5 T/ gal. of water	Spectrum Garden Safe Insecticidal Soap Eight Insecticidal Soap (Bonide) Bayer Advanced Natria Insecticidal Soap ⁶
imidacloprid ⁴	0.235% concentrate	0.5 oz./ 10 sq.ft. of vegetable row (apply as drench in water)	Bayer Advanced Fruit, Citrus and Vegetable Concentrate (Note: Bonide Systemic Granules are NOT registered for use in vegetables)
gamma-cyhalothrin	0.25% concentrate 0.5% liquid 0.002% RTU	1 T/ gal. of water	Spectracide Triazicide Insect Killer
malathion	50% and 55% liquid	1.5 t. - 2 T/ gal. of water ³ . Use and registration vary with specific product.	Hi-Yield 55% Malathion Gordon 50% Malathion Bonide 50% Malathion (Cythion)
oils, insecticidal	Various concentrations and mixtures	Check product label before use (may cause foliage burn if used without caution). Do not spray if temperatures exceed 90°F. Do not spray if sulfur was applied to foliage.	Bonide All Season's Horticultural Oil ⁶ Green Light Neem Concentrate (70% neem oil) Bonide Mite-X (0.4% cottonseed oil, 0.2% clove oil, 0.1% garlic extract) Ahimsa Organics Neem Oil

Insecticide	Formulations	Application Rates on Labels ¹	Examples of Products
pepper extract (Repellent)	0.185% capsaicin	Consult product label.	Bonide Hot Pepper Wax ⁶
permethrin	2.5 % liquid	1-3 oz./gal. of water ²	Eight Insect Control Vegetable, Fruit, and Flower Spray Concentrate (Bonide) Green Light Conquest Insecticide Concentrate Gordon Bug-No-More Multi- Purpose Concentrate
	0.25% dust	Dust lightly. ^{5,4}	Ortho Bug B Gon Multi- Purpose Garden Dust Gordon Garden Guard Insecticide
	13.3% liquid	Check insecticide label.	Bonide Total Pest Control Outdoor Formula
pyrethrins + PBO	Various concentrations and mixtures	Follow label directions.	Spectrum Garden Safe Insect Killer RTU Bonide Pyrethrin Garden Insect Spray (1.1% rotenone, 0.8% pyrethrin) Take Down Garden Spray (0.01% pyrethrin, 1.00% canola oil)
spinosad	0.5%	2 oz./gal. spray	Fertilome Borer, Bagworm, Tent Caterpillar, and Leafminer Spray Bonide Spinosad Ready-to- Spray (Captain Jack's Deadbug Brew) Monterey Garden Insect Spray ⁶ Bonide Colorado Potato Beetle Beater Concentrate ⁶
sulfur	2% RTU	Spray until surface is wet.	Bayer Natria Insect, Disease, and Mite Control ⁶

¹ Use pesticides only according to the directions on the label. Follow all directions, precautions and restrictions that are listed. Do not use pesticides on plants that are not listed on the label. The pesticide rates in this table are recommended only if they are registered with the Environmental Protection Agency and the Alabama Department of Agriculture and Industries. If a registration is changed or cancelled, the rate listed here is no longer recommended. Information on label changes can be obtained by contacting your local county Extension office.

²Rate varies with insect species. For example, the rate recommended for control of flea beetles on cabbage with one brand of 22.5 % carbaryl liquid is 0.75 to 1.5 ounces per gallon of water while the rate recommended for armyworm on cabbage is 3 ounces per gallon. Check label for specific rate for each pest.

³RTU = Ready To Use

⁴Systemic insecticide. Apply early as drench after transplanting vegetables. Has excellent activity against soft bodied sucking pests.

⁵Read label directions to make sure dust is labeled for use on vegetable of interest.

⁶For organic vegetable production.

Table 3. Insecticide Classification, Mode of Action, and Efficacy Chart for Controlling Major Insect Pests of Vegetables in the Home Garden

IRAC Chemical Class and Mode of Action ¹	Active ingredient	Aphids, leaf-hoppers	Whiteflies	Thrips	Onion maggots (adult)	Flea beetles	Cutworms (in soil), armyworms (on foliage)	Fruitworm, hornworm, tomato pinworm (on foliage)	Colorado potato beetle	Stink bugs, Harlequin bugs	Squash vine borer	Spider mites
1A (contact/stomach poison)	Carbaryl					+		+				
1B (contact /stomach poison)	Malathion	+		+				+	+	+	+	
3 (contact poison)	Bifenthrin					+	+	+		+	+	+
3 (contact poison)	Cyfluthrin					+	+			+	+	
3 (contact poison)	Esfenvalerate					+	+	+	+		+	
3 (contact poison)	Gamma-cyhalothrin	+		+	+	+	+	+	+	+		
3 (contact poison)	Permethrin					+		+	+	+	+	
4A (systemic and stomach poison)	Imidacloprid (NEW IN 2010)	+	Suppression only	+		+			+			
5 (contact/stomach poison)	Spinosad						+	+	+		+	
	Pyrethrin + synergist (PBO)		+					+				
	Insecticidal soap	+	+	+								+
	Sulfur											+
Bacteria	<i>Bacillus thuringiensis</i>						+	+				

¹ IRAC (Insecticide Resistance Action Committee) provides agricultural producers and crop protection professionals with information on resistance management.

Table 4. Some Common Insect Predators Found Naturally in the Home Garden and Also Available Commercially

Biological Control Agent	Predatory stages	Target Insect Pest
Lady beetles	Adult and larva	Soft-bodied insects (aphids, thrips) , caterpillars, mites
Lacewings	Adult and larva	Soft-bodied insects (aphids, thrips) , caterpillars, mites
Spined soldier bug	Adult and nymph	Small caterpillars and nymphs
Big-eyed bug	Adult and nymph	Eggs and caterpillars of many insects
Syrphid fly	Adult and maggot	Maggots feed actively on aphids and other soft-bodied insects
Minute pirate bug	Adult and nymph	Thrips, mites
Predacious damsel bug	Adult and nymph	Small caterpillars, leafhoppers, aphids
Assassin bug	Adult and nymph	Soft-bodied insects
Striped earwig	Adult and nymph	Egg and larvae of many insects
Ground beetles	Adult and larva	Egg and larvae of many insects, spiders, etc.
Insidious flower bug	Adult and nymph	Thrips

Table 5. Where to Buy Beneficial Insects

Arbico Organics (Tucson, AZ): <http://www.arbico-organics.com/category/beneficial-insects-predators-parasites>

Extremely Green Gardening Company (Abington, MA): <http://www.extremelygreen.com/pestcontrolguide.cfm>

Biobest Belgium N.V. (Westerlo, Belgium): www.biobest.be

Koppert Biological Systems B.V. (The Netherlands): <http://www.koppert.com/products/products-pests-diseases/>

Syngenta Bioline Limited (UK): <http://www.syngenta-bioline.co.uk/products.htm>

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For more information, contact your county Extension office. Visit <http://www.aces.edu/counties> or look in your telephone directory under your county's name to find contact information.

Use pesticides **only** according to the directions on the label. Follow all directions, precautions, and restrictions that are listed. Do not use pesticides on plants that are not listed on the label.

The pesticide rates in this publication are recommended **only** if they are registered with the Environmental Protection Agency or the Alabama Department of Agriculture and Industries. If a registration is changed or canceled, the rate listed here is no longer recommended. Before you apply **any** pesticide, check with your county Extension agent for the latest information.

Trade names are used **only** to give specific information. The Alabama Cooperative Extension System does not endorse or guarantee any product and does not recommend one product instead of another that might be similar.

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