Introduction for Home Vegetable Insect Section

Eric R. Day, Extension Entomologist, Virginia Tech

Insect pests are rarely a problem on vigorous plants that are adapted for the climate zone where you have your home vegetable garden. Consult your local Virginia Cooperative Extension office for vegetables recommended for Virginia.

In addition to the following tips for pest management, follow these links for more information on control and management of pests in gardens:

An Introduction to Integrated Pest Management (ENTO-365) - Integrated pest management (IPM) is commonly discussed and used by pest management professionals, but is not widely understood by the general public. This publication explains the fundamentals of IPM and why it is an important tool for professionals and homeowners.

Organic vs. Conventional (Synthetic) Pesticides: Advantages & Disadvantages (ENTO-384) - This factsheet attempts to clarify some of the information surrounding organic and synthetic pesticides. Knowing their similarities and differences will prepare you to choose the best management solution for your pest problem.

Myth-busting IPM for Extension Master Gardeners (ENTO-388) - A survey conducted in March 2020 identified a handful of myths among Extension Master Gardeners (EMGs) concerning integrated pest management (IPM). This publication highlights the myths associated with IPM, explains the facts, and serves to increase overall understanding of IPM among EMGs and others.

The following tips adapted from Integrated Pest Management for Vegetable Gardens, Publication 426-708 will help in reducing insect and mite problems:

- Plant crops and varieties that are well suited to the soil and climate, and recommended by Virginia Cooperative Extension and the School of Plant and Environmental Sciences.
- If possible, select for insect resistance in vegetable varieties.
- Inspect transplants when purchasing so that they are insect pest free. Insects in young seedlings may start in greenhouses or plant beds and cause heavy losses in the garden.
- Develop a calendar, by writing down the time of year you find a particular pest and if control was needed. Refer to it next year to check for earlier signs of infestations. A daily walk in the garden will do a world of good.
- Space plants properly and thin young vegetables to a proper stand. Overcrowding causes weak growth and reduces air movement, resulting in increased insect problems.
- Keep down weeds and grass. They often harbor insect and mite pests.
- Rotate your garden plot, if you can. Do not grow the same kind of produce in the same place each year. Use related crops in one site only once every three or four years. Avoid mixing soils in areas by forming permanent raised beds with distinct borders.
- Gardens growing in areas that were turf or grass the year before will often have white grub and wireworm problems the first year or two. Consider using a planting time soil insecticide.
- Time plantings in such a way that the majority of your crop will avoid the peak of insect infestations. For example, plant cucurbits in mid June to avoid squash bug and cucumber beetles. Plant beans in early May so that they mature before Mexican bean beetles build up and cause damage.
- Use row covers over cucurbits from time of planting to just before bloom to avoid squash vine borer.
- Keep a record of the dates insect problems occur to use as a guide for following years.
- Inspect plants for egg clusters, beetles, caterpillars, and other insects as often as possible. Handpick as many pests as you can. Avoid sprays until the population of insects has reached a critical threshold level.
- Where slugs are a problem, use approved baits and traps and try to create drier conditions. Heavy mulches may encourage slugs. Diatomaceous earth, crushed eggshells, beer baits, and hydrated lime near plants may help deter slug activity.
- Insecticides are valuable tools for dealing with insect problems, make sure the insecticide is labeled for the crop you are protecting and be sure to read the label before mixing and applying.
- Encourage Beneficial Insects by tolerating insect damage and not spraying. Naturally occurring predators and parasites are found in gardens, orchards, and fields. Learn to properly identify these species as benefits of your environment. Avoid using pesticides around them. They are as susceptible to insecticides as the pests.

Organic Controls for Insects

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Table 2.1 - Organic Products and Predators

Product[1]	Insects Controlled	Remarks
Azadirachtin	Beetles, Aphids, Caterpillars, Others	Various Trade names including AzaGuard, AzaMax, Azatin, AzaSol, etc.
Bacillus thuringiensis	Most caterpillars, loopers, hornworms, bagworms	This product, also known as *Bt*, is sold under many trade names.
Beauveria bassiana	Beetles, Aphids, Others	Various Trade names including BotaniGard, Mycotrol, and Naturalis
Foil, M-One, M-Track, Novodor	Colorado potato beetle	Two strains of *Bt* will control potato beetles: *Bacillus thuringiensis* ssp. *san diego* is genetically engineered and therefore is not allowed in certified organic production. On the other hand, *B. thuringiensis* ssp. *tenebrionis*, a form of *Bt* that is not genetically engineered, can be used by organic producers.
Hot Pepper Wax	Aphids, mites, thrips	See label for precautions.
Insecticidal soap	Works well on soft bodied insects, in particular aphids, mites, mealybugs	This product is sold under many trade names and is a fatty acid soap.
Kaolin clay	Beetles, Aphids, Caterpillars, Others	Various Trade names
Neem	Broad spectrum	See label for precautions.
Mineral Oil	Caterpillar eggs and soft bodied insects such as aphids and thrips	Only use products labeled for use on vegetable plants for pest control
Pyrethrin	Broad spectrum; works on a wide variety of insects	Usually sold mixed with other botanical insecticides.
Pyrethrum/Diatomaceous Earth	Whiteflies, fireants	See label for precautions.
Spinosad	Caterpillars, beetles	See label for precautions.

[1]Botanical insecticides are derived from various plant parts and are commonly used in organic control situations. It is important to read the label and follow all precautions regarding protective clothing, mixing, and labeled plants. Just because they are derived from plants doesn't mean that safety can be disregarded. Biological control is in two major forms. Microbial, which is a formulation containing a microorganism such as *Bacillus thuringiensis*, or the other form, which involves the release of predatory insects or mites, such as lady beetles. Use caution with insecticides when a release of predators is planned.

Table 2.1 - Organic Products and Predators (cont.)

Organic Predators

Encourage Beneficial Insects: Naturally occurring predators and parasites of pests are found in gardens, orchards, and fields. Learn to properly identify these species as benefits of your environment. Avoid using pesticides around them. They are as susceptible to insecticides as the pests. The key to keeping native or purchased natural enemies is to eliminate spraying any insecticides including organic insecticides.

Beneficial Insects and Mites: Many species of beneficial insects and mites can be purchased although many occur naturally. Beneficial insects are target specific, and require gardener knowledge of existing pests. Timing of release is an important factor, and if pests are not present, neighboring gardens may benefit more than your garden. In general, these insects have specific requirements for long-term survival, and may need to be released anew each season.

Beneficial Insects and Mites	Remarks
	Assassin bug - *Reduviidae* - The assassin bug feeds mainly on aphids, caterpillars, Colorado potato beetles, Japanese beetles, leafhoppers, and Mexican bean beetles. Naturally occurring also.
	Bean Beetle Parasite (*Pediobius foveolatus*) for Mexican bean Beetle. These wasps are shipped to you inside their host—Mexican bean beetle larvae. Once the adults emerge, the females deposit their eggs in the larvae of the Mexican bean beetle. Release rate: timing is critical; release one unit (6 mummies/unit, 20-25 wasps/mummy=120-150 wasps/unit) for every 400 sq ft of beans or 100 units/A when the bean beetle larvae are present. These wasps do not overwinter. See: https://pubs.ext.vt.edu/ENTO/ENTO-170/ENTO-170-PDF.pdf
	Damsel bug - *Nabidae* - The damsel bug feeds on aphids, leafhoppers, mites, and caterpillars.
	Big-eyed bug - *Gocoridae* - Big-eyed bugs feed on aphids, caterpillar eggs and larvae, immature bugs, leafhoppers, and spider mites.
	Predacious stink bug - *Pentatomidae* - Predacious stink bugs feed on Colorado potato beetles and various caterpillar larvae. Most commonly sold is the Spined Soldier Bug but it occurs naturally as well.

Adapted from VCE Publication 426-708

Table 2.1 - Organic Products and Predators (cont.)

Beneficial Insects and Mites (cont.)	Remarks
	Syrphid fly larvae - *Syrphidae* - Fly larvae of this species feed on aphids and mealybugs.
	Lady beetles - Hippodamia convergens - Naturally occurring lady beetles feeds mainly on aphids and other soft-bodied insects, such as mealybugs and spider mites. *Hippodamia convergens* is commonly sold for use in gardens but is not recommended because they leave the garden area soon after release.
	Green lacewing larvae - *Chrysoperla* sp. - Lacewing larvae, known as aphid lions, feed on insect eggs, aphids, spider mites, thrips, leafhopper nymphs, and small caterpillar larvae. Adult lacewings are not predacious.
	Predatory mites - *Phytoseiulus persimilus* and several other species feed on many mite pests, including the two-spotted spider mite. Release at the rate of 2/square foot.
	Predatory Nematodes: For wood boring and ground dwelling insects. These nematods will see host insects and not harm plants or humans.
	*Trichogramma* wasp - *Trichogrammatidae* - This tiny wasp attacks eggs of more than 200 pest species, including cutworms, corn borers, corn earworms, armyworms, codling moths, and cabbage moths. Release time is critical for their effectiveness since they only attack pest eggs.
	Encarsia wasp - *Encyrtidae* - The greenhouse whitefly is parasitized by this wasp in third and fourth larval instars when Encarsia lay their eggs inside the whitefly pupa.

Adapted from VCE Publication 426-708

Vegetable Insects

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How to use this guide: Find the crop in table 2.2 and check the list of common pests in those crops. Go to the specific table for the pest for management and control. If your pest is not found consider submitting a sample to the Insect Identification Laboratory for identification.

Table 2.2 - Index

Strawberry Weevil, “Clipper” Table – 2.2.28
Strawberry Rootworms – Table – 2.2.28
Tarnished Plant Bug – Table – 2.2.35

Sweet Corn

Corn Earworm – Table 2.2.4
Corn Sap Beetle – Table 2.2.29
European Corn Borer – Table 2.2.23
Japanese Beetle – Table 2.2.30
Stink Bugs – Table 2.2.7
Fall Armyworm – Table 2.2.31
Flea Beetle – Table 2.2.9
Grasshoppers – Table 2.2.2
Seedcorn Maggot – see Table 2.2.12 “Root maggots”

Tomato

Blister Beetles – Table 2.2.32
Hornworms – Table 2.2.33
Tomato Russet Mite – Table 2.2.34
Cabbage Looper – Table 2.2.11
Colorado Potato Beetle – Table 2.2.22
Cutworms – Table 2.2.36
Flea Beetle – Table 2.2.9
Stink Bugs – Table 2.2.7
Grasshoppers – Table 2.2.2
Leaffooted Bugs – Table 2.2.7 control same as Stink bugs
Fruitworms – see Corn Earworm – Table 2.2.4
Spider Mites – Table 2.2.6
Thrips – Table 2.2.8
Aphids – Table 2.2.3
Whitefly – Table 2.2.26

Table 2.2.1 – Asparagus Beetle

Clemson Univeristy– USDA Cooperative Extension Slide Series, Bugwood.org

Description: Adults of the asparagus beetle are 1/4 inch (6.25 mm) long, metallic blue to black, and have wing covers with three or four white spots and reddish margins. The thorax is red and usually marked with two black spots. The spotted asparagus beetle is about 1/3 inch (8.3 mm) long and orange with 12 spots on its wing covers. Larvae of both are olive green to dark gray with a black heads and legs and attain a length of about 1/3 inch (8 mm). Both have eggs that are approximately 4/100 inch (1 mm) long, oblong, shiny, black and are attached by one end to asparagus spears.

Cultural Control: Harvest spears as early as possible. Beetles are attracted to plants with an abundance of foliage; therefore, growers can leave a small portion of their crop unharvested as a decoy for beetles to congregate, while the rest of the crop is harvested. Thoroughly remove all plant debris from garden and surrounding areas after harvest to eliminate beetle overwintering sites.

Control: Treat with a registered insecticide when beetles begin to lay eggs, or when beetle larvae are feeding on the foliage. Because asparagus spears are harvested almost daily, it is important to use an insecticide with little residual activity. Be sure to follow the necessary wait period between insecticide application and the days before you can harvest again.

Chemical Control (and precautions)

Carbaryl – (Do not apply within one day of harvest)

Malathion – (Do not apply within one day of harvest),

Bifenthrin – (see label)

Permethrin – (Pre-harvest interval = 3 days),

Neem Oil can be applied on day of harvest, must be allowed to dry

Organic Control (and precautions)

Pyrethrins – (Can be applied on day of harvest, must be allowed to dry

Table 2.2.2 – Grasshoppers

Common Host Plant(s): Lettuce, beans and corn.

Damage: Feed on any available vegetation. When abundant, they may destroy complete plantings of such crops as lettuce and potato.

Cultural Control: Avoid planting gardens next to hay fields and ditch banks with high grasshopper populations. Covering them with netting or cheesecloth may protect seedlings. It also helps to remove debris and till the soil in the fall to help expose the eggs to predators and the weather.

Control: Treat using a registered insecticide, following all label instructions, precautions, and preharvest intervals specific to the crop.

Grasshopper (Clemson University)

Chemical Control

Carbaryl – Do not apply within one day of harvest

Malathion – Do not apply within one day of harvest

Permethrin – pre-harvest interval = 3 days

Organic Control

Azadirachtin – Can be applied on day of harvest, must be allowed to dry

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Insecticidal Soap – Can be applied up to the day of harvest

Table 2.2.3 – Aphids

Description: Aphids, or plant lice, are small, soft-bodied insects. Most aphids are about 1/10-inch-long (2.54 mm), and though green and black are the most common colors, they may be gray, brown, pink, red, yellow, or lavender

Damage: Aphids remove sap from plants and cause yellowing, stunting, and puckering of leaves. In addition, aphids may leave clear sticky honeydew on plants that allows black sooty mold to grow.

Control: Treat using a registered insecticide, following all label instructions, precautions, and preharvest intervals specific to the crop.

Chemical Control

Acetamiprid pre-harvest interval = 7 days

Bifenthrin See label for instructions

Imidacloprid pre-harvest interval = 21 days

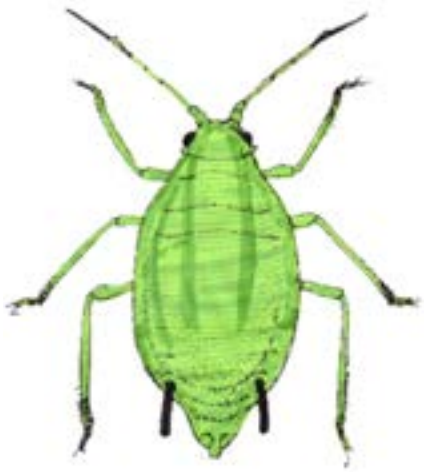
Malathion – (Do not apply within one day of harvest)

Cyfluthrin – See label for instructions

Esfenvalerate – See label for instructions

Malathion – pre-harvest interval = 7 days

Permethrin – See label for instructions



Aphid (USDA)

Organic Control

Insecticidal Soap – Can be applied on day of harvest,

Canola oil – Can be applied on day of harvest, must be allowed to dry

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Beauveria bassiana – Can be applied on day of harvest, must be allowed to dry

Paraffin Oil – (Can be applied up to the day of harvest)

Azadirachtin – (Can be applied on day of harvest, must be allowed to dry)

Neem Oil – (Can be applied on day of harvest, must be allowed to dry)

Table 2.2.4 – Corn Earworm

Other Common Names: Tomato fruitworm, sorghum headworm vetchworm, podworm, and cotton bollworm.

Plants Attacked: The vegetables most commonly attacked by this pest include sweet corn, tomatoes, beans, broccoli, cabbage, pepper, and lettuce.

Description: Fully developed, larvae reach a maximum length of about 1 inch. They have an orange-brown head, and their body color can range from brown, green pink, and yellow, to mostly black.

Control: Treat using a registered insecticide, following all label instructions, precautions, and preharvest intervals specific to the crop.

Chemical Control

Bifenthrin – See label for instructions

Carbaryl – Do not apply within one day of harvest

Imidacloprid – pre-harvest interval = 21 days

Malathion – Do not apply within one day of harvest

Organic Control

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Spinosad – pre-harvest interval = 3 days

Corn Earworm (Eric Day)

Table 2.2.5 – Mexican Bean Beetle

Description Adult: Copper colored, oval, 1/4-inch-long, 16 black spots on back. Larva: Orange to yellow, fuzzy or spiny, up to 1/3-inch long.

Common Host Plant(s): Beans, lima beans.

Damage: Adults and larvae feed on pods and on underside of leaves; pods and leaves are skeletonized. Damaging populations of Mexican Bean Beetles start to appear in late June and early July and can continue for the remainder of the growing season.

Cultural Control: Clean up plant debris after harvest. Plant Beans as early as possible in the spring so that harvest is completed before the July peak of activity for this pest.

Organic/Biological Control: Natural enemies include several species of assassin bugs and a tiny parasitic wasp, Pediobius foveolatus.

Control: Treat with a registered insecticide when damage first appears. For best control, also direct sprays to undersides of leaves.

Chemical Control

Acetamiprid – pre-harvest interval = 7 days

Carbaryl – Do not apply within one day of harvest

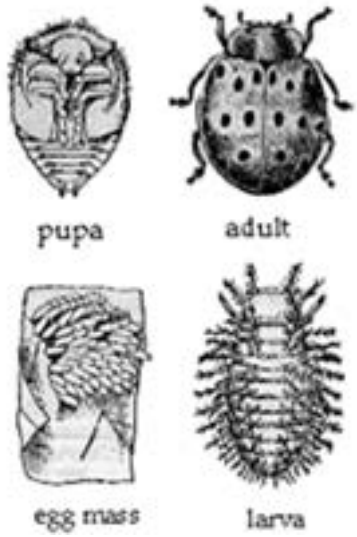
Malathion – Do not apply within one day of harvest

Bifenthrin – See label for instructions

Permethrin – pre-harvest interval = 3 days

Organic Control

Pyrethrins – Can be applied on day of harvest, must be allowed to dry



Mexican bean beetle life stages (USDA)

Table 2.2.6 – Spider Mites

Description: Tiny, only about 1 mm in length or about 1/50 of an inch. Pale in color, often with two dark spots.

Common Host Plant(s): Beans, tomatoes, bedding plants, and greenhouse plants.

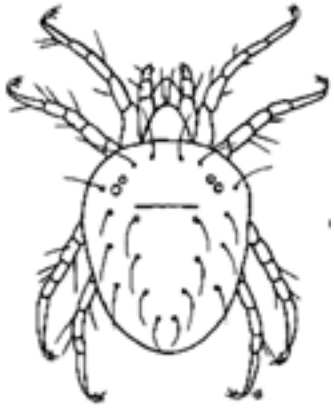
Damage: Mite feeding leaves tiny yellow spots, large numbers of mites cause the leaves to look sandblasted, yellowed, and eventually brown. Mites leave silk webbing and debris on leaves.

Cultural Control: Remove from the garden and compost any green weeds and clumps of grass in the winter. Make sure plant have adequate water.

Organic/Biological Control: Phytoseiid mites can be purchased, and released for control. These are beneficial mites that eat spider mites.

Control: Treat with a registered insecticide when damage first appears. For best control, also direct sprays to undersides of leaves.

Chemical Control: Not recommended, as insecticides may kill off the beneficial mites and make the spider mites worst.



Spider Mite (USDA)

Organic Control

Insecticidal Soap – Apply when mites are first found on leaves.

Canola Oil – Can be applied on day of harvest, must be allowed to dry

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Soybean Oil – See label for instructions

Spinosad – pre-harvest interval = 3 days

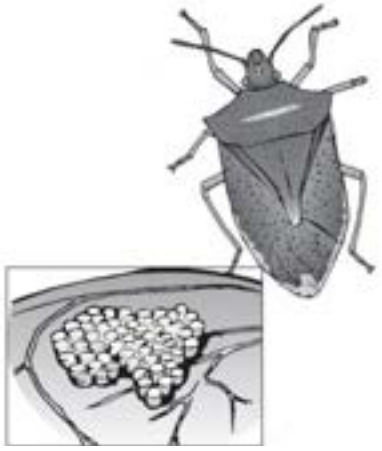
Table 2.2.7 – Stink Bugs

Identification: Stink bugs have the characteristic five-sided shield shape and are about 5/8 inch long when full grown. Eggs of both species are barrel shaped and laid in clusters of 20 to 70. Nymphs resemble adults in shape but are smaller and have contrasting color patterns. The two most common stink bugs are the Harlequin Bug and the Brown Marmorated Stink but many other specie damage vegetables in Virginia. Leaffooted bugs cause similar damage and are controlled in the same manner as stink bugs

Damage: Adults and nymphs suck sap, feeding primarily on buds and seedpods. This feeding result in weakened plants and malformed buds and fruit. On okra and bean pods, the damage appears as pimples or wart-like growths. On tomatoes and peppers, white marks, often resembling halos, appear on the fruit. On pecans and beans, the damage shows up as brown spots on the nutmeat or seed. On some tree fruit, stink bugs can cause a deforming condition called cat facing on the fruit.

Cultural Control: Controlling weeds and wild fruit trees adjacent to fields helps to prevent some species of stink bugs.

Control: Treat with a registered insecticide when damage appears or when insects appear in damaging numbers. Repeat as needed and carefully follow label instructions.



Stink Bug eggs and adult (Virginia Cooperative Extension)

Chemical Control

Acetamiprid – pre-harvest interval = 7 days

Bifenthrin – See label for instructions

Carbaryl – Do not apply within one day of harvest

Imidacloprid – pre-harvest interval = 21 days

Malathion – Do not apply within one day of harvest

Organic/Biological Control

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Table 2.2.8 – Thrips

Description: Bright yellow, but because of their small size are hard to see. The adult is about 1/25-inch long. The immatures are wingless and look like adult but smaller.

Common Host Plant(s): Onion, beans, beet, carrot, cabbage, cauliflower, celery, cucumber, melons, peas, squash, tomato, and turnip.

Damage: Since they feed in the bud, the damage is seen as distorted and damaged leaves and vegetables. Adults and larvae suck out juices and leave white blotches appear on leaves. Tips of leaves wither and turn brown.

Lifecycle: Thrips overwinter as adults and immature nymphs in plant debris in or near fields. Thrips fly to gardens in early summer and lay eggs on buds and leaves. The time span from egg to adult can occur in 3-4 weeks. Multiple, overlapping generations occur annually in Virginia.

Cultural Control: Some varieties of sweet onion are resistant to thrips.

Control: Treat with a registered insecticide when damage appears or when insects appear in damaging numbers. Repeat as needed and carefully follow label instructions.

Chemical Control

Acetamiprid – pre-harvest interval = 7 days

Carbaryl – Do not apply within one day of harvest

Imidacloprid – pre-harvest interval = 21 days

Malathion – Do not apply within one day of harvest

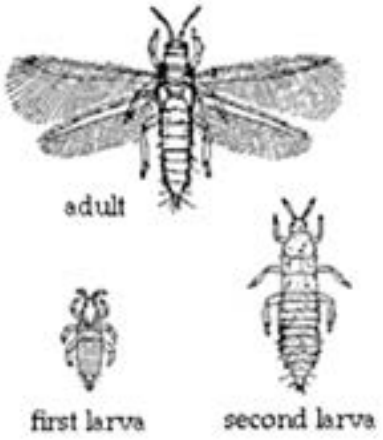
Organic/Biological Control

Apply a dust of diatomaceous earth to control thrips. Minute pirate bugs and some lady beetle are predators of thrips.

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Insecticidal Soap – Can be applied up to the day of harvest

Spinosad – pre-harvest interval = 3 days



Life stages of thrips (USDA)

Table 2.2.9 – Flea Beetles

Description: Many species. Black, brown, or striped beetles; about 1/16-inch long. Active, hops away when disturbed.

Common Host Plant(s): Tomato, pepper, cabbage and related crops, eggplant, beet, spinach, turnip, mustard and radish.

Damage: Young plants, especially transplants, are severely damaged. Adults and larvae chew many tiny holes in leaves.

Lifecycle: Adults overwinter in soil; in early spring they begin feeding on crop foliage. Females deposit eggs near the soil line where larvae emerge in about a week and feed on roots. Larvae feed for two to three weeks until reaching maturity and then pupate, emerging from the soil as adults in about two weeks.

Cultural Control: Plow under weed and crop debris in the fall after harvest.

Control: Treat with a registered insecticide when damage appears or when insects appear in damaging numbers. Repeat applications as needed and carefully follow label instructions.

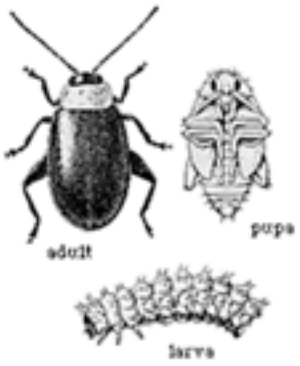
Chemical Control

Carbaryl – Do not apply within one day of harvest FOR SWEET CORN: CAUTION Application of Carbaryl to tassel region of corn during the pollen shedding period will seriously reduce the bee population

Imidacloprid – pre-harvest interval = 21 days

Malathion – Do not apply within one day of harvest

Thiamethoxam – See label for instructions



Life stages of the Flea Beetle (USDA)

Organic/Biological Control

Dust with diatomaceous earth or rotenone for serious infestations.

Azadirachtin – Can be applied on day of harvest, must be allowed to dry

Kaolin clay – See label for instructions

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Table 2.2.10 – Imported Cabbage Worm

Description: Velvety green with faint yellow longitudinal stripes and many fine hairs; up to 1 and 1/4 inches long.

Common Host Plant(s): Cabbage, cauliflower, collards, Brussels sprouts, mustard, turnip and kale.

Damage: Feeds on underside of leaves, producing ragged holes; bores into heads.

Lifecycle: Imported cabbageworms overwinter in plant debris as pupae. The time span from egg to adult moth is about four to five weeks. Multiple generations occur annually in Virginia.

Cultural Control: Handpick caterpillars where found. Conduct thorough postharvest cleanup in gardens where the imported cabbageworm has been a problem in the previous year.

Chemical Control: Treat with a registered insecticide every 4 days after first true leaves appear until harvest if worms are still present. Direct insecticides to the undersides of leaves.

Carbaryl – pre-harvest interval = 3 days

Malathion – pre-harvest interval = 7 days

Permethrin – Do not apply within one day of harvest

Organic/Biological Control: *Bacillus thuringiensis*, or Bt, (Bactur, Dipel, SOK BT, Thuricide) 2.0 to 3.0 tbsp in 1 gallon water. It is not necessary to wait before harvesting after an application of Bt. A parasitic wasp, *Trichogramma* sp., attacks imported cabbageworm eggs; mass releases of *Trichogramma* sp. may be successful in reducing pest populations. Several other parasites attack pupae and larvae of the imported cabbageworm. The braconid wasp *Apanteles glomeratus* is most effective. The imported cabbageworm is also susceptible to attack by generalist predators such as stinkbugs and *Polistes* sp. wasps. Natural control by viruses and bacterial diseases occurs as well.

Beauvaria bassiana – Can be applied on day of harvest, must be allowed to dry

Azadirachtin – Can be applied on day of harvest, must be allowed to dry

Bacillus thurgingiensis – Can be applied on day of harvest, must be allowed to dry

Insecticidal Soap – Can be applied on day of harvest, must be allowed to dry

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Spinosad – Do not apply within one day of harvest

Fig. 1: Adult and larva of Cabbageworm, with leaf damage. Left photo: David Cappaert, Michigan State University, Bugwood.org, right photo: Clemson University – USDA Cooperative Extension Slide Series, Bugwood.org

Table 2.2.11 – Cabbage Looper

Description: Pale green measuring worm with thin white stripes down back and sides. Up to 1 and 1/2 inches long. Caterpillar doubles-up, or loops, when it crawls.

Common Host Plant(s): Cabbage, lettuce, cauliflower, kohlrabi, collards, Brussel sprouts, turnip, mustard, broccoli and kale.

Damage: Feeds on underside of leaves producing ragged holes; large loopers burrow into heads. Damage similar to Imported Cabbageworm.

Lifecycle: Several generations of cabbage loopers can occur during a year with the time from egg to adult only taking a few days over a month.

Cultural Control: Handpick caterpillars off plants. Plow under crop remnants in spring to bury overwintering pupae before the emergence of adults.

Chemical Control: When worms are present, treat with a registered insecticide every 4 days after first true leaves appear until harvest. Direct insecticide to the undersides of leaves.

Carbaryl – pre-harvest interval = 3 days

Malathion – pre-harvest interval = 7 days

Permethrin – Do not apply within one day of harvest

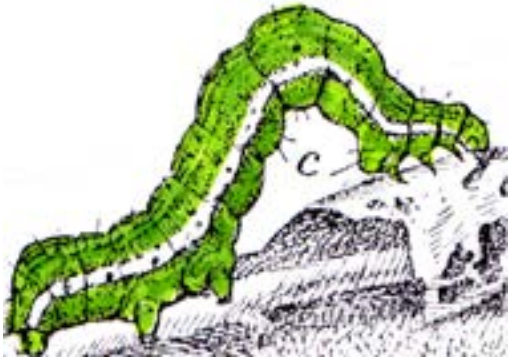


Fig. 1: Caterpillar stage of Cabbage Looper

Biological Control

Bacillus thuringiensis, or Bt, (Bactur, Dipel, SOK BT, Thuricide) 2.0 to 3.0 tbsp in 1-gallon water. *Bacillus thuringiensis* will work but its results are not quickly observable; loopers (and other caterpillars) get sick the first day and die later. It is not necessary to wait before harvesting after an application of Bt.

Several parasitic wasps (Hyposoter, Copidosoma, Trichogramma) attack the cabbage looper as do general predators and virus diseases. Mass releases of Trichogramma may provide control in tomatoes.

Organic Control

Beauvaria bassiana – Can be applied on day of harvest, must be allowed to dry

Azadirachtin – Can be applied on day of harvest, must be allowed to dry

Bacillus thurgingiensis – Can be applied on day of harvest, must be allowed to dry

Insecticidal Soap – Can be applied on day of harvest, must be allowed to dry

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Spinosad – Do not apply within one day of harvest

Table 2.2.12 – Root maggots

Identification: Root maggots are small pale fly larvae that are found in the soil near rotting sections or roots and seeds.

Damage: Plants infested grow slower and have a stunted or yellow appearance. In severe cases, the newly germinating seeding dies and the row has very spotty emergence of crop plants.

Cultural Control: Root maggots are a problem on cold wet soils. Use raised rows and planting bed that make the soil warmer. This will promote quick germination and plant growth.

Chemical Control: Use a granular insecticide at planting time.

Table 2.2.13 – Parsleyworm

Also referred to as the Black swallowtail, Carrot Caterpillar, or Celeryworm.

Description: Green with yellow and white spotted black band; up to 2 inches long. Two orange "horns" just behind the head are projected when the caterpillar is disturbed. This caterpillar is the larva of the black swallowtail butterfly.

Common Host Plant(s): Carrot, celery, parsley, dill and parsnip.

Damage: Chews leaves and stems, destroys tops. Seldom numerous enough to reduce yield.

Lifecycle: After the black swallowtail butterfly emerges from its cocoon in the spring it deposits eggs on plants in the carrot family. This insect overwinters as pupa on the host plant. There are two or more generations annually.

Cultural Control: Handpicking these caterpillars is usually sufficient.

Organic/Biological Control

Bacillus thuringiensis, or Bt – can be applied up to the day of harvest.

Chemical Control: Treat with a registered insecticide if cultural control fails, follow all label instructions regarding wait period between application and harvest.

Cypermethrin – spray up to 1 day before harvesting.

Caterpillar of Parsleyworm (USDA)

Table 2.2.14 – Squash Vine Borer

Plants Attacked: Cucumber, cantaloupe, winter squash, pumpkin, gourd, summer squash, and watermelon, as well as many other species of cucurbits.

Damage: Larval stage borers into stems can cause the vine or entire plant to wilt and die.

Lifecycle: Adult moth lay eggs on vines and after hatching the new larvae quickly borers into the stem where it will feed until its full size and ready exit the vine and pupate into the adult.

Cultural Control: Plant cucurbits as late as possible to avoid this and other pests. Use a row cover from planting until first flower. For cucurbits with long running vines, place a single shovel full of soil over the vine about every 6 feet, this will aid in developing secondary roots.

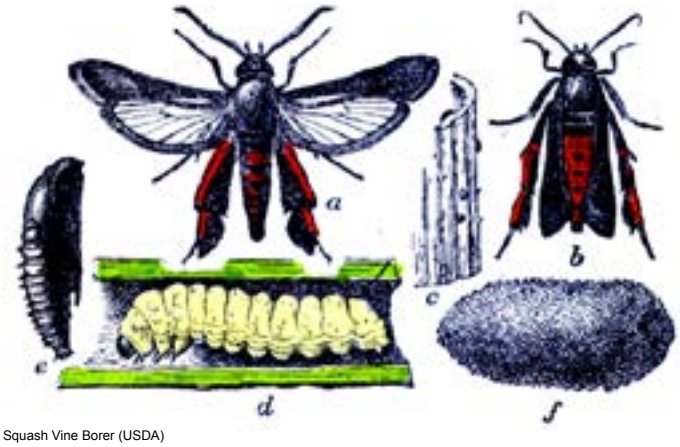
Organic Control

Kaolin clay – Can be applied up to the day of harvest

Chemical Control: Treat with a registered insecticide if cultural control fails, follow all label instructions regarding wait period between application and harvest. For Squash Vine Borer, it's important to treat as soon as the first damage is found and continue every 10 days for the rest of the growing season.

Acetamiprid – Can be applied up to the day of harvest

Permethrin – Can be applied up to the day of harvest



Squash Vine Borer (USDA)

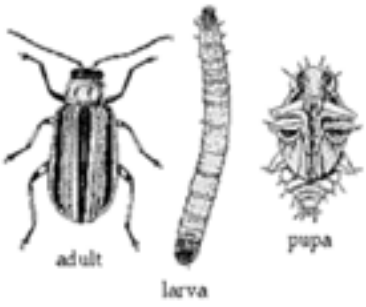
Table 2.2.15 – Cucumber Beetles

Plants Attacked: Cucumber, cantaloupe, winter squash, pumpkin, gourd, summer squash, and watermelon, as well as many other species of cucurbits. Cucumber beetles may also feed on beans, corn, peanuts, potatoes, and other crops.

Description of Damage: Cucumber beetles damage leaves, stems, and fruit. They can also transmit a disease called bacterial wilt.

Cultural Control: Plant as late as possible, plant pumpkins, squash and cucumbers after June 15th, this date may have to be adjusted depending on local conditions. Use a row crop covers that will exclude the beetles. Row cover needs to be in place from planting until bloom. Row covers may also provide protection from cucumber beetles, and in addition provide late frost protection and help in moisture retention.

Control Practices: Chemical control is often needed, particularly in commercial plantings. To prevent cucumber beetle damage to seedlings, treat when one beetle per 10 feet of row is found. To prevent bacterial wilt, treat when one beetle per 100 feet of row is found.



The Striped Cucumber Beetle, Acalymma vittatum (Fabricius) Coleoptera: Chrysomelidae (USDA)

Organic/Biological Control

Azadirachtin – Can be applied up to the day of harvest

Kaolin clay – See label for instructions

Neem Oil- Can be applied on day of harvest, must be allowed to dry

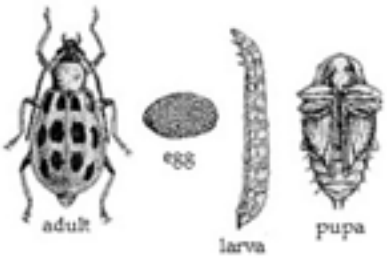
Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Chemical Control: Treat with a registered insecticide if cultural control fails, follow all label instructions regarding wait period between application and harvest.

Carbaryl – pre-harvest interval = 3 days

Imidacloprid – pre-harvest interval = 21 days

Permethrin – Can be applied up to the day of harvest



Spotted Cucumber Beetle, Diabrotica undecimpunctata howardi Barber. Coleoptera: Chrysomelidae (USDA)

Table 2.2.16 – Leafhopper

Description: Several species. Adults: Green wedge shaped, up to 1/8 inch long; they fly quickly when disturbed. Nymphs resemble adults but are smaller; they crawl sidewise like crabs.

Common Host Plant(s): Beans, lettuce, and potato. Also, can damage shade trees such as maple.

Damage: Adults and nymphs attack beans and potatoes. Leaves of beans curl, or roll downward, crinkle, and tend to become yellow or bronze. Some plants are dwarfed and may die. On potatoes attack by Potato Leafhoppers causes hopperburn. Tips and sides of potato leaves curl upward, turn yellow to brown, and become brittle. Potato and western potato leafhoppers are most destructive.

Cultural Control: Pick and destroy infested leaves.

Organic/Biological Control: Lacewings, damsel bugs, lady beetles, minute pirate bugs, and spiders are included among the natural enemies of leafhoppers. Dusting plants lightly with diatomaceous earth may help control leafhoppers.

Azadirachtin – Can be applied on day of harvest, must be allowed to dry

Canola oil – Can be applied on day of harvest, must be allowed to dry

Spinosad – pre-harvest interval = 3 days

Neem Oil & Azadirachtin – Can be applied up to the day of harvest

Neem Oil – Can be applied on day of harvest, must be allowed to dry

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Kaolin clay – Can be applied up to the day of harvest

Chemical Control: Treat with a registered insecticide when damage first appears.

Permethrin – Can be applied up to the day of harvest

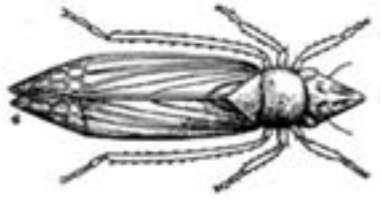

Leafhopper (USDA)

Table 2.2.17 – Leafminers

Description: Larva: Yellow, 1/8-inch-long, lives in leaves. Adult fly: Tiny, black and yellow. Several generations of this insect develop in a summer.

Damage: Larvae make long, slender, winding, white tunnels in leaves.

Cultural Control: Pick and destroy infested leaves.

Organic/Biological Control: Parasitic wasps often control leafminers.

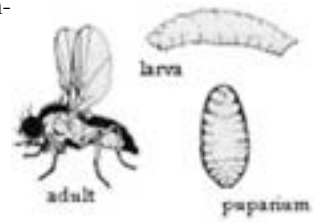
Chemical Control: Treat with a labeled insecticide as soon as damage is first noticed; repeat as needed.

Permethrin – Can be applied up to the day of harvest

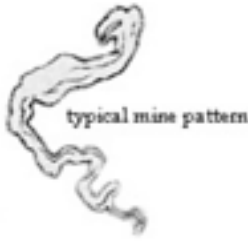
Kaolin clay – See label for instructions

Insecticidal Soap – Can be applied up to the day of harvest

Pyrethrins – Can be applied up to the day of harvest



Life stages of a Leafminer (USDA)



Example of Leafminer damage (USDA)

Table 2.2.18 – Squash bug

Identification: Squash bug eggs are laid in clusters and are coppery brown just before hatch. Just after hatch nymphs are green and later turn gray. Adult squash bugs are dark brown to black.

Damage: Squash bugs can attack cucumber but prefer squashes. Feeding causes leaves to wilt and for fruit to develop poorly and rot. Squash bug damage can be confused with bacterial wilt in cucumbers which is transmitted by cucumber beetles.

Cultural Control: Use a row cover from planting until flowering.

Chemical Control: For home gardens use a registered insecticide as soon as squash bugs are found; repeat as needed.

Permethrin – Can be applied up to the day of harvest

Kaolin clay – See label for instructions

Insecticidal Soap – Can be applied up to the day of harvest

Pyrethrins – Can be applied up to the day of harvest

See: https://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/ENTO/ENTO-64/ENTO-64-pdf.pdf


Squash Bug (USDA)

Table 2.2.19 – Pickleworm

Identification: Young pickleworm larvae are yellowish-white with a brownish head. There are numerous rows of dark spots in young larvae, but these disappear with age. Older larvae are greener and may turn pinkish and coppery close to pupation. Larval coloration may vary with their food plant. Mature larvae measure 25–30 mm (about 1 inch) long. Adult moths are distinctively colored with a wingspan of about 3 cm (1.2 inches). Both the front wing and the hind wing have a central yellow splotch bordered by chocolate brown; the central splotch is somewhat transparent. Legs and antennae are yellowish. Both sexes have a prominent brush of yellow hairs on the tip of the abdomen that serve in pheromone communication.

Damage: Pickleworm larvae burrow into the buds, flowers, and developing fruits of their host plant to feed. Tunneling in buds and flowers limits fruit set, while feeding in fruits ruins them. Caterpillars neatly chew round holes in the host plant; wet, pulpy frass (fecal material) is often found at these entrances. Feeding injury also encourages the onset of disease, but the presence of pickleworm larvae ruin the fruit for consumption anyways. Larvae will attack the central vines once the blossoms and fruits have been eaten.

Cultural Control: Plant early using resistant and/or early maturing varieties. Plantings made in very early spring are seldom damaged by pickleworm. Crush or otherwise destroy infested fruit and pupae among leaves whenever found. Destroy vines,

unused fruits, other crop residue, and nearby weeds as soon as the crop is harvested. Spading or plowing in the early fall will destroy pickleworm pupae, although pupae are not likely to survive our winters in Virginia.

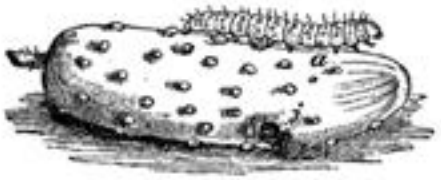
Chemical Control

Permethrin – Can be applied up to the day of harvest

Kaolin clay – See label for instructions

Insecticidal Soap – Can be applied up to the day of harvest

Pyrethrins – Can be applied up to the day of harvest



Pickleworm and damage (USDA)

Source: https://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/3104/3104-1559/3104-1559_pdf.pdf

Table 2.2.20 – Mushroom Pests

Fungus Gnats are small pale larvae that damage the below ground sections of mushrooms and cause poor growth.

Rove Beetles are small beetles that damage the upper sections of the mushroom.

Cultural Control: Start with clean sterile manure

Chemical Control: Azadirachtin – Can be applied up to the day of harvest

Table 2.2.21 – Cowpea Curculio

Identification: Small black weevils about ¼ inch long. If disturbed, will quickly drop to the ground.

Damage: Cowpea Curculios feed on the seeds in the pod while the plant is still growing leaving hole and damaged peas and beans.

Cultural Control: Since this insect does not fly, rotating crops is effective.

Chemical Control

Esfenvalerate – See label for instructions

Spinosa – Can be applied up to the day of harvest

Table 2.2.22 – Colorado Potato Beetle

Identification: The adult beetle is orange with black spots and the wing covers have alternating yellow and black stripes. The larvae are reddish in color with two rows of black spots along each side and eggs are yellow and found in clusters.

Damage:. Larva chew away leaves until only the midribs and stems are left in place. Heavily damaged plants are completely defoliated and have poor potato set.

Cultural Control: Hand pick and drop in soapy water for small populations.

Biological control: *Bacillus thuringiensis* var. san diego and *Bacillus thuringiensis* var. tenebrionis are two strains of Bt that work on Colorado Potato Beetle. Other strains of Bt that are for caterpillars will not work on beetles.

Organic control: Neem (azadirachtin) or cryolite are effective if applications are timed to coincide with peak egg hatch and small-larvae activity. Spinosad is effective against both larvae and adult

Chemical Control

Imidacloprid – pre-harvest interval = 21 days

Permethrin – pre-harvest interval = 7 days

Neem Oil & Azadirachtin – Can be applied up to the day of harvest

Pyrethrins – Can be applied up to the day of harvest

Colorado Potato Beetle (USDA)

Spinosad – Can be applied up to the day of harvest

Cryolite – See label for instructions

Azadirachtin – Can be applied on day of harvest, must be allowed to dry

Canola Oil & Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Neem Oil – Can be applied on day of harvest, must be allowed to dry

Table 2.2.23 – European Corn Borer

Description of Damage: Borer into stems of potatoes and cause lodging of plants and borer in to green peppers and cause fruit rot. On corn, they enter the stalk near the ear and cause it to break.

Identification: When fully grown, ECB larvae are 3/4 to 1 inch in length and creamy-white to pink in color. The larval head capsule is dark brown and, on top of each abdominal ring or segment, there are several small dark brown or black spots. (Figure 1)

Cultural Control: Remove and destroy infested stems and peppers.

Chemical Control Must be applied as soon as damage is noticed to stop additional borers from entering the plants.

Acephate – pre-harvest interval = 7 days

Acetamiprid – pre-harvest interval = 7 days

Carbaryl – pre-harvest interval = 7 days

Permethrin – pre-harvest interval = 3 days

Azadirachtin & Pyrethrins – Can be applied up to the day of harvest

Pyrethrins – Can be applied up to the day of harvest

Horticultural Oil – See label for instructions

Imidacloprid – See label for instructions

Azadirachtin – Can be applied on day of harvest, must be allowed to dry

Neem Oil – Can be applied on day of harvest, must be allowed to dry

European corn borer larva. (USDA)

Table 2.2.24 – White Grubs

Description: Several species, but the most common white grub is larva of the Japanese beetle. Other white grubs can be May beetles, June beetle, chafers, and other scarab beetles. White grubs are white or light yellow, hard brown heads, curved; 1/2 inch to 1 1/2 inches long when fully grown. White grubs live in soil. They require 3 years to mature.

Damage: Larvae feed on roots and underground parts of potato and many other plants. Adults feed on tree foliage.

Cultural Control: Turn over the soil in late summer or early fall. This will kill many grubs and expose others to predators.

Organic/Biological Control: Birds, hogs, and skunks are natural predators of the grubs. Parasitic wasps may also provide some control.

Chemical Control: Apply a planting time soil insecticide, follow all label precautions and directions

Depicted are 3 species, among the pest complex called “white grubs.” The photo is useful as a comparison for size and appearance of these. The species L to R are: Japanese beetle, Popillia japonica, European chafer, Amphimallon majalis, and june bug, Phyllophaga sp. David Cappaert, Michigan State University, Bugwood.org

Table 2.2.25 – Potato Tuberworm

Description: Pinkish white, brown head, up to 1/2-inch long.

Damage: Tunnels in stems, leaves, and tubers. Shoots wilt and die.

Lifecycle: Larvae or pupae overwinter in tubers or in the soil. Moths appear in spring and may be seen at dawn or dusk when they are normally active or when plants are disturbed. Females lay 60-200 eggs, singly, on plants in as little as four days. Usually eggs are deposited in the tuber eyes or on the underside of potato foliage. Larvae emerge in 3-6 days. Larvae often enter potato tubers through the eyes, leaving frass around the eye. Larvae may feed near the tuber surface or tunnel deeply into the tuber, leaving a trail of excrement along their path. During the summer larvae mature in 7-10 days and pupate in soil or plant debris around potato plants. Second generation moths emerge in approximately a week. Multiple generations occur annually in Virginia.

Cultural Control: Protective measures for controlling the potato tuberworm include the following:

1) plant only seed pieces that are not infested,

2) cultivate so as to hill the soil against the plants – keeping at least 2 inches of soil over the developing tubers, 3) harvest as soon as the crop is mature. During harvest, do not leave the dug potatoes in the field overnight, and do not cover piles of potatoes with potato tops,

4) destroy all culled or infected potatoes as soon as possible,

5) store tubers at temperatures below 52 degrees F is possible and practical. Use either new or thoroughly cleaned bags or baskets when storing. The storage area should be screened or enclosed in such a way that moth cannot get in. Without such an enclosed storage area, moths can still fly in and still become a problem even though the storage area was clean and potatoes insect-free when stored.

Organic Control:

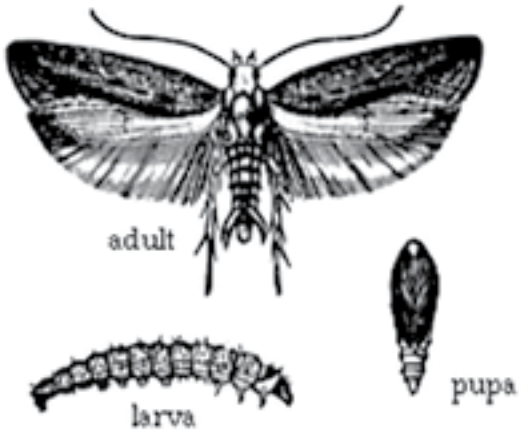
Pyrethrins – Can be applied up to the day of harvest

Chemical Control: There is no known chemical control for this insect in stored potatoes.

Esfenvalerate – See label for instructions

Permethrin – pre-harvest interval = 14 days

Pyrethrins – Can be applied up to the day of harvest



Life stages of the Potato Tuberworm (USDA)

2.2.26 – Whiteflies

Description: Adult whiteflies are small and large numbers will fly away when heavily infested plants are moved. Immature stages are pale and attached to the undersides of the leaves.

Cultural Control: When purchasing plants, check carefully to make sure they are pest free.

Chemical Control:

Horticultural Oil – See label for instructions

Imidacloprid – pre-harvest interval = 21 days

Permethrin – Can be applied up to the day of harvest

Azadirachtin – Can be applied on day of harvest, must be allowed to dry

Canola Oil – Can be applied on day of harvest, must be allowed to dry

Neem Oil – Can be applied on day of harvest, must be allowed to dry

Insecticidal Soap – Can be applied up to the day of harvest

Pyrethrins – Can be applied up to the day of harvest

Table 2.2.27 – Leafrollers

Description: Leaves folded over with silk. Small caterpillar inside.

Cultural Control: Handpick and destroy small infestations.

Chemical control

Capsaicin & Oil of Mustard – Can be applied on day of harvest, must be allowed to dry
Carbaryl – pre-harvest interval = 7 days
Horticultural Oil – See label for instructions
Malathion – pre-harvest interval = 3 days
Permethrin – pre-harvest interval = 7 days
Azadirachtin – Can be applied up to the day of harvest
Canola Oil & Pyrethrins – Can be applied on day of harvest, must be allowed to dry
Neem Oil – Can be applied on day of harvest, must be allowed to dry
Neem Oil & Azadirachtin – Can be applied up to the day of harvest
Pyrethrins – Can be applied on day of harvest, must be allowed to dry
Spinosad – Can be applied up to the day of harvest

Table 2.2.28 – Strawberry Rootworm and Strawberry Clipper

Description: Holes in leaves, cut leaf petioles, and poor growth.

Cultural Control: Renovate strawberry bed and replant as far away as possible.

Chemical control to be applied only when damage to leaves is occurring.
Capsaicin & Oil of Mustard – Can be applied on day of harvest, must be allowed to dry
Carbaryl – pre-harvest interval = 7 days
Horticultural Oil – See label for instructions
Malathion – pre-harvest interval = 3 days
Permethrin – pre-harvest interval = 7 days
Azadirachtin – Can be applied up to the day of harvest
Canola oil & Pyrethrins – Can be applied on day of harvest, must be allowed to dry
Neem Oil – Can be applied on day of harvest, must be allowed to dry
Neem Oil & Azadirachtin – Can be applied up to the day of harvest
Pyrethrins – Can be applied on day of harvest, must be allowed to dry
Spinosad – Can be applied up to the day of harvest

Table 2.2.29 – Corn Sap Beetle

Description: Small brown beetles found in ears near rot. They are secondary and feed on rot after the ear is damaged by earworms or birds.

Cut off and discard damaged sections of ear, remaining is OK to eat.

Chemical Control

Carbaryl – pre-harvest interval = 3 days
Esfenvalerate – See label for instructions
Malathion – pre-harvest interval = 5 days
Permethrin – pre-harvest interval = 3 days
Pyrethrins – Can be applied up to the day of harvest

Table 2.2.30 – Japanese Beetle

Description: Shiny metallic green beetles feed on the silk and disrupt pollination.

Cultural control: Place and Japanese Beetle trap about 30 feet away from the corn.

Chemical Control:

Carbaryl – pre-harvest interval = 3 days

Esfenvalerate – See label for instructions

Malathion – pre-harvest interval = 5 days

Permethrin – pre-harvest interval = 3 days

Pyrethrins – Can be applied up to the day of harvest

Photo by Eric Day.

Table 2.2.31 – Fall Armyworm

Description: Brown caterpillars feeding on the ear in a similar manner to Corn Earworms.

Cultural Control: Hand pick small populations

Chemical Control

Carbaryl – See label for instructions

Horticultural Oil – Can be applied up to the day of harvest

Permethrin – pre-harvest interval = 3 days

Neem Oil & Azadirachtin – Can be applied up to the day of harvest

Photo by Russ Ottens,University of Georgia, Bugwood.org.

Table 2.2.32 – Blister Beetles

Description: Black beetles with gray lines or tan beetles with brown strips show up in clusters and feed on the leaves of tomato. If handled beetles can cause blisters on human skin.

Cultural Control: Wear gloves if hand picking to avoid blisters. Drop beetles in soapy water.

Chemical Control

Capsaicin & Oil of Mustard – Can be applied on day of harvest, must be allowed to dry

Carbaryl – pre-harvest interval = 3 days

Malathion – pre-harvest interval = 1 day

Beauvaria bassiana – Can be applied up to the day of harvest

Neem Oil & Azadirachtin – Can be applied up to the day of harvest

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org

Table 2.2.33 – Tomato Hornworm

Two species of hornworm damage tomato plants in Virginia, the tobacco hornworm, *Manduca sexta* (Linnaeus) and the tomato hornworm *Manduca quinquemaculata* (Haworth) (Insecta: Lepidoptera: *Sphingidae*).

Description: Both species are green with diagonal lines on sides and prominent horn on rear end. They can be up to 4 inches long.

Damage: These caterpillars feed on leaves and green fruit. They are typically found on the upper portions of the plant. Since they consume 90% of the foliage just before they pupate they seem to appear "overnight". This is not actually true; the smaller stages of the caterpillars did limited feeding that was quickly covered by regrowth. They in fact were on the same plant all along.

Cultural Control: Hand pick worms, but do not destroy caterpillars with cocoons, leave in garden to continue biological control.

Organic/Biological Control

Bacillus thuringiensis, Bt, will control the caterpillars but must be applied when they are less then ½ inch long.

Chemical Control: Apply a labeled insecticide, following all instructions and precautions. Insecticides must also be applied when the caterpillars are less then ½ inch long.

Capsaicin & Oil of Mustard – Can be applied on day of harvest, must be allowed to dry

Carbaryl – pre-harvest interval = 3 days

Malathion – pre-harvest interval = 1 day

Beauveria bassiana – Can be applied up to the day of harvest

Neem Oil & Azadirachtin – Can be applied up to the day of harvest

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Figure 1, Left: tomato hornworm, Whitney Cranshaw, Colorado State University, Bugwood.org Center: Tobacco hornworm, Sturgis McKeever, Georgia Southern University, Bugwood.org Right: Hornworms with cocoons of wasp parasites, Clemson University – USDA Cooperative Extension Slide Series, Bugwood.org

Table 2.2.34 – Tomato Russet Mite

Description: Tiny slender mites make leaves turn pale and brown. Russet mite damage is similar to spider mites, but they do not make silk webbing.

Cultural Control: Purchase clean damage free plants.

Chemical Control: Treat with insecticidal soap as soon as mites or damage is found.

Table 2.2.35 – Tarnished Plant Bug

Tarnished Plant Bugs are also known as Lygus bugs. The tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), is in the order Hemiptera, family Miridae.

Description: The adult is a small insect, about 1/4" in length. It is light brown and variously spotted.

Common Host Plant(s): Strawberries, vegetables, tree fruits, and flowers (dahlias, chrysanthemums, marigolds, zinnia, and many others).

Damage: Damage when the fruit is small can cause the fruit to be deformed and misshapen when it reaches maturity, thus catfaced. The fruit may also be aborted and drop to the ground if it is too heavily damaged.

Control: Insecticide treatments probably are only partially effective. Plant bugs are active and move about freely, thus avoiding the treatment. Feeding injury can resume as soon as the effectiveness of sprays dissipates.

Chemical control

Carbaryl – See label for instructions

Esfenvalerate – pre-harvest interval = 1 days

Permethrin – pre-harvest interval = 3 days

Pyrethrins – Can be applied up to the day of harvest

Fall armyworm – Carbaryl – See label for instructions

Horticultural Oil – Can be applied up to the day of harvest

Permethrin – pre-harvest interval = 3 days

Neem Oil & Azadirachtin – Can be applied up to the day of harvest

Tarnished plant bug. Scott Bauer, USDA Agricultural Research Service, Bugwood.org

Table 2.2.36 – Cutworms

Description: Many species. Cutworms are dull gray, brown, or black, and may be striped or spotted. They are stout, soft-bodied and smooth, and up to 1 and 1/4 inches long. They curl up tightly when disturbed.

Common Host Plant(s): Tomato, pepper, cabbage, peas, beans, and squash.

Damage: Cut off plants above, at, or below soil surface. Some cutworms feed on leaves, buds, or fruits; others feed on the underground portions of plants. Particularly destructive to early season plantings.

Cultural Control: Place a stiff 3-inch cardboard collar around the stems; allow it to extend about 1 inch into the soil and protrude 2 inches above the soil; clear the stem by about 1/2 inch. Till garden so that weedy growth is not present in the spring.

Organic/Biological Control: *Bacillus thuringiensis* (Bt is sold under various trade names and formulations) will kill cutworms and is safe. Worms get sick the first day and die later.

Chemical Control: If cultural control fails, follow the label instructions and precautions for pre-planting treatment of cutworm for Beans, Beets, Cabbage, Carrots, Cauliflower, Celery, Collards, Cucumbers, Endive, Kale, Lettuce, Lima Beans, Melons, Muskmelons, Onions, Parsley, Parsnips, Peas, Peppers, Potatoes, Radishes, Snap Beans, and Sweet Corn.

Bifenthrin – See label for instructions

Capsaicin & Oil of Mustard – Can be applied on day of harvest, must be allowed to dry

Carbaryl – pre-harvest interval = 3 days

Cyfluthrin – See label for instructions

Esfenvalerate – See label for instructions

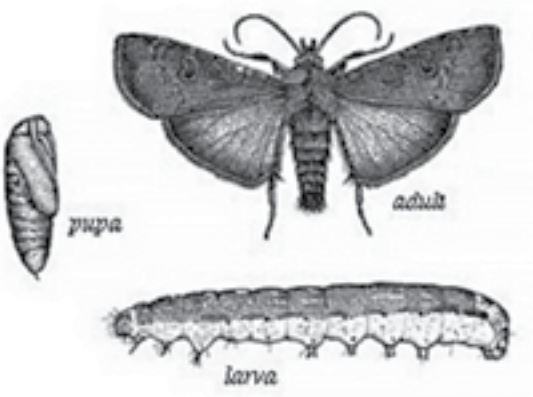
Imidacloprid – See label for instructions

Malathion – pre-harvest interval = 1 day

Permethrin – pre-harvest interval = 3 days

Azadirachtin – Can be applied up to the day of harvest

Spinosad – Can be applied up to the day of harvest



Life stages of Cutworms (USDA)

This chapter was not reviewed in 2021.

Vegetable Diseases

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Overview

Home gardeners can avoid many disease problems in their vegetable gardens by practicing cultural and other preventative tactics. If a disorder is found, the first step in controlling the disease is to accurately identify the pathogen. Often abiotic (non-living) problems or insect problems are mistaken for plant diseases and pesticides are used needlessly. Accurate identification of the pathogen ensures that pesticides are used appropriately and only when other control tactics can't control the problem. Accurate identification of the pathogen also allows formulation of an integrated pest management approach to control the disease based on the pathogen's life cycle. Use pesticides in conjunction with cultural and other control tactics.

General Cultural Controls

- Provide optimal growing conditions: Healthy plants are less likely to become diseased than stressed plants.
  - Provide adequate water and fertilization, but avoid over-fertilization, which creates succulent tissue that is prone to disease and pest problems. Also do not apply fertilizer close to tender root and stem tissue, since this can seriously injure or kill plants.
  - Ensure soil pH is optimal for nutrient uptake by plants by submitting a soil sample for analysis to the Virginia Tech Soil Testing Laboratory when starting a new garden. Re-test every two to three years.
  - Plant crops at recommended planting times. Planting too early, in particular, predisposes seedlings and transplants to disease.
  - Space plants adequately to ensure vigor and to promote foliar drying—wet foliage favors most foliar diseases.
  - Stake or cage tomato plants.
  - Check the soil drainage and if drainage is poor, correct before planting. Excessively wet soils can cause soilborne diseases and poor growth even in the absence of a pathogen.
  - Irrigation: Most plant diseases favor high humidity and wet foliage. Avoid overhead irrigation when possible, as it creates wet foliage. If irrigating overhead, do so early in the day to promote foliar drying. Also avoid over-irrigation; this can cause root problems and favors the development of certain pathogens.
- Sanitation:
  - Rotate crops: Avoid growing the same crop species AND same crop family (e.g. solanaceous family: potato, tomato, pepper, eggplant) in the same garden location for consecutive years, since this may result in a build-up of pathogen inoculum in the soil.
  - Use disease-free seed and/or transplants. Certain pathogens survive in seed, so purchase certified seed and be mindful when saving your own seed, as it may harbor pathogens. Do not save seed from diseased plants.
  - Some plant pathogens can survive on plant debris. Therefore, removing diseased plants and crop debris from the garden reduces inoculum for new infections in the next season's garden. Compost crop debris or till it into the soil at the end of the growing season; however, some pathogens produce survival structures that are not killed by composting or burying in soil.
  - Stakes, rototillers, and gardening tools can be infested with pathogen inoculum; stakes, equipment and tools must be cleaned and disinfected. Also, some pathogens may be present in soil, so avoid any practice that moves infested soil to non-infested areas.
  - Avoid working or harvesting in the garden when plants are wet. This spreads pathogens.
  - Weeds are alternate hosts for many pathogens, so controlling weeds reduces the likelihood of some diseases.
- Resistance:
  - To avoid commonly occurring disease problems use disease-resistant plants if they are available (e.g. late blight-resistant tomato).

General Biological Controls

- Disease-resistant plants: Resistant cultivars are available for some common plant disease problems. For example, tomato varieties designated with the letters "VFN" are resistant to Verticillium and Fusarium species, soil borne fungi with no chemical controls. The 'N' indicates root-knot nematode resistance, another soil-borne pathogen with no available chemical controls.
- Soil amendments: Adding compost or other organic matter to garden soil may increase populations of beneficial microbes in the soil. Some of these microbes may be antagonistic, predatory, or may simply out-compete pathogens, and reduce the likelihood of disease.
- Biological pesticides: Biological pesticides are formulated from living organisms, such as fungi, bacteria, and nematodes that may be antagonistic, predatory, parasitic or may simply out-compete pathogens. The number of biological control products available to homeowners for disease control is growing. These products are safer to handle, break down quickly, and are considered to be environmentally friendly compared to other pesticides. Some biological pesticides are ineffective or less effective compared to other pesticide products for controlling certain plant diseases. However, when biological pesticides are used in conjunction with cultural and other control tactics, or when disease pressure is low, disease may be controlled to an acceptable level with these pesticides.
- Naturally-occurring organisms: Using broad-spectrum pesticides may reduce populations of naturally occurring organisms that are beneficial to crops or have an adverse effect on plant pathogens and other pests. Use these pesticides only when necessary.

General Mechanical Controls

- Most plant disease problems are made worse by wet foliage. Staking crops, like tomatoes, reduces leaf wetness and promotes foliar drying. Staking also reduces spread of inoculum that may splash onto foliage and fruit from the soil.
- Reflective row covers deter insects that carry plant pathogens.
- Organic and plastic mulches reduce the spread of some soil-borne pathogens and also reduce weeds that may host plant pathogens.

General Chemical Controls

- Fungicides can also be used to manage disease problems in the home garden. When using fungicides, it is important that you read and follow the fungicide product label. The active ingredients in the fungicides listed in this section are available under many different commercial names and may be found in garden centers or ordered over the Internet. Because different manufacturers' labels vary widely, always check the label carefully before purchasing a particular brand to make sure it is labeled for both your crop and the disease you are trying to control. For disease problems not covered in the recommendations, contact your local Extension agent.
- Calibrate sprayers and spreaders.
- Wear Personal Protective Equipment (PPE) when applying chemicals, as specified on the pesticide label. Each pesticide product varies in toxicity and must be evaluated individually regarding re-entry and preharvest intervals.
- Most homeowner pesticides are protectants and must be applied preventatively, before infection occurs. It is important to completely cover the plants when using these pesticides. Most homeowner pesticides cannot cure plants that are already diseased and do not have systemic activity.
- Each pesticide has different amounts of toxicity and each can have a different negative effect on the environment and other organisms. Pesticides receiving EPA approval today are generally less toxic and have reduced negative impact on the environment than those approved prior to the late 1990s.

Precautions

- Humans: Protect yourself when applying chemicals: read the product label to determine the proper PPE and accessories you need before using any chemicals. Do not assume that because a product is labeled "organic" it is non-toxic to humans. Products vary in human toxicity and each pesticide product must be assessed according to its product label.
- Bees: In general broad-spectrum insecticides are toxic to bees. Read each product label and determine what precautions to take to protect bees and other beneficial insects when applying pesticides.

- Animals (pets, birds, etc.) and water: Read the specific product label to determine what precautions to take to protect the health of other animals and aquatic invertebrates when applying pesticides.
- Pesticide resistance: Over-using pesticides may make pests resistant to the pesticide. Pesticides containing thiophanate-methyl, for example, often develop resistance. Broad-spectrum pesticides have a low risk of developing resistance. Read the pesticide product label to determine if a pesticide is at risk of developing pesticide resistance. To avoid pesticide resistance:
  - Limit applications of the pesticides (the number of allowed applications is usually specified on the label for at-risk pesticides),
  - Use pesticide products with different modes of action or use a mix of pesticides with different modes of action
  - Use the recommended rate as specified on the product label.

Factsheets

- Virginia Cooperative Extension Plant Disease Factsheets http://pubs.ext.vt.edu/category/plant-diseases.html

Virginia Tech Diagnostic and Identification Laboratories

- Plant Disease Clinic http://www.ppws.vt.edu/extension/plant-disease-clinic/index.html
- Insect Identification Lab http://www.idlab.ento.vt.edu/
- Nematode Assay Lab http://www.ppws.vt.edu/extension/nematode-laboratory/index.html
- Soil Testing Lab http://www.soiltest.vt.edu/
- Weed Identification Lab http://www.ppws.vt.edu/extension/weedid-clinic/index.html

Table 2.3 – Fungicide Brands Available for Home Vegetable Gardens

Chemical Name	Product Name
Captan	American Captan Garden Fungicide Bonide Captan 50W Dragon Captan Wettable Hi-Yield Captan Fungicide 50W Orthocide Garden Fungicide Southern Agricultural Home and Garden Captan Fungicide
Chlorothalonil	Bonide Fung-onil Dragon Daconil 2787 Earl May Fung-onil Ferti-Lome Liquid Fungicide Fung-onil Multipurpose Gordon's Multi-Purpose Fungicide Ortho Daconil 2787 Ortho Garden Disease Control Southern Agricultural Lawn, Ornamental, & Vegetable Fungicide
Basic copper	Acme Bordeaux Mix Bonide Garden Dust Cooke Copper Fungicide Cooke KopRSpray Conc. Dragon Bordeaux Mix Fertilome Bordeaux Mixture Gordon's Bordeaux Mix Hi-Yield Bordeaux Mix Lilly Miller Microcop Fungicide – Basic $CuSO_4$ Southern Agricultural Neutral Copper Fungicide Southern Agricultural Tomato Dust
Fixed copper	American Copper Fungicide Bonide Liquid Copper Fungicide Dragon Copper Fungicide Hi-Yield Copper Fungicide Southern Agricultural Liquid Copper Fungicide
Mancozeb	Bonide Mancozeb Flowable with Zinc Dragon Mancozeb Green Light Broad Spectrum Mancozeb Fungicide Southern Agricultural Dithane M-45
Neem oil	Green light Powdery Mildew Killer Garden Safe Fungicide 3
PNCB (pentachloro-nitrobenzene)	Hi-Yield Terraclor Granule Southern Agriculture Terraclor
Potassium bicarbonate	Bonide Remedy Cleary First Step
Sulfur	Bonide Liquid Sulfur Bonide Sulfur Fungicide Dragon Garden Sulfur Green Light Wettable Dusting Sulfur Hi-Yield Lime Sulfur Ortho Garden Sulfur Dust Safer Garden Fungicide Southern Agricultural Wettable or Dusting Sulfur

Table 2.4 - Disease Management Tools for Specific Crops and Diseases

Crop Disease	Treatment (PHI)[1]	Rate/Gal. (Unless otherwise Stated)	Remarks
Asparagus Rust	Mancozeb	2.0 tbsp	Use resistant varieties or apply 3-4 post-harvest sprays at 7- to 10-day intervals beginning in late June.
Beans (Snaps or Lima) Anthracnose (Lima bean only)	chlorothalonil 12.5% (7)	2.0 tbsp	Begin early bloom – reapply every 7 to 10 days. For use only on beans to be harvested dry with pods removed.
Bacterial Blights	copper	1.5 tbsp powder	Use certified western-grown seed. Begin with 4.0 tsp liquid at tri-foliage and reapply every 7 to 10 days.
Botrytis Blight (Gray mold)	chlorothalonil 12.5% (7) chlorothalonil 30% (7)	4.0 tbsp 1.0 tbsp	Begin at early bloom; apply after extended wet periods.
Downy mildew (Lima beans only)	chlorothalonil 12.5% (7)	2.0 tsp	Begin early bloom – reapply every 7 to 10 days. For use only on beans to be harvested dry with pods removed.
Powdery mildew	Neem Oil Wettable Sulfur or Sulfur dust	2.0 tbsp 2.5 tbsp or 6.0 tbsp dust	Spray or dust at first sign and reapply every 7 days. Sulfur may injure blossoms and some varieties of beans.
Rhizoctonia root and stem rot	PCNB	4.0 tbsp/gal for 1000 ft row	Apply at planting only. Direct spray in the seed furrow or over the planted row.
Rust	chlorothalonil 12.5% (7) chlorothalonil 30% (7) Wettable Sulfur or Sulfur dust	2.0-4.0 tbsp 1.0 tbsp 2.5 tbsp 6.0 tbsp dust	Spray or dust at first sign and reapply every 7 days. Sulfur may injure blossoms and some varieties of beans.
Seed rot and damping off	Captan	0.5 tsp/1lb seed	Mix thoroughly in paper bag or glass jar.
Viruses	No chemicals registered		Clover control around edge of garden areas is important to reduce spread of virus from clover to beans. Some bean varieties are resistant. Aluminum foil mulch may prevent aphid feeding.
Beets *Cercospora*	copper leaf spot	2.0 tbsp	Spray at 7- to 10-day intervals beginning when disease first appears.
Seed rot and damping off	Captan	2.5 tsp/1 lb seed	Mix thoroughly in paper bag or glass jar.
Cabbage, Broccoli, Brussels Sprout, Cauliflower, Turnips, Kale, Collards Black leg, Black rot	copper	2.0 tbsp	Use western-grown, hot-water treated seed. Use resistant varieties for black rot control. Apply copper at 7- to 10-day intervals. Copper sprays may reduce spread of blackrot.
Club root	PCNB	1.0 tbsp	Apply in transplant water. Use 0.5 pt per plant. Thoroughly mix with the soil.
Downy mildew, *Alternaria* leaf spot	chlorothalonil 12.5% chlorothalonil 30% copper	2.5 tbsp 1.0 tbsp 1.0 tsp	Begin when disease threatens and reapply every 7 days. Do not spray copper when plants are stressed.
Seed rot and damping off	Captan	0.5 tsp/1 lb seed	Mix thoroughly in paper bag or glass jar.
Carrots Leaf Blight	chlorothalonil 12.5% chlorothalonil 30% copper	2.5 tbsp 1.0 tbsp 2.0 tbsp	Start applications when disease threatens and reapply every 7 to 10 days if needed.

[1]PHI = post-harvest interval and indicates the number of days before harvest that the last fungicide application can be made.

Table 2.4 - Disease Management Tools for Specific Crops and Diseases (cont.)

Crop Disease	Treatment (PHI)[1]	Rate/Gal. (Unless otherwise Stated)	Remarks
Celery Bacterial Blight	copper	2.0 tbsp	Apply at first sign of disease; reapply every 7 to 10 days.
Cercospora (Early Blight)	chlorothalonil 12.5% (7) chlorothalonil 30% (7) copper	3.0-4.0 tbsp 1.0 tbsp 2.0 tbsp	Apply at first sign of disease; reapply every 7 days.
Septoria (Late blight) or Stalk rot (*Rhizoctonia*)	chlorothalonil 12.5% (7) chlorothalonil 30% (7)	3.0 tbsp 1.0 tbsp	Apply at first sign of disease; reapply every 7 days.
Cucurbits (Cucumbers, Summer Squash, Cantalopes, Pumpkins) *Alternaria* leaf spot; Anthracnose; Downy mildew; Gummy stem blight	chlorothalonil 12.5% chlorothalonil 30% mancozeb (5) copper	2.0-3.0 tbsp 1.0 tbsp 2.0 tbsp 2.0 tbsp	Apply at first sign of disease or after runners are formed and reapply every 7 days. Shorten the spray interval to 5 days if disease pressure is high.
Angular leaf spot (cucumbers only)	copper	1.0-2.0 tbsp	Apply at first sign of disease and reapply every 7 days. Copper may injure some young plants.
Belly rot (*Rhizoctonia*)-suppression only	chlorothalonil 30%	1.0 tbsp	Use mulch to keep fruit off soil surface. For plants in bare soil, begin when plants are in first true leaf stage. Apply during wet soil conditions.
Powdery mildew	chlorothalonil 12.5% chlorothalonil 30% copper Neem Oil potassium bicarbonate	3.0 tbsp 1.0 tbsp 2.0 tbsp 2.0 tbsp 2.0 tbsp	Begin at first sign of disease. Reapply every 7 days. Shorten interval if disease is severe.
Seed rot and damping off (melons and squash)	Captan	0.5 tsp/1 lb seed	Mix thoroughly in paper bag or glass jar.
Irish Potatoes Early blight, late blight, and *Botrytis* vine rot	chlorothalonil 12.5% chlorothalonil 30% mancozeb (14) copper	2.0 tbsp 1.5 tbsp 2.0 tbsp 2.5 tbsp	Apply at first sign of disease and reapply every 7 days.
Onion Bacterial Soft rot	copper	2.0 tbsp	Apply during extended periods of wet soil. Reapply every 7 days up to harvest.
Onion (dry bulb) *Botrytis* leaf blight, Downy mildew, Purple blotch	chlorothalonil 12.5% (7) chlorothalonil 30% (7)	2.0 tbsp 1.0 tbsp	Apply at first sign of disease and reapply every 7 days. Do not apply to exposed bulbs.
Onion (green bunching), leeks, shallots	chlorothalonil 12.5% (14) chlorothalonil 30% (14) copper	2.0-4.0 tbsp 1.0 tbsp 2.0 tbsp	See above. Do not apply chlorothalonil more than 3 times per season and maneb more than 7 times per season.
Peas Powdery mildew and Bacterial blight	copper Neem Oil	2.0 tbsp 2.0 tbsp	Apply at first sign of disease and reapply every 7 days up to harvest.
Seed rot and damping off	captan	0.5 tsp/1 lb seed	Mix thoroughly in paper bag or glass jar.
Peppers Anthracnose, fruit rot			Begin when fruit are half size. Spray on a 7- to 10-day interval.

[1]PHI = post-harvest interval and indicates the number of days before harvest that the last fungicide application can be made.

Table 2.4 - Disease Management Tools for Specific Crops and Diseases (cont.)

Crop Disease	Treatment (PHI)*	Rate/Gal. (Unless otherwise Stated)	Remarks
Bacterial spot and *Cercospora* leaf spot	copper	2.0 tbsp	Apply at first sign of disease and reapply every 7 days up to harvest.
Phytophthora blight	No chemicals registered		Avoid planting in low land. Grow resistant varieties, 'Paladin' or 'Aristotle'.
Southern Blight	PCNB	1.0 tbsp	Apply at transplant. Apply 0.5 pt/plant.
Sweet Corn Bacterial wilt	No chemicals registered		Plant resistant varieties. Spray with approved insecticide to control flea beetles.
Leaf blight, Rust	chlorothalonil 12.5% (14) chlorothalonil 30% (14) mancozeb (7)	1.0-2.5 tbsp 1.0 tbsp 1.5 tbsp	Apply after observing disease and reapply every 7 days.
Tomato Early blight, late blight, *Septoria* leaf spot, gray mold, Anthracnose and *Rhizoctonia* fruit rot	chlorothalonil 12.5% chlorothalonil 30% mancozeb (5) copper	3.0-4.0 tbsp 1.0 tbsp 3.0 tbsp 2.0 tbsp	Repeat at 7- to 10-day intervals throughout the season. Under severe conditions shorten spray intervals.
Bacterial spot and speck	copper	2.0 tbsp	Apply after observing disease and reapply every 7 days.
Fusarium wilt and *Verticillium* wilt			Use resistant varieties. Maintain soil pH from 6.5-7.0. Rotate out of area.
Southern Blight	PCNB	1.0 tbsp	Apply at transplanting. Apply 0.5 pt/plant
Watermelon Anthracnose, gummy stem blight, *Alternaria* leaf blight, downy mildew and powdery mildew	chlorothalonil 12.5% chlorothalonil 30% mancozeb (5) copper Neem Oil (powdery mildew)	3.0-4.0 tbsp 1.0 tbsp 2.0 tbsp 2.0 tbsp 2.0 tbsp	Apply at first sign of disease or when runners meet within the row and reapply every 7 days. Shorten interval under severe conditions.

[1]PHI = post-harvest interval and indicates the number of days before harvest that the last fungicide application can be made.

Table 2.5 - Nematode Disease Control in Home Vegetables

Nematode	Remarks
Root knot and other plant parasitic nematodes	Plant parasitic nematodes may cause reduced yield and stunted or weakened plants. There are no chemical controls for nematodes in home gardens. Root knot nematodes cause galls to form on roots. They are soil-borne and are difficult to control. The host range of the root knot nematode is very broad, so using crop rotation to control them is challenging. Several tactics can be implemented to minimize nematode problems in the home garden. 1) Avoid transporting nematodes to new areas on tillers, tools, soil, plant debris, etc. 2) Early, cool season crops are generally less affected by root knot nematode, because populations of nematodes are lower in the early part of the growing season. 3) Consider using certain cover crops that can reduce nematode populations, e.g. cover crop radish. 4) Control weeds, which may harbor nematode populations. 5) Ideally, the whole garden should be rotated to a different area each year, with any known nematode-infested areas being used only once every three years; however, this is impractical for most situations. Alternatively, rotating crops among plant families within a vegetable garden will minimize the chance of nematode problems. For example, rotate solanaceous crops with cucurbit crops, solanaceous crops with cruciferous crops, etc. 6) Incorporate hardwood leaf litter mulch into soil to increase beneficial fungi that kill nematodes and to increase tannins that inhibit nematode reproduction. Increasing the amount of organic matter in the garden soil is generally a good approach. 7) Root knot-resistant cultivars are available for tomato. These varieties are usually designated by the letters "VFN" after the variety name (the "V" designates Verticillium wilt, the "F" Fusarium wilt and the "N" root-knot nematode). 8) Consider using grafted transplants that possess rootstocks resistant to root-knot. These are new additions to the homeowner/garden arena and some rootstocks can offer resistance to other soilborne diseases. Both already-grafted transplants and transplanting kits for do-it-yourself grafting are available.

Weed Management in Home Vegetable Gardens

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Overview

Weed management is necessary in vegetable gardens. Weeds compete with vegetable crops for water, nutrients, and light, and can harbor insect and disease pests. Start a weed control program before planting and then continue weeding throughout the growing season. Keeping weeds down early in the season, when they are small, reduces the amount of hand weeding required later in the summer when higher temperatures and humidity make this task more difficult. Weeds are difficult to eradicate. Their seeds can remain dormant but viable for five, 10, 20, or more years in the soil, depending on species. Control weeds in areas near the garden to limit the movement of weed seed or weed propagules into the garden. Prevent weeds from flowering, as this helps reduce the amount of weed seed in the soil over time.

Cultural control of weeds in vegetable gardens is preferred because there are few chemical control options. Not many herbicides can be applied to a wide range of vegetables. For information related to larger areas planted with an individual vegetable species, such as a planting of an acre or more, consult the Commercial Vegetable Production Recommendations guide (Va. Coop Ext. Pub. 456-420).

General Cultural Controls

Winter cover crop: Plant rye, annual ryegrass, or other cover crops in the fall after the final harvest. Till the cover crop into the soil in spring prior to planting vegetables.

Cultivation/Hoeing/Hand weeding: Tilling the garden in spring controls winter annual weeds like common chickweed and controls or suppresses perennial weeds. Troublesome perennial weeds like bermudagrass, quackgrass, yellow nutsedge, and other creeping perennials need repeated tilling. Hoe weeds out of the alleyways between vegetable rows. Cut annual weeds at or slightly below the soil surface to minimize soil disturbance. Deeper hoeing brings weed seed from greater depths in the soil to the surface where they can germinate. Controlling weeds prior to flowering reduces weed populations in future years by depleting the weed seed reservoir in the soil.

Organic mulches: Pine bark, pine straw, sawdust, and grass clippings are good mulching materials. Do not use grass clippings from a lawn or pasture that has been recently treated with an herbicide, especially herbicides used for controlling broadleaf weeds. Monitor soil fertility, as nitrogen tie-up can occur when using mulches like sawdust. Organic mulches conserve soil moisture and cool the soil. Spread mulch two to four inches deep. Place newspaper on the soil surface prior to applying mulch in order to suppress weeds. Organic mulches suppress or control annual weeds but will not control perennial weeds. Use mulches that are free of weed seed and that do not have a rotten egg or ammonia odor. Improperly composted mulch can have a low pH and contain chemicals that injure crop plants.

Synthetic mulches: Using solid black plastic or a landscape fabric improves weed control compared to mulch alone. Solid black plastic is more effective for weed control than the available landscape fabrics but water cannot pass through it. Place drip irrigation under solid black plastic to allow water to reach plant roots. Landscape fabrics allow for air and water movement but weed roots and/or shoots can penetrate through openings in the material. Place plastic or fabric on the soil surface and then cut an X or a hole into the material to transplant plants or vegetable seeds. One can place organic mulch over these materials; however, weeds may germinate in the mulch layer and then send roots through the fabric to the soil below. Black plastic and landscape fabrics control annual weeds and suppress perennial weeds like yellow nutsedge.

General Biological Controls

There currently are no biological control options for weed control in vegetable gardens.

General Chemical Controls

Organic

Postemergence: Acetic acid (Weed Pharm 20% acetic acid or other labeled formulation). Contact nonselective herbicide. Do not use unlabeled forms of acetic acid. Wear eye protection, a long-sleeved shirt, long pants, shoes, socks, and waterproof gloves since this product is corrosive. Cover the weed foliage thoroughly. Treat weeds when small, as large annual weeds may require retreatment. Perennial weeds need retreatment, as this is a contact herbicide and does not affect underground plant parts such as roots, bulbs, and rhizomes. Keep the spray off the foliage and stems of desired plants by using a shield. No residual control.

Conventional

After final harvest in fall or prior to planting: Glyphosate (Roundup and other trade names). Apply at least one week before planting. Rinse glyphosate off plastic prior to transplanting vegetables through the black plastic or do not use glyphosate at all when using plastic mulch. Use glyphosate to control perennial weeds like bermudagrass, quackgrass, and horsenettle. Apply to weed foliage before frost, when the weeds are still actively growing.

At planting: Trifluralin (Preen Garden Weed Preventer, Miracle-Gro Garden Weed Preventer, or other labeled formulation). Apply at seeding of broccoli, Brussels sprouts, cabbage, carrots, cauliflower, celery, collards, black-eyed peas, field peas, garden peas, lima beans, mustard greens, snap beans, and turnip greens. Apply before transplanting celery, broccoli, Brussels sprouts, cabbage, cauliflower, eggplant, peppers, onions, and tomatoes. Apply to established cantaloupe, cucumber, and watermelon that have at least four true leaves. Apply to established asparagus prior to spear emergence. Apply after planting potatoes. Trifluralin will not control existing weeds. It does provide preemergence control of annual grasses like crabgrass, foxtail, and goosegrass, and small-seeded broadleaf weeds like purslane and pigweed.

Perennial weeds

Perennial vines and weeds (bermudagrass, poison ivy, dock, honeysuckle, etc.) around the garden borders or in the tilled area may be controlled with a postemergence application of glyphosate (Roundup or other labeled formulations) after completion of the summer vegetable harvest. For small areas or individual weed treatments, the Roundup formulation is packaged in small quantities suitable for home use and does not require special sprayers. Many of the perennial weeds are more effectively controlled when treated in late summer or fall before frost causes the leaves to drop. Since glyphosate is not biologically active in the soil, it cannot result in residue problems.

Do not spray vegetables with a sprayer that has been used to apply 2,4-D or other broadleaf herbicides to turfgrass.

Index

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

R

S

T

V

W

Y