

Managing

Insect and Mite Pests in Vegetable Gardens



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Vegetable gardening can be an entertaining pastime and a source of fresh, homegrown produce. Producing your own vegetables adds to the enjoyment of consuming them and may also be cheaper than purchasing produce.

However, growing your own vegetables can be challenging. One of the challenges is successfully dealing with pests, especially insects. This publication discusses some of the management alternatives that vegetable gardeners can use to deal with insects and other pests and provides information on insecticides that are registered for use in home gardens.

Understanding Insects

Although there are about 30,000 species of insects in Texas, fewer than a hundred are routine pests in vegetable gardens. Actually, most insects in gardens are either incidental or beneficial organisms that contribute to pollination, the balance of nature or recycling of organic matter. A garden with an abundant supply of insects may actually be quite healthy and productive. However, some pest species can reduce the quantity and/or quality of the vegetables produced or transmit plant diseases from one plant to another. Consider control measures when insects threaten a garden.

Identify the insects in your garden to determine whether they are beneficial or pest species. Learn to recognize the common insects in your area, especially the common pests, and the signs of pest damage, and inspect your garden at least once per week to detect pests.

Insect pests can enter vegetable gardens by walking or flying. Flight especially allows many insects great mobility, and their movement in large numbers is possible. Moreover, certain pests such as aphids and mites have a short gen-

eration time, about a week under good conditions, and their numbers can increase rapidly. When pests seem to appear in large numbers almost overnight, they have either flown in or are reproducing rapidly.

As insects grow, they change size and shape. This process is called metamorphosis. Some insects damage plants in both the immature and adult stages. Because insects change form, they may be difficult to identify and their damage may change with them. Small caterpillars may barely scrape the surface of a leaf, while larger caterpillars may eat great chunks of leaves.

An insect's mouthparts often determine the type of damage expected from a pest. Insects with sucking mouthparts feed by piercing leaves or fruit. Damage appears as pock marks or mottled leaves. Insects with chewing mouthparts chew holes in plant tissue. Recognizing how an insect feeds also helps a gardener select the proper insecticides — stomach poisons for chewing insects or contact poisons for sucking insects.

Plan Ahead

When planning a vegetable garden, anticipate the pests that may occur later. Consider the management practices for specific pests before they become a problem. Implement the management plan in plenty of time to deal with the pest problems. Use past experience as a guide to anticipating pests for the upcoming season.

Integrated Pest Management

Integrated pest management — IPM — is a philosophy of managing pests by using a combination of control techniques. IPM balances the goals of economic production and environmental stewardship when implementing control practices. IPM is the overriding strategy for

most of production agriculture today, and it is rapidly being adopted in urban environments as well.

Monitoring or scouting crops for the presence and abundance of pests is an important part of IPM. IPM programs typically reserve the use of insecticides for situations where a pest is known to be present and the numbers are high enough to justify the cost of control practices.

Although many other insect control practices can be implemented as part of an IPM program, the use of insecticides is generally included as a control option. When alternate control practices are substituted for insecticides, the IPM approach is much like organic gardening.

Many of the control practices available for home vegetable gardeners are categorized in the following sections.

Cultural Control

Cultural control consists of physical garden management practices that reduce pest impact. This may include crop rotation, cultivation, weed management, water management and proper fertilizer use. For some pests, it is effective to interrupt the life cycle of the pests by leaving acreage fallow for a period or by rotating crops. Always remove plant debris from a garden area because it can harbor pests. Control weeds because they can attract insects that may feed on vegetables. Some pests of landscape plants may also move into vegetable gardens.

Host Plant Resistance

Vegetable varieties differ in susceptibility to insect pests, a response called host plant resistance (HPR). Resistance can be expressed as tolerance, non-preference or antibiosis. Tolerance is the ability of a plant to grow and produce even with insect damage. Non-preference is exhibited when an insect chooses to feed on or lay eggs on alternate varieties or host plants. Antibiosis is the ability of a plant to kill or slow development of a pest, usually with chemicals that occur naturally in the plant.

Extensive trials are needed to understand the HPR of vegetables. Most variety selection emphasizes other factors, such as appearance, taste and production volume. HPR status of

many modern varieties is not well known because of the need to test new varieties as they become available in the marketplace.

Recently, researchers have altered the genetic material of some field crops and vegetables such as tomatoes, potatoes and corn. These are called transgenic plants. Dramatic results can be achieved when genes for resistance to insects are incorporated in the new varieties. Most of the insect-resistant transgenic vegetable varieties incorporate genes of the bacteria, *Bacillus thuringiensis*, making them resistant to caterpillar pests. This resistance is an antibiosis effect that inhibits the growth of caterpillars on these plants. Resistant transgenic vegetable varieties are expected to become increasingly available to homeowners.

Biological Control

Biological control is the use of one organism to control another. Three approaches to biological control have been successfully implemented: importation, conservation and augmentation. Importation requires bringing a parasite or predator from a foreign country into our country to control a pest species. Importation is highly regulated and is generally beyond the scope of home vegetable gardeners, although we all benefit from importation programs performed by research groups.

The conservation approach to biological control is encouraging natural enemies that are already present in an area. Conservation methods are useful in home gardens. They include planting nectar-producing flowers that provide food for parasites and avoiding unnecessary pesticide applications. Conservation also includes selecting pesticides that are toxic to a pest but relatively non-toxic to beneficial insects.

Augmentation is the release of additional predators and parasites, such as ladybird beetles, preying mantids and parasitic wasps, into the natural populations of biological control organisms. However, many of these organisms occur naturally in the environment, and any additional benefit from such releases may be marginal. There are many commercial sources of biological control agents.

Biological control should not be considered an instant solution to pest problems. Generally, a sound biological control program needs to be

supported by careful study. Proper identification of pests, careful selection of beneficial organisms and increased monitoring are all necessary for success. Biological control solutions cannot be implemented for all pest situations because biological control agents are not available for every pest.

Mechanical Control

Mechanical control is the use of physical means to reduce the number of insects or their damage. Mechanical methods include the use of barriers, covers, high pressure water sprays and hand picking of pests.

Barriers come in many shapes and sizes to prevent the movement of pests onto plants. Cardboard or plastic cylinders around the base of transplants are an example of a type of barrier that discourages cutworms and other soil inhabiting pests from attacking transplants. Cloth or plastic screening can prevent the invasion of pests into a newly planted garden. Screening may raise the temperature of a planting bed, often an additional benefit. Screening is most useful for young plants and seedlings that are most susceptible to pest attack.

High pressure water sprays are another mechanical control method. These are most effective against small, soft-bodied pests such as aphids. High pressure water sprays may help remove webbing, dissolve droppings and reduce the number of pests in a short time. This is one of the few options available when vegetables are near harvest.

Hand picking and destroying some pests may be feasible in small gardens. Hand picking can be successful for tomato hornworms and squash bugs if persistently done. Obviously, hand picking is more feasible for large insects than for small insects.

Chemical Control

Pesticides come in many forms and provide a wide array of tools for pest management. Pesticides are regulated for safety by the Environmental Protection Agency, and the sale and use of these products is regulated by the Texas Department of Agriculture. These agencies do not consider efficacy ("how well it works") in the registration process but safety issues only.

Labeled insecticides may or may not be effective in killing pests that are mentioned on a product label. The number of products available for use in home vegetable gardens and the rapid turnover in the market makes it difficult to know the efficacy of products available to gardeners. The response of pests can also change as they become tolerant or as environmental factors interact with a chemical. Furthermore, pesticides may fail because a user did not read the label and/or calibrate the application equipment and, consequently, applied the wrong amount of product.

The USER is always the person responsible for the proper use of any pesticide. It is illegal to use a product in a manner or situation that is not defined on a pesticide label.

Product labels may carry a number of restrictions that must be considered by the user. Labels include limits on product rate, number of applications per season, specific crops, method of applications, days from last application to harvest and other items. There are numerous trade names for generic insecticides, and special restrictions may be noted on a specific label. Be sure to read the label for additional restrictions and follow the directions carefully.

The EPA approves pesticides for use on a particular crop after examining safety data. If a crop is not listed on a product label, the pesticide cannot be considered safe for use on that crop. A summary of the chemicals available for use in home gardens is included as Table 1. This list was prepared from product labels and not all products have been examined by the Texas Cooperative Extension. Product labels also bear a suggested list of target pests. Table 2 lists the product labels that were reviewed to develop the information in this guide. It includes most of the common active ingredients available for use in home gardens. Use this list as a guide when purchasing products to use in home vegetable gardens.

Pesticide registration status changes rapidly. Since the last printing of this guide, products containing dicofol (Kelthane®), endosulfan (Thiodan®), chlorpyrifos (Dursban®), dimethoate (Cygon®), lindane and methoxychlor have all been discontinued for home vegetable garden use. Products containing diazinon are being

phased out, and the status is changing. At the time of printing, diazinon can be sold through retail outlets until December 31, 2004. Due to the changes in the registration status of diazinon, it has been left out of Table 1. In most cases, products are phased out with dates to stop wholesale sales and later dates to stop retail sales. Usually there are provisions to allow the homeowner to use products they have in stock beyond those dates.

Pesticides vary widely in their hazard to humans and the environment. The key words on a label — CAUTION, WARNING and DANGER — indicate product toxicity. Use this information on a product label as a guide to product use and potential hazard. Most of the products mentioned here bear the CAUTION safety word on the label.

Insecticide products can also be categorized by their compound class. Insecticide classes provide a key to understanding the mode of action of the product and thus the pests that are most likely controlled by the product. When insect control is unsatisfactory, it is wise to change to a product from another compound class (See Table 3).

Less Toxic Approaches

Many gardeners prefer to use less toxic approaches to manage insects rather than standard insecticides. Less toxic approaches range from selecting "soft" insecticides to natural control with no action. There are increasingly more products available for use by organic gardeners than ever before. Some of the less toxic products are included in this guide if they are registered and sold as pesticides.

Less toxic chemicals are becoming available under different legal registrations. Chemicals listed in the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) EPA Title 40, Chapter 1, Subchapter E, Part 152.25 are considered "minimum risk pesticides" and are exempt from FIFRA registrations. This includes cedar oil, citric acid, citronella, cloves, garlic, lemongrass oil, mint, peppermint, rosemary, thyme, white pepper and several other products. For a complete list of these products see FIFRA. These products may be sold as repellents, e.g., Garlic Barrier® and Hot Pepper Spray® (capsaicin).

Some products have very broad site and pest combinations on the product label. For example, the product label might say just "pests" on "vegetables." Some products with very broad site/pest statements are Green Light® Tomato & Vegetable Spray Ready-to-Use (neem oil), Green Light® Neem Concentrate (neem oil), Green Light® Neem II Ready-to-Use (neem oil and pyrethrins) and the Green Light® Biogonic series.

Putting It All into Practice

Plant a Garden of Manageable Size

Garden size directly affects control methods that work for individual plants or small gardens. Removing pests by hand and swabbing pests with alcohol may not be feasible in larger gardens. The larger the garden, the greater the need for insecticides.

Leave the Garden Fallow for a Time Before Plantings

Insect pests such as white grubs, wireworms and cutworms overwinter in the soil and feed on abandoned plants or weeds. Removing these food sources during the off season reduces pest numbers before spring planting.

Good Sanitation

Remove dead leaf piles, boards, railroad ties and other objects where pests such as cutworms, slugs, snails, pillbugs and sowbugs congregate. Mulches help maintain moisture and provide shelter for spiders and predatory insects. However, mulch also provides shelter for pests.

Select Pest-free Transplants

Inspect plants at the store to be sure they have no pests. Most common insect and mite pests can be found on the under surfaces of leaves. Purchase only healthy, pest-free transplants.

Select Pest-Resistant Vegetable Varieties

Some vegetable varieties are unattractive to or resistant to certain pests. Planting resistant varieties adapted to your area can dramatically reduce the need for insecticides. For example, the sweet corn variety "Seneca Sentry" is resistant to corn earworms and is adapted to central Texas. The leaves that wrap around the corn ear tip in this variety are much tighter than in more susceptible varieties. Unfortunately, the pest

resistance status of only a few vegetable varieties is known.

Practice Good Horticultural Methods

- *Properly prepare the soil before planting.* Tilling the soil thoroughly will kill many soil insects and provide good growing conditions for seedlings and transplants. Healthy plants will be less susceptible to severe pest damage. The composition of the soil and spring growing conditions (weather) also affect pest populations. Soils with high organic matter are more likely to support white grubs, root maggots, pillbugs and sowbugs, even though these soils may promote better plant growth.
- *Keep a weed-free garden.* Weeds supply food for insect pests, compete with vegetable plants for soil nutrients and water and can decrease vegetable yield considerably. Keep weeds out of the garden and grass mowed short around the garden to discourage insects such as grasshoppers and armyworms from moving in.
- *Fertilize properly.* Plants need adequate nutrients to grow well. Without them, plants may be slow growing, stunted and more susceptible to pest damage. However, too much fertilizer can produce lush green plants that attract insects such as aphids. A soil test will tell you which nutrients may be lacking and which are at adequate levels for good plant growth.
- *Water properly.* Either too much or too little water can be unhealthy for plant growth. Drought-stressed plants are more likely to attract spider mites.

Inspect Plants for Pests and Properly Identify Them

Learn to identify the various insects and other creatures encountered in the garden. Many of them are actually beneficial. County Extension agents can help identify plant pest problems. Avoid treating undiagnosed problems.

Pests attack garden plants from seed to maturity. Inspecting plants weekly or more often helps detect pest infestations early, monitor natural enemies and evaluate the effects of control tactics. Check the undersides of leaves for aphids, whiteflies, spider mites and egg clusters of pests

such as armyworms, Colorado potato beetles and squash bugs. To detect low populations of spider mites and thrips, beat plants on a piece of off-white paper. The pests can be seen and identified on the paper. Although yellow sticky cards are occasionally promoted as insect control devices, they are best used to monitor pest activity. These cards attract the winged adult stages of aphids, leafminers, thrips, whiteflies and a wide variety of flies. Cards should be inspected and replaced regularly so that pests can be detected early and their numbers monitored. Sex-attractant chemicals called pheromones are also available commercially to monitor many insect pests, especially moths.

Consider All Pest Suppression Methods

When a pest outbreak occurs, consider how it might have been prevented and the best method of reducing pest numbers to a tolerable level. Some mechanical suppression methods include:

- *Reflective mulches.* Highly reflective mulches such as foil paper slow infestation by some pests such as aphids.
- *Barriers.* Young plants or transplants are vulnerable to attack by cutworms, sowbugs or pillbugs. They can be protected by placing a barrier around the base of each plant. Barriers can be made of cardboard, plastic or metal cans with the bottoms cut out.
- *Screens over the garden.* Fine mesh screens or fabrics can provide a barrier that even tiny insects such as thrips cannot cross. Several products are available to cover and protect crops. This method works best in early spring or fall when frost is possible. When barriers are properly maintained, insects can be excluded. However, plants should still be monitored regularly, which requires removing the barrier. The temperature inside barriers often exceeds that outside, so remove them before plants experience heat stress.
- *Cages and trellises.* Plants growing on the ground are susceptible to soil pests. Vine plants such as cucumbers and even tomatoes are easier to manage when grown in trellises or cages. It is easier to monitor pests and spray plants when they are held off the ground.
- *High pressure water sprays.* Small pests such as aphids and spider mites can be dislodged from

plants with high pressure water sprays directed to the undersides of leaves. Although commercial spray devices are available (Water Wand® and Jet-All Water Wand®), similar devices also can be made at home. Take care not to harm the plant or distribute pests around the garden. Repeated treatments may be needed to keep pest numbers low.

Conserve Natural Enemies and Protect Bees

The first line of defense against insect pests is their natural enemies. Spiders, praying mantids, lady beetles, ground beetles, green lacewings, ambush bugs, assassin bugs, minute pirate bugs and even some wasp species prey upon insects. However, the most effective natural enemies are the tiny parasitic wasps and parasitic flies, bacteria, fungi and viruses that are rarely observed with the naked eye.

Whether naturally occurring or released into the garden, these organisms should be preserved and encouraged to thrive. Use pesticides only as a last resort; allow natural enemies an opportunity to suppress the pest infestation. If a pesticide is required, select the least toxic, most target-specific pesticides that decompose quickly in the environment.

Natural enemies can be released in the garden to control pests. Lady beetles and green lacewing larvae eat aphids and whiteflies, predatory mites eat two-spotted spider mites, and certain wasps parasitize some insect pests (*Trichogramma* species develop inside caterpillar eggs and *Encarsia* species develop inside immature whiteflies). Companies that sell these natural enemies do not guarantee the results, particularly in outdoor sites. Factors such as the number of pests present, the environment, timing of releases, prior pesticide use and the presence of ants can affect such releases. Parasitic nema-

todes (Biosafe 100® and other products containing *Steinernema carpocapsae*) are available to control a wide variety of vegetable garden soil pests.

Bees are necessary for pollinating vegetables such as cucumbers, pumpkins, squash and melons and should be protected. Don't apply pesticides while bees are active during the day. Instead, treat plants early in the morning or late in the afternoon. Avoid using products or formulations highly toxic to bees. If a bee hive is located nearby, cover it during pesticide application or arrange to have the hive protected from pesticide drift.

Apply Pesticides Only When Justified

If a pest population becomes too damaging and other control measures have failed, a pesticide may be required. Pesticides are regulated by law and must be applied strictly according to label directions. Pesticides can be toxic and must be used carefully to reduce the risk of negative side effects.

To control leaf-feeding insects effectively, a pesticide must thoroughly cover the undersides of leaves. This is difficult to do with dust-formulated products. When using liquids (emulsifiable concentrates, wettable powders), mix the directed amount with water and spray immediately. Alkaline water will decompose the active ingredients of some products if the solution is allowed to stand. Agitate the mixture while treating. If spray droplets bead up and roll off the treated foliage, a spreader-sticker may be necessary. After treatment, clean the sprayer thoroughly, store pesticides properly and wash protective clothing separately from other laundry. Proper disposal of left-over pesticides and "empty" or used containers is an essential step in safe pesticide use.

POLICY STATEMENT FOR MAKING CHEMICAL CONTROL SUGGESTIONS

Texas Cooperative Extension bases its suggestions for pesticide use on:

- Product registration status
- Avoidance of residues in excess of allowable tolerances
- Avoidance of toxicity to desirable vegetation and animals, and to humans
- Avoidance of adverse side effects to beneficial predators and parasites, honeybees, fish and other wildlife, plants, animals and humans.

Suggested pesticides must be registered and labeled for use by both the Environmental Protection Agency and the Texas Department of Agriculture. The status of pesticide label clearances is subject to change and may have changed since this publication was printed. County Extension agents and appropriate specialists may have information about the label status of products.

Natural Enemies of Common Garden Pests*



Trichogramma wasp



Syrphid fly



Minute pirate bug



Big-eyed bug



Damsel bug



Green lacewing



Convergent lady beetle

*Diagrams are not to scale.

Table 1. Registered Pesticides for Use on Home Garden Vegetables and Common Insect Pests.

Only some of the more common pests and vegetables are listed herein.

NA — no specific pre-harvest interval information was found on the label.

P — the application is a pre-plant soil application. Such applications are generally for pests in the soil.

PHI — pre-harvest interval or the time from last application to harvest in days.

Product labels found in trade channels were the primary source of information in this table. This includes many, but not all, of the products available to the home vegetable grower. Table 2 lists the products reviewed during preparation of the guide. Only a few products with a mixture of two or more active ingredients were reviewed. Multiple active ingredients complicate the summary so these were not included in this table.

The column “Registered Pesticides” lists the common name of the chemicals that have that particular vegetable listed on the label. “Pesticides Registered by Pest” is similarly the pesticides that show that pest on the label. **The user should be aware that the pesticide may not specifically state the combination of commodity and pest on a particular label. The user is responsible for reading the label and following directions on the label.**

Pests sometimes have several common names. Additional names for the same pest are given in parenthesis. Some labels show a general common name for a pest group. This group is listed under the pest name, and specific examples are listed after the colon. In a few cases, the adult and immature form have different common names and control measures. The control measures for each stage are indicated in the table or both names are listed separately with different control measures. An example is cucumber beetles where

immatures are called rootworms. This example actually includes several species that can be damaging in Texas with adults that feed on flowers and larvae that feed on roots.

General and Additional Pests

Ants — Several ant species can be found in vegetable gardens. Fire ants and Texas leafcutting ants are the most severe pests. Control ants outside the garden if possible, preferably with bait formulations or individual mound treatments. In the garden, use a mound drench of boiling water if this is feasible. Never use an ant treatment in a vegetable garden if vegetables do not appear on the product label.

Snails and slugs — Products containing metaldehyde are the primary control measures for snails and slugs. These products are typically granular baits, meal or pastes. Some snail and slug baits contain carbaryl and include other pests on the label. Iron phosphate is another active ingredient in some snail and slug baits.

Grasshoppers and crickets — Grasshoppers and crickets may move into gardens rapidly, especially when winged. When these pests are abundant, protecting foliage with an insecticide may not be very successful. Insecticides like carbaryl are generally preferred. Bait formulations with carbaryl and metaldehyde are available for this situation. Treating the premises outside of the garden may help. Use barriers to protect the most valuable plants.

Sowbugs, pillbugs, millipedes, centipedes, mole crickets, root maggots, white grubs, wireworms, cutworms and earwigs are considered soil pests. These pests typically have been controlled with pre-plant treatments of insecticides such as diazinon incorporated into the soil. Some formulations of synergized pyrethrins and carbaryl are labeled for many of these pests. Some baits may also list these pests on the label. No home vegetable pesticide products were found with white grubs or wireworms on the label except diazinon.

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
asparagus	<i>Bacillus thuringiensis</i> (0) carbaryl (1) insecticidal soap (0) malathion (1) permethrin (3) petroleum oil (0) pyrethrins (0) rotenone (1) sulfur (NA)	asparagus beetles	carbaryl malathion permethrin pyrethrins rotenone
		cutworms	<i>Bacillus thuringiensis</i> carbaryl permethrin
beans Comments: Pesticide restrictions are often different between succulent beans and dried beans. Read the label to check the restrictions.	azadirachtin <i>Bacillus thuringiensis</i> (0) carbaryl (0-3) (14-21 dry beans) disulfoton (P) endosulfan (3) esfenvalerate (3) (21 dry beans) insecticidal soap (0) malathion (1)	aphids: pea aphid	azadirachtin carbaryl disulfoton endosulfan esfenvalerate insecticidal soap malathion permethrin petroleum oil pyrethrins rotenone

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
beans (continued)	permethrin (3) petroleum oil (0) pyrethrins (0) rotenone (1) spinosad (3) sulfur (NA)	beetles: yellow-margined leaf beetle	azadirachtin carbaryl disulfoton endosulfan esfenvalerate insecticidal soap malathion permethrin petroleum oil pyrethrins rotenone spinosad
		blister beetles	endosulfan pyrethrins
		cabbage looper	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin pyrethrins rotenone
		corn earworm (tomato fruitworm bollworm, soybean podworm)	<i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate permethrin pyrethrins
		cucumber beetles	carbaryl endosulfan malathion permethrin pyrethrins rotenone
		cutworms: black cutworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate permethrin
		European corn borer	<i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate permethrin

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
beans (continued)		flea beetles	azadirachtin carbaryl disulfoton endosulfan esfenvalerate insecticidal soap malathion permethrin pyrethrins rotenone
		leafhoppers	carbaryl disulfoton endosulfan esfenvalerate insecticidal soap malathion permethrin petroleum oil pyrethrins rotenone
		leafminers: serpentine leafminer	azadirachtin disulfoton esfenvalerate malathion permethrin petroleum oil rotenone spinosad
		Mexican bean beetle	azadirachtin carbaryl endosulfan esfenvalerate malathion permethrin pyrethrins rotenone spinosad
		mites: spider mites	azadirachtin carbaryl endosulfan esfenvalerate malathion permethrin pyrethrins rotenone
		plant bugs	carbaryl endosulfan esfenvalerate insecticidal soap permethrin

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
beans (continued)		plant bugs (continued)	petroleum oil pyrethrins rotenone
		saltmarsh caterpillar	<i>Bacillus thuringiensis</i> carbaryl esfenvalerate
		stink bugs	carbaryl endosulfan esfenvalerate insecticidal soap permethrin pyrethrins rotenone
		thrips: western flower thrips	azadirachtin carbaryl disulfoton insecticidal soap malathion petroleum oil pyrethrins rotenone spinosad
beets (roots and tops) Remarks: There are often differences in restrictions between table beets and beet greens.	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) carbaryl (3-7) (14 tops) insecticidal soap (0) malathion (7) petroleum oil (0) pyrethrins (1) rotenone (1) sulfur (0)	aphids	azadirachtin insecticidal soap malathion petroleum oil pyrethrins rotenone
		armyworms: beet armyworm	azadirachtin carbaryl pyrethrins
		flea beetles	azadirachtin carbaryl insecticidal soap malathion pyrethrins rotenone
		stink bugs	carbaryl insecticidal soap pyrethrins rotenone
		webworms: beet webworm, garden webworm	azadirachtin pyrethrins rotenone
Bok choy (see lettuce)			

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
broccoli (see cole crops)			
brussels sprouts (see cole crops)			
cabbage (see cole crops)			
cantaloupe (see melons)			
carrots	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) carbaryl (0-7) cyfluthrin (0) endosulfan (7) esfenvalerate (7) insecticidal soap (0) malathion (7) pyrethrins (1) rotenone (1) sulfur (NA)	cutworms: black cutworm	azadirachtin carbaryl cyfluthrin
		flea beetles	carbaryl cyfluthrin endosulfan esfenvalerate malathion pyrethrins rotenone
		leafhoppers	carbaryl cyfluthrin endosulfan esfenvalerate malathion pyrethrins rotenone
		mites: spider mites	endosulfan malathion rotenone
		weevils: carrot weevil	carbaryl cyfluthrin esfenvalerate rotenone
cauliflower (see cole crops)			
celery	<i>Bacillus thuringiensis</i> (0) endosulfan (7) insecticidal soap (0) malathion (7) permethrin (1-3) petroleum oil (NA) pyrethrins (0) rotenone (1)	aphids	endosulfan insecticidal soap malathion permethrin petroleum oil pyrethrins rotenone

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
celery (continued)	spinosad (1) sulfur (NA)	armyworms: beet armyworm	<i>Bacillus thuringiensis</i> endosulfan permethrin pyrethrins
		cabbage looper	<i>Bacillus thuringiensis</i> endosulfan insecticidal soap malathion permethrin pyrethrins rotenone
		corn earworm	<i>Bacillus thuringiensis</i> endosulfan permethrin pyrethrins
		cutworms: black cutworm	<i>Bacillus thuringiensis</i> permethrin
		leafhoppers	endosulfan insecticidal soap malathion permethrin petroleum oil pyrethrins rotenone
		leafminers: serpentine leafminer	insecticidal soap malathion permethrin
		mites: spider mites	endosulfan insecticidal soap malathion permethrin petroleum oil rotenone sulfur
		weevils: carrot weevil	permethrin rotenone
chives	<i>Bacillus thuringiensis</i> (0) insecticidal soap (0)		
cole crops: broccoli, brussel sprouts, cabbage, cauliflower, kohlrabi Remarks: Product labels vary greatly regarding crops on the label and PHI.	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) carbaryl (3) disulfoton (P) endosulfan (7-14) esfenvalerate (3) insecticidal soap (0) malathion (3-7)	aphids: cabbage aphid, poplar-petiole gall aphid	azadirachtin carbaryl disulfoton endosulfan esfenvalerate insecticidal soap malathion permethrin

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
cole crops (continued)	permethrin (1) petroleum oil (NA) pyrethrins (0) rotenone (1) spinosad (1) sulfur (NA)	aphids (continued)	petroleum oil pyrethrins rotenone
		armyworms: beet armyworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate permethrin pyrethrins
		cabbage looper	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin pyrethrins rotenone
		corn earworm (tomato fruitworm, bollworm, soybean podworm)	<i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate permethrin pyrethrins
		cutworms: black cutworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate permethrin
		diamondback moth	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate permethrin pyrethrins rotenone
		flea beetles	azadirachtin carbaryl disulfoton endosulfan esfenvalerate insecticidal soap malathion permethrin pyrethrins rotenone

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
cole crops (continued)		imported cabbageworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin pyrethrins
		harlequin bug	carbaryl endosulfan insecticidal soap malathion pyrethrins rotenone
		root maggots: cabbage maggot	carbaryl endosulfan malathion
		thrips: western flower thrips	azadirachtin carbaryl disulfoton insecticidal soap malathion petroleum oil pyrethrins rotenone spinosad
		weevils: vegetable weevil	azadirachtin carbaryl esfenvalerate permethrin rotenone
		whiteflies: sweetpotato whitefly	endosulfan esfenvalerate insecticidal soap petroleum oil pyrethrins rotenone
collards (see greens)			
corn (sweet)	<i>Bacillus thuringiensis</i> (NA) carbaryl (0-2) (14 for forage or silage) (48 for dry grain) cyfluthrin (0) endosulfan (0) (not for dry corn)	aphids	carbaryl cyfluthrin endosulfan esfenvalerate malathion permethrin petroleum oil

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
corn (sweet) (continued)	esfenvalerate (1) malathion (5) permethrin (1) petroleum oil (0) pyrethrins (1) rotenone (1) spinosad (1)	aphids (continued)	pyrethrins rotenone
		armyworms: fall armyworm	carbaryl cyfluthrin endosulfan esfenvalerate permethrin pyrethrins
		chinch bugs	carbaryl cyfluthrin endosulfan esfenvalerate malathion
		corn earworm (tomato fruitworm, bollworm, soybean podworm)	carbaryl cyfluthrin endosulfan esfenvalerate permethrin pyrethrins
		cucumber beetles	carbaryl endosulfan esfenvalerate malathion permethrin rotenone
		European corn borer	<i>Bacillus thuringiensis</i> carbaryl cyfluthrin endosulfan esfenvalerate permethrin rotenone
		flea beetles	carbaryl cyfluthrin endosulfan esfenvalerate malathion permethrin pyrethrins rotenone
		rootworms: southern corn rootworm, spotted corn rootworm, twelve spotted cucumber beetle	carbaryl cyfluthrin esfenvalerate malathion
		root maggots: seedcorn maggots	none labeled

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
corn (sweet) (continued)		stalk borers: lesser cornstalk borer, southwestern corn borer	esfenvalerate
		stink bugs	carbaryl cyfluthrin endosulfan permethrin pyrethrins rotenone
cowpeas (see peas, southern)			
cucumbers	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) carbaryl (0-5) endosulfan (0-5) esfenvalerate (3) insecticidal soap (0) malathion (1) permethrin (0-3) petroleum oil (0) pyrethrins (1) rotenone (1) spinosad (1)	aphids: melon aphid or cotton aphid	azadirachtin carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin petroleum oil pyrethrins rotenone
		cabbage looper	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin pyrethrins rotenone
		cucumber beetles: southern corn rootworm	carbaryl endosulfan esfenvalerate
		cutworms: black cutworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate permethrin
		leafminers: serpentine leafminer	azadirachtin esfenvalerate insecticidal soap malathion permethrin

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
cucumbers (continued)		melonworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan permethrin rotenone
		mites: spider mites	endosulfan insecticidal soap malathion permethrin petroleum oil rotenone
		pickleworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan malathion permethrin rotenone
		squash bug	carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin rotenone
		squash vine borer	endosulfan esfenvalerate malathion rotenone
		stink bugs	carbaryl endosulfan esfenvalerate insecticidal soap permethrin pyrethrins rotenone
		thrips: western flower thrips	azadirachtin carbaryl insecticidal soap malathion petroleum oil pyrethrins rotenone spinosad
		whiteflies: sweetpotato whitefly	insecticidal soap petroleum oil pyrethrins rotenone

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
eggplant	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) <i>Bacillus thuringiensis tenebrionis</i> (NA) carbaryl (3-7) endosulfan (1) esfenvalerate (7) insecticidal soap (0) malathion (3) permethrin (0-3) petroleum oil (NA) pyrethrins (0) rotenone (1) spinosad (1) sulfur (NA)	aphids	azadirachtin carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin petroleum oil pyrethrins rotenone
		Colorado potato beetle Comments: Certain <i>Bacillus thuringiensis</i> formulations are specific for beetles.	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate permethrin pyrethrins rotenone spinosad
		cucumber beetles	carbaryl endosulfan esfenvalerate malathion permethrin pyrethrins rotenone
		flea beetles	azadirachtin carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin pyrethrins rotenone
		lace bugs: eggplant lace bug	carbaryl insecticidal soap malathion
		leafminers: serpentine leafminer	azadirachtin esfenvalerate insecticidal soap malathion permethrin
		mites: broad mite, spider mites	endosulfan insecticidal soap malathion permethrin petroleum oil rotenone sulfur

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
eggplant (continued)		whiteflies: sweetpotato whitefly	azadirachtin endosulfan esfenvalerate insecticidal soap petroleum oil pyrethrins rotenone
<p>greens: Chinese cabbage, collards, kale, mustard greens, turnip greens</p> <p>Comments: Registration for specific crops varies between product labels. Be sure to check the label for specifics.</p>	<p>azadirachtin (0) <i>Bacillus thuringiensis</i> (0) carbaryl (14) endosulfan (21) esfenvalerate (7) insecticidal soap (0) malathion (7) permethrin (1) pyrethrins (0) rotenone (1) spinosad (1) sulfur (NA)</p>	aphids	azadirachtin carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin pyrethrins rotenone
		armyworms: beet armyworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate permethrin pyrethrins
		beetles: yellow-margined leaf beetle	azadirachtin carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin pyrethrins rotenone spinosad
		cabbage looper	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate permethrin pyrethrins
		diamondback moth	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate permethrin pyrethrins
		flea beetles	azadirachtin carbaryl endosulfan

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
eggplant (continued)		flea beetles (continued)	insecticidal soap malathion permethrin pyrethrins rotenone
		imported cabbageworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin pyrethrins rotenone
		leafhoppers	carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin pyrethrins
		mites: spider mites	endosulfan insecticidal soap malathion permethrin rotenone sulfur
herbs	<i>Bacillus thuringiensis</i> (0) insecticidal soap (0)		
horseradish	<i>Bacillus thuringiensis</i> (0) carbaryl (7) permethrin (22)		
kale (see greens)			
kohlrabi (see cole crops)			
lettuce Comments: Registration status may vary for head lettuce or leaf lettuce. Be sure to check the label for specifics.	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) carbaryl (14) (3 head lettuce) disulfoton (P) endosulfan (14) insecticidal soap (0) malathion (7) permethrin (1) petroleum oil (NA) pyrethrins (0)	aphids: red lettuce aphid	azadirachtin carbaryl disulfoton endosulfan insecticidal soap malathion permethrin petroleum oil pyrethrins rotenone

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
lettuce (continued)	rotenone (1) spinosad (1)	armyworms: beet armyworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan permethrin pyrethrins
		beetles: yellow- margined leaf beetle	azadirachtin carbaryl disulfoton insecticidal soap malathion permethrin petroleum oil pyrethrins rotenone spinosad
		cabbage looper	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan insecticidal soap malathion permethrin pyrethrins rotenone
		corn earworm (bollworm, tomato fruitworm, soybean podworm)	<i>Bacillus thuringiensis</i> carbaryl endosulfan permethrin pyrethrins
		cutworms: black cutworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan permethrin
		diamondback moth	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan permethrin pyrethrins
		flea beetles	azadirachtin carbaryl endosulfan insecticidal soap malathion permethrin pyrethrins rotenone

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
lettuce (continued)		imported cabbageworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan insecticidal soap malathion permethrin pyrethrins rotenone
		leafhoppers	carbaryl endosulfan insecticidal soap malathion permethrin petroleum oil pyrethrins rotenone
		leafminers: serpentine leafminer	azadirachtin insecticidal soap malathion permethrin
		thrips: western flower thrips	azadirachtin carbaryl disulfoton insecticidal soap malathion petroleum oil pyrethrins rotenone spinosad
melons Comments: Specific melon types may be listed on some of the labels. Be sure to check product labels for specific restrictions.	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) carbaryl (0-5) endosulfan (0-5) esfenvalerate (3) insecticidal soap (0) malathion (1) permethrin (0-3) petroleum oil (0) pyrethrins (1) rotenone (1) spinosad (3) sulfur (NA)	aphids: melon aphid or cotton aphid	azadirachtin carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin petroleum oil pyrethrins rotenone
		cabbage looper	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin pyrethrins rotenone

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
melons (continued)		cucumber beetles: southern corn rootworm	carbaryl endosulfan esfenvalerate malathion permethrin pyrethrins rotenone
		cutworms: black cutworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate permethrin
		leafminers: serpentine leafminer	azadirachtin esfenvalerate insecticidal soap malathion permethrin
		melonworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan permethrin rotenone
		mites: spider mites	endosulfan insecticidal soap malathion permethrin petroleum oil pyrethrins rotenone sulfur
		pickleworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate malathion permethrin rotenone
		squash bug	carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin rotenone

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
melons (continued)		squash vine borer	endosulfan esfenvalerate malathion
		stink bugs	carbaryl endosulfan esfenvalerate insecticidal soap permethrin pyrethrins rotenone
		thrips: western flower thrips	azadirachtin carbaryl insecticidal soap malathion petroleum oil pyrethrins rotenone
		whiteflies: sweetpotato whitefly	endosulfan esfenvalerate insecticidal soap petroleum oil pyrethrins rotenone
muskmelon (see melons)			
mustard greens (see greens)			
okra	<i>Bacillus thuringiensis</i> (0) carbaryl (0-3) insecticidal soap (0) permethrin (1) pyrethrins (NA) rotenone (1)	aphids	carbaryl insecticidal soap permethrin pyrethrins rotenone
		corn earworm (bollworm, tomato fruitworm, soybean podworm)	<i>Bacillus thuringiensis</i> carbaryl permethrin pyrethrins
		stink bugs	carbaryl insecticidal soap permethrin pyrethrins rotenone
onions Comments: Dry onions are sometimes on the label as a separate site.	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) insecticidal soap (0) malathion (3) petroleum oil (NA)	armyworms: beet armyworm	azadirachtin <i>Bacillus thuringiensis</i> pyrethrins
		cutworms: black cutworm	azadirachtin

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
onions (continued)	pyrethrins (1) rotenone (1) sulfur (NA)	cutworm (continued)	<i>Bacillus thuringiensis</i>
		root maggots: onion maggot	malathion rotenone
		thrips: onion thrips, western flower thrips	azadirachtin insecticidal soap malathion petroleum oil pyrethrins rotenone
parsley	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) carbaryl (14) insecticidal soap (0) malathion (21) permethrin (1) pyrethrins (NA) spinosad (1)	aphids	azadirachtin carbaryl insecticidal soap malathion permethrin pyrethrins
		armyworms	azadirachtin <i>Bacillus thuringiensis</i> carbaryl permethrin pyrethrins
		flea beetles	azadirachtin carbaryl malathion permethrin pyrethrins
		weevils: carrot weevil	azadirachtin carbaryl permethrin
peas (English, green, succulent) Remarks: Dry peas have different restrictions. Be sure to read the label.	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) carbaryl (0-3) (21 dry) disulfoton (P) esfenvalerate (3) (21 dry) insecticidal soap (0) malathion (3) pyrethrins (1) rotenone (1) spinosad (3) sulfur (NA)	aphids: pea aphid	carbaryl endosulfan esfenvalerate insecticidal soap malathion pyrethrins rotenone
		armyworms	<i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate pyrethrins
		cutworms: black cutworm	<i>Bacillus thuringiensis</i> carbaryl esfenvalerate

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
peas (continued)		leafhoppers	carbaryl disulfoton endosulfan esfenvalerate insecticidal soap malathion pyrethrins rotenone
		leafminers	esfenvalerate insecticidal soap malathion spinosad
		loopers: alfalfa looper	<i>Bacillus thuringiensis</i> endosulfan esfenvalerate insecticidal soap malathion pyrethrins rotenone
		stink bugs	carbaryl endosulfan esfenvalerate insecticidal soap pyrethrins rotenone
peas (southern, blackeyed, crowder, cowpeas) Remarks: Succulent use has different restrictions than dry pea use. Read the label for specifics.	<i>Bacillus thuringiensis</i> (0) carbaryl (3) (21 dry) endosulfan (3) (not on dry peas) malathion (1) pyrethrins (NA) rotenone (1) spinosad (30)	aphids: cowpea aphid	carbaryl disulfoton endosulfan esfenvalerate insecticidal soap malathion pyrethrins rotenone
		cowpea curculio	carbaryl endosulfan esfenvalerate
peppers	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) carbaryl (0-7) cyfluthrin (7) endosulfan (4-7) esfenvalerate (7) insecticidal soap (0) malathion (3) permethrin (3) petroleum oil (0)	aphids: green peach aphid, melon aphid or cotton aphid	azadirachtin carbaryl cyfluthrin endosulfan esfenvalerate insecticidal soap malathion permethrin petroleum oil pyrethrins

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
peppers (continued)	pyrethrins (0) rotenone (1) spinosad (1) sulfur (NA)	aphids (continued)	rotenone
		armyworms: beet armyworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl cyfluthrin endosulfan esfenvalerate permethrin pyrethrins
		cutworms: black cutworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl cyfluthrin endosulfan esfenvalerate permethrin
		corn earworm (tomato fruitworm bollworm, soybean podworm)	<i>Bacillus thuringiensis</i> carbaryl cyfluthrin endosulfan esfenvalerate permethrin pyrethrins
		flea beetles	azadirachtin carbaryl cyfluthrin endosulfan esfenvalerate insecticidal soap malathion permethrin pyrethrins rotenone
		leafminers: serpentine leafminer	azadirachtin cyfluthrin esfenvalerate insecticidal soap malathion permethrin petroleum oil rotenone
		mites: broad mites, spider mites	endosulfan insecticidal soap malathion permethrin petroleum oil rotenone sulfur

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
peppers (continued)		psyllids	endosulfan esfenvalerate insecticidal soap permethrin
		thrips: western flower thrips	azadirachtin carbaryl cyfluthrin insecticidal soap malathion petroleum oil pyrethrins rotenone spinosad
		weevils: pepper weevil	azadirachtin carbaryl cyfluthrin esfenvalerate permethrin rotenone
potatoes (Irish, white)	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) <i>Bacillus thuringiensis tenebrionis</i> (NA) carbaryl (0-7) disulfoton (P) endosulfan (0-14) esfenvalerate (7) insecticidal soap (0) malathion (0) permethrin (7) petroleum oil (NA) pyrethrins (0) rotenone (1) spinosad (7) sulfur (NA)	aphids: green peach aphid, melon aphid or cotton aphid	azadirachtin carbaryl disulfoton endosulfan esfenvalerate insecticidal soap malathion permethrin petroleum oil pyrethrins rotenone
		Colorado potato beetle	azadirachtin <i>Bacillus thuringiensis tenebrionis</i> carbaryl endosulfan esfenvalerate permethrin pyrethrins rotenone spinosad
		cutworm: black cutworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate permethrin
		cucumber beetles	carbaryl endosulfan esfenvalerate

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
potatoes (continued)		cucumber beetles (continued)	malathion permethrin pyrethrins rotenone
		flea beetles	azadirachtin carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin pyrethrins rotenone
		leaffooted bug	endosulfan
		leafhoppers	carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin petroleum oil pyrethrins rotenone spinosad
		plant bugs	carbaryl endosulfan esfenvalerate insecticidal soap permethrin petroleum oil pyrethrins rotenone
		psyllids Comments: Disulfoton is labeled for use for potato psyllid as a preplant treatment.	disulfoton endosulfan esfenvalerate insecticidal soap permethrin pyrethrins
pumpkin (see squash)			
radishes	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) carbaryl (3-7) cyfluthrin (0) esfenvalerate (7)	aphids	azadirachtin carbaryl cyfluthrin esfenvalerate insecticidal soap

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
potatoes (continued)	insecticidal soap (0) malathion (7) petroleum oil (NA) pyrethrins (0) rotenone (1)	aphids (continued)	petroleum oil pyrethrins rotenone
		beetles: yellow-margined leaf beetle	azadirachtin carbaryl cyfluthrin esfenvalerate insecticidal soap malathion petroleum oil pyrethrins rotenone
		cabbage looper	azadirachtin <i>Bacillus thuringiensis</i> cyfluthrin esfenvalerate insecticidal soap malathion pyrethrins rotenone
		flea beetles	azadirachtin carbaryl cyfluthrin esfenvalerate insecticidal soap pyrethrins rotenone
rutabagas	carbaryl (3-7) <i>Bacillus thuringiensis</i> (0) rotenone (1) sulfur (NA)		
spinach	<i>Bacillus thuringiensis</i> (0) carbaryl (3-14) endosulfan (21) insecticidal soap (0) malathion (7) permethrin (1-7) pyrethrins (0) rotenone (1) spinosad (1) sulfur (NA)	aphids	azadirachtin carbaryl endosulfan insecticidal soap malathion permethrin pyrethrins rotenone
		armyworms: beet armyworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan permethrin pyrethrins
		cabbage looper	azadirachtin <i>Bacillus thuringiensis</i> endosulfan insecticidal soap

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
spinach (continued)		cabbage looper (continued)	malathion permethrin pyrethrins rotenone
		cutworms: black cutworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan permethrin
		flea beetles	azadirachtin carbaryl endosulfan insecticidal soap malathion permethrin pyrethrins rotenone
		webworms: garden webworm	azadirachtin <i>Bacillus thuringiensis</i> pyrethrins rotenone
squash Comments: Product labels differ regarding winter squash, summer squash, pumpkin, etc. Be sure to read the product labels for specifics.	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) carbaryl (0-5) endosulfan (0-5) esfenvalerate (3) insecticidal soap (0) malathion (1) permethrin (0-3) petroleum oil (0) pyrethrins (1) rotenone (1) spinosad (3)	aphids: melon aphid or cotton aphid	azadirachtin carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin petroleum oil pyrethrins rotenone
		cabbage looper	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin pyrethrins rotenone
		cucumber beetles: southern corn rootworm	carbaryl endosulfan esfenvalerate malathion permethrin pyrethrins rotenone

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
squash (continued)		cutworms: black cutworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate permethrin
		leafminers: serpentine leafminer	azadirachtin esfenvalerate insecticidal soap malathion permethrin petroleum oil rotenone
		melonworm	azadirachtin carbaryl endosulfan permethrin rotenone
		mites: spider mites	insecticidal soap malathion permethrin petroleum oil rotenone
		pickleworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl endosulfan esfenvalerate malathion permethrin rotenone
		squash bug	carbaryl endosulfan esfenvalerate insecticidal soap malathion permethrin rotenone
		squash vine borer	endosulfan esfenvalerate malathion
		stink bugs	carbaryl endosulfan esfenvalerate insecticidal soap permethrin pyrethrins rotenone

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
squash (continued)		thrips: western flower thrips	azadirachtin carbaryl insecticidal soap malathion petroleum oil pyrethrins rotenone spinosad
		whiteflies: sweetpotato whitefly	endosulfan esfenvalerate insecticidal soap petroleum oil pyrethrins rotenone
strawberries	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) carbaryl (1-7) endosulfan (4) permethrin (14) petroleum oil (NA) pyrethrins (0) rotenone (1)		
sweet corn (see corn)			
sweet potatoes	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) endosulfan (P, 0) malathion (3) pyrethrins (NA) rotenone (1) spinosad (7)	beetles: golden tortoise beetle	azadirachtin endosulfan malathion pyrethrins rotenone spinosad
		cutworms: black cutworm	azadirachtin <i>Bacillus thuringiensis</i> endosulfan
		flea beetles	azadirachtin endosulfan malathion pyrethrins rotenone
		sweetpotato weevil	no labels found
Swiss chard	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) carbaryl (14) insecticidal soap (0) malathion (7) permethrin (1)	aphids	azadirachtin\ carbaryl insecticidal soap malathion permethrin pyrethrins

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
Swiss chard (continued)	pyrethrins (NA) rotenone (1) spinosad (1)	aphids (continued)	rotenone
		armyworms: beet armyworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl permethrin pyrethrins
		flea beetles	azadirachtin carbaryl malathion permethrin pyrethrins rotenone
		stink bugs	carbaryl permethrin pyrethrins rotenone
		webworms: beet webworm, garden webworm	azadirachtin <i>Bacillus thuringiensis</i> pyrethrins rotenone
tomatoes Remarks: Permethrin use is not permitted on varieties with mature fruit under 1 inch in diameter.	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) <i>Bacillus thuringiensis</i> <i>tenebrionis</i> (NA) carbaryl (0-7) cyfluthrin (0) disulfoton (P) endosulfan (1-5) esfenvalerate (1) insecticidal soap (0) malathion (1) permethrin (0) petroleum oil (0) pyrethrins (0) rotenone (1) spinosad (1) sulfur (NA)	aphids	azadirachtin carbaryl cyfluthrin disulfoton endosulfan esfenvalerate insecticidal soap malathion permethrin petroleum oil pyrethrins rotenone
		armyworms: beet armyworm, fall armyworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl cyfluthrin endosulfan esfenvalerate permethrin pyrethrins
		cabbage looper	azadirachtin <i>Bacillus thuringiensis</i> carbaryl cyfluthrin endosulfan esfenvalerate insecticidal soap malathion

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
tomatoes (continued)		cabbage looper (continued)	permethrin pyrethrins rotenone
		cutworms: black cutworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl cyfluthrin endosulfan esfenvalerate permethrin
		flea beetles	azadirachtin carbaryl cyfluthrin disulfoton endosulfan esfenvalerate insecticidal soap malathion permethrin pyrethrins rotenone
		leaffooted bug	endosulfan
		leafminers: serpentine leafminer	azadirachtin cyfluthrin esfenvalerate insecticidal soap malathion permethrin petroleum oil
		plant bugs	carbaryl endosulfan esfenvalerate insecticidal soap permethrin petroleum oil pyrethrins rotenone
		stink bugs	carbaryl cyfluthrin endosulfan esfenvalerate insecticidal soap permethrin pyrethrins rotenone
		thrips: western flower thrips	azadirachtin carbaryl cyfluthrin disulfoton

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
tomatoes (continued)		thrips (continued)	insecticidal soap malathion petroleum oil pyrethrins rotenone spinosad
		tomato pinworm	azadirachtin <i>Bacillus thuringiensis</i> carbaryl cyfluthrin esfenvalerate permethrin rotenone
		tomato russet mite	endosulfan
		tomato hornworm (tobacco hornworm is a close relative)	azadirachtin <i>Bacillus thuringiensis</i> carbaryl cyfluthrin endosulfan esfenvalerate permethrin rotenone
		tomato fruitworm (corn earworm, bollworm, soybean podworm)	azadirachtin <i>Bacillus thuringiensis</i> carbaryl cyfluthrin endosulfan esfenvalerate permethrin pyrethrins
		whiteflies: sweetpotato whitefly	endosulfan esfenvalerate insecticidal soap petroleum oil pyrethrins rotenone
turnips Comments: The site generally refers to roots. Also see greens for turnip tops.	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) carbaryl (3-7) (14 tops) endosulfan (21 greens) insecticidal soap (0) malathion (3-7) pyrethrins (0) rotenone (1) sulfur (NA)	aphids	azadirachtin carbaryl endosulfan insecticidal soap malathion pyrethrins rotenone
		blister beetles	endosulfan pyrethrins
		weevils: vegetable weevil	azadirachtin carbaryl

Vegetable	Registered Pesticides (PHI)	Common Insect Pests	Pesticides Registered by Pest
watermelon Comments: Also see melons.	azadirachtin (0) <i>Bacillus thuringiensis</i> (0) carbaryl (3-5) malathion (1) permethrin (0) pyrethrins (NA) rotenone (1) spinosad (3)	aphids: melon aphid or cotton aphid	azadirachtin malathion permethrin pyrethrins rotenone
		armyworms: beet armyworm	azadirachtin permethrin pyrethrins
		cabbage looper	azadirachtin <i>Bacillus thuringiensis</i> malathion permethrin pyrethrins rotenone
		cucumber beetles	malathion permethrin pyrethrins rotenone
		cutworms: black cutworm	azadirachtin permethrin
		leafminers: serpentine leafminer	azadirachtin malathion permethrin
		mites: spider mites	malathion permethrin rotenone
		squash bug	malathion permethrin rotenone
		thrips: western flower thrips	azadirachtin malathion pyrethrins rotenone spinosad
		webworms: garden webworm	azadirachtin pyrethrins rotenone
whiteflies: sweetpotato whitefly	pyrethrins		

Table 2. Insecticides and example product names.

Insecticide	Example Product Names
azadirachtin	Gordon's® Garden Guard Liquid insecticide
B.t., <i>Bacillus thuringiensis</i> var. <i>kurstak</i> (and other caterpillar products)	Bonide® Dipel® 150 Dust Bonide® Thuricide® Bacillus Thuringiensis (BT) Bonide® Dipel® 10G Bonide® Dipel® .86% W.P. Green Light® BT Worm Killer Green Light® Dipel® Dust Monterey® Caterpillar Clobber Bioinsecticide Thuricide® HPC
B.t., <i>Bacillus thuringiensis</i> var. <i>tenebrionis</i> (and others for beetles)	Bonide® Colorado Potato Beetle Beater 3%
carbaryl (some baits also contain metaldehyde)	Allpro® Carbaryl 4L Flowable Allpro® Carbaryl 80S Allpro® 10% Carbaryl Dust Bonide® Slug, Snail, & Sowbug Bait Cutworm & Cricket Bait, Southern® Agricultural Insecticides, Inc. Gordon's® Liquid Dura-Spray Carbaryl Insecticide Green Light® Bug Bait Monterey® "7" Carbaryl Insecticide Southern® Ag Mole Cricket Bait
cyfluthrin	Bayer® Advanced Garden™ Power Force Multi-Insect Killer Concentrate Bayer® Advanced Garden™ Power Force Multi-Insect Killer Ready-to-Use Bayer® Advanced Garden™ Power Force Multi-Insect Killer Ready-to-Spray
diazinon	5% Diazinon Granules, Southern® Agricultural Insecticides, Inc. Gordon's® Diazinon 25% Emulsifiable Concentrate Gordon's® Diazinon 5G Lawn & Garden Insect Control Green Light® Diazinon Granules Green Light® Diazinon Concentrate
disulfoton	Bonide® Systemic Granules 2%
endosulfan	.75 Thiodan® Insecticide Spray Bonide® Tomato-Potato Vegetable Dust Bonide® Thiodan Spray Concentrate
esfenvalerate	Monterey® Bug Buster
insecticidal soap	AllPro® Insecticidal Soap 40% Bonide® Bon-Neem Insecticidal Soap RTU Bonide® Bon-Neem Insecticidal Soap Concentrate
iron phosphate	Sluggo® Monterey
malathion	Bonide® Malathion Gordon's® Malathion 50% Spray for Flies and Garden Insects Green Light® 50% Malathion Insect Spray Malathion 50% E. C., Southern® Agricultural Insecticides, Inc.

Insecticide	Example Product Names
metaldehyde	Bonide® No Escape Slug & Snail Killer (Pellet) Bonide® No Escape Slug & Snail Killer (Meal) Bonide® No Escape Slug & Snail Killer Eliminator® Snail & Slug Bait Ortho® Bug-Geta Snail & Slug Killer
neem oil extracts (some also contain pyrethrins)	Green Light® Neem Concentrate Green Light® Neem II Ready-to-Use Green Light® Tomato & Vegetable Spray Ready-to-Use
permethrin	Bonide® Total Pest Control Bonide® Borer Miner Killer Concentrate Bonide® Eight™ Insect Control, Garden & Home Bonide® Eight™ Garden Dust Bonide® Eight™ Insect Control, Vegetable, Fruit & Vegetable Bonide® Eight™ Insect Control, Yard & Garden Dexol® Yard & Garden Bug Killer Gordon's® Bug-No-More Yard & Garden Insect Spray Green Light® Conquest® Insecticide Concentrate Green Light® Borer Killer Green Light® Conquest® Hose-End Concentrate (RTS) Southern® Ag, Garden Insect Dust with Permethrin Southern® Ag Lawn Insect Control
petroleum oil (paraffinic oil)	Bonide® All season Horticultural & Dormant Spray Bonide® All Seasons Horticultural and Dormant Spray Oil Monterey® Saf-T-Side™
pyrethrins (some also have canola oil or piperonyl butoxide)	Bonide® Japanese Beetle RTU Gordon's® Garden Guard® Monterey® Bug Buster - O Monterey® Take Down Spray RTU Monterey® Take Down Garden Spray Natural Pyrethrins Concentrate Southern® Ag.
rotenone (usually with cube extracts, some have copper)	Bonide® Rotenone 1.00% Dust Bonide® Garden Dust Bonide® Rotenone 5% Dust Bonide® Rotenone - Copper Dust
rotenone + pyrethrins	Bonide® Liquid Rotenone-Pyrethrins Spray
spinosad	Fertilome® Borer, Bagworm, Leafminer & Tent Caterpillar Spray Southern® Ag Conserve Naturalyte Insect Control
sulfur	Bonide® Liquid Sulfur Green Light® Wettable Dusting Sulfur Monterey® Sulfur 90W
thyme oil, clove oil and sesame oil	Green Light® Bioganic® Lawn & Garden Insect Spray Green Light® Bioganic® Organic Insect Control Concentrate Green Light® Bioganic® Lawn & Garden Hose-End Concentrate (RTS)

Table 3. Chemical classes and mode of action.

Insecticide Class	Examples	Mode of Action
Botanical	azadirachtin	Insect growth regulator that inhibits molting
	pyrethrins	Derived from a dried pyrethrum daisy flower head Provides quick “knockdown” by destabilizing nerve cell membranes
	rotenone	Derived from several tropical legume roots such as derris and cube root Inhibits cellular respiration primarily in nerve and muscle cells causing death to occur hours or days after exposure
Synthetic pyrethroid	cyfluthrin esfenvalerate permethrin	Synthetic compounds related to natural pyrethrins Destabilizes nerve cell membranes
Carbamate	carbaryl metaldehyde	Inhibits cholinesterase, preventing the termination of nervous impulses
Chlorinated hydrocarbon	endosulfan	Destabilize nerve cell membranes, preventing them from transmitting nervous impulses
Inorganic	sulfur	Elemental sulfur, when ingested, causes dehydration and electrolyte depletion
	iron phosphate	Causes pathological changes at the cellular basis in slug and snail crop and hepatopancreas
Microbial	<i>Bacillus thuringiensis</i>	Bacteria-produced spores and delta endotoxin cause disruption of the stomach lining of certain leaf feeding caterpillars and beetles
Naturalite	spinosad	Extract of <i>Actinomyces</i> fungus Activates nerve receptors with a unique mechanism
Organophosphate	diazinon disulfoton malathion	Inhibits cholinesterase, preventing the termination of nervous impulses
Insecticidal soaps and oils	insecticidal soap neem oil paraffinic oil	Derived from animal byproducts (fat) or plant oils Causes physical disruption of the insect cuticle, resulting in water imbalance and dessication

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Common Vegetable Garden Pests*



Blister beetle



Colorado potato beetle



Cowpea curculio



Spotted cucumber beetle



Flea beetle



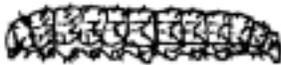
White grub



Leaf beetle



Wireworm



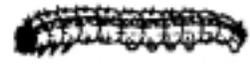
Armyworm



Cabbage looper



Cutworm



Corn earworm



Melonworm



Saltmarsh caterpillar



Squash vine borer



Tomato hornworm



Mole cricket



Aphid



Fleahopper



Leafhopper



Plant bug



Squash bug



Stink bug



Whitefly



Fungus gnat



Leaf miner



Maggot



Thrips



Spider mite



Millipede



Slug



Sowbug

*Diagrams are not to scale.

For more information on vegetable insect management see:

<http://vegipm.tamu.edu>

or

<http://insects.tamu.edu>

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Revision