Crop	Insect/Pest	Synthetic[1]	Organic[2]
TOMATOES (cont'd)	MITES	Malathion (1B)	Horticultural oil (paraffinic oil or mineral oil) (HO) Insecticidal soap (potassium salts of fatty acids) (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN)

[1] Synthetic insecticides are processed from natural sources or manufactured.

[2] Organic insecticides are derived from natural sources including extractions from plants or animals or from naturally occurring inorganic sources including minerals. The use of these insecticides fits within constraints dictated in guidelines for production under "organic" standards. However, not all products containing these active ingredients are labeled for organic production.

*** The numbers associated with the pesticide class column were developed by the Insecticide Resistance Action Committee, (IRAC) in 2005. It is intended to help in the selection of insecticides for preventative resistance management. If you make multiple applications for a specific pest or group of pests during a growing sequence, simply select a registered insecticide with a different number for each generation (14-21 days). You can rotate within the same number if more than one subgroup is available (Example: 2A and 2B). To further delay resistance from developing, integrate other control methods into your pest management programs.**

1A= Carbamates
1B= Organophosphates
2A= Cyclodiene organochlorines
2B= Phenylpyrazoles (Fiproles)
3A= Pyrethroids, Pyrethrins
3B= DDT, Methoxychlor
4A= Neonicitinoids
4B= Nicotine
4C= Sulfoxaflor
4D= Butenolides
5= Spinosyns
6= Avermectins, Milbemycins
7A= Juvenile hormone analogues
7B= Fenoxycarb
7C= Pyriproxyfen
8A= Alkyl halides
8B= Chloropicrin
8C= Sulfuryl fluoride (fumigant)
8D= Borax
8E= Tartar emetic
8F= Methyl isothiocyanate generators
9B= Pymetrozine
9C= Flonicamid
10A= Clofentezine. Hexythiazox, Diflovidazin
10B= Etoxazole
11A= Bacillus thuringiensis and the insecticidal proteins they produce
11B= Bacillus sphaericus
12A= Diafenthiuron
12B= Organotin miticide
12C= Propargite
12D= Tetradifon
13= Chlorfenapyr, DNOC, Sulfluramid
14= Nereistoxin analogues
15= Benzoylureas
16= Buprofezin
17= Cyromazine
18= Diacylhydrazines
19= Amitraz
20A= Hydramethylnon
20B= Acequinocyl
20C= Fluacrypyrim
21A= METI acaricides and insecticides
21B= Rotenone
22A = Indoxacarb
22B= Metaflumizone
23= Tetronic and tetramic acid derivatives
24A= Phosphine
24B= Cyanides
25= Beta-ketonitrile derivatives
26= (unassigned)
27= (unassigned)
28= Diamides
UN= Unknown mode of action
NS= Non-specified, multi-site
M= Microbials
BLO= Biological organisms

NOTES:

1. **Before purchasing and using any pesticide, read the label carefully for registered use(s), rates, and application frequency. Also note toxicity category on the label of each pesticide since toxicity ratings may affect reentry intervals and note any ventilation requirements. Wear protective clothing as recommended on each pesticide label.**
2. **When using horticultural oils it is important to not use oils with insecticidal soap or any sulfur containing compounds. Also, do not use horticultural oils in sprayers in which fungicides have been used. Frequent agitation is required when using horticultural oil sprays.**
3. **Insecticides with a broad spectrum of activity in the chemical classes pyrethroids, organophosphates, carbamates, and neonicotinoids may be harmful to natural enemies (parasitoids and predators). Some broad-spectrum insecticides are more selective than others, and selectivity further depends on how, when, and where the insecticide is applied. Be sure to check the label for the kinds of insects controlled by the product, or contact your county extension educator for information on the use of insecticides with natural enemies.**

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Home Vegetable Garden Insect Pest Control

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http://osufacts.okstate.edu

Pests vs. Beneficials

Insects and mites are classified as pests based on their ability to damage plants and reduce yield. Many insects and most spiders found in home vegetable gardens are beneficial and control of these arthropods is not recommended. An introduction to beneficial insects and other arthropods of Oklahoma can be found in Oklahoma Cooperative Extension Service Publications EPP-7307: Beneficial Insects and E-1023: Conserving Beneficial Arthropods in Residential Landscapes.

Monitoring Pest Insects in the Home Garden

Insects and mites can move into the garden and rapidly increase in abundance. Examine plants in and around the garden at least twice weekly throughout the season, focusing on a few plants of each cultivar. Search under leaves, inside developing fruit, along stems, and at the plant base or crown. Note signs and symptoms of feeding damage such as insect excrement, holes in leaves or fruit, and twisted or deformed leaves. Record the extent of damage from week to week to aid in determining whether insects and/or damage are increasing.

Identifying Insects

Identifying insects and other arthropods can be a daunting task, so become familiar with common pest species and use a hand lens with at least 10X magnification to aid in identification of very small specimens. Color photos and descriptions of the most common insect pests are included in this fact sheet. Once the pest is properly identified, it can be classified by the type and amount of damage it causes.

Identifying the Damage

Damage is classified by how and where pests feed.

Chewing damage - Insects with chewing mouthparts tear off plant tissue and chew it. Examples include beetles, caterpillars, and grasshoppers, which feed on fruit or leaves and often leave holes in affected plant tissue. These insects defecate on plants and soil, leaving behind excrement (frass) that may be brown, black, or green.

Sucking damage - Insects with piercing-sucking mouthparts insert their straw- or needle-like mouthparts into plant tissue and 'suck' plant sap and other liquids. Examples include squash bugs, aphids, and stink bugs. Many insects that feed in this manner defecate a sticky liquid (honeydew) that often builds up on leaves or fruit, leaving a shiny residue that may support the growth of sooty mold. Damaged foliage will turn yellow and eventually become brown and necrotic or malformed. Thrips and mites also feed on plant juices, but their mouthparts differ slightly.

Key Pests

Pests that feed directly on the harvested portion of the plant are often the most destructive. Hence, little tolerance is given for these key pests and they should be controlled when found in large numbers in the garden. Examples include corn earworm and tomato fruitworm. Many insects and mites feed on leaves or on parts of the plants that will not be harvested. Most gardeners can tolerate low numbers of these in the garden. They often serve a useful purpose because they attract and help maintain populations of predatory or parasitic insects or mites that also feed on and control key pests. You must decide how many of these pests you are willing to tolerate, keeping in mind that large numbers can cause leaf curl and other damage and reduce the vigor of your garden plants. Examples include aphids and spider mites. A list of commonly grown vegetables and associated arthropod pests are provided in Table 1.

Controlling Pests

Ideally, pests should be prevented from becoming a problem in the first place. Pest problems can be prevented by selecting crops that are well adapted to the local climate and soil. Also, pests are kept in check by maintaining a healthy crop through cultural practices such as proper fertility and irrigation. Finally, prevent small infestations from becoming a major problem by removing pests early. Pest monitoring enhances the success of early pest detection and elimination. If additional control options are warranted, numerous strategies can be adopted. Often, the most effective control is achieved by combining control tactics. Additional information about maintaining garden plant health can be found in Oklahoma Cooperative Extension Service Publications HLA-6013 Summer Care of the Home Vegetable Garden, HLA-6007: Improving Garden Soil Fertility, and HLA-6032: Vegetable Varieties for the Home Garden in Oklahoma.

Table 1. Commonly Grown Vegetables and Associated Pests.

Asparagus
- Asparagus beetle
- Aphids

Beans
- Bean leaf beetles
- Aphids
- European corn borer
- Leafhoppers
- Corn earworm

Cole crops (broccoli, cauliflower, cabbage, collards, kale, mustard, turnips)
- Diamondback moth
- Cabbage looper
- Aphids

Cucurbit crops (cucumbers, melons, squash, pumpkins)
- Cucumber beetles
- Squash bug
- Aphids
- Spider mites

Sweet Corn
- Corn earworm
- Armyworms
- Mites
- Seedcorn maggot
- Flea beetles
- European corn borer
- Cutworms

Tomatoes (peppers, eggplant, potato)
- Tomato fruitworm
- Hornworms
- Blister beetles
- Flea beetles
- Colorado potato beetle
- Aphids
- Spider mites
- Stick bugs
- Leaffooted bugs
- Leafhoppers
- Cutworms

Okra
- Aphids

Onion
- Thrips

Peas
- Aphids
- Stink bugs
- Loopers

Spinach
- Aphids
- Stink bugs
- Loopers

Lettuce
- Aphids
- Spider mites

Cultural Control

Vigorous, rapidly growing plants often 'outgrow' pest damage. Plant recommended cultivars and maintain fertile soil with proper pH and moisture to provide your garden a means to outgrow pest damage.

Sanitation - dispose of infested plant and trash materials that harbor pests, and cultivate the soil to expose and destroy pests dwelling there.

Weed control - keep the garden border areas mowed and trimmed and cultivate the garden to control unwanted plants (weeds). Weeds can serve as hosts to insects that can move to vegetable plants.

Time your plantings - many insect pests, including corn earworm and squash bug, are less numerous early in the season. An early planting of vegetables will often 'escape' with little to no damage.

Traps are devices that collect pests or cause them to congregate, such as flat boards lain on top of the soil. Check traps frequently and collect and destroy insect pests contained in the traps.

Barriers serve to exclude pests from the crop and include the use of 'cutworm collars' placed around the stem collar of young transplants to prevent cutworm damage. Other barriers include row covers made of transparent or translucent materials such as mesh that allows light and air to enter, but blocks insects. Typically, row covers are supported above the plants with hoop frames although light-weight woven covers can rest on the canopy.

Mechanical removal - large insect pests can be removed by hand whereas small, soft-bodied pests such as aphids or mites can be washed from plants with a directed stream of water. Two water wands specifically designed for this purpose are the Water Wand for Spider Mites and the Jet-All Water Wand (see Texas A&M Agrilife Extension Publication EEE-00006: Water Wands: High Pressure Water Spray Devices for Insect and Mite Control).

Biological Control

Oklahoma gardens contain a large abundance and diversity of arthropod predators and parasitoids that attack many common vegetable pests. Examples include lady beetles, lacewings, and spiders. These **beneficial** arthropods are best used by preserving or augmenting their numbers. You can maintain a diverse and healthy garden by not spraying the garden unnecessarily with insecticides and by maintaining a diverse planting that provides sources of prey, nectar, and pollen (see E-1023: Conserving Beneficial Arthropods in Residential Landscapes). Beneficial insects can be purchased from suppliers and released in mass numbers, but this practice has not proven reliable in home gardens. Many insects are attacked by pathogens, reducing their reproductive capacity and/or killing them. Several fungal and bacterial pathogens are formulated as insecticides and available to homeowners. Natural disease outbreaks occur during periods of wet and humid weather.

Pesticides

Pesticides are materials that are applied directly to pests or their environment that will kill pests or otherwise disrupt their life cycles. Insecticides are specifically designed to kill insects and many other arthropods. A list of insecticides can

Crop	*Insect/Pest*	*Synthetic*[1]	*Organic*[2]
ONIONS	THRIPS	Acetamiprid (4A) Lambda-cyhalothrin (3A) Malathion (1B) Permethrin (3A)	Azadirachtin (UN) *Beauveria bassiana* (M) Horticultural oil (paraffinic oil or mineral oil) (HO) Kaolin clay (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN)
PEAS	APHIDS	Acetamiprid (4A) Esfenvalerate (3A) Imidacloprid (4A) Malathion (1B)	Azadirachtin (UN) *Beauveria bassiana* (M) Insecticidal soap (potassium salts of fatty acids) (NS) **(Do not use insecticidal soap on sweet peas)** Neem oil (UN) Pyrethrins + sulfur (3A + UN)
	BEETLES and WEEVILS	Acetamiprid (4A) Carbaryl (1A) Esfenvalerate (3A) Malathion (1B)	Azadirachtin (UN) *Beauveria bassiana* (M) Kaolin clay (NS) Neem oil (UN)
PEPPERS	APHIDS	Acetamiprid (4A) Cyfluthrin (3A) Esfenvalerate (3A) Imidacloprid (4A) Malathion (1B) Permethrin (3A)	Azadirachtin (UN) *Beauveria bassiana* (M) Horticultural oil (paraffinic oil or mineral oil) (HO) Insecticidal soap (potassium salts of fatty acids) (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN)
	FLEA BEETLE	Acetamiprid (4A) Carbaryl (1A) Cyfluthrin (3A) Esfenvalerate (3A) Imidacloprid (4A) Permethrin (3A)	*Beauveria bassiana* (M) Kaolin clay (NS) Neem oil (UN)
	CATERPILLARS (tomato fruitworm, tomato pinworm, tomato hornworm)	Acetamiprid (4A) Carbaryl (1A) Cyfluthrin (3A) Esfenvalerate (3A) Malathion (1B) Permethrin (3A)	Azadirachtin (UN) *Bacillus thuringiensis* subsp. *kurstaki* (11A) Insecticidal soap (potassium salts of fatty acids) (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN) Spinosad (5)
POTATOES (Irish)	COLORADO POTATO BEETLE	Carbaryl (1A) Cyfluthrin (3A) Esfenvalerate (3A) Permethrin (3A)	Azadirachtin (UN) *Beauveria bassiana* (M) Neem oil (UN) Spinosad (5)
	FLEA BEETLES	Acetamiprid (4A) Carbaryl (1A) Cyfluthrin (3A) Esfenvalerate (3A) Permethrin (3A)	*Beauveria bassiana* (M) Kaolin clay (NS) Neem oil (UN)
POTATOES (Sweet)	SWEET POTATO WEEVIL	Acetamiprid (4A) Carbaryl (1A) Cyfluthrin (3A)	Azadirachtin (UN) *Beauveria bassiana* (M) Neem oil (UN)
TOMATOES	APHIDS	Acetamiprid (4A) Cyfluthrin (3A) Esfenvalerate (3A) Imidacloprid (4A) Lambda-cyhalothrin (3A) Malathion (1B) Permethrin (3A)	Azadirachtin (UN) *Beauveria bassiana* (M) Horticultural oil (paraffinic oil or mineral oil) (HO) Insecticidal soap (potassium salts of fatty acids) (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN)
	CATERPILLARS (tomato fruitworm, tomato pinworm, tomato hornworm)	Acetamiprid (4A) Carbaryl (1A) Cyfluthrin (3A) Esfenvalerate (3A) Lambda-cyhalothrin (3A) Permethrin (3A)	Azadirachtin (UN) *Bacillus thuringiensis* subsp. *kurstaki* (11A) Insecticidal soap (potassium salts of fatty acids) (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN) Spinosad (5)

Crop	*Insect/Pest*	*Synthetic*[1]	*Organic*[2]
CUCURBIT CROPS (cantaloupe, melons, pumpkin, squash)	APHIDS	Acetamiprid (4A) Esfenvalerate (3A) Imidacloprid (4A) Malathion (1B) Permethrin (3A)	Azadirachtin (UN) *Beauveria bassiana* (M) Horticultural oil (paraffinic oil or mineral oil) (HO) Insecticidal soap (potassium salts of fatty acids) (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN)
	BEETLES	Acetamiprid (4A) Carbaryl (1A) Cyfluthrin (3A) Esfenvalerate (3A) Imidacloprid (4A) Malathion (1B) Permethrin (3A)	Azadirachtin (UN) *Beauveria bassiana* (M) Horticultural oil (paraffinic or mineral oil) (HO) Kaolin clay (NS) Neem oil (UN)
	CATERPILLARS (armyworms, cutworms, earworms, melonworm, pickleworm, loopers, squash vine borer)	Acetamiprid (4A) Carbaryl (1A) Cyfluthrin (3A) Esfenvalerate (3A) Malathion (1B) Permethrin (3A)	Azadirachtin (UN) *Bacillus thuringiensis* subsp. *kurstaki* (11A) Insecticidal soap (potassium salts of fatty acids) (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN) Spinosad (5)
	MITES	Malathion (1B)	Horticultural oil (paraffinic oil or mineral oil) (HO) Insecticidal soap (potassium salts of fatty acids) (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN)
	SQUASH BUG	Acetamiprid (4A) Carbaryl (3A) Esfenvalerate (3A) Permethrin (3A)	Neem oil (UN)
EGGPLANT	APHIDS	Acetamiprid (4A) Cyfluthrin (3A) Esfenvalerate (3A) Imidacloprid (4A) Malathion (1B) Permethrin (3A)	Azadirachtin (UN) *Beauveria bassiana* (M) Horticultural oil (paraffinic oil or mineral oil) (HO) Neem oil (UN)
	CATERPILLARS (armyworms, cutworms, loopers, tomato hornworm)	Acetamiprid (4A) Carbaryl (1A) Cyfluthrin (3A) Esfenvalerate (3A) Malathion (1B) Permethrin (3A)	Azadirachtin (UN) *Bacillus thuringiensis* subsp. *kurstaki* (11A) Neem oil (UN) Spinosad (5)
	COLORADO POTATO BEETLE	Acetamiprid (4A) Carbaryl (1A) Cyfluthrin (3A) Esfenvalerate (3A) Imidacloprid (4A) Permethrin (3A)	Azadirachtin (UN) *Beauveria bassiana* (M) Horticultural oil (paraffinic or mineral oil) (HO) Neem oil (UN) Spinosad (5)
	FLEA BEETLES	Acetamiprid (4A) Carbaryl (1A) Cyfluthrin (3A) Esfenvalerate (3A) Imidacloprid (4A) Permethrin (3A)	*Beauveria bassiana* (M) Kaolin clay (NS) Neem oil (UN)
LEAFY GREENS (kale, collards, mustard, turnips, spinach)	APHIDS	Acetamiprid (4A) Imidacloprid (4A) Malathion (1B) Permethrin (3A)	Azadirachtin (UN) Esfenvalerate (3A) *Beauveria bassiana* (M) Insecticidal soap (potassium salts of fatty acids) (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN)
	CATERPILLARS (armyworms, cabbageworms, cutworms, earworms, European corn borer, green cloverworm, saltmarsh caterpillar)	Acetamiprid (4A) Cyfluthrin (3A) Carbaryl (1A) Esfenvalerate (3A) Malathion (1B) Permethrin (3A)	Azadirachtin (UN) *Bacillus thuringiensis* subsp. *Kurstaki* (11A) *Beauveria bassiana* (M) Insecticidal soap (potassium salts of fatty acids) (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN) Spinosad (5)

be found in Table 2. Insecticides sold commercially must be registered with the U.S. Environmental Protection Agency and the State of Oklahoma's Department of Agriculture, Food, and Forestry. The label attached to the insecticide container provides specific information on proper use, handling, and disposal of the insecticide. **ALWAYS USE PESTICIDES ACCORDING TO LABEL INSTRUCTIONS** (refer to EPP-7450: Safe Use of Pesticides in the Home and Garden).

Organic Pesticides

Organic gardeners consider insecticides extracted from plants or derived from a 'naturally' occurring source as suitable tor 'organic' production. Examples of botanical insecticides include neem extracts and pyrethrum. Materials derived from other acceptable sources include insecticidal soaps, vegetable and mineral oils, and sulfur dusts. Many of these materials have been evaluated in university trials and have been shown to have short residual activity and can be moderately effective in killing insect pests. Several of these materials can be detrimental to beneficial insects but have low toxicity to humans and pets.

Synthetic Pesticides

In contrast to most 'organic' pesticides, synthetic pesticides have been synthesized from raw products using industrial technology. All currently labeled and registered pesticides have been determined to be safe based on current regulations from the United States Environmental Protection Agency and the State of Oklahoma when used as specified by the label. Examples of synthetic insecticides labeled for General Use Purposes (i.e., homeowner products) include malathion and carbaryl. These materials were evaluated in university trials and were shown to be moderately effective in killing insect pests. Most are detrimental to beneficial insects and may have low to moderate toxicity to humans and pets.

Application of Pesticides

Whether applying synthetic or organic pesticides, the user is responsible for reading the label and making applications in a proper manner. Homeowners need to adhere to restrictions concerning the target crop and insect pest, the interval of time required between application and harvest, and proper protection of people, pets, and beneficial organisms including bees, predators, birds, and fish (i.e., non-target organisms). Both synthetic and organic pesticides can be toxic and/or irritating; therefore, wear unlined neoprene gloves and keep all materials out of contact with eyes, mouth, and bare skin. Always wash thoroughly after applying pesticides.

Most pesticides approved for use around the home are moderately effective in killing pest insects. To achieve the best control with these materials, it is important to direct the spray to the plant surface where the pest is living or feeding. Also, since many pests will continue to hatch from eggs or migrate into the garden, it may be necessary to monitor pest infestations two to three days after the first application and to repeat applications as needed following label directions.

Common Pests of Gardens and Their Management

Aphids

Aphids are small insects, ranging from yellow to green to red, and may or may not have wings. Look for these insects on the undersides of the leaves. Aphids feed by inserting needle-like mouthparts in leaves, stems, and fruit to remove plant nutrients. When numerous, aphids generally cause damage; however, they can transmit viruses to crops even when present in low numbers. Aphids may be controlled by natural factors including rain, wind, parasitoids (e.g., tiny wasps) and predators (e.g., lady beetles). Aphids occur on almost all garden crops and are of special concern on tomatoes, peppers, potatoes, squash, melons, and cucumbers. They may transmit virus diseases among crops and can be very damaging.

Recommended Control: To prevent virus transmission, place row covers over new plantings and maintain until first flowers are present or use reflective mulch. To control large populations on leaves, spray with insecticidal soaps, horticultural oils, or neem oil, making certain to obtain good spray coverage. Sprays must be directed at the feeding sites on the undersurface of leaves. Cultural control methods include the use of row covers and reflective mulch. Beneficial insects can be released into the garden or recruited from surrounding landscapes. Infested plants can be washed thoroughly with a directed stream of water as a mechanical control method.

True Bugs

True bugs include stink bugs, leaffooted bugs, and squash bugs that have piercing-sucking mouthparts used to 'suck' nutrients from plant leaves, stems, and fruit. They often are key pests that feed on tomatoes, beans, and squash, causing discolored spotting, pimples, or desiccation. Adults are excellent fliers and can move long distances among gardens. There are few natural controls limiting their numbers and damaging populations must be treated with insecticides.

Recommended Control: Use row covers to prevent bugs from feeding on young plantings, but remove at first flower. Kill nymphs and adults with broad-spectrum insecticides that kill on contact. Organic control methods include the use of row covers, hand picking, traps, and spraying with neem oil or pyrethrum. Nymphs can be killed with insecticidal soap. Spray applications must be directed towards the feeding sites under the leaves and under the plant canopy. Squash bugs are perennial pests, primarily of squash and pumpkin. Squash bugs,should be controlled by initiating insecticide applications or hand picking when adults or egg masses are first noted on plants.

Leafhoppers

Leafhoppers are closely related to true bugs and feed in the same manner. They are generally much smaller and brighter. They can become very numerous and are very active. Nymphs actively run when disturbed and adults actively 'hop' or fly when disturbed.

Recommended Control: Nymphs and adults can be killed with broad-spectrum insecticides that kill on contact. Organic control is best achieved with applications of neem

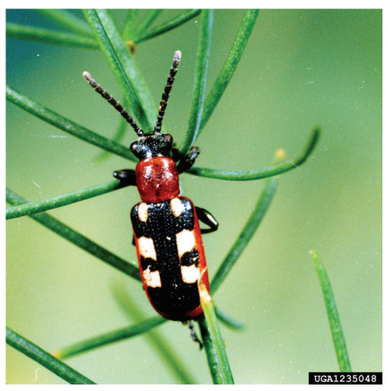
Leafhopper (adult). Courtesy A.C. Magyarosy, Bugwood.org

Striped Blister Beetle. Courtesy Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

Margined Blister Beetle. Courtesy Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

Colorado Potato Beetle (adult). Courtesy Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

Colorado Potato Beetle (larva). Courtesy Whitney Cranshaw, Colorado State University, Bugwood.org



Asparagus Beetle. Courtesy Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

Table 2. Insecticide options for arthropod pests of home vegetable gardens.

Crop	*Insect/Pest*	*Synthetic*[1]	*Organic*[2]
ASPARAGUS	APHIDS	Imidacloprid (4A) Permethrin (3A)	Azadirachtin (UN) *Beauveria bassiana* (M) Horticultural oil (paraffinic or mineral oil) (HO) Neem oil (UN)
	BEETLES	Carbaryl (1A) Permethrin (3A)	Horticultural oil (paraffinic or mineral oil) (HO) Kaolin clay (NS) Neem oil (UN) Spinosad (5)
BEANS	APHIDS	Acetamiprid (4A) Esfenvalerate (3A) Imidacloprid (4A) Malathion (1B)	Azadirachtin (UN) *Beauveria bassiana* (M) Horticultural oil (paraffinic oil or mineral oil) (HO) Insecticidal soap (potassium salts of fatty acids) (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN)
	BEETLES CRICKETS LEAFHOPPERS	Acetamiprid (4A) Carbaryl (1A) Esfenvalerate (3A) Imidacloprid (4A) Malathion (1B)	*Beauveria bassiana* (M) Horticultural oil (paraffinic or mineral oil) (HO) Insecticidal soap (potassium salts of fatty acids) (NS) Kaolin clay (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN)
	MITES	Malathion (1B)	Horticultural oil (paraffinic oil or mineral oil) (HO) Insecticidal soap (potassium salts of fatty acids) (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN)
COLE CROPS (cabbage, cauliflower, broccoli)	APHIDS	Acetamiprid (4A) Esfenvalerate (3A) Imidacloprid (4A) Lambda-cyhalothrin (3A) Malathion (1B) Permethrin (3A)	Azadirachtin (UN) *Beauveria bassiana* (M) Horticultural oil (paraffinic oil or mineral oil) (HO) Insecticidal soap (potassium salts of fatty acids) (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN)
	CATERPILLARS (armyworms, cabbageworms, cutworms, diamondback moth larvae, earworms, loopers)	Acetamiprid (4A) Carbaryl (1A) Cyfluthrin (3A) Esfenvalerate (3A) Lambda-cyhalothrin (3A) Malathion (1B) Permethrin (3A)	Azadirachtin (UN) *Beauveria bassiana* (M) *Bacillus thuringiensis* subsp. *kurstaki* (11A) Horticultural oil (paraffinic or mineral oil) (HO) Insecticidal soap (potassium salts of fatty acids) (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN) Spinosad (5)
	HARLEQUIN BUG	Carbaryl (1A) Malathion (1B)	Neem oil (UN)
CORN (SWEET)	APHIDS	Esfenvalerate (3A) Lambda-cyhalothrin (3A) Permethrin (3A)	Azadirachtin (UN) *Beauveria bassiana* (M) Horticultural oil (paraffinic oil or mineral oil) (HO) Insecticidal soap (potassium salts of fatty acids) (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN)
	CATERPILLARS (corn earworm, armyworms) For corn earworm control, apply insecticides in mixture with vegetable oil directed to corn silk at 2-3 day intervals	Carbaryl (1A) Cyfluthrin (3A) Esfenvalerate (3A) Lambda-cyhalothrin (3A) Permethrin (3A)	Azadirachtin (UN) Insecticidal soap (potassium salts of fatty acids) (NS) Kaolin clay (NS) Neem oil (UN) Pyrethrins + sulfur (3A + UN) Spinosad (5)
	BEETLES	Carbaryl (1A) Cyfluthrin (3A) Esfenvalerate (3A) Lambda-cyhalothrin (3A) Permethrin (3A)	Azadirachtin (UN) *Beauveria bassiana* (M) Kaolin clay (NS) Neem oil (UN)

Soil Insects

Several soil-dwelling insects (e.g., wireworms, white grubs, cutworms) are pests, feeding on roots or other portions of the plant that are in contact with the soil. Healthy, vigorously growing plants can outgrow the damage from a limited number of root feeding insects; however, large numbers can limit harvest or kill plants.

Recommended Control: There are few effective methods of killing soil insects once they are damaging plants, therefore, prevention is the best policy. Prevent problems by planting into well-cultivated soil that has not been in sod the previous year. Several broad-spectrum granular insecticides are available and application prior to planting will effectively control pest insects.

Spider Mites

Spider mites are closely related to insects. Look for mites on the underside of leaves. They cause a general yellowing and stippling of leaf tissue. Webbing similar to spider webs may be present around colonies on leaves, stems, and fruit. Large populations can kill leaves and reduce yield.

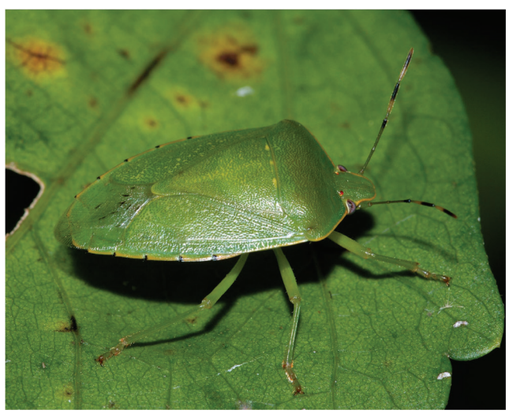
Recommended Control: Control can be achieved with applications of insecticidal soaps or horticultural oils, making certain to obtain good spray coverage. Sprays must be directed at the feeding sites on the undersurface of leaves and repeated applications may be necessary. Infested plants can be washed thoroughly with a directed stream of water early in the morning to allow the leaves to dry before evening.

Tomato Fruitworm. Courtesy Whitney Cranshaw, Colorado State University, Bugwood.org

Corn Earworm. Courtesy R.L. Croissant, Bugwood.org

Green Peach Aphid (winged adult). Courtesy Scott Bauer, USDA Agricultural Research Service, Bugwood.org

Green Peach Aphid (nymphs and wingless adults). Courtesy Whitney Cranshaw, Colorado State University, Bugwood.org



Green Stink Bug. Courtesy Susan Ellis, Bugwood.org

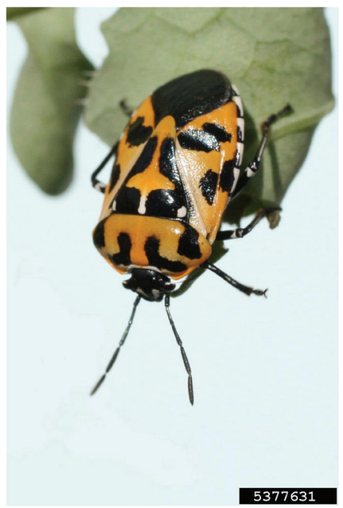
Spotted Cucumber Beetle. Courtesy J.P. Michaud, Kansas State University, Bugwood.org

Striped Cucumber Beetle. Courtesy Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

Black Cutworm. Courtesy Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

Squash Bug (eggs). Courtesy Gerald Holmes, Valent USA Corporation, Bugwood.org

Squash Bug (nymphs and adult). Courtesy Whitney Cranshaw, Colorado State University, Bugwood.org



Harlequin Bug. Courtesy Russ Ottens, University of Georgia, Bugwood.org

White Grub. Courtesy Alton N. Sparks, Jr., University of Georgia, Bugwood.org

Wireworms. Courtesy Frank Peairs, Colorado State University, Bugwood.org

Tomato Hornworm. Courtesy Whitney Cranshaw, Colorado State University, Bugwood.org

Twospotted Spider Mites. Courtesy Frank Peairs, Colorado State University, Bugwood.org

oil or pyrethrum. These pests are very active and migrate great distances; therefore, spray treatments may have to be repeated to bring large populations under control.

Beetles

Beetles are large or small and dark black to metallic green. They have hard 'shell-like' bodies, chewing mouth parts, and are good fliers. They feed on leaves, stems, and fruit. Common beetles in vegetable gardens include Colorado potato beetles, blister beetles, bean beetles, and cucumber beetles. Lady beetles are common beneficial insects that feed on insect eggs, larvae, and aphids.

Recommended Control: Use row covers to protect young plants and remove at first flowering. Larvae and adults can be killed with broad-spectrum insecticides that kill on contact. Organic methods of control include the use of row covers, hand picking, and applications of neem oil or pyrethrum. Larvae can be killed with insecticidal soap.

Caterpillars and Cutworms

Caterpillars and cutworms are worm-like larval stages of insects that will mature into moths or butterflies. They emerge from small eggs laid on plant tissue and can grow to several inches in length. Caterpillars have chewing mouthparts and feed on leaves, stems, and fruit. Most caterpillars are found feeding on leaves or fruit and their activity is often noticed by the presence of excrement on leaves or soil.

Recommended Control: Young plants and transplants can be protected from cutworms by placing 'collars' around the base of the plant stems. The best method to control caterpillars that feed on leaves and fruit is with applications of pesticides derived from *Bacillus thuringiensis* var *kurstaki* (e.g., Dipel or Thuricide Bt).

Grasshoppers

Grasshoppers are fairly large, green or brown insects that can jump or fly, are extremely active, and difficult to catch. Grasshoppers leave ragged holes at the leaf margin, but when present in large numbers they can remove all leaf material. They are difficult to control because they can migrate into the garden from areas outside the garden.

Recommended Control: Row covers will protect young plants. Maintain well-trimmed borders around the garden to act as a 'barrier' and to prevent their migration into the garden. Several broad-spectrum synthetic insecticides effectively kill grasshoppers in the garden; however, grasshoppers have a tendency to continuously migrate into gardens and thus repeated applications are often necessary. Organic control may best be achieved using repeated applications of neem oil or pyrethrum. Insecticide applications, whether synthetic or organic, are most effective when targeted against small nymphs. Larger and adult grasshoppers are more difficult to kill.

Thrips

Thrips are very small insects that rasp, tear, and remove nutrients from leaves, causing a silver streaking of the leaf tissue and leaf curling. They often are very abundant early in the season and the damage may be very notable on cotyledons and first true leaves. Generally, plants outgrow the damage and often control is not necessary.

Recommended Control: When extremely abundant, or if they are damaging fruit or edible leaves, control may be warranted. Applications of broad-spectrum insecticides that kill on contact are most effective in reducing numbers, but must be repeated because eggs are laid in plant tissue and are not affected by pesticides. Organic control may be achieved by repeated, direct applications of neem oil or pyrethrum.