



VEGETABLE PESTS OF UTAH

disease and arthropod pest identification guide

EXTENSION 

UtahStateUniversity

PUBLICATION COORDINATORS AND EDITORS

Cami Cannon (Vegetable IPM Associate and Graphic Design)

Marion Murray (IPM Project Leader)

Editing assistance by:

Diane Alston (Entomologist)

Claudia Nischwitz (Plant Pathologist)

AUTHORS

Cami Cannon

Marion Murray

Taun Beddes (*diseases*: herbicide damage, sunscald)

Candace Schaible (*insects*: spinach leafminer *diseases*: phytophthora root/stem/crown rot)

CONTACT INFORMATION

Utah State University IPM Program

Dept. of Biology

5305 Old Main Hill

Logan, UT 84322

(435) 797-0776

utahpests.usu.edu/IPM

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PREFACE

How to Use this Guide

This guide is organized by specific insect pests and diseases within the following groups:

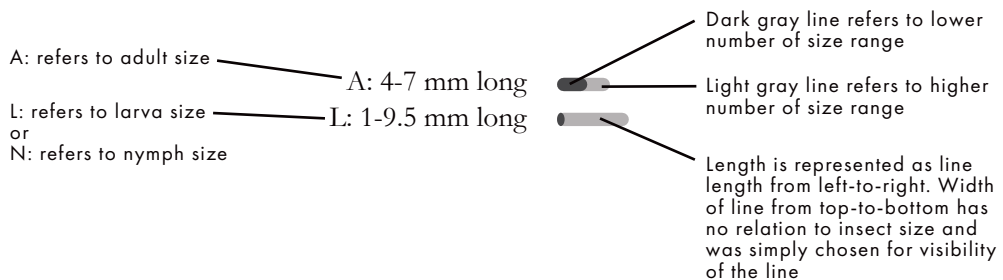
Insects and Related Pests:

- Aphids
- Beetles
- Caterpillars/Moths
- Earwigs
- Grasshoppers
- Leafhoppers
- Maggots/Flies
- Plant/Seed Bugs
- Psyllids
- Thrips
- Whiteflies
- Mites
- Symphylans
- Collembola/Springtails
- Crustaceans
- Molluscs

Diseases Caused by:

- Bacteria
- Fungi
- Fungus-Like Organisms
- Nematodes
- Viruses
- Abiotic (Non-Living)

Each insect pest page lists the approximate size range of adults and sometimes nymphs or larvae and should be interpreted as follows:



Purpose of this Guide

One of the goals of the USU IPM program is to reduce the use of broad-spectrum pesticides for pest control in favor of using more selective products that are safe on beneficial insects, water quality, and human health. Proper identification of pests in monitoring practices is crucial in accurately identifying alternative control methods.

INSECT, MITE, AND OTHER ARTHROPOD PESTS

Aphids	10
Beetles	14
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APHIDS

Cabbage Aphid (<i>Brevicoryne brassicae</i>)	A: 2-2.5 mm long	●
Corn Leaf Aphid (<i>Rhopalosiphum maidis</i>)	A: 1-2.4 mm long	●
Green Peach Aphid (<i>Myzus persicae</i>)	A: 1.8-2.1 mm long	●
Melon/Cotton Aphid (<i>Aphis gossypii</i>)	A: 1-2 mm long	●
Potato Aphid (<i>Macrosiphum euphorbiae</i>)	A: 2.4-3.6 mm long	●

Hosts: Wide host range including apricot, asparagus, barley, broccoli, cabbage, catalpa, celery, some cherries, corn, cucumber, eggplant, legumes, melon, millet, mustard green, nectarine, oats, okra, peach, pepper, some plums, potato, pumpkin, rose, rose-of-sharon, rye, sorghum, spinach, squash, tomato, wheat, weeds such as crabgrass, foxtail, and other ornamentals, weeds, and vegetables

Appearance: Adults may be winged or wingless with a pear-shaped, soft body. Adults and nymphs vary in color from pale to dark-green, pink, red, bluish-green, black, yellow, and gray, and may have a waxy covering (cabbage aphid).

Damage Symptoms: Adults and nymphs feed on hosts with piercing-sucking mouthparts causing stippling, chlorosis, curled leaves, and/or slow plant growth. Over one hundred different viruses can be transmitted by adults and nymphs.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph (4 stages) | Adult (wingless or winged)
- Multiple generations per growing season.
- Overwinter as eggs on woody hosts or crop debris.

Time for Concern: Mid-April through the end of the growing season.

When and Where to Scout:

- Adults first seen late May and June.
- Adults and nymphs often found in clusters on leaves or stems, but may be found singly.
- Eggs laid in fall or winter on woody host plants, crop residue, or weeds.
- Watch for rapidly increasing populations and feeding damage in the late spring through early fall.

Threat Level: Aphids are common but typically do not cause severe economic damage unless they vector a virus or are present in high populations.

Top Management Techniques:

- Manage nitrogen levels; avoid excess.
- Encourage natural enemies; avoid toxic chemicals, provide nectar and pollen resources.
- Keep crop area weed-free.
- For viruses transmitted by aphids:
 - Plant resistant cultivars
 - Plant early
 - Remove and destroy infected plants immediately.

When to Consider Treatment:

- If populations are high and causing economic damage.
- If vectored virus diseases cannot be tolerated (e.g. seed production).
- If vectored viruses occur.

Look-alikes: potato/tomato psyllid (winged adults), whiteflies (shed aphid skins)

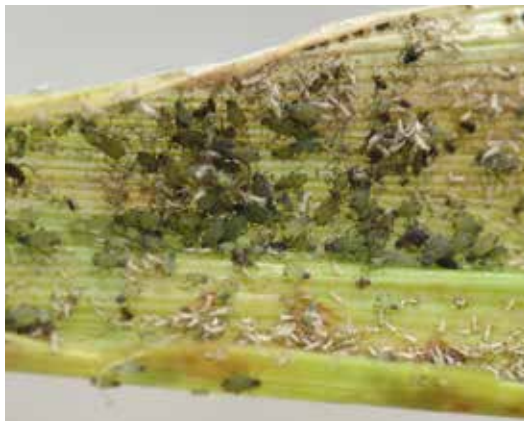
Aphids can generally be recognized by a pair of cornicles (tailpipe-like appendages at the posterior end of the body), pear-shaped body, and fairly long antennae.



Green peach aphid adults can be yellow to green in summer and vary from pale to dark-green, pink, or red in fall. David Cappaert, Bugwood.org



Green peach aphid winged adult. David Cappaert, Bugwood



Corn leaf aphids are bluish green or gray in color and can give plants a black, sooty appearance. Cami Cannon, Utah State University



Cabbage aphids are gray to green with a waxy covering and short cornicles. David Cappaert, Bugwood.org



Potato aphid adults can be pink or green in color. Joseph Berger, Bugwood.org



Melon/cotton aphid adults can be yellow, dark green, or almost black in color. Joseph Berger, Bugwood.org

Aphid Plant Hosts by Species and Season

Common Name	Winter Hosts	Summer Hosts
Cabbage Aphid	Only crucifers (crop residue and weeds)	Only crucifers including broccoli, cabbage, Brussels sprouts, cauliflower, and other plants in the mustard family (Brassicaceae)
Corn leaf aphid	Corn, barley, rye, oats, wheat, sorghum, millet, crabgrass, foxtail	Corn, barley, rye, oats, wheat, sorghum, millet, crabgrass, foxtail
Green peach aphid	Peach, apricot, nectarine, and rarely certain cherries and plums	Wide range including tomato, potato, pepper, eggplant, squash, pumpkin, cucumber, spinach, mustard greens, cabbage, broccoli, legumes, celery, okra, corn, and many ornamentals, weeds, and other vegetables
Melon/Cotton aphid	Catalpa, rose-of-sharon	Melon, cucumber, squash and related vine crops, pepper, eggplant, spinach, asparagus, okra, and many shrubs and weeds
Potato aphid	Rose	Potato, tomato, many of the same vegetable hosts as green peach aphid



Aphids on a chard leaf. Cami Cannon, Utah State University



Ear of corn damaged by a corn leaf aphid infestation. Cami Cannon, Utah State University



Parasitized aphid (black aphid in bottom, left corner of image) and aphid skins (upper right corner of image). Cami Cannon, Utah State University



Chlorotic (yellowing) leaves from an aphid infestation. Tiny white specks are aphid skins. Bonnie Bunn, Utah State University



Aphids feed on stems and fruits and can leave behind stippling. Cami Cannon, Utah State University



Aphid feeding can cause leaves to curl, making pesticide applications difficult. Cami Cannon, Utah State University

ASPARAGUS BEETLE

Asparagus Beetle (*Crioceris asparagi*)

Spotted Asparagus Beetle (*Crioceris duodecimpunctata*)

A: 5-6 mm long

L: 1.5-8 mm long



Hosts: asparagus

Appearance: Adults are brightly-colored leaf beetles. Asparagus beetle has four yellow spots and orange wing margins, and a bluish black head. Spotted asparagus beetle has a mostly orange body with six black spots on the forewings. Larvae are plump and brown with a dark head capsule.

Damage Symptoms: Adults and larvae feed with chewing mouthparts, consuming leaves and chewing pits in spears, causing distortions of growth. Large dark eggs may be laid on spears. Larvae chew on ferns, giving them a bleached appearance and reducing photosynthesis. Sometimes, large populations of beetles can reduce yields and kill plants.

Damaging Lifestage(s): Larva, Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2 generations (spotted) or 2-3 generations (asparagus) per season.
- Overwinter as adults in hollow asparagus stems, or under soil clods, loose tree bark, weeds, or other plant debris.

Time for Concern: Spring through summer.

When and Where to Scout:

- Adults and eggs first seen in approximately mid-May.
- Adults feed on spears as soon as they break through the soil surface in early spring.
- Larvae are found feeding on spears or burrowing into the soil (asparagus) or berry (spotted) to pupate.
- Eggs are found glued to asparagus spears.
- Scout plants for presence of beetles in the afternoon when they are most active.
- This pest is active from mid-May through the end of July.

Threat Level: The most serious damage is caused during the spring when adults are feeding on new spears. Occasional damage occurs during the summer, but rarely stunts growth or reduces yield. The spotted asparagus beetle prefers to eat asparagus berries and rarely causes damage to leaves and spears. Larval berry feeding is not economically important unless growing asparagus for seed.

Top Management Techniques:

- Remove volunteer asparagus.
- Minimize weeds or other debris near asparagus.
- Encourage predatory beetles and parasitoid wasps; avoid toxic chemicals.

When to Consider Treatment:

When persistent beetle damage occurs.

Look-alikes: none



Asparagus beetle (*Crioceris asparagi*) adults have dark bodies with red and white markings. Whitney Cranshaw Colorado State University Bugwood.org



Asparagus beetle eggs are cemented onto spears or ferns and are difficult to remove. Whitney Cranshaw Colorado State University Bugwood.org



Asparagus beetle larvae are plump and brown with a dark head capsule. Whitney Cranshaw, Colorado State University, Bugwood.org



Asparagus beetle feeding damage on asparagus ferns. Whitney Cranshaw Colorado State University Bugwood.org




Spotted asparagus beetle (*Crioceris duodecimpunctata*) adults are red to orange with dark spots. Bonnie Bunn, Utah State University




Asparagus beetle feeding damage. Whitney Cranshaw, Colorado State University, Bugwood.org

COLORADO POTATO BEETLE

Leptinotarsa decemlineata

A: 8.5-11.5 mm long 

L: 5.5-11 mm long 

Hosts: eggplant, nicotiana, pepper, petunia, potato, tomato, and weeds such as belladonna, buffalo bur, henbane, horse nettle, jimson weed, mullein, and thistle

Appearance: Adults are about the same size and shape as a lady beetle but with yellow and black stripes. Bright yellow to orange oval-shaped eggs are laid in clusters of about 20-45 on the undersides of leaves. Larvae are reddish in color with a bulbous-shaped body and two rows of black spots along the sides.

Damage Symptoms: Adults and larvae feed with chewing mouthparts and can defoliate plants. Symptoms include notch wounds along the leaf margin, ragged injuries, and dark frass on foliage.

Damaging Lifestage(s): Larva, Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2-3 generations per season.
- Overwinter as adults under plant debris and in the soil.

Time for Concern: Late April through potato vine-kill.

When and Where to Scout:

- Adults emerge in approximately May.
- Larvae begin to feed on leaves in June and prefer tops of plants.
- Begin scouting in mid-spring for feeding damage or the presence of adults, eggs, or larvae.

Threat Level: Adults and larvae can cause great damage to potato foliage. Potatoes in the vegetative stage can tolerate up to 30% defoliation, but when tubers start to bulk, plants can tolerate no more than about 10% defoliation.

Top Management Techniques:

- Rotate crops to non-solanaceous crops.
- Keep crop area free of solanaceous weeds.
- Application of insecticides may be needed; resistance is common so rotate insecticide groups.

When to Consider Treatment:

For potatoes, when there is one adult or larva per plant early in the season or at tuber bulking/after flowering when there are an average of 1.5 large larvae or adults per plant. **Note:** Colorado potato beetle has developed resistance to nearly every class of chemicals.

Look-alikes: none



Colorado potato beetle adults have black and yellow stripes and a shape similar to ladybugs. Cami Cannon, Utah State University



Colorado potato beetle eggs are bright yellow-orange and laid in clusters on the undersides of leaves. David Cappaert, Michigan State University, Bugwood.org



Colorado potato beetle Pest and Diseases Image Library Bugwood.org



Colorado potato beetle larvae are bulbous in shape, reddish to orange in color, and have black spots. Cami Cannon, Utah State University




Colorado potato beetles pupate in the soil after larval feeding. Whitney Cranshaw Colorado State University Bugwood.org




Colorado potato beetle larvae feed on potato foliage resulting in defoliation. Whitney Cranshaw Colorado State University Bugwood.org

CUCUMBER BEETLES

Spotted Cucumber Beetle (*Diabrotica undecimpunctata*)

A: 8-9 mm long 

Striped Cucumber Beetle (*Acalymma trivittatum*)

L: 8-13 mm long 

Hosts: beans, corn, cucurbits (squash, cucumbers, melons, etc.), potato, tomato, small grains, other grasses including weeds, and almost any type of flower

Appearance: Adults have a black head, legs, and antennae with yellowish green bodies and either black spots (spotted) or stripes (striped) on their wings. Larvae are worm-like with white to yellowish bodies, a brown head, and three pairs of brown legs.

Damage Symptoms: Adults of both species chew on fruits, stems, leaves, and flowers. Larvae of only the striped cucumber beetle may tunnel roots (reducing plant stands and stunting or killing plants) and may also feed on fruit rinds that touch the soil.

Damaging Lifestage(s): Larva (striped), Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2 generations per season.
- Overwinter as adults in protected outdoor areas.

Time for Concern: Entire season, but especially when plants are small.

When and Where to Scout:

- Adults become active at temperatures above 50°F in the spring.
- Striped cucumber beetle larvae feed on roots and fruits touching the soil.
- Adults of both species feed on stems, leaves, flowers, and immature fruit.
- Visually scout newly emerged or transplanted cucurbits for feeding injury or presence of adults or eggs.
- Monitor with yellow sticky cards.

Threat Level: The striped cucumber beetle causes more damage in Utah than the spotted cucumber beetle. Feeding damage is of most concern when plants are in the cotyledon and first through third true-leaf stages. After these stages, several cucurbits can tolerate high levels of defoliation.

Top Management Techniques:

- Keep crop area weed free.
- Use floating row covers.
- Use plastic or organic mulches and drip irrigation.
- Destroy crop residues after harvest.
- Lure beetles away with trap crops.
- Application of insecticides may be needed.

When to Consider Treatment:

When two or more beetles are found per plant on 25% of plants.

Look-alikes: western corn rootworm



Spotted cucumber beetle adults have yellowish green wings with black spots. Bonnie Bunn, Utah State University



Striped cucumber beetle adults have yellow wings with black strips. Bonnie Bunn, Utah State University



Cucumber beetle eggs. Gerald Holmes California Polytechnic State University at San Luis Obispo Bugwood.org



Cucumber beetle larva in cantaloupe rind. Whitney Cranshaw, Colorado State University, Bugwood.org



Cucumber beetle larval damage on a melon fruit. Diane Alston, Utah State University



Cucumber beetle adult scarring on a melon fruit. Diane Alston, Utah State University



Striped cucumber beetle feeding damage of a cucurbit leaf. Whitney Cranshaw, Colorado State University, Bugwood.org



Striped cucumber beetle infestation on a pumpkin flower. Howard F. Schwartz, Colorado State University, Bugwood.org

FLEA BEETLES

Tribe: *Alticini*

A: 1.6-3.2 mm long ●

Hosts: cole crops, edible greens, tomato, eggplant, pepper, beets, potato, melons, seedlings, and many weeds

Appearance: Adults jump when disturbed with large hind legs and their metallic bodies range in color from black, bronze, bluish, brown, or gray, with stripes in some species. Larvae are small, white, and worm-like with a brown head.

Damage Symptoms: Adults and larvae feed with chewing mouthparts. Adult feeding causes shallow pits and small, round holes in foliage, cotyledons, and stems. Larvae feed on roots and tunnel into root vegetables (e.g. potatoes, carrots) leaving shallow winding grooves and tunnels that may be filled with frass.

Damaging Lifestage(s): Larva (tuber flea beetles in potato), Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- 1-3 generations per season.
- Overwinter as adults on weeds.

Time for Concern: Early April through August and early stages of plant development.

When and Where to Scout:

- Adults emerge from early April to mid-June.
- Adults can be found feeding on the foliage of host plants.
- Monitor seedlings in spring for flea beetle presence or round holes in leaves.
- Use yellow sticky cards and visual scouting when seedlings emerge.
- Inspect crops for adult flea beetle injury near field borders with cruciferous weeds.

Threat Level: Flea beetles are an annual problem in the early spring and can cause cosmetic damage and/or stunt or kill small plants. Flea beetles are especially harmful during cool springs when plants cannot outgrow damage. Tuber flea beetle larvae can cause severe tunneling in potato tubers; summer management is necessary to prevent tuber damage.

Top Management Techniques:

- Keep crop area weed free.
- Plant trap crops.
- Use row covers during seedling establishment.
- Eliminate old crop debris and other surface trash.
- Application of insecticides may be needed.

When to Consider Treatment:

In seedlings, when there are 1-5 flea beetles per plant or defoliation reaches 10-30%.

Look-alikes: none



Flea beetle adults, feeding damage, and excrement on kale. Cami Cannon, Utah State University



Flea beetle adults, feeding damage, and excrement on arugula. Bonnie Bunn, Utah State University



Flea beetle adult. Cami Cannon, Utah State University



Striped flea beetle adult. Bonnie Bunn, Utah State University



Flea beetle adult. Bonnie Bunn, Utah State University



Tuber flea beetle adult. Mike Quinn, TexasEnto.net



Tuber flea beetle larval tunneling in potato tuber. Whitney Cranshaw, Colorado State University, Bugwood.org



Tuber flea beetles can damage potato foliage and tubers. Art Cushman, USDA Systematics Entomology Laboratory, Bugwood.org



Flea beetles have metallic bodies and enlarged hind legs. Cami Cannon, Utah State University

SAP BEETLES

Corn Sap Beetle (<i>Carpophilus dimidiatus</i>).....	A: 1.6-3.2 mm long	
Dusky Sap Beetle (<i>Carpophilus lugubris</i>).....	A: 2.8-4.5 mm long	
Picnic Beetle (<i>Glischrochilus quadrisignatus</i>).....	A: 4-7 mm long	

Hosts: corn, tomato, melons, most overripe fruits and vegetables

Appearance: Adults are small, dark beetles with club shaped-antennae that may have colored wing markings depending on the species. Larvae are white to cream with a brown head and three pairs of short legs near the head.

Damage Symptoms: Adults and larvae feed with chewing mouthparts on fruits and vegetables. Adults feed on corn silk and pollen, and chew on tassels. Dusky sap beetle larvae chew on developing kernels, although there is rarely any external evidence of infestation. Sap beetles are attracted to ripe, damage, or overripe fruits and vegetables.

Damaging Lifestage(s): Larva, Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- Several generations per season.
- Overwinter as adults in protected places such as decaying vegetation, debris, or in soils.

Time for Concern: When corn is tasseling or host crops are overripe or damaged.

When and Where to Scout:

- Eggs are laid in April to early May on or near decomposing plant material or in the soil.
- Sap beetles are attracted to sweet corn as it tassels and often prefer damaged ears.
- Adults feed on corn silk and pollen and chew on tassels.
- Larvae attack and feed on kernels in the upper half of the ear.

Threat Level: Sap beetles are typically secondary pests of corn, but can act as primary pests if populations are high. Super sweet corn varieties and damaged or overripe crops are particularly susceptible to sap beetle damage.

Top Management Techniques:

- Prevent damage from other primary pests (corn earworm, European earwig).
- Harvest host crops promptly when ripe; remove decayed and damaged corn ears and fruits.
- Use bait/pheromone traps to monitor and reduce populations.
- Disk or plow crops immediately after harvest.

When to Consider Treatment:

Insecticides are generally inappropriate because sap beetles invade crops near harvest and control with insecticides is difficult because adults and larvae are protected inside the ear.

Look-alikes: none



Sap beetles are tiny beetles that feed on over-ripe corn and other vegetables. Marion Murray, Utah State University



Dusky sap beetle (*Carpophylus lugubris*) adult on melon fruit. Whitney Cranshaw, Colorado State University, Bugwood.org



Picnic beetle (*Glischrochilus quadrisignatus*) Don Magnusson



Corn sap beetle (*Carpophylus dimidiatus*) adult. Pest and Diseases Image Library, Bugwood.org



Sap beetle larvae damaging kernels of an ear of corn. Eugene E. Nelson, Bugwood.org



Dusky sap beetle larvae on corn. Marion Murray, Utah State University

WESTERN CORN ROOTWORM

Diabrotica virgifera

A: 4.4-6.8 mm long 

L: 3.2-13 mm long 

Hosts: Larvae feed solely on roots of corn and a few related grasses while adults feed on corn silk, flowers (especially cucurbits), and foliage of a wide variety of plants.

Appearance: Adults are small beetles with yellow-green bodies and three black stripes on the forewings. Larvae are creamy white with a brown head capsule.

Damage Symptoms: Larvae feed with chewing mouthparts on roots causing browning, lesions, tunneling, curved cornstalks (goosenecking), yield losses, and susceptibility to root and stalk diseases. Adults feed with chewing mouthparts, resulting in poorly-filled ears.

Damaging Lifestage(s): Larva, Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- 1 generation per year.
- Overwinter as eggs in the soil.

Time for Concern: Early June to mid-July.

When and Where to Scout:

- Monitor adults with yellow sticky traps; check and replace traps weekly.
- Larvae are present from early June to mid-July.
- Adults are present from mid-July to mid-August.

Threat Level: Larval feeding is the most damaging, while adult feeding will not typically result in economic loss.

Top Management Techniques:

- Rotate corn crops.
- Plant early.
- Select varieties with vigorous root systems that are well adapted to the area.

When to Consider Treatment:

If adults exceed 35 per trap per week in continuous corn (fields where corn is planted for two or more consecutive years), treat the following year.

Look-alikes: cucumber beetles



Western corn rootworm adults. Whitney Cranshaw, Colorado State University



Western corn rootworm adult on pumpkin rind. Jim Jasinski, Ohio State University Extension, Bugwood.org



Western corn rootworm life cycle. Jim Kalisch UNLorg



"Gooseneck" symptom caused by western corn rootworm. Bryan Jensen, University of Georgia, Bugwood.org



Western corn rootworm damage. Eric Burkness, Bugwood.org

WIREWORMS

Ctenicera spp.

Limonius spp.

A: 6.4-12.7 mm long



L: 12.7-38 mm long



Hosts: Seeds and roots of a wide variety of plants. Most commonly affected root crops include potato, carrot and sweet potato.

Appearance: Adults are known as click beetles (a hinge-like mechanism between the thorax and abdomen creates a clicking noise) with a black to brown hard-shell body. Larvae are wiry with a light brown, slightly hard, elongate body.

Damage Symptoms: Larvae tunnel through germinating seeds, roots, and other belowground plant parts. Tunneling degrades the quality of root crops and seedlings may be killed.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- Variable generations per year.
- Overwinter as adults in the soil.

Time for Concern: Throughout the season.

When and Where to Scout:

- Adults emerge in late April to early May in northern Utah.
- Inspect the soil surface for wireworms after plowing or disking fields.
- Baits (carrots, untreated corn or wheat seed, ground whole wheat flour) can be used to detect wireworm larvae. Place two bait stations per acre, 4-6 inches deep in the soil, when soil temperatures are at 50°F and check for wireworms just prior to planting.

Threat Level: Wireworm injury is uncommon, but there have been a few problems in Utah. Once present in a field, wireworms can be difficult to eradicate.

Top Management Techniques:

- Crop rotation.
- Remove dead plants and tubers throughout the season and at harvest.
- Maintain healthy soils.

When to Consider Treatment:

If there are one or more larvae per bait station.

Look-alikes: none



Wireworm damage to a carrot. Doug Young Professor Emeritus of Washington State University



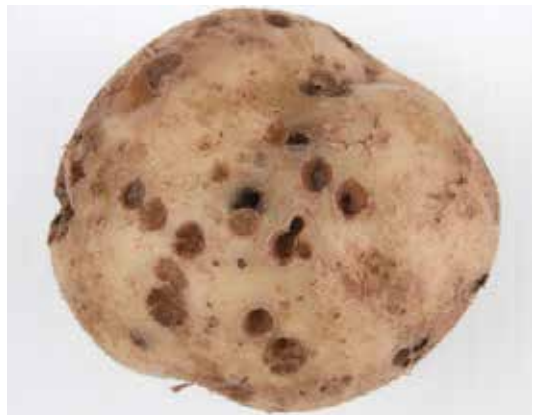
Wireworm pupa and larva. Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA)



Wireworm adult, eggs, larva, pupa, and damage to carrot, potato, and onion. Art Cushman, USDA Systematics Entomology Laboratory, Bugwood.org







Wireworm adult. Pavel Kirillov



Wireworm damage to potato tuber. Ontario Crop IPM, OMAFRA

ARMYWORM

Beet armyworm..... (<i>Spodoptera exigua</i>)	A: 25-30 mm wingspan.....	L: 1-30 mm 
Bertha armyworm..... (<i>Mamestra configurata</i>)	A: 40 mm wingspan.....	L: 3-40 mm 
Fall armyworm..... (<i>Spodoptera frugiperda</i>)	A: 31-38 mm wingspan.....	L: 1.7-34.2 mm 
Western yellowstriped armyworm.... (<i>Spodoptera praefica</i>)	A: 34-41 mm wingspan.....	L: 2-40 mm 

Hosts: alfalfa, artichoke, asparagus, beans, beets, broccoli, Brussels sprouts, cabbage, carrot, cauliflower, celery, collards, corn, cucumber, garlic, kale, lettuce, melon, onion, parsley, parsnip, pea, pepper, potato, radish, rhubarb, spinach, sweet potato, Swiss chard, tomato, grassy weeds and crops, and many herbaceous ornamentals and weeds

Appearance: Adults are mottled gray and brown moths with light-colored markings. Larvae vary in color from tan, green, and almost black.

Damage Symptoms: Larvae feed on leaves with chewing mouthparts, causing skeletonized foliage, irregular holes, shredded leaves, or defoliation. Larvae may tunnel into corn ears, bore into the head of leafy vegetables, and chew into stems, flower buds, and sometimes upper plant roots.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva (6-9 stages) | Pupa | Adult (moth)
- 1-3 generations per growing season.
- Overwinter as pupae in the soil.

Time for Concern: Mid-July through September.

When and Where to Scout:

- Monitor adults (fall and beet armyworms) with pheromone traps, starting in June.
- Eggs are found on leaves of crops or weeds.
- Young larvae are found near the egg mass, or in groups on host plants.
- Maturing larvae disperse and move towards the center of the plant, or may be seen in the soil.

Threat Level: Corn may be regularly attacked while other vegetables are only occasionally attacked depending on the armyworm species and host plant. In dense, crowded populations, armyworms migrate and may completely defoliate crops.

Top Management Techniques:

- Keep crop area weed-free (especially grassy weeds).
- Till in the fall.
- Application of insecticides; Bt and spinosad are effective on young caterpillars.

When to Consider Treatment:

- For corn seedlings, if 25% of plants show damage and live larvae are still present.
- If armyworms move into fields and infest crop areas.

Look-alikes: cutworms, corn earworm



Beet armyworm adult. Paul Harris, Bugwood.org



Bertha armyworm adult. Hanna Royals, Screening Aids, USDA APHIS ITP, Bugwood.org



Fall armyworm adult. Robert J. Bauernfeind Kansas State University Bugwood.org



Western yellowstriped armyworm adult. Jim Moore



Beet armyworm larva. John Capinera, University of Florida, Bugwood.org



Bertha armyworm larva. David Gent, USDA Agricultural Research Service, Bugwood.org



Fall armyworm larvae have a distinct inverted 'Y' on the front of the head. Phil Sloderbeck, Kansas State University, Bugwood.org



Western yellowstriped armyworm larva. Khazelbaker

ARMYWORM (CONT.)

Beet armyworm..... (<i>Spodoptera exigua</i>)	A: 25-30 mm wingspan.....	L: 1-30 mm
Bertha armyworm..... (<i>Mamestra configurata</i>)	A: 40 mm wingspan.....	L: 3-40 mm
Fall armyworm..... (<i>Spodoptera frugiperda</i>)	A: 31-38 mm wingspan.....	L: 1.7-34.2 mm
Western yellowstriped armyworm.... (<i>Spodoptera praefica</i>)	A: 34-41 mm wingspan.....	L: 2-40 mm

CATERPILLARS
/ MOTHS



Fall armyworm pupa. Matt Bertone North Carolina State University 2014



Fall armyworm egg mass. Ronald Smith, Auburn University, Bugwood.org



Beet armyworm egg mass. Ronald Smith, Auburn University, Bugwood.org



Beet armyworm egg mass hatching. Alton N. Sparks, Jr., University of Georgia, Bugwood.org



Beet armyworm damage to sweet pepper. David Riley, University of Georgia, Bugwood.org



Armyworm damage. David Riley, University of Georgia, bugwood.org



Beet armyworm damage on onion. Bob Hammon, Colorado State University, Bugwood.org State University 2014



Fall armyworm larva in corn whorl and damage. University of Georgia, University of Georgia, Bugwood.org



Fall armyworm damage to corn ear. Billy R. Wiseman, USDA Agricultural Research Service, Bugwood.org




Beet armyworm larva, excrement, and leaf injury to pepper. Whitney Cranshaw, Colorado State University, Bugwood.org

CABBAGE LOOPER

Trichoplusia ni

A: 33-38 mm wingspan 

L: 30.5-40.6 mm long 

Hosts: brassicas, beet, celery, cucumber, lettuce, lima bean, parsnip, pea, pepper, potato, snap bean, spinach, squash, sweet potato, tomato, nasturtium, carnation, and weeds such as curly dock, dandelion, lambsquarters, and wild lettuce

Appearance: Adults are grayish brown semi-nocturnal moths with a silver “8” on each wing. Caterpillar larvae arch their body into a loop as they move and are pale to dark green with few sparse hairs on their body. Pupae form a fuzzy cocoon on leaves, plant debris, and soil.

Damage Symptoms: Larvae feed with chewing mouthparts causing “window panes” and/or ragged holes in leaves and sometimes serious defoliation. Larval bodies and frass contaminate harvested brassicas.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 1-3 generations per season.
- Overwinter as pupae on leaves, plant debris, and soil.

Time for Concern: Mid-July through harvest. Strong winds from southern locations may suddenly increase populations while cold, wet weather will reduce populations. Damage typically occurs after head formation begins in brassicas, but caterpillars sometimes attack seedling plants.

When and Where to Scout:

- Monitor with pheromone traps starting in mid-July.
- Scout plantings for eggs and larvae and feeding damage on the undersides of leaves (especially innermost leaves).
- Examine at least 10% of the crop, checking random interior and edge areas.

Threat Level: Cabbage looper is a common pest of home gardens and has a broad host range. Feeding damage and contamination (larval body or frass) are of most concern in brassicas.

Top Management Techniques:

- Use row covers.
- Remove plant debris at the end of the growing season.
- Hand-pick and destroy larvae.
- Application of insecticides; Bt and spinosad are effective.

When to Consider Treatment:

- For head-forming plants, when 1 larva has been found in 25-50 plants or when 10% of plants have at least 1 larva.
- Non-head forming plants can tolerate a higher population.

Look-alikes: diamondback moth (larva, pupa), imported cabbageworm (larva)



Cabbage looper adult moth; note the silvery figure-8 on the front wings. Keith Naylor, Bugwood.org



Cabbage looper eggs are small, yellow, and round. Whitney Cranshaw, Colorado State University



Close-up of cabbage looper egg. Whitney Cranshaw, Colorado State University, Bugwood.org



Cabbage looper larva or caterpillar; note the loop-like crawling. Bonnie Bunn, Utah State University



Cabbage looper pupa exposed from cocoon. Whitney Cranshaw, Colorado State University



Cabbage looper feeding damage. John C. French Sr., Retired, Universities:Auburn, GA, Clemson and U of MO, Bugwood.org

CORN EARWORM (TOMATO FRUITWORM)

Helicoverpa zea

A: 38 mm wingspan

L: 1.5-38 mm long



Hosts: artichoke, asparagus, cabbage, cantaloupe, collards, corn, cucumber, eggplant, lettuce, lima bean, melon, okra, pea, pepper, potato, pumpkin, snap bean, spinach, squash, sweet potato, tomato, watermelon, weeds such as common mallow, lambsquarters, pigweed, purslane, ragweed, sunflower, other weeds, and many field crops, fruits, and flowers

Appearance: Adults are tannish brown moths that are most active at dusk. Larvae are brown-headed caterpillars with green, brown, or black bodies.

Damage Symptoms: Larvae chew into corn kernels near the ear tip, leave behind frass, and/or chew on silks, decreasing pollination and leading to poor ear-fill. Larvae also feed on leaves and reproductive structures of other host crops and can bore deeply into fruit causing premature fruit ripening.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 3 generations per year in northern Utah.
- 4 or more generations per year in southern Utah.
- Overwinter as pupae in the soil in central and southern Utah.

Time for Concern: Mid-July through harvest.

When and Where to Scout:

- Dispersing adults are first seen as early as May or as late as August.
- In corn, monitor adult moths with a *Heliothis* trap.
 - Place trap by early June along edge of corn field, and move it throughout the season to keep it near fresh corn silk.
 - Check twice weekly until first catch, then check daily for best results.

Threat Level: Corn earworm is the most destructive insect pest of sweet corn in Utah. Corn is strongly preferred, but tomato and pepper may also be attacked.

Top Management Techniques:

- Plant resistant corn varieties with long, tight husks.
- Plant corn early and harvest before 1300 DD50 (about Jul 20-Aug 5).
- Till soil in the fall.
- Application of insecticides in corn, based on trap catches (apply before larvae enter corn ears).

When to Consider Treatment:

In corn, calculate average # of moths caught per night in *Heliothis* trap and follow threshold guidelines found in the *Utah Vegetable Production and Pest Management Guide* to decide when to take treatment action.

Look-alikes: cutworms, armyworms



Corn earworm adult. Utah State University



Corn earworm eggs on corn silk.



Typically, corn ears never have more than one corn earworm.



Corn earworm larva and corn damage. Utah State University



Corn earworm feeding through corn husk. Utah State University



Corn earworm feeding damage. Utah State University

CUTWORMS

Army Cutworm (<i>Euxoa auxiliaris</i>)	A: 35-45 mm wingspan	L: 1.5-50 mm
Black Cutworm (<i>Agrotis ipsilon</i>)	A: 40-55 mm wingspan	L: 3-50 mm
Glassy Cutworm (<i>Crymodes devastator</i>)	A: 35-40 mm wingspan	L: 2-40 mm
Pale Western Cutworm (<i>Agrotis orthogonia</i>)	A: 30-38 mm wingspan	L: 3.2-38 mm
Variegated Cutworm (<i>Peridroma saucia</i>)	A: 38-56 mm wingspan	L: 2-45 mm

Hosts: Nearly all vegetables, alfalfa, clover, sorghum, strawberry, sometimes grains and grasses, and weeds such as curly dock, lambsquarters, pigweed

Appearance: Larvae are dull gray to brown caterpillars that curl into a 'C' when disturbed.

Damage Symptoms: Larvae feed with chewing mouthparts and can clip off seedlings at the soil line reducing stands. Later in the season, fruit and foliage may be damaged.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2 overlapping generations of black and variegated cutworms per year.
- 1 generation of army, pale western, and glassy cutworms per year.
- Overwinter as larvae in the soil or under plant debris.

Time for Concern: Cutworms are most active and cause the most damage during spring and early summer months.

When and Where to Scout:

- Larvae can be seen as early as late January into April.
- Look for seedlings (especially beans) cut off near the soil and use a trowel to look for larvae in the soil nearby.
- Look for wilted plants that may indicate stem feeding injury.
- Later in the season, monitor plants for foliage damage.
- Pheromone traps can be used to monitor adult male moths.

Threat Level: Cutworms infestations are sporadic.

Top Management Techniques:

- Remove cool-season weeds along field edges (e.g. lambsquarters and wild mustards).
- Fall tillage can help destroy or expose overwintering pupae.
- Focus on fields with an early season weed infestation, and those planted late.
- Protect seedlings with cardboard collars.

When to Consider Treatment:

If chronic cutworm infestations have been experienced, or large numbers of overwintering cutworms are observed.

Look-alikes: armyworms, corn earworm



Army cutworm larva. Frank Peairs, Colorado State University, Bugwood.org



Black cutworm larva. Adam Sisson, Iowa State University, Bugwood.org



Glassy cutworm larva. Joseph Berger, Bugwood.org



Pale western cutworm larva. Frank Peairs, Colorado State University, Bugwood.org



Variegated cutworm larva. Frank Peairs, Colorado State University, Bugwood.org



Cutworm eggs and newly hatched larvae. Charles Olsen, USDA APHIS PPQ, Bugwood.org



Cutworm moths have varied wing patterns and wingspans. John Capinera, University of Florida, Bugwood.org



Cutworm larvae feed at the soil surface and can cut off the stems of young plants. Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

DIAMONDBACK MOTH

Plutella xylostella

A: 12-15 mm wingspan

L: 1.7-11.2 mm long



Hosts: brassicas including broccoli, Brussels sprouts, cabbage, cauliflower, Chinese cabbage, collards, kale, kohlrabi, mustard, radish, rutabaga, turnip, watercress, and many related weeds

Appearance: Adults are slender, grayish brown moths with distinct diamond-shape markings on the back and are most active at night. Eggs are small, relatively flat, yellowish-white and laid singly or in groups. Larvae are pale yellow-green and have a habit of wriggling vigorously or dropping from a plant on a string of silk when disturbed.

Damage Symptoms: Larvae feed with chewing mouthparts causing “window panes” and/or ragged holes in leaves and sometimes serious defoliation. Larval bodies and frass contaminate harvested brassicas.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 4-6 overlapping generations per year.
- Overwinter as adults in warmer, southern locations.

Time for Concern: Early May through harvest. Strong winds from southern locations may suddenly increase populations while cold, wet weather may reduce populations. Damage typically occurs after head formation begins in brassicas, but caterpillars sometimes attack seedling plants.

When and Where to Scout:

- Monitor for adults with pheromone traps starting in mid-spring.
- Larvae can be found feeding on the undersides of leaves.
- Eggs are found on the undersides of leaves or lower stalks.
- Scout for larvae, pupae, and feeding injury on leaves of susceptible plants at the seedling stage, during crop thinning, and just before crop head formation.

Threat Level: Diamondback moth is the primary caterpillar pest in commercial brassica crops, and rarer in home gardens. Feeding damage and contamination (larval body or frass) are of most concern in brassicas. Damage is variable from year-to-year but can be serious.

Top Management Techniques:

- Heavy irrigation can reduce early larval populations.
- Use row covers on susceptible crops.
- Hand pick and destroy larvae.
- Application of insecticides; Bt and spinosad are effective.

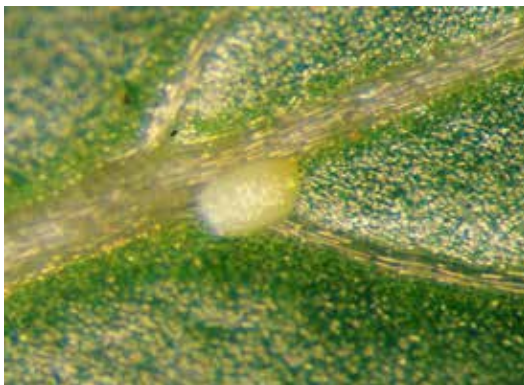
When to Consider Treatment:

When 5% of susceptible crops are infested with larvae and before they move into crop heads or broccoli and cauliflower buds.

Look-alikes: cabbage looper (larva, pupa), imported cabbageworm (larva)



Diamond back moth adult. David Cappaert, Bugwood.org



Diamond back moth egg. Whitney Cranshaw Colorado State University Bugwood.org



Diamond back moth larva. Cami Cannon, Utah State University



Diamond back moth pupa and "window pane" feeding damage. Cami Cannon, Utah State University



Diamond back moth damage on cabbage; note the ragged holes and smaller cabbage head (right). Diane Alston, Utah State University



Diamondback moth larva, feeding damage, and excrement. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org

IMPORTED CABBAGEWORM

(CABBAGE WHITE BUTTERFLY)

Pieris rapae

A: 45-65 mm wingspan

L: 3.2-30 mm long



Hosts: brassicas including broccoli, Brussels sprouts, cabbage, and many related weeds

Appearance: Adults are white-yellow butterflies, active during the day and often seen fluttering above crops during the summer. Eggs are small, yellow, rocket-shaped, and usually found on brassica leaves. Larvae are green, sluggish caterpillars with a fuzzy body due to short hairs.

Damage Symptoms: Larvae feed with chewing mouthparts causing “window panes” and/or ragged holes in leaves and sometimes serious defoliation. Larval bodies and frass contaminate harvested brassicas.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 3-4 generations per season.
- Overwinter as pupae on leaves and occasionally on debris.

Time for Concern: Early June through September.

When and Where to Scout:

- Watch for white butterflies during the day.
- Beginning at the button stage (before cauliflower and broccoli heads begin to elongate and expand) examine 10 leaves from 10 different plants at 10 different locations of the field.
- Look for small larvae and eggs on the undersides of leaves and larger caterpillars toward the center of the plant or near the midribs of leaves.
- Feeding damage and frass (excrement) are also signs of an infestation.

Threat Level: Imported cabbageworm is a common pest of home gardens. Feeding damage and contamination (larval body or frass) are of most concern in brassicas.

Top Management Techniques:

- Use row covers.
- Remove plant debris at the end of the growing season.
- Hand-pick and destroy larvae.
- Application of insecticides; Bt and spinosad are effective.

When to Consider Treatment:

If 2 or more medium-sized larvae are found per 10 leaves at the button stage, two sprays will be needed: 1) a spray at button stage and 2) a clean-up spray 7-10 days before harvest. Organic options are available.

Look-alikes: diamondback moth (larva), cabbage looper (larva)



Imported Cabbageworm adult. Cami Cannon, Utah State University



Imported Cabbageworm eggs are rocket-shaped and yellow in color. Bonnie Bunn, Utah State University



Imported Cabbageworm larva. Utah State University



Imported Cabbageworm pupa. Whitney Cranshaw Colorado State University Bugwood.org



Imported Cabbageworm damage. Whitney Cranshaw, Colorado State University, Bugwood.org




Imported Cabbageworm adult and damage on cabbage. Ward Upham, Kansas State University, Bugwood.org

TOMATO & TOBACCO HORNWORM


Tomato Hornworm (*Manduca quinquemaculata*)

Tobacco Hornworm (*Manduca sexta*)

A: 100-120 mm wingspan



L: 6.7-81.3 mm long



Hosts: tomato, pepper, potato, and others such as some nightshade family weeds and tobacco

Appearance: Adults are large moths also known as sphinx, hawk, or hummingbird moths. Larvae are large, cylindrical and usually green in color. **Tomato hornworm** larvae have eight white “v” shaped marks along each side and a black horn at the end of its body. The **tobacco hornworm** has seven diagonal white stripes along its body and a horn at the end of its body that is usually orange or red.

Damage Symptoms: Larvae use chewing mouthparts to feed primarily on leaves, but will also eat blossoms, stems, and fruits, leaving behind dark green or black frass. Larvae can defoliate plants and scar fruit, especially when populations are high.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 1-2 generations per year.
- Overwinter as pupae in the soil.

Time for Concern: July until the end of the season.

When and Where to Scout:

- Larval populations peak in mid-summer.
- Start monitoring in early July.
- Larvae are easiest to see when actively feeding near dusk and dawn.
- Visually monitor plants for feeding damage, defoliation, larvae, dark droppings, or fruits with large, deep, cavities.

Threat Level: Hornworm populations often do not cause economic injury due to predation from natural enemies. However, localized plant defoliation in backyard gardens or in high tunnels can occur.

Top Management Techniques:

- Plow field after harvest to destroy pupae.
- Rotate crops.
- Larvae can be handpicked.
- Spot treat infected plants; Bt and spinosad are effective.

When to Consider Treatment:

If larvae are causing extensive defoliation, or if they are feeding on fruit.

Look-alikes: whitelined sphinx larvae (which rarely causes significant damage)



Tomato hornworm adult. Utah State University



Newly hatched tomato hornworm larva. Cami Cannon, Utah State University



Tomato hornworm larva feeding on a partially defoliated tomato plant. Utah State University



Tomato hornworm feeding damage on tomato plant; note dark excrement next to the plant. Utah State University



Tomato hornworm larva and feeding damage on tomato fruit. Utah State University




Tobacco hornworm larvae. Eddie McGriff, University of Georgia, Bugwood.org




Tobacco hornworm feeding damage. John C. French Sr., Retired, Universities: Auburn, GA, Clemson and U of MO, Bugwood.org

EUROPEAN EARWIG

Forficula auricularia

A: 13-14 mm long 

N: 4.2-11 mm long 

Hosts: Wide host range including beans, beets, cabbage, cauliflower, celery, chard, corn, cucumber, lettuce, pea, potato, rhubarb, tomato, flower petals, as well as other insects and organic matter

Appearance: Adults are slender with a brown body, red-brown head, and a prominent pair of “pinchers” (cerci) on the rear of the body. European earwigs are omnivores, feeding on a diverse diet including plants, fungal spores, small invertebrates, and decaying organic matter.

Damage Symptoms: Earwigs feed on buds, flowers, fruits, corn silks (and some corn kernels), tender vegetable seedlings, and leaves causing direct plant damage, reduced crop yields, and aesthetic injury. They like to crawl into tight, dark places to spend the day making them an unwanted presence in harvested fruits, vegetables and flowers.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph (4 stages) | Adult
- 2 or more generations per year.
- Overwinter as brooding pairs or above ground in aggregations.

Time for Concern: Populations tend to build to their highest densities in mid- to late summer.

When and Where to Scout:

- Place boards, corrugated cardboard, rolled-up or crumpled moistened newspaper, or bait containers (e.g. tuna can, yogurt container) with smelly oils (e.g. clam oil, bacon grease) in crop areas early spring and monitor weekly.
- Adults like to hide in dark, tight, and moist places during the daytime and may seek shelter inside buildings.
- Eggs are laid in clusters of 30-40 within nests in the soil.

Threat Level: It is more abundant in highly irrigated or mulched areas.

Top Management Techniques:

- Only manage when there is unacceptable crop damage.
- Use traps to monitor and reduce numbers.
- Reduce or remove nesting and hiding places.

When to Consider Treatment:

Since European earwigs can be both beneficial and detrimental to crops, only consider treatment when there is unacceptable crop damage.

Look-alikes: none



European earwig adult. Males have strongly curved forceps (tip of abdomen). David Cappaert, Bugwood.org



European earwig adult. Females forceps at the tip of the abdomen are only slightly curved. David Cappaert, Bugwood.org



Earwig adults like to hide in dark, tight, and moist places during the daytime. Bonnie Bunn, Utah State University



Earwig feeding damage on cabbage. Bonnie Bunn, Utah State University



European earwig adult male. Whitney Cranshaw, Colorado State University, Bugwood.org



European earwig feeding damage on common mallow. Whitney Cranshaw, Colorado State University, Bugwood.org







European earwigs in Allium flower at night. Whitney Cranshaw, Colorado State University, Bugwood.org



European earwig pitfall trap with canola oil. Whitney Cranshaw, Colorado State University, Bugwood.org

EARWIGS

GRASSHOPPERS

Differential Grasshopper.....A: 44.5 mm long (<i>Melanoplus differentialis</i>)	
Migratory Grasshopper.....A: 25.4 mm long (<i>Melanoplus sanguinipes</i>)	
Redlegged Grasshopper.....A: 25.4-38.1 mm long (<i>Melanoplus femurrubrum</i>)	
Twostriped Grasshopper.....A: 31.8-50.8 mm long (<i>Melanoplus bivittatus</i>)	

Hosts: Almost all vegetable plants

Appearance: Adults and nymphs have a robust body, hind legs with enlarged femurs for long-distance jumping, and relatively short antennae.

Damage Symptoms: Adults and nymphs feed with chewing mouthparts causing random, ragged holes in leaves, flowers, and sometimes immature pods and fruit.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph (5 stages) | Adult
- Most species in Utah have 1 generation per year.
- Overwinter as eggs within pods in the soil.

Time for Concern: Damage occurs starting in early summer after rangeland weeds dry up and may continue all season.

When and Where to Scout:

- Eggs hatch from late May to early July.
- Look for nymphs from late May to early July to determine when eggs have hatched.
- Watch for ragged holes in plants.

- Number of grasshoppers present in late summer and early fall can be a good indicator of problems the subsequent year.

Threat Level: Utah's grasshopper populations fluctuate from year to year. Large populations can be economically damaging but outbreaks are hard to predict.

Top Management Techniques:

- Manage nymphs with bait before the majority of the population is more than 1/2 grown.
- Encourage area-wide control.
- Protect crops with floating row covers.
- Till soil in and near plantings to discourage egg-laying.
- Application of baits, dusts, and sprays may be needed.

When to Consider Treatment:

During periods when a local outbreak develops, control usually involves using sprays or baits. Apply in spring and early summer when nymphs are young and concentrate at sites where egg laying occurs. Area wide (multiple-farm) control is most effective.

Look-alikes: none



Differential grasshopper adult. David Cappaert, Bugwood.org



Migratory grasshopper adult. Joseph Berger, Bugwood.org



Redlegged grasshopper adult. Russ Ottens, University of Georgia, Bugwood.org



Twostriped grasshopper adult. Whitney Cranshaw Colorado State University Bugwood.org



Grasshopper eggs. John Gavloski Entomologist, Manitoba



Grasshopper nymph. Cami Cannon, Utah State University



Grasshopper feeding damage. Cami Cannon, Utah State University



Grasshopper feeding damage. Cami Cannon, Utah State University

GRASSHOPPERS

BEET LEAFHOPPER

Circulifer tenellus

A: 3 mm long ●

Hosts: beans, beets, borage, cucumber, flax, gourds, melon, pepper, potato, pumpkin, spinach, Swiss chard, tomato, and weeds such as filaree, kochia, lambsquarters, mustard family weeds, pepperweed, pigweed, plantain, rabbitbrush, Russian thistle, sagebrush, shepherd's purse, and verbena

Appearance: Adults and nymphs jump when disturbed and have wedge-shaped bodies varying in color from pale green, gray, or tan. Adults are winged, but not nymphs.

Damage Symptoms: Adults and nymphs feed with piercing sucking mouthparts which can cause shriveled and burned leaves under severe infestations. The beet leafhopper can transmit curly top virus to beans, beets, cucurbits, flax, pepper, potato, spinach, squash, Swiss chard, and tomato. Curly top virus symptoms include small twisted leaves with purple veins, thickened crisp leaves, yellowing and death of mature leaves, small fruits that ripen prematurely, reduced fruit quality and yield, and stunted growth. (see Curly top virus on pg. 140-141).

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph | Adult
- Multiple generations per growing season.
- Overwinter as adults on weeds and volunteer plants in southern Utah.
- Adults migrate north on spring wind currents.

Time for Concern: Early summer when weeds begin to dry up and for the first 6-8 weeks of planting.

When and Where to Scout:

- Adults move into cultivated areas when weeds begin to dry up.
- Adults and nymphs are difficult to differentiate from other leafhopper species.
- Symptoms of curly top virus may occur in susceptible hosts before nymphs or adults are seen.

Threat Level: Direct feeding damage is not economically important, but beet leafhoppers can infect plants with curly top virus for which there is no cure; remove infected plants to slow virus spread.

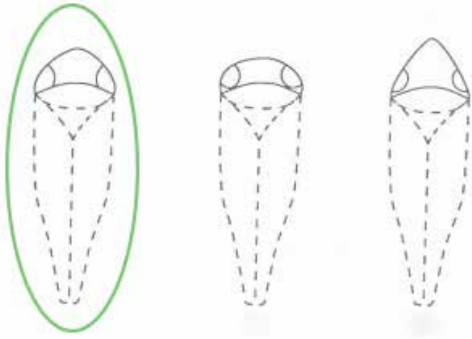
Top Management Techniques:

- Exclude leafhoppers with floating row covers.
- Shade tomato and pepper plants.
- Destroy and remove plant debris.
- 'Hide' susceptible plants among resistant plants.

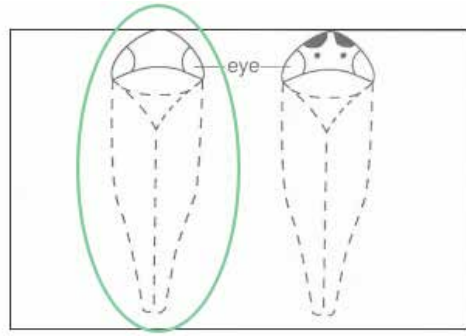
When to Consider Treatment:

Insecticide applications directed at leafhoppers are ineffective.

Look-alikes: other leafhopper species (e.g. potato leafhopper)



Beet leafhoppers are wedge-shaped with a slightly roof-shaped face (as opposed to well-rounded or sharply pointed). University of Wyoming Extension



Beet leafhoppers have a face absent of clearly defined spots. University of Wyoming Extension



Beet leafhopper adult. G. Oldfield, USDA, Bugwood.org



Beet leafhopper adult. University of Idaho Extension



Beet leafhopper adult, nymphs, and damage to host plants. Art Cushman, USDA Systematics Entomology Lab, Bugwood.org



Tomato plant infected with curly top virus. Cami Cannon, Utah State University



Curled, yellowed, and crispy tomato leaves infected with curly top virus. Cami Cannon, Utah State University

LEAFHOPPERS

POTATO LEAFHOPPER

Empoasca spp.

A: 3 mm long ●

Hosts: Wide host range including alfalfa, beans, eggplant, potato, and weeds including pigweed and shepherd's purse

Appearance: Adults are wedge-shaped, light green in color, and widest at the head with an elongated body. Both adults and nymphs move quickly and can run forward, backward, or sideways.

Damage Symptoms: Adults and nymphs feed with piercing-sucking mouthparts that result in white flecked injury and sometimes premature plant death (potato). "Hopperburn" characterized by yellowing and necrosis of leaflets and eventually defoliation, is rarely seen in Utah.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph (5 stages) | Adult
- Several overlapping generations per year.
- Overwinter in warmer locations (not Northern Utah).

Time for Concern: Early June through August.

When and Where to Scout:

- Look for pale leaf veins and curling leaves on host plants starting in spring.
- Look under leaves of host plants for green flying or jumping insects or for the pale, flightless nymph which readily moves when disturbed.

Threat Level: This pest rarely causes significant damage to vegetables in Utah. Potato leafhoppers are known to vector the fire blight bacterium which is a serious disease of pear, apple, and related pome fruit trees.

Top Management Techniques:

- Spray high pressure water to dislodge nymphs.
- Use floating row cover.

When to Consider Treatment:

Generally, potato leafhopper does not cause enough damage in Utah vegetables to require treatment.

Look-alikes: other leafhopper species (e.g. beet leafhopper), spider mite (damage)



Potato leafhopper nymph. Frank Peairs, Colorado State University, Bugwood.org



Potato leafhopper adult. Steve L. Brown, University of Georgia, Bugwood.org



Potato leafhopper adult and nymph. Penn State College of Agricultural Sciences



Potato leafhopper adult, nymphs, and "hopper burn" (rare in Utah) damage to potato foliage. Mary Foley Benson, USDA; Property of the Smithsonian Institution, Department of Entomology, Bugwood.org





Potato leafhopper adult, nymph, and "hopper burn" (rare in Utah) damage. Art Cushman, USDA Systematics Entomology Laboratory, Bugwood.org

LEAFHOPPERS

CARROT RUST FLY

Psila rosae

A: 6 mm long 
L: 3-8 mm long 

Hosts: Primarily carrot but sometimes celeriac, celery, coriander, dill, fennel, parsley, parsnip, and turnip

Appearance: Adults are small, black, slender flies with a reddish yellow head and yellowish legs. Larvae are creamy white maggots with a tapered body. Larvae tunnel through the lower third of carrot roots with rasping mouth hooks and may kill plants.

Damage Symptoms: Feeding damage occurs as mined roots, particularly the lower third. Young plants may be killed while older carrots sustain scarring, with burrows often a red rusty color. Damage can promote rotting.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2-3 generations per year.
- Overwinter as pupae in the soil or occasionally as larvae in roots.

Time for Concern: May until harvest.

When and Where to Scout:

- Monitor adults with yellow sticky cards beginning in late April and throughout the season.

Threat Level: This pest is sporadic in Utah, and when present, can be economically damaging.

Top Management Techniques:

- Row covers.
- Harvest carrots in blocks (rather than selectively) as soon as possible.
- Remove all carrots from the ground after harvest.

When to Consider Treatment:

When there are 2-3 adults per sticky trap per field.

Look-alikes: seedcorn maggot, onion maggot, cabbage maggot, leafminers

Look-alikes: onion maggot (adult), seedcorn maggot (adult), cabbage maggot (adult), leafminers (adult), other root and seed maggots (adult)



Carrot rust fly adult. Rasbak, wikimedia commons



Carrot rust fly adult. Remi Coutin 1997



Carrot rust fly damage. Rasbak wikimedia commons



Carrot rust fly damage. Remi Coutin 1997



Carrot rust fly damage. Whitney Cranshaw, Colorado State University, Bugwood.org



Carrot rust fly larva. Rasbak wikimedia commons



Carrot rust fly pupae. Remi Coutin 1997

MAGGOTS / FLIES

LEAFMINERS

American Serpentine Leafminer (<i>Lyriomyza trifolii</i>)	A: 1-1.7 mm long	L: 0.4-3 mm long
Pea Leafminer (<i>Lyriomyza langeti</i>)	A: 1.3-2.3 mm long	L: 0.4-3.25 mm long
Spinach Leafminer (<i>Pegomya hyoscyami</i>)	A: 5-6 mm long	L: 6-8 mm long
Vegetable Leafminer (<i>Lyriomyza sativae</i>)	A: 1.3-1.5 mm long	L: 0.6-3 mm long

Hosts: Wide host range including beans, beets, carrot, celery, cucumber, eggplant, lettuce, melon, onion, pea, pepper, potato, spinach, squash, Swiss chard, tomato, and weeds such as lambsquarter and related weeds

Appearance: Adults flies range in color from black to gray; some bear yellow markings. Eggs are oblong and white in color.

Damage Symptoms: Larvae feed and tunnel between the upper and lower leaf surfaces causing irregular shaped, whitish mines or “blisters”. Mines are initially opaque, eventually turning brown. Pale yellow larvae may be found within the mines.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- Several generations per season.
- Pupae overwinter in the soil, emerging mid-spring.

Time for Concern: Early in the season.

When and Where to Scout:

- Starting in May, begin looking for small rows of white, oblong eggs on host leaves.
- Fully grown, larvae drop to the ground, and pupate in the soil.

Threat Level: In general, more than 5% infestation of potential harvest of leafy greens.

Top Management Techniques:

- Exclude adult flies with row cover.
- Crop rotation.
- Cultivate soil after harvest to disturb pupae.

When to Consider Treatment:

If populations are high and causing economic damage.

Look-alikes: onion maggot (adult), seedcorn maggot (adult), cabbage maggot (adult), carrot rust fly (adult), other root and seed maggots (adult)



American serpentine adult. Central Science Laboratory Harpenden British Crown Bugwood. org



Pea leafminer adult. Jeffery Lotz and Gary Steck FDACS-DPI



Spinach leafminer adult. Whitney Cranshaw, Colorado State University, Bugwood.org



Vegetable leafminer adult. Pest and Diseases Image Library Bugwood.org



Leafminer eggs. Cami Cannon, Utah State University



Leafminer larvae are usually hidden inside a leaf but can be exposed by tearing off the top or bottom layer of the leaf. Cami Cannon, Utah State University



Leafminer damage to chard. Cami Cannon, Utah State University



Leafminer damage to onion. Cami Cannon, Utah State University




Leafminer damage to a small, early-season pea plant. Cami Cannon, Utah State University




Extensive leafminer damage to chard . Cami Cannon, Utah State University

CABBAGE MAGGOT

Delia radicum

A: 5-7 mm long 

L: 6-7.6 mm long 

Hosts: beets, broccoli, Brussels sprouts, cabbage, cauliflower, celery, collards, cress, kohlrabi, radish, turnip, and other brassicas

Appearance: Onion maggots and cabbage maggots look very similar and are most easily distinguished by the crops they attack. Adult flies are slightly smaller and more slender than houseflies with longer legs and overlapped wings at rest. Eggs are oblong and white in color.

Damage Symptoms: Larvae feed on roots of crops and can tunnel through taproots providing entry for decay, fungi, and bacteria. Damaged plants show wilting, reduced growth, and lighter green plant parts.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2 generations per year.
- Overwinter as pupae in the soil and crop debris.

Time for Concern: April through July under cool and moist conditions. Populations tend to decline in summer heat but can be high if soils are cooler than normal due to a particularly rainy season. Small, slow-growing, young plants are most susceptible to the first generation.

When and Where to Scout:

- Adults emerge in early May.
- Larvae burrow into the stem of host plants or feed on roots or stems.
- As susceptible crops emerge, watch for wilting, reduced growth, and signs of chlorosis (yellowing).
- If maggots are suspected, pull up affected plants and check roots and soil to confirm maggot presence. If tunnels are found in roots, but no maggots are present, then maggots have already exited roots to pupate in the soil.

Threat Level: This pest is sporadic and can be very serious, but cultural methods are generally adequate for control.

Top Management Techniques:

- Rotate susceptible crops with unrelated crops.
- Plant seeds into raised soil beds to promote soil drying and warming.
- Destroy or disc under crop residues immediately after harvest.

When to Consider Treatment:

In most cases, adequate control is possible with cultural control and practices that speed up germination and plant emergence.

Look-alikes: onion maggot, seedcorn maggot, carrot rust fly, leafminers (adult), other root and seed maggots (adult)



Cabbage maggot adult. James Lindsey, creative commons



Cabbage maggot larva and pupa. Rasbak



Cabbage maggot eggs, larva, pupa, and adults. Cornell University



Cabbage maggot eggs on host. Ken Gray Insect Image




Cabbage maggot damage to broccoli. OMAFRA




Cabbage maggot damage on a young cabbage plant; note the chlorotic (yellowing) plant parts. Mary Ann Hansen, Virginia Polytechnic, Institute and State University, bugwood.org

ONION MAGGOT

Delia antiqua

A: 5-7 mm long 

L: 6-10 mm long 

Hosts: onion, garlic, leek, carrot, radish, and related allium crops including wild relatives of onion

Appearance: Onion maggots and cabbage maggots look very similar and are most easily distinguished by the crops they attack. Adults flies are slightly smaller and more slender than houseflies with longer legs and overlapped wings at rest. Eggs are oblong and white in color.

Damage Symptoms: Larvae use hooked mouthparts to feed on roots and bulbs of young plants, causing wilting and plant death. Feeding can also result in rotting bulb tissue and provide openings for other diseases, reducing bulb quality and storability.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 3 generations per season.
- Overwinter as pupae in the soil among harvested onions and culls.

Time for Concern: May through the end of the season.

When and Where to Scout:

- Monitor adults with yellow sticky cards starting in mid-May.
- First generation adults emerge in approximately mid-May with peak flights about 2 weeks later.
- Larvae burrow into the basal plate of the onion plant or feed on the roots.
- Watch for wilting, death, or reduced quality in onion plants.

Threat Level: Damage is uncommon in Utah due to soils low in organic matter and typically dry, warm conditions in the spring.

Top Management Techniques:

- Rotate onions with unrelated crops.
- Avoid herbicide, cultivation, and disease damage to onion plants.
- Remove and destroy volunteer onions in the spring and onion culls and debris from fields after harvest, and till in the fall.

When to Consider Treatment:

In most cases, adequate control is possible with cultural control and practices that speed up germination and plant emergence.

Look-alikes: cutworm (damage), cabbage maggot, seedcorn maggot, carrot rust fly, leafminers (adult), other root and seed maggots (adult)



Onion maggot adult. Ken Gray Insect Image Collection



Onion maggot eggs near host plant. Ken Gray Insect Image Collection



Onion maggot larvae. Wikimedia commons



Onion maggot pupae. Pest and Diseases Image Library Bugwood.org



Onion maggot levels of injury.



Onion maggot damage to onion bulb. Wikimedia commons

MAGGOTS
/ FLIES

SEEDCORN MAGGOT

Delia platura

A: 4.8-6.4 mm long

L: 5-6.3 mm long

Hosts: cabbage, corn, bean, melon, cress, beet, celery, broccoli, cauliflower, collards, kohlrabi, Brussels sprouts, radish, turnip, and other warm-season plants

Appearance: Adults flies slender and grayish black in color. Eggs are oblong and white in color.

Damage Symptoms: Larvae burrow into seeds and roots of many vegetable crops, destroy the seed germ, and may cause rot in plant tissue. Seeds and plants attacked may not emerge causing reduced stands. Larvae are sometimes secondary pests on plants that have been damaged by disease.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2-3 generations per year.
- Overwinter as pupae in the soil.

Time for Concern: At planting.

When and Where to Scout:

- Adult flies emerge in April and May.
- Larvae burrow into seeds and feed on emerging cotyledons.
- Watch for reduced plant stands which may indicate maggot feeding.
- Monitor with yellow sticky cards.

Threat Level: Damage is uncommon in Utah due to soils low in organic matter and typically dry, warm conditions in the spring.

Top Management Techniques:

- Rotate susceptible crops with unrelated crops.
- Plant seeds into raised soil beds to promote soil drying and warming.
- Destroy or disc under crop residues immediately after harvest.

When to Consider Treatment:

In most cases, adequate control is possible with cultural control and practices that speed up germination and plant emergence.

Look-alikes: cabbage maggot, onion maggot, bean seed maggot, carrot rust fly, leafminers (adult), other root and seed maggots (adult)



Seedcorn maggot adult. Pest and Diseases Image Library, Bugwood.org



Seedcorn maggot larvae may feed on underground stems. Whitney Cranshaw, Colorado State University, Bugwood.org



Seedcorn maggot damage. Mariusz Sobieski, Bugwood.org



Seedcorn maggot on a corn seed. Mariusz Sobieski Bugwood.org



Seedcorn maggot life stages and damage. Art Cushman, USDA Systematics Entomology Laboratory, Bugwood.org



Cabbage infested with seedcorn maggot (left); note the yellow leaves and stunted growth. Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

OTHER ROOT MAGGOTS

Bean Seed Maggot (<i>Delia florigela</i>)	A: 6.35 mm long ●	L: 6.35 mm long ●
Radish Root Maggot (<i>Delia planipalpis</i>)	A: 5-6 mm long ●	L: 7.9 mm long ●
Sugarbeet Root Maggot (<i>Tetanops myopaeformis</i>)	A: 6.35 mm long ●	L: 8.4 mm long ●

Hosts: **Bean seed maggot:** similar hosts to seedcorn maggot (pg. 60-61). **Radish root maggot:** roots of crucifers including, radish, turnip, cabbage, Chinese cabbage, and mustard family weeds. **Sugarbeet root maggot:** sugarbeet, beet, spinach

Appearance: Adults are gray flies resembling small house flies. Larvae are pale maggots associated with roots of host plants.

Damage Symptoms: Larvae feed on and tunnel through roots of host plants causing decay, openings for other organisms, and sometimes wilting of the entire plant.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2-3 generations per year.
- Overwinter as pupae in the soil.

Time for Concern: At planting.

When and Where to Scout:

- Watch for larval tunneling in the roots of host plants throughout the season.
- Check host plant roots for decay.
- Watch plants for wilting.

Threat Level: Damage is uncommon in Utah due to soils low in organic matter and typically dry, warm conditions in the spring.

Top Management Techniques:

- Plant seeds into raised soil beds to promote soil drying and warming.
- Destroy or disc under crop residues immediately after harvest.

When to Consider Treatment:

In most cases, adequate control is possible with cultural control and practices that speed up germination and plant emergence.

Look-alikes: cabbage maggot, onion maggot, seedcorn maggot, carrot rust fly, leafminers (adult), other root and seed maggots (adult)



Radish root maggot adult. University of Alberta E.H. Strickland Entomological Museum



Sugarbeet root maggot adults. Whitney Cranshaw, Colorado State University, Bugwood.org



Radish root maggot damage to radish. Melodie Putnam, Oregon State University



Sugarbeet root maggot adult. Ken Gray Insect Image Collection



Sugarbeet root maggot larva. Ken Gray Insect Image Collection



Sugarbeet root maggot damage to roots. Ken Gray Insect Image Collection

FALSE CHINCH BUG

Nysius raphanus

N, A: 2-4 mm long ●

Hosts: Wide variety including brassicas, lettuce, mustard greens, potato, quinoa, radish, turfgrass and weeds such as Kochia, mustard family weeds, pigweed, Russian thistle, and sagebrush

Appearance: Adults are brownish gray with silvery wings. Nymphs are mottled gray brown with red to orange markings on the abdomen.

Damage Symptoms: Adults and nymphs feed with piercing-sucking mouthparts. Large numbers of aggregating adults on individual plants can cause plants to wilt and die rapidly. Outbreaks that destroy plantings usually occur early in the year. Later in the season aggregations are commonly seen on developing seed heads.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph (4 stages) | Adult
- About 3 generations per year.
- Overwinter as nymphs and adults under debris near winter annual mustards.

Time for Concern: July and early August.

When and Where to Scout:

- Adults and nymphs move to developing mustards in early spring.
- Look for aggregations on individual plants during July and early August.
- Adults and nymphs are most active during cooler mornings or late evenings.

Threat Level: False chinch bug feeding does not seem to be very destructive to vegetables and often little, if any injury is observed. Spot infestations are sporadic but can cause wilting and plant death, especially early in the year.

Top Management Techniques:

- Low numbers do not need to be managed.
- Row covers on crops near uncultivated areas of mustard family plants.
- Keep plants well irrigated.

When to Consider Treatment:

If economically damaging infestations are present.

Look-alikes: beneficial big-eyed bug, chinch bug, other seed bugs



False chinch bug adult. Russ Ottens, University of Georgia, Bugwood.org



False chinch bug adult. Marion Murray, Utah State University



False chinch bug nymph. HortNET The Horticulture and Food Research Institute of New Zealand Bugwood.org



False chinch bug nymph. HortNET The Horticulture and Food Research Institute of New Zealand Bugwood.org



False chinch bug egg. HortNET The Horticulture and Food Research Institute of New Zealand Bugwood.org



False chinch bug damage. Whitney Cranshaw Colorado State University Bugwood.org



False chinch bug (left) and the beneficial big-eyed bug (right). Ronald Smith, Auburn University, Bugwood.org

LYGUS BUG (TARNISHED PLANT BUG)

Tarnished plant bug (<i>Lygus lineolaris</i>).....	A: 3.7-6 mm long	<input checked="" type="checkbox"/>
Western tarnished plant bug (<i>Lygus hesperus</i>).....	A: 4.2-5.2 mm long	<input checked="" type="checkbox"/>

Hosts: Wide host range including asparagus, cabbage, carrot, celery, lettuce, lima bean, snap bean, soybean, tomato, several other vegetables, seed crops, alfalfa, fruit, and weeds such as butterweed, dock, dog fennel, fleabane, goldenrod, and vetch

Appearance: Adults are brown with yellow, black, and red markings and have a yellow or green triangle on the upper center of the back. Nymphs are usually lighter in color with dark spotting and a more rounded form.

Damage Symptoms: Adults and nymphs feed with piercing-sucking mouthparts, causing shriveled seeds, premature drop of buds, flowers, and fruits, ragged discolored leaves, bronzing, and cat-facing (on fruit).

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph | Adult
- 3-4 generations per year.
- Overwinter as adults in plant debris.

Time for Concern: Throughout the season.

When and Where to Scout:

- Visually scout or use sweep nets and regularly examine flowers to monitor for adults and nymphs starting in early spring.
- Watch for feeding damage throughout the season.

Threat Level: Commonly found in Utah and can cause economic injury to vegetables. Low densities can be tolerated when plants are vegetative.

Top Management Techniques:

- Remove preferred hosts (flowering weeds, legumes, alfalfa) from field edges.
- Control weeds.
- Application of insecticides may be needed.

When to Consider Treatment:

If feeding damage is high. Thresholds vary depending on the crop.

Look-alikes: other plant bugs, beneficial big-eyed bug



Western tarnished lygus adult. Whitney Cranshaw Colorado State University Bugwood.org



Tarnished lygus adult. Russ Ottens University of Georgia Bugwood.org



Tarnished lygus egg. Scott Stewart University of Tennessee Bugwood.org



Tarnished lygus multiple life stages. University of Georgia University of Georgia Bugwood.org



Lygus bug damage to bean pods and seeds. Howard F. Schwartz, Colorado State University, Bugwood.org



Tarnished plant bug damage on daisy. Whitney Cranshaw, Colorado State University, Bugwood.org

RED FIRE BUG

Pyrrhocoris apterus

N, A: 6.5-12 mm long

Hosts: Plants the mallow family, such as linden, common mallow, okra and cotton; some other plants, such as tomato

Appearance: Adults are vibrant red with varying wing markings (most commonly two black dots on shortened wings). Young nymphs look similar to boxelder bugs while older nymphs begin to resemble adults. Adults and nymphs feed on seeds with piercing-sucking mouthparts. The red fire bug can be a nuisance pest when it forms aggregations.

Damage Symptoms: Adults and nymphs can be found massing on structures, plants, and under leaf litter, but no significant plant damage has been reported to date.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph (5 stages) | Adult
- 1 generation per year.
- Overwinter as adults.

Time for Concern: April through fall.

When and Where to Scout:

- Adults become active in April.
- Adults and nymphs avoid direct sunlight and can be found in masses in grass, leaf litter, trees, plant foliage, and shaded soil beneath plants.

Threat Level: Red fire bug is a nuisance pest; no significant plant damage has been reported to date.

Top Management Techniques:

- Directly spray congregations with water to drown them.
- Spray with insecticidal soap.
- Application of insecticides may be needed; pyrethroids are effective.

When to Consider Treatment:

There are no insecticides specifically registered for red fire bug in Utah, but insecticides effective on other plant/seed bugs will be effective on red fire bug. The insect does not have to occur on the label, but the plant site must be there.

Look-alikes: boxelder bugs



Red fire bug adult. Bonnie Bunn, Utah State University



Red fire bug nymph. Bonnie Bunn, Utah State University



Red fire bug adults can be a nuisance when they form aggregations.



Red fire bug adult. Cami Cannon, Utah State University



Red fire bug adults move quickly when disturbed. Cami Cannon, Utah State University



Red fire bug adult. Bonnie Bunn, Utah State University

SQUASH BUG

Bactericera cockerelli

N, A: 2.5-17 mm long

Hosts: winter squash, summer squash, and melon

Appearance: Adults are flat and brown to gray with orange and brown bands along the margins of the abdomen. Eggs are shiny bronze to red and located on undersides of leaves. Nymphs are bright green but become gray-brown and begin to resemble adults as they mature.

Damage Symptoms: Adults and nymphs feed with piercing-sucking mouthparts initially causing small yellow flecks on foliage that eventually turn brown. Later, foliage often wilts and dies beyond damaged areas. Feeding may occur on fruit causing scars and wounds that are readily colonized by rotting organisms resulting in increased fruit rot in the field and during storage.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph (5 stages) | Adult
- 1 generation per year (potentially a partial second generation in southern Utah).
- Overwinter as adults in protected sites around building and under plant debris or compost piles.

Time for Concern: When plants develop runners through harvest.

When and Where to Scout:

- Monitor in the spring for squash bug adults under plant debris, perennial plants, or near buildings.

- Look daily for eggs under leaves starting in late spring and early summer until harvest.
- Watch for plant wilt.
- Adults and nymphs congregate on lower parts of the plant.

Threat Level: Squash bugs are common in cucurbits (especially pumpkin and squash) occurring every year and can be very difficult to control when populations are allowed to build.

Top Management Techniques:

- Rotate crops annually to a non-cucurbit crop.
- Remove or till under plant debris at the end of the season and keep fields free of trash or wood.
- Place wooden boards between susceptible plants and lift them each morning to destroy aggregated adults and existing eggs.
- Avoid heavy mulch or no-till in susceptible varieties.
- When scouting, remove egg masses.
- Cover young squash plants with row cover to exclude squash bugs; uncover in the morning hours when plants are in bloom.
- Application of insecticides may be needed.

When to Consider Treatment:

If 1 egg mass per plant is found in the early flowering stage. Insecticides work best on nymphs. **Note:** Squash bugs are prone to developing resistance and adults are difficult to kill.

Look-alikes: brown marmorated stink bug, stink bugs, boxelder bugs (nymphs), other leaffooted bugs



Squash bug adult. Cami Cannon, Utah State University



Squash bug egg cluster. Cami Cannon, Utah State University



Squash bug early nymph. Bonnie Bunn, Utah State University



Squash bug late nymphs. Cami Cannon, Utah State University











Squash bug feeding can cause host leaves to dieback, turning yellow and then brown. Utah State University



Squash bug aggregation and damage on pumpkin. Whitney Cranshaw, Colorado State University, Bugwood.org

STINK BUGS

Brown marmorated stink bug (BMSB) (<i>Halyomorpha halys</i>).....	A: 12-17 mm long	
Brown stink bug (<i>Euschistus servus</i>).....	A: 11-15 mm long	
Conchuela stink bug (<i>Chlorochroa ligata</i>).....	A: 13-19 mm long	
Conspersed stink bug (<i>Euschistus conspersus</i>).....	A: 8-12 mm long	
Green stink bug (<i>Acrosternum hilare</i>).....	A: 13-19 mm long	
Onespotted stink bug (<i>Euschistus variolarius</i>).....	A: 11-15 mm long	
Say's stink bug (<i>Chlorochroa sayi</i>).....	A: 8-19 mm long	
Uhler stink bug (<i>Chlorochroa uhleri</i>).....	A: 12-16 mm long	

Hosts: Wide host range including asparagus, corn, eggplant, green bean, okra, pepper, Swiss chard, tomato, and others including fruit trees, and ornamental plants

Appearance: Adults are shield-shaped bugs. Eggs are barrel-shaped and laid in clusters of 10-30 on host leaves. See pages 73-75 for specific species descriptions.

Damage Symptoms: Nymphs and adults feed with piercing-sucking mouthparts primarily causing damage to fruiting parts of plants. Damage initially occurs as hard, whitish, callous areas surrounding a central feeding puncture, later developing into cloudy areas of hard yellow spots. Fruit begins to grow in a distorted manner, with indented areas developing at the feeding sites (catfacing). Young fruit may abort from stink bug damage and seeds of legumes may be killed or shrunken after pod feeding. Green fruit damage occurs as dark pinpricks surrounded by a light colored area. Damage may cause poorly developed flavor of fruits and vegetables.

Beneficial Stink Bugs: Most stink bugs feed on plants, but a few are beneficial predators including the twospotted stink bug (*Perillus bioculatus*) and spined soldier bug (*Podisus maculiventris*). The rough

stink bug (*Brochymena quadripustulata*, *B. pustula*) is mostly a predator of insects but sometimes feeds on leaves.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph (5 stages) | Adult
- 2-3 overlapping generations per year.
- Overwinter as adults under leaves, plant debris, weedy areas, and other protected sites such as buildings or structures, wood piles, or dead trees.

Time for Concern: From July through harvest (damage may be greater during warm, dry periods).

When and Where to Scout:

- Infestations typically occur along field edges.
- Look for eggs on host plants along field edges starting in late spring and throughout the season.
- Shake foliage over a beating sheet/tray and count fallen nymphs and adults.
- Monitor for BMSB with Pherocon® BMSB and GSB lures on a Pherocon® STKY™ dual panel clear sticky trap.
- Watch for feeding injury on fruit and vegetables.

Threat Level: Small numbers of stink bugs can cause serious damage to fruits and vegetables. Stink bugs can be difficult to kill with insecticides due to their strong flight capability and tolerance to insecticide residues. Brown, consperse, and onespotted stink bugs are only minor pests of fruits and buds. BMSB is a new invasive pest in Utah; it has the potential to cause severe crop damage.

Top Management Techniques:

- Plant trap crop barriers around border of cash crop.
- Row covers or fine-mesh netting over plants in gardens and small acreage crops.

- Attract and conserve natural enemies.
- Application of insecticides are often necessary.

When to Consider Treatment:

- For consperse and green stink bugs, when stink bug counts average one in three shake samples. Time treatments in tomatoes to start when fruits reach 1 inch in diameter.
- For BMSB, action thresholds have not yet been developed.

Look-alikes: squash bug, beneficial stink bugs listed above, western conifer-seed bug, leaffooted bug

BMSB adults are distinguished by smooth and rounded shoulders, white bands on antennae and legs, and alternating dark and light bands on margins of the abdomen.



BMSB adult and feeding damage on a corn leaf; note white bands on legs and antennae. Cami Cannon, Utah State University



BMSB egg shells and newly hatched nymphs. Gary Bernon, USDA APHIS, Bugwood.org











BMSB nymph. Cami Cannon, Utah State University



BMSB nymph. Susan Ellis, Bugwood.org

STINK BUGS (CONT.)

Brown marmorated stink bug (BMSB) (<i>Halyomorpha halys</i>).....	A: 12-17 mm long	
Brown stink bug (<i>Euschistus servus</i>).....	A: 11-15 mm long	
Conchuela stink bug (<i>Chlorochroa ligata</i>).....	A: 13-19 mm long	
Conspersus stink bug (<i>Euschistus conspersus</i>).....	A: 8-12 mm long	
Green stink bug (<i>Acrosternum hilare</i>).....	A: 13-19 mm long	
Onespotted stink bug (<i>Euschistus variolarius</i>).....	A: 11-15 mm long	
Say's stink bug (<i>Chlorochroa sayi</i>).....	A: 8-19 mm long	
Uhler stink bug (<i>Chlorochroa uhleri</i>).....	A: 12-16 mm long	

Brown stink bug adults are brown and look similar to BMSB but have more pointed shoulders, and yellowish, less apparent bands on its antennae.



Brown stink bug adult; note pointed shoulders and lack of banding on antennae. Stopbmsb.org



Brown stink bug eggs. Herb Pilcher, USDA Agricultural Research Service, Bugwood.org



Brown stink bug newly hatched nymphs. Herb Pilcher, USDA Agricultural Research Service, Bugwood.org



Brown stink bug late nymph. Russ Ottens, University of Georgia, Bugwood.org

Conchuela stink bug dark green to black body with orange or red margins on the sides and an orange or red spot near the tip of the abdomen.



Conchuela stink bug adult; red phase. Whitney Cranshaw, Colorado State University, Bugwood.org



Conchuela stink bug eggs. Whitney Cranshaw, Colorado State University, Bugwood.org











Conchuela stink bug nymph. Salvador Vitanza, Ph.D.

Conspere stink bug adults are gray-brown with black specks and yellow to green on the underside.



Conspere stink bug adult; note darker tips of antennae. Stopbmsb.org

STINK BUGS (CONT.)

Brown marmorated stink bug (BMSB) (<i>Halyomorpha halys</i>).....	A: 12-17 mm long	
Brown stink bug (<i>Euschistus servus</i>).....	A: 11-15 mm long	
Conchuela stink bug (<i>Chlorochroa ligata</i>).....	A: 13-19 mm long	
Conspersus stink bug (<i>Euschistus conspersus</i>).....	A: 8-12 mm long	
Green stink bug (<i>Acrosternum hilare</i>).....	A: 13-19 mm long	
Onespotted stink bug (<i>Euschistus variolarius</i>).....	A: 11-15 mm long	
Say's stink bug (<i>Chlorochroa sayi</i>).....	A: 8-19 mm long	
Uhler stink bug (<i>Chlorochroa uhleri</i>).....	A: 12-16 mm long	

Green stink bug adults are bright green and yellow on the underside near the head and legs.



Green stink bug adult. Susan Ellis, Bugwood.org



Green stink bug egg shells and newly hatched nymphs. Susan Ellis, Bugwood.org

Onespotted stink bug is brown and looks similar to the brown stink bug but with more sharply pointed shoulders with orange tips.



Onespotted stink bug adult; note sharply pointed shoulders. Stopbmsb.org

Say's stink bug similar to conchuela stink bug with a green body with orange or white margins on the sides and orange markings on the head and body.



Say's stink bug adult. William M. Ciesla, Forest Health Management International, Bugwood.org

Uhler stink bug similar in appearance to the Say's and conchuela stink bugs but with yellow to white markings instead of orange or red.



Uhler stink bug adult. Ken Schneider

POTATO/TOMATO PSYLLID

Bactericera cockerelli

A: 2 mm long ●

Hosts: Many solanaceous plants including potato, tomato, eggplant, pepper, certain nightshades, and bindweed

Appearance: Adults resemble small cicadas or winged aphids, readily jump when disturbed, and have black bodies with white markings and a white inverted ‘V’ on the back. Nymphs are flat, green (yellowish green or orange when newly hatched), with red eyes, and an oval-shaped body with spines around the edges.

Damage Symptoms: Nymphs and adults feed with piercing-sucking mouthparts causing disruptions in plant growth, collectively described as “psyllid yellows”. Common symptoms of psyllid yellows are leaf curling, slowed plant growth, and color changes. Damage to potatoes results in reduced size, premature sprouting, and rough skin. Tomato damage includes the production of small, soft, poor quality fruits. Potato psyllids also vector *Candidatus Liberibacter solanacearum* which causes zebra chip disease in potato, tomato, and pepper. (see Zebra chip on pg. 108-109).

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph (5 stages) | Adult
- Multiple generations per season.
- Overwinter as adults in warmer locations (not northern Utah).

Time for Concern: As soon as potato season starts until the end of the season.

When and Where to Scout:

- Place yellow sticky cards as soon as the potato season starts to detect the first occurrence of psyllid in the area.
- Look for nymphs and eggs on the undersides of leaves by collecting 10 mature leaves from the middle of the plant at 10 locations among the outer rows of the field.
- A hand lens is needed to see nymphs and eggs.

Threat Level: Psyllid yellows is generally less damaging than zebra chip disease. Zebra chip can be destructive for potato (especially for chip production), tomato, and pepper and is occasionally seen in these crops in Utah.

Top Management Techniques:

- Monitoring is a critical component of management decisions.
- Application of insecticides; there are currently no effective non-chemical controls for potato psyllid.

When to Consider Treatment:

If potato psyllids have caused zebra chip disease or psyllid yellows in past years, if nearby fields are experiencing these problems, or if potato psyllid is detected, even if populations are low.

Look-alikes: winged aphids (adults)



Adult psyllid. Whitney Cranshaw, Colorado State University, Bugwood.org



Microscopic view of a psyllid nymph. Cami Cannon, Utah State University



Psyllid nymphs and adults. Marion Murray, Utah State University



Yellow potato foliage due to psyllid yellows. Whitney Cranshaw, Colorado State University, Bugwood.org



Psyllid yellows can cause yellow or reddish-pink discoloration of potato foliage. Cami Cannon, Utah State University



Psyllid damage on potato foliage can cause curled leaves. Eugene E. Nelson, Bugwood.org

THRIPS

Onion Thrips (*Thrips tabaci*)

A: 1.3 mm long ●

Western Flower Thrips (*Frankliniella occidentalis*)

A: 1.5 mm long ●

Hosts: Wide host range including artichoke, beans, cabbage, cauliflower, corn, cucurbits, eggplant, garlic, leafy greens, leek, lettuce, onion, pea, pepper, tomato, and many grasses, flowers, and many weeds

Appearance: Adults are minute with elongated yellow or yellow-brown bodies and two pairs of fringed (hairy) wings. Larvae are creamy yellow.

Damage Symptoms: Thrips feed with a punch-and-suck behavior causing light flecking wounds and silvery scars, often with dark fecal spots. Thrips may vector tospoviruses including tomato spotted wilt virus (tomato, pepper, tobacco) and iris yellow spot virus (allium crops).

Damaging Lifestage(s): Instars (larval stages) I and II, and Adult

Life Cycle:

- Egg | Larvae (4 stages) | Pupa | Adult
- 5-8 generations per year.
- Overwinter as adults in plant debris and protected areas.

Time for Concern: Populations are favored by hot, arid conditions and decrease with heavy rain or overhead irrigation.

When and Where to Scout:

- Adults become active in the spring.
- Onion thrips are commonly found in the neck of the onion.
- Look for silvery scars, bleached spots on foliage, and dark fecal spots.

Threat Level: Thrips populations increase under hot, arid conditions leading to economic crop losses on certain onions. Serious infestations in cabbage make the crop unmarketable. Tomato spotted wilt virus may be vectored by thrips and can cause death in some host plants. Iris yellow spot virus vectored by onion thrips and can cause reduced bulb size and quality in allium crops.

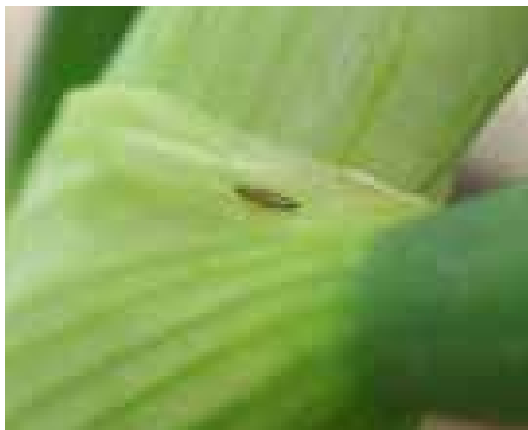
Top Management Techniques:

- Plow under plant debris after harvest and remove volunteer host plants.
- Inspect transplants for thrips infestations (using a 10x hand lens) and discard infested plants.
- Use overhead sprinkler irrigation to wash thrips from plants.
- Remove weeds near vegetable fields.
- Application of insecticides may be needed.

When to Consider Treatment:

- Thrips have rapidly developed resistance to several classes of insecticides. Insecticides will be most effective when used in conjunction with other non-pesticide management practices.
- For onions:
 - June to early July in highly susceptible onion varieties (e.g. red onions): 115 thrips per plant.
 - July and August in more tolerant onion varieties (many yellow and white varieties): 30 thrips per plant.

Look-alikes: beneficial thrips (e.g. black hunter thrips, banded thrips or *Aeolothrips*)



Thrips adult on onion. Cami Cannon, Utah State University



Thrips adult, feeding damage, and excrement (black specks) on early season cucurbit. Cami Cannon, Utah State University



Thrips adult and nymphs in the neck of onion.



Thrips feeding damage on foliage can leave specks of yellow/chlorotic tissue. Cami Cannon, Utah State University



Silvering damage caused by thrips feeding on onion.



Microscopic view of onion thrips. Alton N. Sparks, Jr., University of Georgia, Bugwood.org



Microscopic view of western flower thrips. Jack T. Reed, Mississippi State University, Bugwood.org

WHITEFLIES

Family: Aleyrodidae

A: 1.5-2.5 mm long ●

Hosts: Wide host range of vegetables and ornamentals including ageratum, aster, beans, begonia, calendula, cucumber, grape, hibiscus, lantana, nicotiana, poinsettia, squash, tomato

Appearance: Adults are tiny with white wings that are held roof-like over their body. Immature stages are inconspicuous with pale, almost translucent, flat bodies that resemble scale nymphs.

Damage Symptoms: Adults and nymphs feed with piercing-sucking mouthparts, causing leaves to turn yellow, appear dry, or fall off plants. Whiteflies, like aphids, also excrete a sugary substance called honeydew, causing sticky leaves or sooty mold growth on leaves.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph (3 feeding stages 1 nonfeeding stage) | Pupa | Adult
- Several generations per year.
- Populations continue from year to year in greenhouses and in the far south.

Time for Concern: During warm weather, on transplants, or when natural enemies are disrupted by insecticide applications, dusty conditions, or interference with ants that are attracted to the honeydew secreted by whiteflies.

When and Where to Scout:

- Look for large colonies during warm weather on the underside of lower leaves.
- Inspect transplants for whiteflies.
- Monitor with yellow sticky cards to detect whitefly presence.

Threat Level: Economic damage from whiteflies in the garden or field is rare in Utah and is more commonly seen in greenhouses or high tunnels.

Top Management Techniques:

- Attract and conserve natural enemies.
- Inspect transplants and remove any with high whitefly populations.
- Remove infested leaves or hose them down with water sprays.

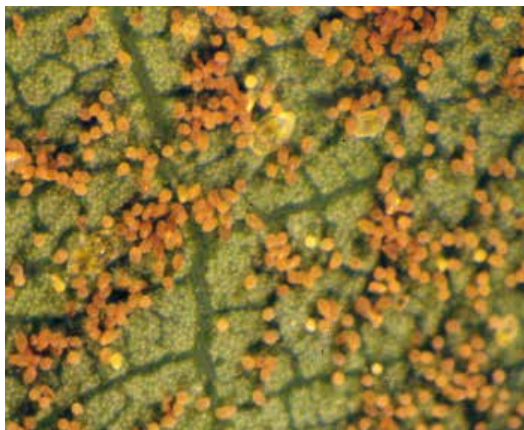
When to Consider Treatment:

Whiteflies develop resistance to insecticides quickly and treatment is not generally needed for garden plants in Utah. Greenhouse plants have a threshold of 10 nymphs/leaf.

Look-alikes: aphid skins, leafhopper adults, scale insects



Whitefly adults. Central Science Laboratory, Harpenden , British Crown, Bugwood.org



Whitefly eggs. David Riley, University of Georgia, Bugwood.org



Whitefly nymph. Florida Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Bugwood.org



Whitefly adult and nymphs. Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org



Whitefly adults on squash. Marion Murray, Utah State University



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

BANK'S GRASS MITE

Oligonychus pratensis

A: 0.8 mm long

Hosts: corn and other grasses including turfgrass

Appearance: Very small arachnids (requiring a 10x lens) with yellowish to greenish bodies and patchy black spots that cover the sides of the abdomen. Colonies are often associated with webbing.

Damage Symptoms: Mites feed with piercing-sucking mouthparts causing stippling (tiny yellow or brown spots), silver discoloration, and sometimes a burnt appearance on the upper leaf surface. Severe damage from mite feeding causes leaves to desiccate and drop, stalks to break, and corn kernels to shrink.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Larva | Nymph (2 stages) | Adult
- Multiple, overlapping generations per year.
- Overwinter as adults in the soil, leaf litter, and weeds.

Time for Concern: Corn is most susceptible to yield damage from the tasseling stage to the soft dough stage of growth.

When and Where to Scout:

- Adults are active from late spring throughout the summer.
- Cream-colored, spherical eggs are laid in clusters on stems and leaves.
- Watch for stippling on leaves and webbing.

Threat Level: Occasional damage occurs on sweet corn when mites feed on leaves and scar husks.

Top Management Techniques:

- Reduce drought stress.
- Manage grassy weed hosts.
- Avoid broad-spectrum pesticides that suppress beneficial mite predators.
- Application of pesticides may be needed.

When to Consider Treatment:

Pesticides are typically necessary when 15-20% of the leaf area is covered with mite colonies, leaf damage is noted, and hot, dry conditions are predicted.

Look-alikes: two-spotted spider mite



Bank's grass mite adult. F.C. Schweissing, Bugwood.org



Bank's grass mites and eggs (clear and round). Frank Peairs, Colorado State University, Bugwood.org



Bank's grass mites. Whitney Cranshaw, Colorado State University, Bugwood.org



Bank's grass mite damage to sweet corn husk. Whitney Cranshaw, Colorado State University, Bugwood.org



Bank's grass mite damage to sweet corn. Whitney Cranshaw, Colorado State University, Bugwood.org



Bank's grass mite damage to corn. Frank Peairs, Colorado State University, Bugwood.org

BULB MITES

Rhizoglyphus spp.

Tyrophagus spp.

A: 0.4 mm long

Hosts: Wide host range (many kinds of bulbs, roots, and tubers) including onion, garlic, lily, dahlia, tulip, hyacinth, freesia, and gladiolus.

Appearance: Bulb mites are shiny, creamy white, bulbous mites often described as pearls with legs.

Damage Symptoms: Adults and nymphs feed with piercing-sucking mouthparts on the roots, basal plate, and outer layer of plant tissue providing openings for soil-borne fungal pathogens such as *Pythium*, *Rhizoctonia*, and *Fusarium*. Bulb mites can reduce plant stands and vigor, and promote rot of bulbs in storage.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Larva | Nymph (2 stages) | Adult
- Multiple, overlapping generations per year.
- Overwinter on decaying vegetation such as weeds or crop debris.

Time for Concern: Injury typically occurs during early vegetative growth stages and is most damaging when plant growth is slowed by cool, wet weather. Infestations can affect bulbs both in field and in storage.

When and Where to Scout:

- Adults and nymphs are typically found in clusters under the root plate of onion bulbs or garlic cloves.
- Watch for feeding damage symptoms which resemble those of damping-off caused by *Pythium*.

Threat Level: Bulb mites primarily feed on decaying fungi but can greatly aggravate existing plant wounds and promote decay in plants. Growing tips of bulbs can be damaged and cause distortion under high numbers of bulb mites. This pest can also continue to develop on bulbs in storage.

Top Management Techniques:

- Rotate crops.
- Allow crop residues to fully decompose prior to planting.
- Use clean seed and transplants.
- Clean bulbs before storage and store in cool temperatures with low relative humidity.
- Application of pesticides may be needed.

When to Consider Treatment:

No thresholds have been established.

Look-alikes: insect eggs, root aphids



Tyrophagus mite magnified about 100x. Eric Erbe, USDA
Agricultural Research Service, Bugwood.org



Tyrophagus mite magnified. Charley Eisean

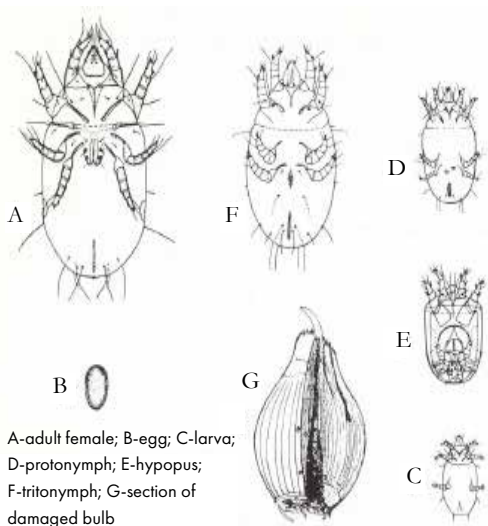


Tyrophagus mite magnified. Don Loarie



Tyrophagus mite magnified. Don Loarie

MITES



A-adult female; B-egg; C-larva;
D-protonymph; E-hypopus;
F-tritonymph; G-section of
damaged bulb

Bulb mite stages of development and feeding injury.
UMass Amherst

TOMATO RUSSET MITE

Aculops lycopersici

A: 0.15-0.2 mm long

Hosts: tomato, eggplant, pepper, potato, tomatillo, and weeds of other solanaceous plants, nightshade weeds, and morning glory

Appearance: Adults and nymphs have cigar-shaped, yellowish-tan or pink bodies and require a microscope to observe.

Damage Symptoms: Adults and nymphs feed with piercing-sucking mouthparts causing bronzing or “russeting” of the surface of stems, leaves, and fruits. Damaged leaves may turn yellow, curl, wither, appear “deflated”, and fall from plants. Mite feeding on fruits can cause longitudinal cracks and bronze coloration.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph | Adult
- Multiple, overlapping generations per year.
- Overwinter as adults in crop debris.

Time for Concern: When weather conditions are hot and dry.

When and Where to Scout:

- The presence of tomato russet mites often goes unnoticed, due to their tiny size, until injury is evident.
- Watch for injury symptoms especially during hot, dry conditions.
- Look for bronzing on lower leaves and stems.
- Use a microscope to check damaged leaves and surrounding healthy leaves for mites.

Threat Level: If not controlled, this pest can kill plants. Tomatoes are most commonly affected, especially during hot, dry conditions.

Top Management Techniques:

- Avoid planting during hot, dry periods.
- Promptly remove or destroy infested plant debris.
- Clean tools used on infested plants before using on healthy plants.
- Applications of pesticides.

When to Consider Treatment:

Once russet mites are present on plants, insecticide treatment (sulfur, abamectin) is the primary control option.

Look-alikes: nutritional deficiencies (damage), plant diseases (damage), water stress (damage)



Microscopic view of tomato russet mites on tomato stem; note the cigar-shape of the mites. Cami Cannon, Utah State University



Microscopic view of tomato russet mites on tomato stem. Cami Cannon, Utah State University



Tomato russet mites and damage on tomato. NSW Department of Primary Industries



Tomato russet mite damage on tomato. Cami Cannon, Utah State University



Tomato russet mite damage on tomato; note the "deflated" appearance of the dying stem. Cami Cannon, Utah State University



Tomato russet mite damage on tomato. Utah State University

TWOSPOTTED SPIDER MITE

Tetranychus urtica

A: 0.4-0.6 mm long

Hosts: beans, beets, carrot, corn, cucurbits (cucumber, squash, melon), eggplant, parsley, pea, pepper, potato, sweet potato, tomato, and many weeds and other plants

Appearance: Tiny mite (best seen with a 10x hand lens or microscope) with a yellowish body and two dark spots on either side of its back.

Damage Symptoms: Feeds with piercing-sucking mouthparts resulting in stippling at feeding sites. A generalized bronzing or reddish discoloration often develops as infestations progress. Plant vigor may be seriously reduced, and premature leaf drop often occurs on heavily infested plants. Webbing may be visible when populations on plants are high.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Larva | Nymph (2 stages) | Adult.
- 8 or more generations per year.
- Overwinter as adults in ground cover around the base of host plants.

Time for Concern: Anytime weather conditions are hot and dry.

When and Where to Scout:

- Check the undersides of leaves for moving specks of “dirt” (twospotted spider mites can look like dirt without a hand lens).
- Start with older leaves and leaves closest to the ground.
- Watch for injury symptoms especially during hot, dry conditions.
- Webbing indicates the presence of heavy populations.

Threat Level: If not controlled, this pest can kill plants.

Top Management Techniques:

- Keep plants healthy and free of drought stress.
- Avoid broad-spectrum pesticides that suppress beneficial mite predators.

When to Consider Treatment:

Twospotted spider mites show high resistance to pesticides. No thresholds have been established but consider treatment when mites are easily detectable, damage is evident, and hot, dry conditions persist.

Look-alikes: leafhopper (damage), drought stress (damage), beneficial predatory mite *Galendromus*, Bank’s grass mite



Twospotted spider mite adult.



Twospotted spider mite adults and egg.



Twospotted spider mite infestation on bean. Cami Cannon, Utah State University



Twospotted spider mite feeding damage causes leaves to die. Cami Cannon, Utah State University




Twospotted spider mite feeding damage on tomato fruit, stem, and foliage. Cami Cannon, Utah State University



Twospotted spider mite feeding damage on tomato leaf. Cami Cannon, Utah State University

SYMPHYLANS (GARDEN CENTIPEDE)

Garden symphylan (*Scutigereella immaculata*)

A: 2-10 mm long 

Hosts: Wide range of vegetables especially cabbage, carrot, beet, broccoli, lettuce, potato, radish, spinach, and squash, and several small fruits, flowers, and plants with flower bulbs

Appearance: Adults are slender, elongated, “centipede-like”, and white with prominent antennae. They have 15 body segments, 10-12 pairs of legs, and move rapidly when disturbed. All life stages occur in the soil, typically in the upper few inches. Symphylans feed on sprouting seeds and underground plant parts.

Damage Symptoms: Feeding damage causes root death on younger roots and a gnarled appearance with corky tissues forming around wound sites on older roots. Damage also includes reduced stands, general stunting, and susceptibility to soil-borne plant pathogens.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph (7 molts) | Adult
- 1-2 generations per year.
- Overwinter as adults in the soil.

Time for Concern: Throughout the season, especially in (heavy) clay soils high in organic matter.

When and Where to Scout:

- Garden symphylans are not always easy to find due to their patchy distribution. They tend to occur in “hotspots” of a few square feet to several acres.

- Soil, bait, and indirect sampling are the three main sampling methods used to identify damage and inform management decisions. More information on these methods can be found online in the ATTRA publication “*Symphylans: Soil Pest Management Options*”.

Threat Level: Symphylans are limited to areas with clay soils, particularly those high in organic matter. In more tolerant crops, such as potato, bean, and small grains, feeding may not lead to significant damage, even at considerably high population densities. Moderately to highly susceptible crops include broccoli, squash, spinach, and cabbage. Commonly damaged crops include broccoli and other cole crops, spinach, beets, onions, and squash.

Top Management Techniques:

- Tillage.
- Plant potatoes to decrease symphylan population levels.
- Use transplants instead of direct seed or increase transplant size (not effective for broccoli and eggplant).

When to Consider Treatment:

Noticeable damage often occurs if garden symphylans exceed an average of 5-10 per shovelful in moderately to highly susceptible crops such as broccoli, squash, spinach, and cabbage. In conventional cropping systems, 2-3 garden symphylans per square foot is commonly used as a treatment threshold.

Look-alikes: springtails/collembola



Garden symphylan. Soniamartinez



Garden symphylan. Ken Gray Insect Image Collection



Garden symphylan damage can cause reduced stands.
UC ANR



Garden symphylan damage can cause gnarled roots with a corky appearance. Ken Gray Insect Image Collection

SYMPHYLANS

SPRINGTAILS (COLLEMBOLA)

Class: Collembola

A: 1.5-3.2 mm long ●

Common families: Sminthuridae, Entomobyryidae, Onychiuridae

Hosts: Multiple vegetables especially spinach and beets

Appearance: Adults are small, six-legged arthropods with elongate or bulbous bodies that are dull colored purplish gray, cream, or brown. Many springtails have a unique tail-like structure (furcula) that hooks under the body and is used, by snapping downward, to jump short distances when disturbed or during mating.

Damage Symptoms: Some species feed with piercing-sucking mouthparts while others feed with complex, highly specialized mouthparts. Feeding damage on roots and germinating seeds of small plants causes loss of plant vigor and reduced stands.

Damaging Lifestage(s): Adult

Life Cycle:

- Egg | Adult
- Variable generations per year.
- Overwinter primarily as resting adults below the soil surface.

Time for Concern: May and June.

When and Where to Scout:

- Commonly found in heavy, organic soils during wet, cool spring conditions.
- Watch for reduced stands and loss of plant vigor.

Threat Level: Springtails rarely cause economic injury.

Top Management Techniques:

- Reduce moisture and excess organic matter.

When to Consider Treatment:

No thresholds have been developed, but control measures are rarely needed.

Look-alikes: fleas (jumping), symphylans



Globular springtail adult. Joseph Berger, Bugwood.org



Springtail adult. Susan Ellis, Bugwood.org



Springtail adults. Joseph Berger, Bugwood.org



Springtail adult. Joseph Berger, Bugwood.org



Springtails and feeding damage. University of Minnesota



Springtail feeding damage. University of Minnesota

PILLBUGS AND SOWBUGS

Family: Armadillidiidae

A: 6.3-12.7 mm long

Hosts: beans, lettuce, melon, mustard, pea, radish, tomato, and other vegetable crops

Appearance: Adults have a rounded back with a flat under-surface and are dark gray in color with armor-like body segments. Pillbugs and sowbugs are not insects, but are soil-dwelling crustaceans with 7 pairs of legs and prominent antennae.

Damage Symptoms: Pillbug and sowbug feeding damage looks similar to slug damage, ragged holes chewed between leaf veins. These crustaceans thrive where soil is moist and rich in organic matter.

Damaging Lifestage(s): Young, Adult

Life Cycle:

- Egg | Young | Adult
- 1-2 generations per year.
- Overwinter as adults.

Time for Concern: When fruits or vegetables have direct contact with damp soil.

When and Where to Scout:

- Adults and young hide under plant debris when temperatures are warm.
- Adults and young thrive in areas of high moisture.
- Adults and young are most active at night when humidity is high and temperatures are low.

Threat Level: Pillbugs and sowbugs are usually minor pests but occasionally become numerous enough to damage roots, seedlings, foliage, and fruits and vegetables that contact the soil. They primarily feed on decaying organic matter and are opportunistic feeders following disease, slug, and other pest damage.

Top Management Techniques:

- Minimize soil moisture.
- Remove debris such as trash, plant debris, wood, or other items on the soil.
- Trellis vines to improve air circulation.
- Use plastic mulches as a barrier to soil contact for developing fruits.

When to Consider Treatment:

Generally cultural management practices are most effective in preventing pillbugs and sowbugs from becoming a problem.

Look-alikes: none



Pillbug adult. Joseph Berger, Bugwood.org



Pillbug adult. Joseph Berger, Bugwood.org



Pillbug adult. Joseph Berger, Bugwood.org



Pillbug adult and young. Lyle J. Buss, University of Florida



Sowbug adult. James Castner, University of Florida




Pillbugs feeding on a young garden plant. D.W. Reed

CRUSTACEANS

SLUGS AND SNAILS

A: 25-38 mm long



Hosts: Wide variety, especially beans, corn, and lettuce plus many non-vegetable plants

Appearance: Adults are soft-bodied mollusks that leave behind a mucus or slime as they travel. As the mucus dries, it forms a shiny white, silvery trail, indicating that the pests are present. Eggs are small, round, pearl-like and white, covered in a layer of mucus, and laid in groups of about 25-120.

Damage Symptoms: Slugs and snails chew irregular holes that have smooth edges in leaves, eat flowers, clip off small plants and plant parts, and are particularly damaging to new seedlings and maturing vegetables or fruits that touch the soil. They typically leave slime trails on areas where they have been active.

Damaging Lifestage(s): Juvenile, Adult

Life Cycle:

- Egg | Juvenile | Adult
- 1-2 generations per year.
- Overwinter as eggs, juveniles, or adults.

Time for Concern: Throughout the season.

When and Where to Scout:

- Slugs and snails are first seen in the spring.
- They are active at night or on dark, cloudy days.
- They avoid sunny, dry conditions.
- During the day, they migrate to sheltered areas under debris and in soil cracks.

Threat Level: This pest is sporadic but wet weather and poorly composted organic matter favor population increase. Activity is low during hot, dry weather.

Top Management Techniques:

- Remove boards, stones, and any debris that shelters slugs and snails.
- Lure and destroy slugs and snails with bait, lumber, or produce scrap traps.
- Handpick and destroy snails and slugs when practical.
- Use drip or other water-conserving irrigation methods to reduce the extent of soil wetness.
- Increase sun penetration to dry vegetation and soil.
- Application of bait stations and chemical baits.

When to Consider Treatment:

When infestations are severe.

Look-alikes: wind or hail damage (damage)



Snail on pea plant. Cami Cannon, Utah State University



Snail feeding on cabbage. UC IPM Project, University of California



Slug juvenile and eggs. Watchduck (a.k.a. Tilman Piesk)



Slug damage to tobacco. R.J. Reynolds Tobacco Company, Bugwood.org



Slug damage. Iowa State University



Slug damage to hosta leaves. Missouri Botanical Garden

DISEASES, ABIOTIC DISORDERS, AND NEMATODES

Bacterial Diseases	98
Fungal Diseases	106
Fungal-Like Diseases	126
Nematode-Caused Diseases	132
Viral Diseases	134
Abiotic (Non-Living)	150

BACTERIAL CANKER

Caused by: *Clavibacter michiganensis* subsp. *michiganensis*

Spread by: infected transplants/seed; bacteria in splashing water; or on field equipment and tools

Hosts: tomato (primarily) and pepper

Symptoms: Infections can be systemic (wilting due to vascular infection) or superficial (surface of leaves, stems, and fruit). Systemic infections cause foliar wilting and marginal necrosis, starting with the lower leaves. In superficial infections, lesions on leaves are small, circular, white to brown spots while on fruit, they are raised, dark brown spots with a white halo.

Disease Cycle:

- Introduction to new fields occurs through infected seedlings or seeds. Bacteria spread locally in splashing water or on field equipment and tools.
- Bacteria survive up to three years in plant debris, and for several months on stakes and equipment.

Time for Concern: Any time temperatures are warm (75 to 90°F) and moist.

When and Where to Scout:

- Examine lower leaves starting in late spring for wilting and marginal necrosis (death of the outer edge).
- Both green and ripe fruit can be infected.
- If plants are wilting, select a few plants and cut the stems lengthwise and inspect the pith for necrosis.

Threat Level: Sporadic and rare in Utah, but can be devastating where present.

Top Management Techniques:

- Start with disease-free seed and transplants.
- Rotate with non-host crops.
- Avoid overhead irrigation.

When to Consider Treatment:

Use copper at time of diagnosis, repeated at 7-day intervals as needed.

Look-alikes: Verticillium wilt (leaf necrosis is instead v-shaped) and early blight (leaf lesions instead have concentric rings)



Bacterial canker and wilt of tomato symptoms on tomato. Heinz USA , Bugwood.org



Bacterial canker causes vascular discoloration in stems. Utah State University



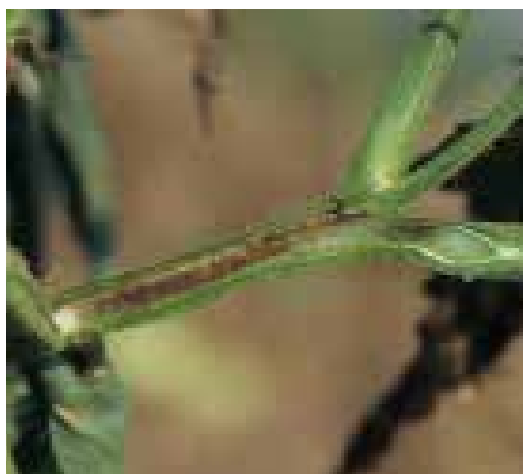
Bacterial canker causes white spots with dark centers on fruits. Utah State University



Bacterial canker and wilt of tomato symptoms on tomato fruit. Heinz USA , Bugwood.org



Bacterial Canker wilt of tomato symptoms. Mary Ann Hansen, Virginia Polytechnic Institute and State University, Bugwood.org



Cross-section through a diseased tomato stem. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org

BACTERIAL SPECK

Caused by: *Pseudomonas syringae* pv. tomato

Spread by: infected transplants/seed; bacteria in splashing water; or on field equipment and tools

Hosts: tomato

Symptoms: Symptoms on leaves are concentrated near margins and are most prominent on the undersides, consisting of brown to black spots with a yellow halo. Spots on fruit are scabby, pinpoint-like, and range in color from brown to black. Damage does not penetrate into the flesh.

Disease Cycle:

- Introduction to new fields occurs through infected seedlings or seeds. Bacteria spreads locally in splashing water or on field equipment and tools.
- Bacteria survive up to three years in plant debris, and for several months on plant stakes and equipment.

Time for Concern: Infections may occur during cool (63 to 75°F) wet conditions.

When and Where to Scout:

- Start examining undersides of leaves soon after planting, especially following cool, wet weather.
- Continue through early summer.

Threat Level: Minor.

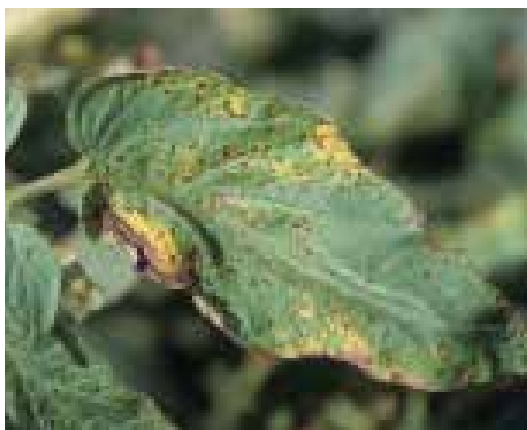
Top Management Techniques:

- Delay planting until cool, wet conditions are over.
- Avoid overhead irrigation.
- Rotate with a non-host crop such as small grains or corn.

When to Consider Treatment:

Copper before a cool, rain event, repeated at 14-day intervals as needed.

Look-alikes: early blight (leaf lesions instead have concentric rings), bacterial canker (spots on fruit have a white halo)



Bacterial speck symptoms on tomato leaf. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org



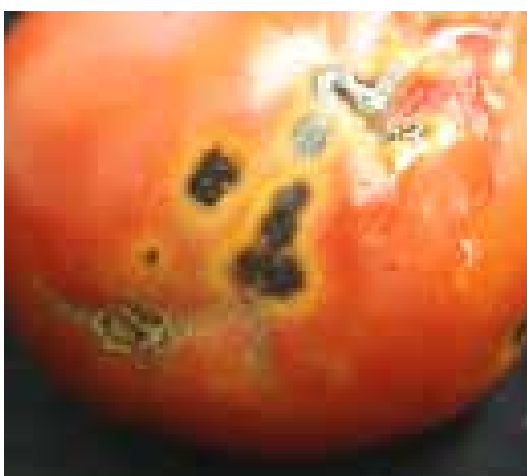
Bacterial speck symptoms on tomato leaf. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org



Bacterial speck symptoms on tomato leaf. Marion Murray, Utah State University



Bacterial speck symptoms on tomato leaf. Utah State University



Bacterial speck on fruit. Utah State University



Bacterial speck on fruit. Marion Murray, Utah State University

BACTERIAL STALK ROT

Caused by: Several formae speciales (special forms) of *Erwinia carotovora*

New Name: *Pectobacterium carotovorum*

Spread by: surface water from overhead/flood irrigation; rain-splash from previously-infected crop debris

Hosts: Primarily corn (forma speciales *zeae*). Other *P. carotovorum* strains cause a soft rot of cabbage, carrot, onion, potato, tomato, and sweet potato

Symptoms: Initially, leaf sheaths on corn and stalk nodes become discolored, followed by decay. Infected tissue emits a foul odor and the top of the plant lodges or can be easily removed.

Onion and potato: soft rot occurs causing infected tissues to dissolve, emit a foul odor, and ooze liquid from wounds. Potato tissue can turn black.

Disease Cycle:

- Infections occur during high temperatures (90°F and above) and high relative humidity and when free moisture is present, such as from rain or overhead irrigation.

Time for Concern: Irrigation water that is pumped from a lake, pond, or slow-moving stream can contribute to infections, especially during periods of heat and high humidity.

When and Where to Scout:

- Examine corn after extended periods of flooding during high temperatures and high humidity.
- Target fields where infections have occurred in the past.
- Look for blotchy brown lesions on stalks, especially near the base.
- Avoid wounding potato tubers or onions.

Threat Level: Commonly occurs on potatoes but rarely occurs on corn and onion in Utah.

Top Management Techniques:

- Plow corn debris deep into the ground.
- Avoid using surface water for irrigation (flooding or overhead).

When to Consider Treatment:

There is no cure for infected plants, so prevention is key.

Look-alikes: none, as symptoms are characteristic (foul odor).



Bacterial stalk rot of corn leaf sheath. Howard F. Schwartz, Colorado State University, Bugwood.org



Bacterial stalk rot symptoms on corn stalks. Howard F. Schwartz, Colorado State University, Bugwood.org



Close-up view of bacterial soft rot damage on a corn stalk. Howard F. Schwartz, Colorado State University, Bugwood.org



Bacterial stalk rot symptoms on a corn stalk. Department of Plant Pathology, North Carolina State University, Bugwood.org



Early death of corn plants can be a symptom of bacterial stalk rot. University of Nebraska Lincoln



Early death of corn plants can be a symptom of bacterial stalk rot. University of Nebraska Lincoln

ZEBRA CHIP DISEASE

Caused by: *Candidatus Liberibacter solanacearum*

Spread by: potato psyllids (*Bactericera cockerelli*)

Hosts: Primarily solanaceous species including eggplant, pepper, potato, tobacco, tomato, carrots, and several solanaceous weeds

Symptoms: Above-ground symptoms include yellowing and a pink-reddish discoloration of the foliage, and brown striations on sliced potato tubers (even more pronounced when fried). **Tomato:** Chlorosis of leaves and stunted plants. **Carrots:** Stunted plants with reddish foliage.

Disease Cycle:

- Infection occurs when disease-carrying potato psyllids feed on healthy plants.
- Overwinters in potato psyllids which overwinter in warmer locations.

Time for Concern: Throughout the growing season.

When and Where to Scout:

- Symptoms on potato can go unnoticed until the potato tubers are sliced. Foliar symptoms are often visible but mistaken for nutrient deficiency.
- Scout for potato psyllids using yellow sticky cards starting early in the season
- Inspect undersides of host leaves for the presence of psyllid nymphs (see psyllids on pg. 78-79)
- Monitor areas that have had the disease in the past.

Threat Level: The disease occurs across Utah but infection levels vary from year to year. The disease tends to be more common in areas that had it in the past.

Top Management Techniques:

- Control psyllids early in the season.
- Remove infected plants.
- Application of insecticides; early in the season to control potato psyllids.

When to Consider Treatment:

Consider treatment when potato psyllids are present.

Look-alikes: nutrient deficiency (leaves)



Zebra chip disease is transmitted by adult potato psyllids that carry the bacterium. Whitney Cranshaw, Colorado State University, Bugwood.org



Zebra chip disease causes foliage of infected plants to turn pink to reddish in color. Whitney Cranshaw, Colorado State University, Bugwood.org



Zebra chip disease symptoms on potato. Whitney Cranshaw, Colorado State University, Bugwood.org



Zebra chip disease symptoms on potato. Whitney Cranshaw, Colorado State University, Bugwood.org



Zebra chip disease results in a brown discoloration of the vascular tissue in the potato tuber. Joseph Munyaneza, Agricultural Research Service, USDA



Zebra chip disease is more pronounced on fried potatoes. Joseph Munyaneza, Agricultural Research Service, USDA

BOTRYTIS NECK ROT

Caused by: *Botrytis acclada* and *B. allii*

Spread by: infected seed or germination of soilborne spores

Hosts: chives, garlic, leek, onion, shallot

Symptoms: Symptoms appear after onions are placed in storage. Infected bulbs may have a sunken appearance and will feel spongy. Scales turn brown at the neck, and rot will extend to the basal plate. Gray fungal spores may be seen on the outside of the bulb.

Disease Cycle:

- Infections may occur in one of three modes: via infected seed; when onion plants come into contact with resting *Botrytis* spores in the soil; when wind-blown spores infect bulbs during harvest.
- For all the modes of infection noted above, the pathogen remains latent in the plant until after storage.
- Infections appear on bulbs 1 to 2 months after storage.

Time for Concern: The disease is most severe when there is poor ventilation, high humidity, and temperatures above 40°F in storage.

When and Where to Scout:

- Since plants are symptomless in the field, monitor stored bulbs for softening neck tissue.

Threat Level: This disease is usually rare in Utah, but can occur in high numbers. Risk increases if bulbs are harvested when wet or not fully cured.

Top Management Techniques:

- Bury cull onions.
- Practice a 3 to 4 year rotation.
- Harvest only mature and fully cured bulbs.

When to Consider Treatment:

Late application of a fungicide can decrease infections if it is rainy during harvest.

Look-alikes: none



Early stage of botrytis neck rot. Utah State University



Advanced decay by botrytis neck rot. Utah State University



White mycelium of Botrytis growing between scales.
Utah State University



"Sclerotia" spores produced by Botrytis on onion bulbs.
Utah State University



Grey Botrytis spores produced on onion. Utah State University



Onion cull pile with Botrytis lesions caused by *Botrytis allii*. Howard F. Schwartz, Colorado State University, Bugwood.org

CORN SMUT

Caused by: *Ustilago maydis*

Spread by: windblown or rain-splashed spores

Hosts: sweet and field corn

Symptoms: White-gray, fleshy galls (swollen plant tissue) form on tassels, corn kernels, leaves, and shoots. When galls are young, they can be cooked and eaten. When galls are older, they turn black and powdery.

Disease Cycle:

- Overwinters as spores in the soil or on infected corn debris.
- In late spring, windblown or rain-splashed spores cause infections on succulent tissue.
- As galls age, they erupt and release thousands of spores that drop to the soil.

Time for Concern: Plants are most commonly infected early in the growing season, at the active growing points.

When and Where to Scout:

- Inspect succulent corn tissues starting in late spring for spongy, gray galls.
- Once ears begin to form, pull back sheaths to check for any gall formation on kernels.

Threat Level: This disease is rare in Utah, but if symptoms develop while ears are still growing, ears become unmarketable.

Top Management Techniques:

- Remove and dispose of galls throughout the season.
- Remove and destroy plant debris in the fall.
- Rotate crops.

When to Consider Treatment:

Fungicides will not provide control of common smut.

Look-alikes: none, as symptoms are characteristic (gray to black galls)



Smut on corn ear (top), as compared to a healthy ear.
Whitney Cranshaw, Colorado State University, Bugwood.org



Tassel infected with corn smut. Claudia Nischwitz, Utah State University



Stalk infected with corn smut. Clemson University, USDA Cooperative Extension Slide Series, Bugwood.org



Leaf infected with corn smut. University of Georgia Plant Pathology Archive, UG, Bugwood.org



Corn smut on sweet corn. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org

EARLY BLIGHT

Caused by: *Alternaria solani*

Spread by: infected seed or transplants; rain-splashed spores from old plant debris

Hosts: potato and tomato (primarily), as well as eggplant and pepper, and solanaceous weeds such as nightshade

Symptoms: In Utah, symptoms mainly occur on foliage, whereas elsewhere, fruit can also be infected. On foliage, lesions are concentrated on older leaves closer to the ground. Round, brown spots form, containing distinctive rings and a yellow margin. On fruits, small spots form that are dark and leathery.

Disease Cycle:

- Overwinters as spores in infected plant debris and may also be introduced via infected seed or transplants.
- Rain-splashed spores land on lower foliage, causing new infections. Infections can continue throughout the season so long as moisture and warm temperatures persist.

Time for Concern: Disease develops during warm temperatures (optimally, 82 to 86°F).

When and Where to Scout:

- Starting in mid to late spring, regularly check older, lower leaves for circular, brown spots.

Threat Level: Minor, as primarily only older leaves may be affected.

Top Management Techniques:

- Cultivars such as Iron Lady, Mountain Magic, Jasper, Juliet, and Verona are resistant.
- Rotate out of tomato/potato for at least two years.
- Remove infected plants and leaves during the season, and after harvest, remove or bury plant debris.

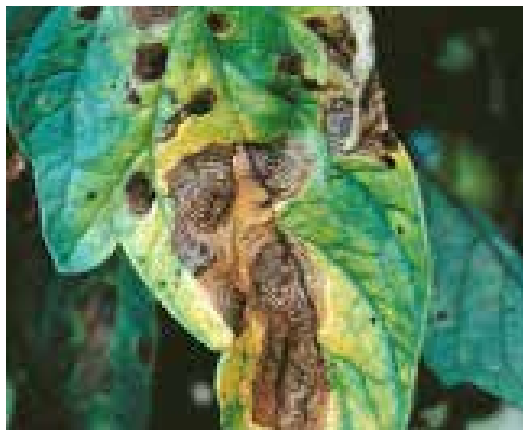
When to Consider Treatment:

Many fungicides are available, but rarely need to be used as fruit is typically not infected in Utah.

Look-alikes: bacterial spot, late blight (except this disease develops under cool conditions, and succulent tissue is susceptible)



Brown spots on leaves caused by early blight. Utah State University



Early blight can cause concentric rings to develop when spores are reduced. Utah State University



Early blight on fruit. Utah State University



Early symptoms of early blight on potato leaves. Howard F. Schwartz, Colorado State University, Bugwood.org



A potato leaflet showing early blight symptoms. Howard F. Schwartz, Colorado State University, Bugwood.org



A potato field showing early blight symptoms. Howard F. Schwartz, Colorado State University, Bugwood.org

FUSARIUM WILT

Caused by: Formae speciales (special forms) of *Fusarium oxysporum*

Spread by: soil

Hosts: Wide range of vegetables including cantaloupe, eggplant, lettuce, pepper, potato, pumpkin, spinach, tomato, and watermelon, alfalfa, many ornamentals, and weeds such as dandelion, groundsel, lamb's quarters, pigweed, sagebrush, and shepherd's purse

Symptoms: General symptoms include wilt, chlorosis, red to purple discoloration of leaves or stems, stunted and/or distorted growth, necrosis, and premature plant senescence. Reduced seed production or yield may occur.

Disease Cycle:

- Infection occurs when fungi infect the roots of host plants.
- Overwinters as resting spores called chlamydospores.
- Fusarium wilt is soilborne and seedborne.
- The pathogen is highly specific. For example, the forma speciales that infects tomato does not infect pepper or any other vegetable. Each forma speciales is specific to one crop.

Time for Concern: During high soil moisture and temperatures (90°F).

When and Where to Scout:

- Watch for symptoms when soil moisture and temperatures are high (90°F).
- Monitor areas that have had the disease in the past.

Threat Level: This disease is widespread in Utah cantaloupe, pea, and tomato production, occasional in celery, cucumber, pumpkin, squash, and watermelon, and rare in potato. Chlamydospores can survive for a several years in the soil and plant debris.

Top Management Techniques:

- Use resistant varieties when available.
- Plant on raised beds for better water drainage.
- Clean equipment and shoes from attached soil.
- Use certified disease-free seed.

When to Consider Treatment:

There are no chemical controls for *Fusarium oxysporum*.

Look-alikes: Verticillium wilt, drought stress, Phytophthora crown rot



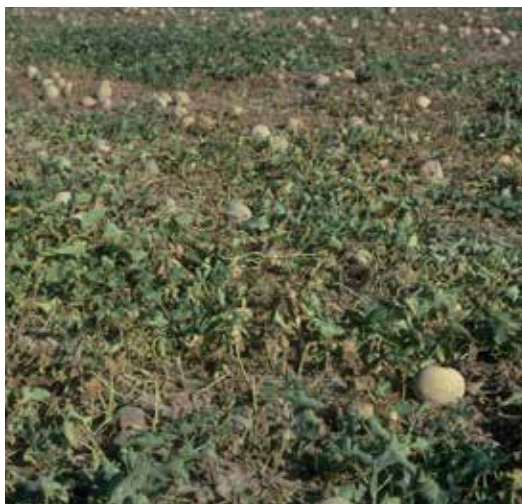
Fusarium wilt on tomato plants. William M. Brown Jr., Bugwood.org



Fusarium wilt symptoms in a melon field. Howard F. Schwartz, Colorado State University, Bugwood.org



Melon plants showing Fusarium wilt symptoms. Howard F. Schwartz, Colorado State University, Bugwood.org



Fusarium wilt symptoms in a field of melons. Howard F. Schwartz, Colorado State University, Bugwood.org



Wilt diseases cause vascular discoloration. Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org



Wilt diseases cause vascular discoloration. Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

GUMMY STEM BLIGHT (BLACK ROT)

Caused by: *Didymella bryoniae*

Spread by: infected seed and rain-splashed spores from infected plant debris

Hosts: cantaloupe, cucumber, pumpkin, squashes, watermelon, and other melons

Symptoms: All above-ground parts of the plant can become infected. Lesions on the stem form a brown, cracked area that may ooze a red to amber gummy substance. Leaves develop dark brown circular spots starting at margins. On squash fruit, the disease is called black rot, causing large necrotic lesions. On butternut squash fruits, the disease may form distinct concentric rings.

Disease Cycle:

- Overwinters in the soil as spores on infected plant debris.
- Splashing water spreads spores onto susceptible plant tissue.

Time for Concern: Optimum conditions for infection range from 65-75°F (depending on the crop) and moisture of up to 10 hours.

When and Where to Scout:

- Inspect seedlings and transplants for symptoms starting in mid-spring.

Threat Level: This disease is most common in Utah on fruit in the field and seedlings produced in greenhouses, where humidity is higher.

Top Management Techniques:

- Rotate out of cucurbit crops for 2-3 years.
- Remove and destroy infected plants.

When to Consider Treatment:

Several fungicides are available, but should only be used upon confirmed diagnosis.

Look-alikes: blossom end rot on fruits



Gummy stem blight (GSB) causes necrotic (dead) spots on infected leaves. Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org



GSB sometimes causes infected stems to ooze a gummy substance. Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org



On squash, the GSB disease is called black rot. Utah State University



Black rot may form distinct concentric rings on butternut squash fruit. Utah State University



Gummy stem blight lesions at the base of a watermelon plant. Don Ferrin, Louisiana State University Agricultural Center, Bugwood.org



Gummy stem blight vine decline in melon. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org

PINK ROOT

Caused by: *Phoma terrestris*

Spread by: soil; water; mechanical activity

Hosts: Primarily onion but can survive in, but not damage, cereals, corn, cucurbits, garlic, grasses, pepper, spinach, and soybean

Symptoms: Infected roots turn a distinctive pink to red color that later turns dark red or purple. Roots may shrivel and die. The fungus spreads to newly produced roots which leads to reduced bulb size in onions. Infected plants are small and stunted and in severe cases, leaves start to die back resembling drought stress.

Disease Cycle:

- Infection occurs when the fungus penetrates roots directly without the need for wounds.
- Once introduced, the pink-root fungus can persist indefinitely in the soil.
- Optimum infection occurs at soil temperatures of 75-85°F.

Time for Concern: Throughout the growing season.

When and Where to Scout:

- Watch for stunted plants throughout the growing season.
- Infection is confined to roots and outer scales of the bulb.
- Pull suspect onions to look for pink roots.

Threat Level: This fungal disease is widespread in Utah onion production. Incidence of disease can worsen when onions are planted after cereals or in very short rotation with onion. The disease is greatly enhanced when plants are stressed.

Top Management Techniques:

- Use resistant varieties.
- Maintain healthy, vigorous plants.
- Rotate crops.

When to Consider Treatment:

Fumigation can be effective against some strains of the fungus but is not always economical because it is very expensive.

Look-alikes: drought stress, nutrient deficiency, *Fusarium* spp. (pink roots)



Pink root symptoms. Utah State University



Aboveground symptoms of pink root. Severely infected plants appear to have a nutrient deficiency or water stress. Utah State University



Symptoms of pink root can cause roots to become desiccated and shrivel up. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org



Symptoms of pink root.



Bulb and root showing evidence of pink root. Howard F. Schwartz, Colorado State University, Bugwood.org



Roots will range in color from light to deep pink. David B. Langston, University of Georgia, Bugwood.org

POWDERY MILDEW OF CUCURBITS

Caused by: *Podosphaera xanthii* and *Erysiphe cichoracearum*

Spread by: windblown spores

Hosts: all cucurbit crops (melons, pumpkins, squashes)

Symptoms: White, powdery fungal growth occurs on leaves, stems, and petioles. Initial infections begin as a few, small, white fungal spots. Eventually, these spots spread and enlarge throughout the plant. As leaves become colonized, they may turn yellow and wilt, exposing the fruit to sunscald and resulting in poor yield.

Disease Cycle:

- Infection occurs via windborne spores that can travel for many miles.

Time for Concern: Infections may occur all season. Temperatures between 75-85°F with high humidity and no rainfall promote rapid spread. (Humidity that forms within the crop is enough for this pathogen.)

When and Where to Scout:

- Early detection is key; begin weekly scouting of the undersides of the lower, oldest leaves of the crop soon after planting.
- Continue scouting up to harvest.

Threat Level: Very common and widespread in Utah.

Top Management Techniques:

- Remove early infected leaves as they are encountered.
- Some resistant cultivars are available, especially cucumber.
- Provide adequate plant spacing.
- Remove old plant debris and volunteers.

When to Consider Treatment:

Many fungicides, both organic and conventional are available, and must be applied to the as soon as first small white spots are observed. Continue to apply every 7-10 days.

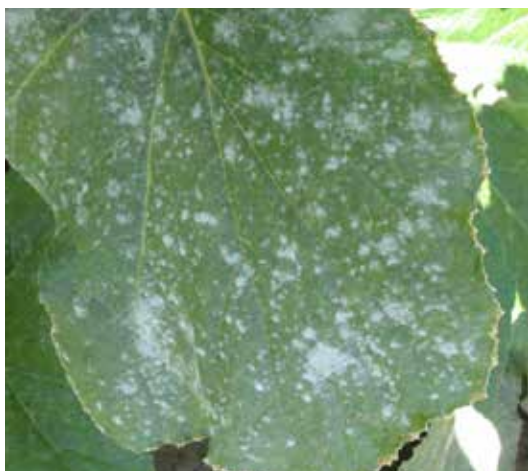
Look-alikes: none, as this disease is characteristic (white spots on leaves)



Spots can be on both upper and lower surfaces of leaves; note several powdery spots on the underside of this infected squash leaf. Cami Cannon, Utah State University



Close-up view of powdery mildew on the underside of squash leaf. Cami Cannon, Utah State University



Powdery mildew appears as white powdery spots. Cami Cannon, Utah State University



Over time, powdery mildew can cover the entire leaf. Cami Cannon, Utah State University



Powdery mildew symptoms on melon. Utah State University



Powdery mildew symptoms on squash. Cami Cannon, Utah State University

PURPLE BLOTCH

Caused by: *Alternaria porri*

Spread by: wind; water

Hosts: garlic, leeks, onion, shallot

Symptoms: Early symptoms include small brown elliptical spots on leaves, similar to IYSV lesions, which enlarge over time and may result in brown, necrotic streaks. Lesions will eventually turn purple as fungal spores develop. In severe cases, lesions enlarge and coalesce to blight the entire leaf. This pathogen requires wounds caused by other diseases (e.g. botrytis), thrips feeding, or hail, to enter the plant.

Disease Cycle:

- Infection occurs when fungal spores from nearby plants are blown by wind into onion fields where they infect wounded plants.
- Overwinters in crop residue on or near the soil surface.
- Optimum temperatures for infection are between 77-85°F.

Time for Concern: Throughout the growing season.

When and Where to Scout:

- Watch for symptoms starting on older leaves throughout the growing season.

Threat Level: This disease is occasional in Utah onion production. Older leaves are more susceptible.

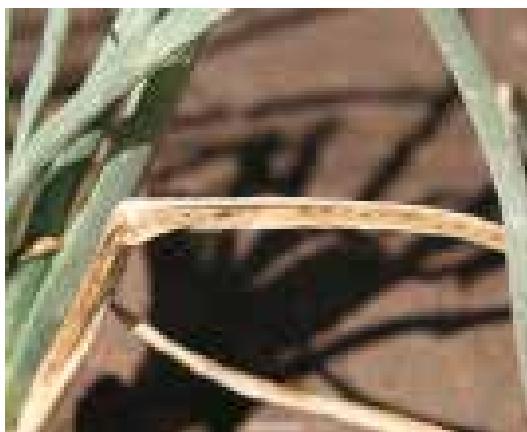
Top Management Techniques:

- Rotate crops.
- Avoid excessive nitrogen applications.
- Bury or dispose of culls and other plant debris.
- Application of fungicides.

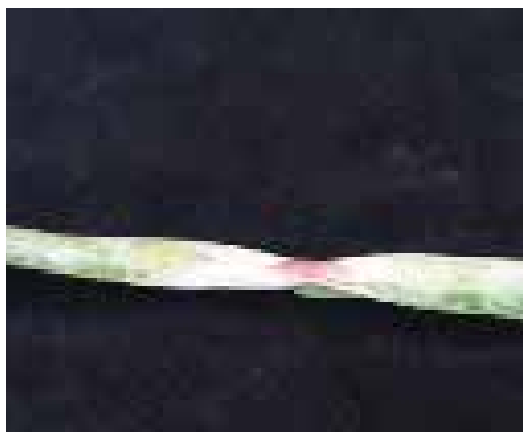
When to Consider Treatment:

Use fungicides as soon as the disease has been confirmed to prevent further spread. Treatment for purple blotch also controls *Stemphylium* leaf blight (see *Stemphylium* leaf blight on pg. 126-127).

Look-alikes: Iris yellow spot virus (lesions)



Onion leaf dieback due to purple blotch. Utah State University



Purple blotch symptoms on onion. Utah State University



Purple blotch symptoms on onion. Howard F. Schwartz, Colorado State University, Bugwood.org



Early leaf symptoms of purple blotch on onion. Howard F. Schwartz, Colorado State University, Bugwood.org



Purple blotch lesion on the neck region of an onion plant. Howard F. Schwartz, Colorado State University, Bugwood.org



Advanced symptoms of purple blotch on a field of onion plants. Howard F. Schwartz, Colorado State University, Bugwood.org

STEMPHYLIUM LEAF BLIGHT

Caused by: *Stemphylium vesicarium*

Spread by: windblown spores

Hosts: onion (primarily), as well as chives, garlic, and wild/ornamental onions

Symptoms: This disease is limited to leaves, and does not extend down to the scales of the bulb. Infections are initially small, light yellow to brown spots that may coalesce into extensive blighting of the leaves. Spots turn dark in appearance due to formation of fruiting bodies.

Disease Cycle:

- The pathogen overwinters on infected plant debris.
- Spores from outside or within the field are windblown and only cause infections through existing wounds on the leaf surface, such as from thrips feeding, hail, windstorms, etc.

Time for Concern: Optimum conditions for spread are 65 to 77°F, heavy dew or rainfall, and conditions that cause foliar wounding.

When and Where to Scout:

- Conduct weekly examination of older leaves (which are most susceptible), starting in mid to late spring.

Threat Level: This disease is common in Utah onion fields, but rarely causes crop loss.

Top Management Techniques:

- Rotate out of onion crops for at least three years.
- Bury plant debris.
- Reduced plant density.

When to Consider Treatment:

Fungicides are available to prevent further spread; only apply after correct diagnosis.

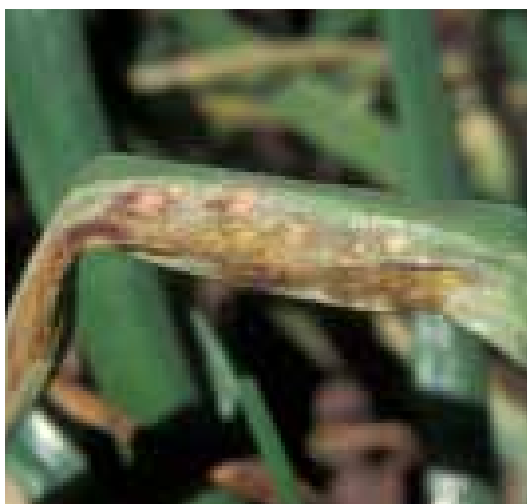
Look-alikes: Iris yellow spot virus, thrips feeding, purple blotch, some bacterial leaf diseases



Stemphylium leaf blight symptoms on onion. Claudia Nischwitz, Utah State University, Bugwood.org



Mixed infection of downy mildew and Stemphylium. Claudia Nischwitz, Utah State University, Bugwood.org



The primary disease is downy mildew. However, some Stemphylium leaf blight is also present. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org



Stemphylium leaf blight on onion. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org



Stemphylium leaf blight in an onion field. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org



Onion umbel stalk showing a lesion caused by Stemphylium . Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org

VERTICILLIUM WILT

Caused by: *Verticillium dahliae*

Spread by: soil

Hosts: Wide range of vegetables including cantaloupe, eggplant, pepper, potato, pumpkin, spinach, tomato, and watermelon, stone fruit trees, alfalfa, many ornamentals, and weeds such as dandelion, groundsel, lamb's quarters, pigweed, sagebrush, and shepherd's purse

Symptoms: General symptoms include wilt, chlorosis, red to purple discoloration of leaves or stems, brown discoloration inside vascular tissue, stunted overall growth, foliar necrosis, and premature plant senescence. Reduced seed production or yield may occur.

Disease Cycle:

- Infection occurs when fungi infect the roots of host plants
- Overwinters as a survival structure called a microsclerotium (hard black ball of fungal tissue)
- Verticillium wilt is soilborne.

Time for Concern: Throughout the growing season; especially if vegetables are planted in fields that previously had alfalfa.

When and Where to Scout:

- Watch for symptoms during cooler temperatures (68-74°F).
- Symptoms are often expressed on one side of a plant, branch, or leaflets.
- Symptoms may not appear until the host initiates flowering.

Threat Level: This disease is widespread in Utah cantaloupe, eggplant, pepper, potato, and tomato production and occasional in squash and pumpkin. Microsclerotia can survive for a decade or more in the soil, waiting for a suitable host to be planted.

Top Management Techniques:

- Use resistant varieties when available.
- Plant on raised beds for better water drainage.

When to Consider Treatment:

There are no chemical controls for Verticillium wilt.

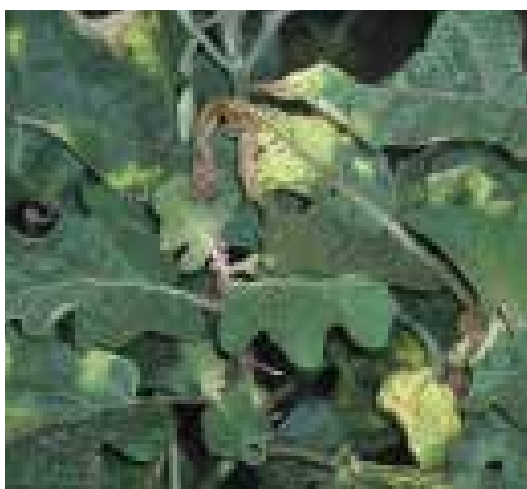
Look-alikes: other wilt diseases, such as Fusarium wilt, drought stress



Close up of distinctive, one-sided chlorotic (yellow) leaf next to healthy leaf on the left. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org



Necrosis (brown dead tissue) and chlorosis (yellow tissue) in tomato caused by verticillium wilt. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org



Foliar symptoms of Verticillium wilt on eggplant. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org



Wilted tomato plants show symptoms of verticillium wilt. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org



Verticillium wilt occasionally causes discoloration of the potato tuber vascular tissue. University of Minnesota Extension



Verticillium wilt causes discoloration of the vascular tissue in the main stem of the host plant. University of Minnesota Extension

LATE BLIGHT

Caused by: *Phytophthora infestans*

Spread by: infected seedlings; splashing water; field equipment and tools

Hosts: potato, tomato, and related weeds such as nightshade and bittersweet

Symptoms: All above-ground portions of plants can be infected, plus potato tubers. Lesions on leaves and stems start as a greasy-gray blotch, and eventually turn black. Infected tomato fruits and potatoes develop hard, brown, blotchy lesions that extend into the flesh.

Disease Cycle:

- Overwinters in infected potato tubers left underground or in cull piles.
- Under wet conditions, spores form in early spring and are carried for miles to cause primary infections on succulent plant tissue. Storms from southern states can also contribute to spread of spores.
- Later in the season, infected tissue releases additional spores, causing new secondary infections and sometimes, epidemics can wipe out entire fields.

Time for Concern: When leaves are wet for more than 10 to 12 hours at moderate temperatures (60-80°F).

When and Where to Scout:

- Start scouting for this disease soon after planting. Early detection is important; as rapid spread can occur.
- Check wet areas of the field first (low spots in the field, edges near hedgerows, shaded areas, etc.).

Threat Level: Epidemics are rare and localized in Utah.

Top Management Techniques:

- Eliminate cull piles, plant debris, and volunteer potato and tomato plants.
- Once the disease is detected, immediately remove and destroy infected plants.
- Avoid overhead irrigation and excessive nitrogen applications.
- Rotate out of tomato or potato for two years.

When to Consider Treatment:

Fungicides are necessary where the disease has occurred in the past.

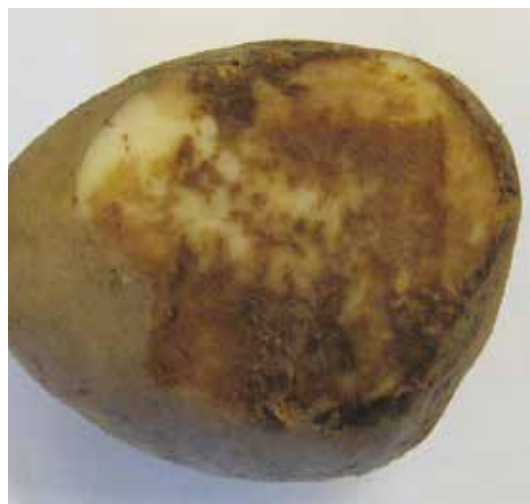
Look-alikes: early blight (leaf lesions instead have concentric rings, and this disease develops under warm conditions on older foliage)



New late blight lesions may have a yellow halo. William M. Brown Jr., Bugwood.org



Late blight lesions quickly enlarge and turn black-brown. Howard F. Schwartz, Colorado State University, Bugwood.org



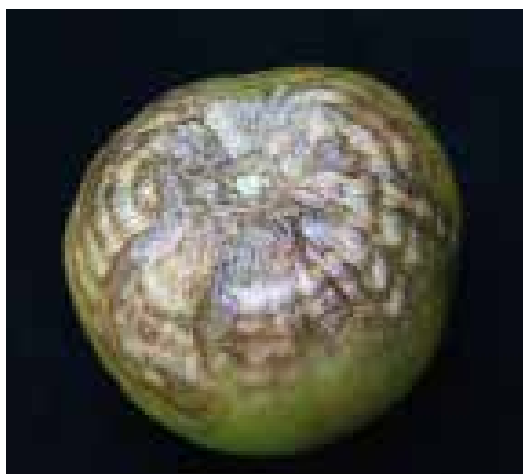
Tubers infected with late blight decay either in the soil or in storage. Sandra Jensen, Cornell University, Bugwood.org



Late blight leaf symptoms. Utah State University



Late blight appearing as a white mold on leaves. Utah State University



Late blight causes brown or olive-colored lesions on fruit. Utah State University

PHYTOPHTHORA FRUIT ROT

Caused by: *Phytophthora* spp.

Spread by: spores in splashing water; field equipment and tools

Hosts: fruits of melon, pumpkin, squash

Symptoms: Water-soaked spots form where fruit touches the ground, eventually turning into a white, yeast-like growth, and finally becoming a soft decay. The fruit will collapse.

Disease Cycle:

- The pathogen survives in soil up to two years on infected plant debris.
- In saturated soils, spores form and may infect nearby fruit that is close to harvest stage.

Time for Concern: When soil remains saturated for at least five hours toward harvest time.

When and Where to Scout:

- A few weeks before harvest, inspect fruits each week, by checking where they touch the soil.

Threat Level: Rare in Utah.

Top Management Techniques:

- Rotate with non-host crops for two years.
- Plant only in well-drained soils and allow soil to dry between irrigations.
- Clean equipment and tools between fields.
- Remove infected fruits.

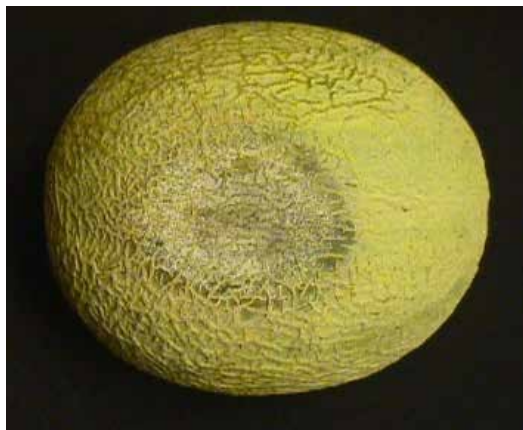
When to Consider Treatment:

Under good preventive practices, fungicides are not necessary in Utah.

Look-alikes: blossom end rot



Phytophthora fruit rot symptoms on cucumbers. Charles Averre, North Carolina State University, Bugwood.org



Phytophthora fruit rot symptoms on melon. Jason Brock, University of Georgia, Bugwood.org



Phytophthora fruit rot symptoms on melon. Jason Brock, University of Georgia, Bugwood.org



Phytophthora fruit rot symptoms on melon. Jason Brock, University of Georgia, Bugwood.org



Phytophthora fruit rot symptoms on squash. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org



Phytophthora fruit rot symptoms on squash. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org

PHYTOPHTHORA ROOT/STEM/CROWN ROT

Caused by: *Phytophthora* spp.

Spread by: soil; water; mechanical activity

Hosts: tomato, pepper, eggplant, other vegetables, fruit trees, nut trees, and ornamental shrubs and trees

Symptoms: Phytophthora root, stem, and crown rot is caused by several species of soilborne pathogens in the genus *Phytophthora*. This disease is favored primarily by wet soil but can be favored by warm temperatures as well. Early infections cause seeds or seedlings to appear bruised, soft, rotted, yellow, brown, and plants can wilt and die. Mid or late season infections cause chocolate-brown lesions on roots and sometimes stems, yellowing leaves, wilting, and plant death in patches or sections of rows.

Disease Cycle:

- Phytophthora organisms thrive, grow, reproduce, and infect plant roots in water, saturated soil, and along river banks and ponds.
- Soil-inhabiting pathogens survive as resting spores in the soil for years when there are no suitable hosts.
- Water in soil pores and root exudates from plant host nearby allow resting spores to germinate.

Time for Concern: Throughout the growing season.

When and Where to Scout:

- Watch for symptoms starting early in the season.
- Watch for poorly draining soil throughout the growing season.

Threat Level: This disease is sporadic in Utah and is promoted primarily by wet soil. Warm temperatures may also promote this disease.

Top Management Techniques:

- Provide good soil drainage and water management to prevent standing water.
- Rotate crops.
- Avoid planting susceptible crops in soil infested with *Phytophthora*.
- Use resistant varieties when available.

When to Consider Treatment:

Disease is difficult to suppress, so prevention and cultural controls are key.

Look-alikes: mechanical injury, overwatering, insect injury, drought stress, damping off (seeds and seedlings), stem canker (mid or late season)



Lower stem lesion on pepper caused by *Phytophthora*.

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



Young pepper plant is wilting due to girdling of lower stem by *Phytophthora*.

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



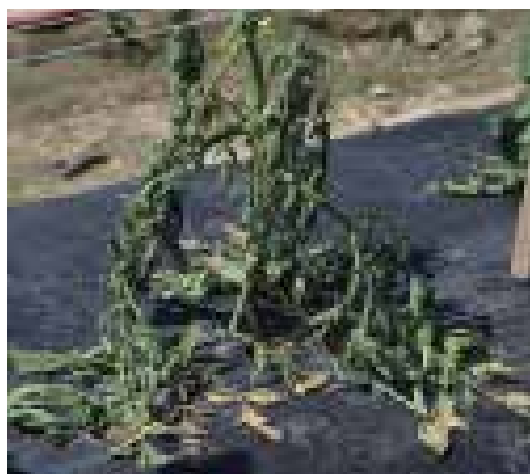
Phytophthora on lower stem of bell pepper. Don Ferrin,

Louisiana State University Agricultural Center, Bugwood.org



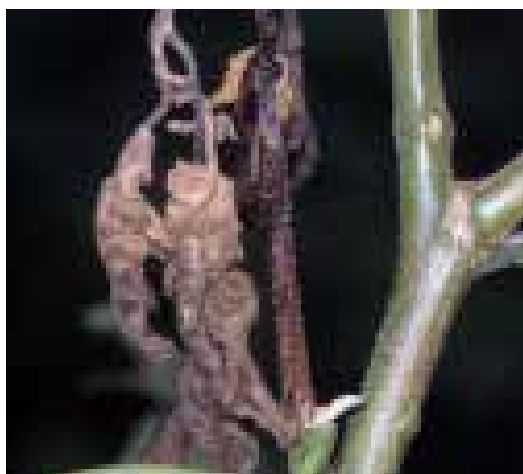
Phytophthora root rot in alfalfa field. Sherm Thomson, Utah State

University



Phytophthora symptoms on tomato. Gerald Holmes, California

Polytechnic State University at San Luis Obispo, Bugwood.org



Phytophthora stem rot on eggplant. Gerald Holmes, California

Polytechnic State University at San Luis Obispo, Bugwood.org

ROOT-KNOT NEMATODES

Meloidogyne hapla

Meloidogyne incognita

Meloidogyne chitwoodi

Hosts: Hundreds of plants including fruits, grasses, vegetables, potatoes, and numerous weeds

Symptoms: Root-knot nematodes are microscopic roundworms that enter plants through the root tips and move up in the root until they find a preferred spot to feed. They feed by releasing chemicals that cause cell nuclei to divide without cell division, creating giant feeding cells. Above-ground symptoms are chlorosis and stunting resembling nutrient deficiency. Roots of infected plants have galls. Large galls can merge to look like one big tumor.

Disease Cycle:

- Infection occurs when root-knot nematodes enter the plant through the roots.
- Overwinter as juveniles in the soil.

Time for Concern: Throughout the growing season, but control measures are only effective before or at planting.

When and Where to Scout:

- Root-knot nematode problems are often discovered after finding galled roots on a previous crop.
- A simple bioassay can be used to detect root-knot nematodes in the soil or a sample can be sent for testing to a nematology lab.

Threat Level: Root-knot nematodes are occasional in Utah.

Top Management Techniques:

- Use tolerant varieties when available.
- Keep infested fields fallow for 2-3 years.
- Remove all weeds.
- Roto-till fallow areas once every 3-4 weeks during the hot, dry summer months.
- Telone soil fumigation in commercial fields.

When to Consider Treatment:

Except fumigation for commercial fields, there are currently no chemical options for root-knot nematode control.

Look-alikes: nitrogen fixing nodules (*Rhizobium*) on roots of legume family plants (confused with galls), drought stress (aboveground), excessive water (aboveground), extreme soil pH (aboveground), extreme soil texture differences (aboveground)



Galled root system of tomato infected with root-knot nematode (left), compared with non-infected root system (right). Jonathan D. Eisenback, Virginia Polytechnic Institute and State University, Bugwood.org



Onion infected with root-knot nematodes (bottom) compared to non-infected onion (top). Jonathan D. Eisenback, Virginia Polytechnic Institute and State University, Bugwood.org



Deformed root system of carrot caused by root-knot nematode. Jonathan D. Eisenback, Virginia Polytechnic Institute and State University, Bugwood.org



Galled roots of beet caused by root knot nematode. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org



Potatoes showing damage caused by root knot nematode. William M. Brown Jr., Bugwood.org



Root knot nematodes in potato tuber. Elizabeth Bush, Virginia Polytechnic Institute and State University, Bugwood.org

ALFALFA MOSAIC VIRUS (AMV)

Genus: *Alfamovirus*

Caused by: *Alfalfa mosaic virus*

Spread by: aphids; alfalfa and pepper seed; mechanical activity

Hosts: alfalfa, basil, bean, birdsfoot trefoil, clover, lettuce, hairy vetch, pea, pepper, potato, tomato, and weeds including bindweed, lambsquarter, nightshade weeds, perennial sowthistle, pigweed, purslane, shepherd's purse

Symptoms: Yellow mosaic or calico patterns, turning to a bronze discoloration on leaves, necrotic phloem tissues, necrotic rings and spots on fruit, sometimes solid brown necrosis on surface of fruit, and usually plant death.

Disease Cycle:

- Aphids acquire the virus by feeding on an infected plant (commonly alfalfa) and transmit it when feeding on healthy plants.
- Can be spread through seeds (in alfalfa and pepper) and mechanical activity.
- Overwinters in perennial host plants.

Time for Concern: When vegetables are planted near alfalfa, clover, or other legume crops.

When and Where to Scout:

- Watch for symptoms on vegetables throughout the growing season.
- Monitor aphid activity throughout the growing season, especially near alfalfa.

Threat Level: Generally, not a major problem in Utah but can occur in localized areas each year and can cause significant losses in potatoes planted next to alfalfa.

Top Management Techniques:

- Avoid planting susceptible vegetables near alfalfa or clover.
- Use reflective mulches to repel aphids.

When to Consider Treatment:

No effective chemical controls are currently available.

Look-alikes: Tomato spotted wilt virus



Alfalfa mosaic virus symptoms on alfalfa. Mary Ann Hansen, Virginia Polytechnic Institute and State University, Bugwood.org



Alfalfa mosaic virus symptoms on potato leaves. Howard F. Schwartz, Colorado State University, Bugwood.org



Alfalfa mosaic virus symptoms on potato leaves. Howard F. Schwartz, Colorado State University, Bugwood.org



Alfalfa mosaic virus symptoms on pepper leaves. Cami Cannon, Utah State University



Alfalfa mosaic virus symptoms on pepper leaves. Cami Cannon, Utah State University



Alfalfa mosaic virus symptoms on pepper leaves. Cami Cannon, Utah State University

CURLY TOP VIRUS (CTV)

Genus: *Curtovirus*

Caused by: *Beet curly top virus*, *Beet severe curly top virus*, *Beet mild curly top virus*, *Spinach severe curly top virus*, *Horseradish curly top virus*, *Pepper yellow dwarf virus*

Spread by: beet leafhopper (*Circulifer tenellus*); potato seed pieces

Hosts: bean, beets, cucurbits (melon, squash, gourds, cucumber), flax, pepper, potato, spinach, Swiss chard, tomato, and weeds such as filaree, kochia, lambsquarter, mustards, pigweed, plantain, Russian thistle, and shepherd's purse

Symptoms: Infected plants occur randomly due to sporadic movement of the beet leafhopper as it feeds. Some plants may exhibit severe symptoms, while others are asymptomatic (many species of weeds). Plants affected early in their growth may quickly die. Symptoms include small, twisted, curled leaves with purple veins, thickened, stiff, and crisp leaves, yellowing and death of mature leaves, small fruits that ripen prematurely, reduced fruit quality and yield, stunted growth, and downward curling petioles.

Disease Cycle:

- Beet leafhoppers acquire the virus when feeding on infected weeds or other plants and transmit it when feeding on healthy plants.
- Can be spread via potato seed pieces.
- Overwinters in living host plants and beet leafhopper.

Time for Concern: Spring and summer.

When and Where to Scout:

- Watch for symptoms on vegetables starting in spring.

Threat Level: Widespread across Utah. Infection is sporadic and unpredictable and is especially threatening to tomato production in Utah.

Top Management Techniques:

- Exclude leafhoppers with floating row cover (only effective on small scale areas with little wind).
- Shade plants.
- Remove infected plants immediately upon detection.

When to Consider Treatment:

There are no chemical control options for curly top and insecticide applications directed at beet leafhoppers are ineffective.

Look-alikes: Tomato spotted wilt virus (early in the season)



Beet leafhoppers vector and spread curly top virus. © Oldfield, USDA, Bugwood.org



Tomatoes infected with curly top are stunted, yellow, and have premature fruit. Cami Cannon, Utah State University



Infection occurs randomly and has no distinct pattern. Cami Cannon, Utah State University



Infected tomatoes may develop purple veins in some leaves. Cami Cannon, Utah State University



Leaves become thick, stiff, crisp, and curled. Cami Cannon, Utah State University



Premature death and ripening of a tomato plant infected with curly top. Cami Cannon, Utah State University

CURLY TOP VIRUS (CTV) (CONT.)

Genus: *Curtovirus*

Caused by: *Beet curly top virus*, *Beet severe curly top virus*, *Beet mild curly top virus*, *Spinach severe curly top virus*, *Horseradish curly top virus*, *Pepper yellow dwarf virus*

Spread by: beet leafhopper (*Circulifer tenellus*); potato seed pieces



Curly top symptoms on bean. Cami Cannon, Utah State University



Curly top symptoms on bean. Cami Cannon, Utah State University



Curly top symptoms on bean leaves. Cami Cannon, Utah State University



Curly top symptoms on bean. Howard F. Schwartz, Colorado State University, Bugwood.org



Stunted pepper plant (left) infected with curly top. Cami Cannon, Utah State University



Curly top symptoms on pepper leaves. Cami Cannon, Utah State University



Curly top symptoms on squash. Cami Cannon, Utah State University



Curly top symptoms on squash. Cami Cannon, Utah State University



Sugar beet infected with Beet curly top virus showing foliar chlorosis and curling of leaves. Oliver T. Neher, The Amalgamated Sugar Company, Bugwood.org



Sugar beet infected with Beet curly top virus showing foliar chlorosis. Oliver T. Neher, The Amalgamated Sugar Company, Bugwood.org

HIGH PLAINS VIRUS (WHEAT MOSAIC VIRUS)

Genus: *Emaravirus*

Caused by: *High plains virus* / *Wheat Mosaic Virus*

Spread by: wheat curl mite (*Aceria tosichella*); seedborne in corn

Hosts: barley, corn, oats, rye, wheat, wild grasses, and weeds such as cheatgrass, downy brome, hare barley, jointed goatgrass, and volunteer wheat

Symptoms: Initial symptoms are stunting and a mosaic pattern on leaves. As symptoms progress, yellow stripes, up to an inch wide, can be observed on leaves of infected plants and in some cases, purple streaks are observed.

Disease Cycle:

- The source of both wheat curl mites and the virus is typically volunteer wheat or grasses in ditches.
- Virus transmission occurs when wheat curl mites feed on host plants.
- Overwinters in winter annual grasses.

Time for Concern: Throughout the growing season.

When and Where to Scout:

- Look for yellow streaking or mosaic patterns on young corn leaves starting in spring.

Threat Level: High risk sweet corn includes sweet corn grown for seed, late May and early June emerging commercial sweet corn planted adjacent to wheat that is between heading and hard dough growth stage, and commercial sweet corn near winter annual grasses that have not matured yet. Especially problematic when no-till or strip till is used and crop rotation is between corn and wheat.

Top Management Techniques:

- Remove volunteer wheat and grass weeds.
- Plant seed early in the season before wheat dries down.

When to Consider Treatment:

There are no effective chemical control options.

Look-alikes: genetic mutation (striping)



High plains virus symptoms on a corn leaf. William M. Brown Jr., Bugwood.org



High plains virus symptoms on a corn leaves. Howard F. Schwartz, Colorado State University, Bugwood.org



High plains virus symptoms on a corn leaves. Howard F. Schwartz, Colorado State University, Bugwood.org



High plains virus symptoms on a corn leaves. William M. Brown Jr., Bugwood.org



Corn showing symptoms of High plains virus. William M. Brown Jr., Bugwood.org



Corn plants showing severe symptoms of High plains virus . William M. Brown Jr., Bugwood.org

IRIS YELLOW SPOT VIRUS (IYSV)

Genus: *Tospovirus*

Caused by: *Iris yellow spot virus*

Spread by: onion thrips (*Thrips tabaci*)

Hosts: onion, garlic, chives, wild/ornamental onions, pigweed, lambsquarter, iris, kochia, prickly lettuce, blue toadflax, geranium, petunia, purslane, roses, puncturevine, vetch, black-eyed pea, sowthistle

Symptoms: A range of lesions can occur including concentric oblong light oval-shaped rings (early sign), light green diamond-shaped areas, concentric green and tan oval-shaped rings, tan necrotic spots, and green islands within tan necrotic spots. Damage can reduce harvest yield and grade of onions.

Disease Cycle:

- Infection occurs when virus-carrying thrips feed on healthy plants.
- Disease likely overwinters from one season to the next in volunteer onions and overwintering thrips.

Time for Concern: June through September.

When and Where to Scout:

- Monitor thrips populations with sticky traps starting in June.
- Damage is often first noticed at field edges, in areas of stressed plants, or in locations with thin plant stands.
- Infected plants may not show symptoms for several weeks.
- Sometimes symptoms may never appear.
- Reduced bulb size and quality of symptoms develop while bulbs are still growing.

Threat Level: This virus is common in Utah and can devastate an onion field (especially for commercial production) by reducing bulb size, yield, and grade of onions at harvest.

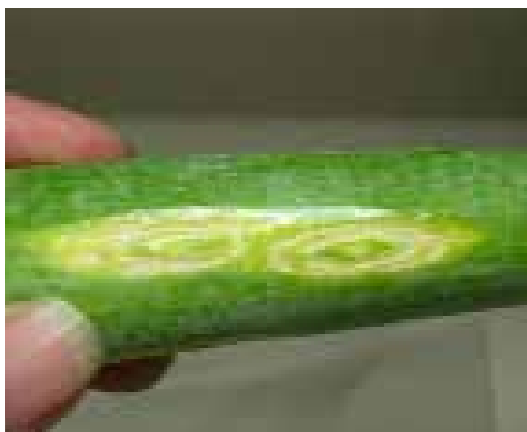
Top Management Techniques:

- Control thrips (see thrips on pg. 80-81).
- Control weeds and volunteer onion plants.
- Remove and destroy infected plants.
- Rotate crops.

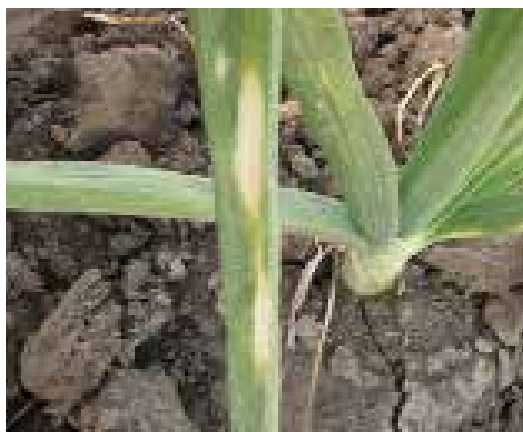
When to Consider Treatment:

There is no cure for infected plants, so prevention is key.

Look-alikes: Cladosporium fungal infection in onions, purple blotch, downy mildew, Tomato spotted wilt virus, hail



Iris yellow spot virus lesion with green island on onion. Cynthia Ocamb, www.pnwhandbooks.org



Iris yellow spot virus lesion on onion. Utah State University



Iris yellow spot virus lesions on onion. Cami Cannon, Utah State University



Iris yellow spot virus lesions on onion. Cami Cannon, Utah State University



Iris yellow spot virus field symptoms. Howard F. Schwartz, Colorado State University, Bugwood.org



Severe leaf dieback due to iris yellow spot virus. Utah State University

POTATO VIRUS Y (PVY)

Genus: *Potyvirus*

Caused by: *Potato virus Y*

Spread by: aphids; tuber seed pieces; volunteer potato plants; weed hosts; water (in hydroponic systems)

Hosts: Solanaceous plants including potato, tomato, pepper, tobacco, eggplant and solanaceous weeds such as nightshade and ground cherry

Symptoms: There are three strains: PVY^O, PVY^N, and PVY^{NTN}. Symptoms vary depending on the strain. PVY^O causes mosaic symptoms on the leaves and no symptoms on the tubers. PVY^N causes necrotic spots on leaves and tubers. PVY^{NTN} causes necrotic lesions on leaves and necrotic ringspots on the tuber surface that extend into the flesh. Infected plants are typically stunted.

Disease Cycle:

- In Utah, infection most frequently occurs when infected seed pieces are introduced into a field. The disease is then spread within a field and beyond by aphids and farm equipment.
- Overwinters in infected seed pieces and in solanaceous weeds (e.g. nightshade, ground cherry).

Time for Concern: Throughout the growing season.

When and Where to Scout:

- Watch for symptoms throughout the growing season.
- Monitor aphid activity throughout the growing season.

Threat Level: PVY symptoms lead to yield reduction and loss of tuber quality. This disease is one of the most serious challenges facing seed potato producers.

Top Management Techniques:

- Remove infected plants.
- Use certified seed potatoes that have been tested for PVY and have more than 90% guarantee to be disease free.
- Control weeds and alternative hosts.

When to Consider Treatment:

Insecticide applications to control aphids are ineffective.

Look-alikes: none



PVY symptoms on potato. Bruce Watt, University of Maine, Bugwood.org



PVY symptoms on potato. Bruce Watt, University of Maine, Bugwood.org



Potato virus Y (PVY) causes mosaic symptoms and necrotic spots on potato leaves. Utah State University



PVY symptoms on potato tuber. Bruce Watt, University of Maine, Bugwood.org



PVY necrotic ringspots extend into the flesh of potato tubers. Utah State University



PVY causes necrotic ringspots on the potato tuber surface. Utah State University

TOBACCO MOSAIC VIRUS (TMV)

TOMATO MOSAIC VIRUS (ToMV)

PEPPER MILD MOTTLE VIRUS (PMMoV)

TOMATO MOTTLE MOSAIC VIRUS (TMoMV)

Genus: *Tobamovirus*

Caused by: *Tobacco mosaic virus*, *Tomato mosaic virus*, *Pepper mild mottle virus*, *Tomato mottle mosaic virus*

Spread by: seed; artificial grafting; human handling (hands, clothing, tools, tobacco cigarettes and chew); soil; infected plant touching healthy plant; occasionally chewing insects

Hosts: tobacco, tomato, other solanaceous plants, and hundreds of other plants

Symptoms: A wide range of symptoms include abnormally shaped fruit, fruit lesions, reduced fruit size, distorted growing points, abnormal color (often yellowing), form, and patterns on leaves, distorted stems, and distortion and dwarfing of the plant as a whole.

Disease Cycle:

- Infection occurs when the virus enters the plant through wounds as small as torn plant hairs.
- TMV, ToMV, PMMoV, and TMoMV are seedborne.
- Overwinters in seed coats, plant debris, perennial (weedy) hosts, and soil.

Time for Concern: Throughout the growing season.

When and Where to Scout:

- Watch for symptoms throughout the growing season.
- Symptoms vary depending on the age of the infected plant, environmental conditions, virus strain, and genetic background of the host plant.

Threat Level: TMV and ToMV are widespread in Utah tomato production and can survive for up to 50 years in plant debris and for weeks to months on trellises or wooden stakes.

Top Management Techniques:

- Remove infected plants immediately.
- Use certified disease-free seed.
- Use resistant varieties (found online by searching “*Cornell table of disease resistant varieties*”).

When to Consider Treatment:

There are no chemical controls for TMV and ToMV.

Look-alikes: none



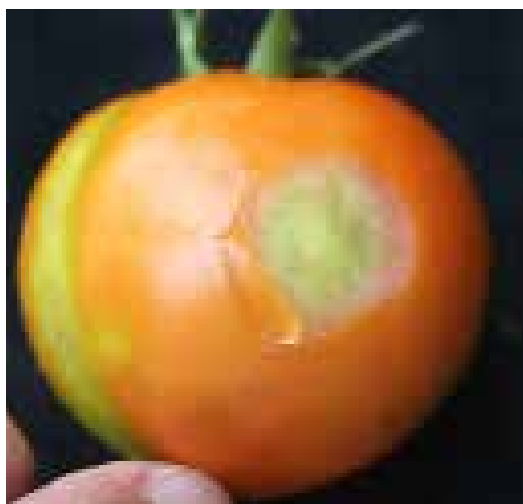
ToMV or TMV mosaic patterned lesions on an infected tomato plant. Cami Cannon, Utah State University



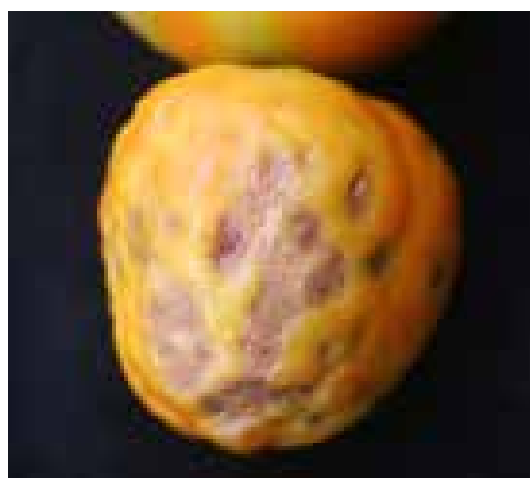
ToMV or TMV mosaic patterned lesions on an infected tomato plant. Cami Cannon, Utah State University



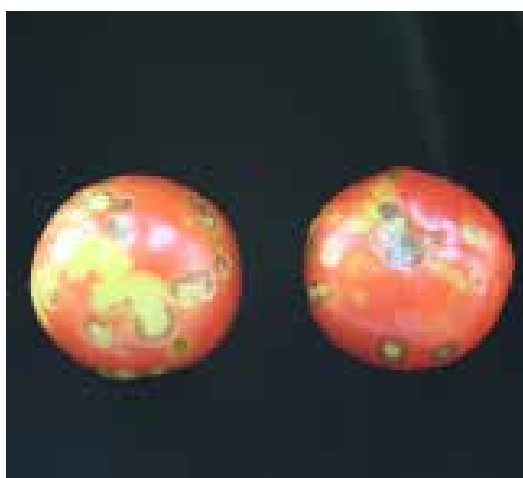
ToMV or TMV mosaic patterned lesions on an infected tomato plant. Cami Cannon, Utah State University



TMV can cause fruit tissues to be discolored. Claudia Nischwitz, Utah State University



Brown sunken lesions are also symptoms of TMV. Claudia Nischwitz, Utah State University



Tomato mosaic virus can cause yellow rings to appear. Claudia Nischwitz, Utah State University

VIRAL DISEASES

TOMATO SPOTTED WILT VIRUS (TSWV)

Genus: *Tospovirus*

Caused by: *Tomato spotted wilt virus*

Spread by: thrips (western flower thrips: *Frankliniella occidentalis* and onion thrips: *Thrips tabaci*);
infected plant material

Hosts: Over 1,000 known hosts including a wide range of vegetables such as artichoke, bean cauliflower, celery, cucumber, eggplant, lettuce, pepper, potato, spinach, and tomato, ornamentals, and weeds such as buttercup, dandelion, lambsquarter, shepherd's purse, and sowthistle

Symptoms: Symptoms of TSWV vary between plant species and within a species depending on the strain of the virus, time of infection, and plant variety. Infected plants are commonly stunted (generally more severe when young plants are infected). Leaves have necrotic spots, fruit may form necrotic rings, and seeds may become discolored (although TSWV is not seed transmitted). Mature fruit has calico patterns.

Disease Cycle:

- Infection occurs when thrips carrying the virus feed on a healthy plant.
- Overwinters in winter weed species and thrips.

Time for Concern: Throughout the growing season.

When and Where to Scout:

- Watch for symptoms throughout the growing season.
- Monitor thrips activity throughout the growing season.
- Monitor fields that had the virus in the past.

Threat Level: This virus is occasional in Utah tomato production but is becoming more widespread. Once a plant is infected there is no cure, and if thrips are reproducing on the plant, it can serve as an inoculum source for neighboring plants. The virus is more likely to occur in fields that have had it in the past.

Top Management Techniques:

- Control thrips (see thrips on pg. 80-81).
- Remove and destroy infected plants.
- Purchase healthy transplants.
- Use resistant varieties.
- Control weeds.

When to Consider Treatment:

There are no chemical controls for TSWV.

Look-alikes: Curly top virus (early in the season), Alfalfa mosaic virus



Tomato spotted wilt virus (TSWV) symptoms on tomato foliage. Nancy Gregory, University of Delaware, Bugwood.org



TSWV causes chlorotic ring spot patterns. Utah State University



TSWV can also appear as ring spots on peppers. Utah State University



TSWV on immature tomato fruit. Utah State University



Blotchiness on tomatoes caused by TSWV. Utah State University



Brown ring spots on TSWV infected mature fruit. Utah State University

WATERMELON MOSAIC VIRUS (WMV)

Genus: *Potyvirus*

Caused by: *Watermelon mosaic virus*

Spread by: aphids

Hosts: bean, cucumber, gourds, pea, pumpkin, squash, watermelon, winter squash, and weeds such as lambsquarter, mallow, and shepherd's purse

Symptoms: Symptoms include stunting, leaf malformation, yellowing or light green mottling, marginal chlorosis, and dwarfed, mottled, or spotted fruit. Fruit may also form warts, or raised blister-like areas.

Disease Cycle:

- Infection occurs when virus-carrying aphids feed on healthy plants.
- Overwinters in perennial weeds or alfalfa.

Time for Concern: June (or earlier if winter was mild or crops are grown in high tunnels) until the end of the season.

When and Where to Scout:

- Watch for symptoms starting in June until the end of the season.
- First symptoms are often seen on field edges.
- Monitor aphid activity starting in June.

Threat Level: This disease is widespread in Utah watermelon and squash production and occasional in cantaloupe.

Top Management Techniques:

- Control weeds.
- Rotate crops.
- Use resistant varieties when available.

When to Consider Treatment:

Insecticides for aphids are of limited value to control this disease.

Look-alikes: herbicide damage (leaves)



Watermelon mosaic virus (WMV) symptoms on squash leaf. Cami Cannon, Utah State University



WMV symptoms on squash fruit. Cami Cannon, Utah State University



Aphid infestation on squash infected with WMV. Cami Cannon, Utah State University



Malformed leaves and stems of squash infected with WMV. Cami Cannon, Utah State University



Watermelon mosaic virus (WMV) symptoms on squash leaf. Cami Cannon, Utah State University



WMV symptoms on pumpkin fruit. Cami Cannon, Utah State University

BLOSSOM END ROT (BER)

Caused by: lack of calcium

Spread by: n/a

Hosts: pepper and tomato (primarily); also occurs on apples, cucumber, melons, and squash

Symptoms: Symptoms only occur at the blossom end of the fruit, where the skin and inner flesh become leathery and turn dark brown to black. Symptoms may occur at any stage in the development of the fruit, but most commonly, are first seen when the fruit is one-third to one-half full size.

Disease Cycle:

- This disease is not infectious, and is related to calcium availability in the plant.
- The primary issue in Utah is having enough water to carry the calcium to the plant. Water flow may be compromised by drought, root disturbance, and compacted soils.

Time for Concern: The disease is especially prevalent when rapidly growing, succulent plants are exposed suddenly to a period of drought.

When and Where to Scout:

- Watch developing green fruits after prolonged periods of dry soils.

Threat Level: Common in Utah, but usually only a few fruits per plant may be affected.

Top Management Techniques:

- Keep the soil evenly moist throughout the growing season.
- Cultivate the soil or add mulch to prevent compaction.
- Prevent root disturbance.

When to Consider Treatment:

Since it is of a physiological nature, prevention is key.

Look-alikes: none, as symptoms are characteristic (dark, leathery skin at blossom end)



Blossom end rot (BER) symptoms on tomato fruit. Cami Cannon, Utah State University



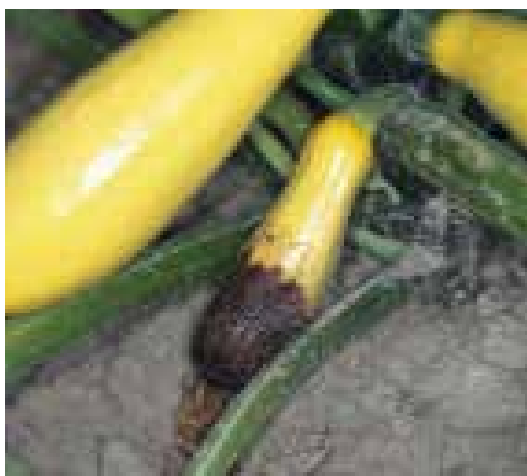
BER symptoms on tomato fruit. Cami Cannon, Utah State University



BER symptoms on tomato fruit. Cami Cannon, Utah State University



BER symptoms on pepper fruit. Paul Bachi, University of Kentucky Research and Education Center, Bugwood.org



BER symptoms on squash fruit. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org



BER symptoms on melon fruit. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org

HERBICIDE DAMAGE

Caused by: misapplication of herbicides (e.g. dicamba, 2,4-D, atrazine); herbicide drift or volatilization; herbicide leaching or run-off; contaminated soil amendments

Spread by: n/a

Hosts: Any plant

Symptoms: Symptoms include twisted or bent stems and leaf petioles, cupped leaves, abnormal growth, yellowing and browning leaves, dead plant parts, dotted or speckled necrosis, stunted plant growth, narrow leaves, and chlorosis around leaf margins and interveinal areas of leaves. Seedlings may fail to emerge and plants wilt and die.

Disease Cycle:

- n/a

Time for Concern: Following application or misuse of herbicides. It is also good to monitor plants for a few weeks after manure or compost applications.

When and Where to Scout:

- Herbicide damage can be difficult to isolate.
- Identify by eliminating other possibilities.
- Look for distorted growth and chlorosis or necrosis on leaves and/or stems.
- Look for a lack of weeds or bare ground in areas near damaged plants (implying recent herbicide or soil sterilizer application).
- Watch for areas where multiple plants of different species show the same symptoms.

Threat Level: Depending on the plant species, some landscape and garden plants are not killed by minimal exposure to the

common broadleaf herbicides 2,4-D or dicamba, while others can be severely damaged and can even die from a little drift or residue in the tank. In severe situations with soil applied herbicides, soil removal may be necessary.

Top Management Techniques:

- Apply herbicides only when necessary and carefully follow the label.
- Be especially careful with soil sterilizers; susceptible roots can grow beyond expected areas.
- Exercise best management practices to reduce or eliminate the need for herbicides.
- Wash with water, plant foliage that has been exposed to spray or drift.
- Apply activated charcoal to soil where soil-active herbicides were used.
- Spread dust or soil on exposed plant surfaces to detoxify glyphosate.
- Ensure compost comes from a reliable source and has not been contaminated by herbicides.

When to Consider Treatment:

Once a plant has been exposed, no treatments are available beyond good plant care.

Look-alikes: distorted growth on leaves and/or stems, nutrient deficiencies (chlorosis) in leaves, bleached leaves, sections of plant decline while other sections of the plant are healthy, salt damage, chronic fungal infections in roots that cause nutrient and water uptake issues, heat scorch, Watermelon mosaic virus



Herbicide damage on melon. Cami Cannon, Utah State University



Herbicide damage on melon. Cami Cannon, Utah State University



Herbicide damage on onion. Howard F. Schwartz, Colorado State University, Bugwood.org



Herbicide damage on tomato. Rebekah D. Wallace, University of Georgia, Bugwood.org



Herbicide damage on potato. Jed Colquhoun, University of Wisconsin, Bugwood.org



Herbicide damage on corn. Utah State University

NUTRIENT DEFICIENCIES

Caused by: lack of nutrients. In Utah vegetable production, the most common nutrient deficiencies that may impede yield are lack of phosphorus or nitrogen (macronutrients). Potassium deficiency may occur in very light, well-drained sandy or gravelly soils. Micronutrients such as iron and zinc are not available in Utah soils for uptake, but this does not affect vegetable production.

Spread by: n/a

Hosts: all vegetable crops can be affected

Symptoms: **Nitrogen deficiency** – slow growth, light green foliar color, low yields and poor plant quality. **Phosphate deficiency** - dark green foliar color, with purpling on leaf undersides, stunted plants and reduced yields.

Disease Cycle:

- n/a

Time for Concern: Apply fertilizer before or at planting.

When and Where to Scout:

- Check plants throughout the growing season for change in foliage color and stunting.

Threat Level: Annual applications of phosphorus can lead to excessively high amounts which can cause micronutrient availability problems.

Top Management Techniques:

- Add moisture after spring fertilizing.
- Conduct regular soil testing to determine whether phosphorus, potassium, or other nutrients need to be applied.
- Enhance soil health by applying amendments, such as manure (in fall), compost, or use cover crops.

When to Consider Treatment:

Annually for nitrogen, and as soil test results require for other nutrients.

Look-alikes: many different conditions may mimic nutrient deficiency, such as wilts, viruses, herbicide injury, frost injury, and more



Nitrogen deficiency in cucumber. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org



Phosphorus deficiency in lettuce. North Carolina State University



Nitrogen deficiency in corn. Felix Francis, University of Delaware, Bugwood.org



Phosphorus deficiency in corn.



Nutrient deficiency in beans. Howard F. Schwartz, Colorado State University, Bugwood.org



Nutrient deficiency in beans. Howard F. Schwartz, Colorado State University, Bugwood.org

SUNSCALD

Caused by: intense solar radiation; low humidity; reflected heat

Spread by: n/a

Hosts: bean, cucumber, eggplant, pea, pepper, summer squash, sweet corn, tomato, melons, and other fruits

Symptoms: Large, light-colored blistered areas develop on the sides of fruits facing the sun. Portions of leaves and stems may also scorch. Commonly seen on plants that have lost foliage due to insect feeding or disease. Affected fruits are inedible.

Disease Cycle:

- Occurs when temperatures are consistently above 90°F during the summer and fruits are exposed to solar radiation.

Time for Concern: When fruits are present and especially after loss of foliage due to insect feeding or disease.

When and Where to Scout:

- Monitor fruit for symptoms as it ripens.
- Watch for openings in the leaf canopy, exposed fruits, and insect and disease damage that may defoliate or thin the leaf canopy.

Threat Level: Sunscald is widespread in Utah tomato and pepper production.

Top Management Techniques:

- Develop and maintain a good leaf canopy.
- Control insect and disease problems (e.g. tomato hornworm, powdery mildew) before they begin to defoliate plants.
- Avoid cutting or breaking off leaves and vines during harvest (especially in pepper, tomato, summer squash, and cucumbers).
- Trellis crops with heavy fruit load (tomato, pepper).
- Construct shade cloth over the crop during the growing season.
- Select varieties noted to retain leaf cover throughout the season, produce more foliage, and/or have a fruit color that reflects more sunlight.

When to Consider Treatment:

Since it is of a physiological nature, prevention is key.

Look-alikes: mechanical damage restricting sap flow, internal fungal infections



Sunscald of bell pepper fruit. Cami Cannon, Utah State University



Sunscald of tomato fruit. Howard F. Schwartz, Colorado State University, Bugwood.org



Sunscald of pepper fruit. Howard F. Schwartz, Colorado State University, Bugwood.org



Sunscald of bean pods. Howard F. Schwartz, Colorado State University, Bugwood.org



Sunscald at the lower stem of recently transplanted pepper. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org



Sunscald at the lower stem of recently transplanted pepper. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org

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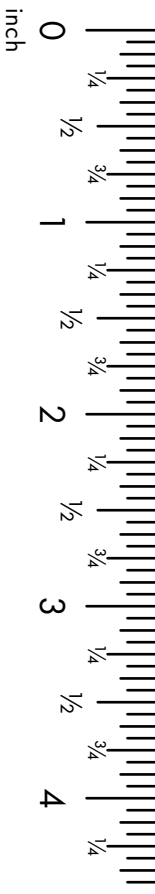
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Rulers in Millimeters and Inches



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