

PESTS OF HEMP IN UTAH



Extension
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COORDINATORS AND EDITORS

Marion Murray (IPM Specialist, Utah State University)

Macahl Evans (IPM Assistant, Utah State University)

Ryan Davis (Forest Entomologist, USFS)

AUTHORS

Marion Murray

Macahl Evans

Claudia Nischwitz

Austin Taylor

Cody Zesiger

CONTACT

Utah State University IPM Program

Department of Biology

5305 Old Main Hill

Logan, UT 84322

ipm.usu.edu

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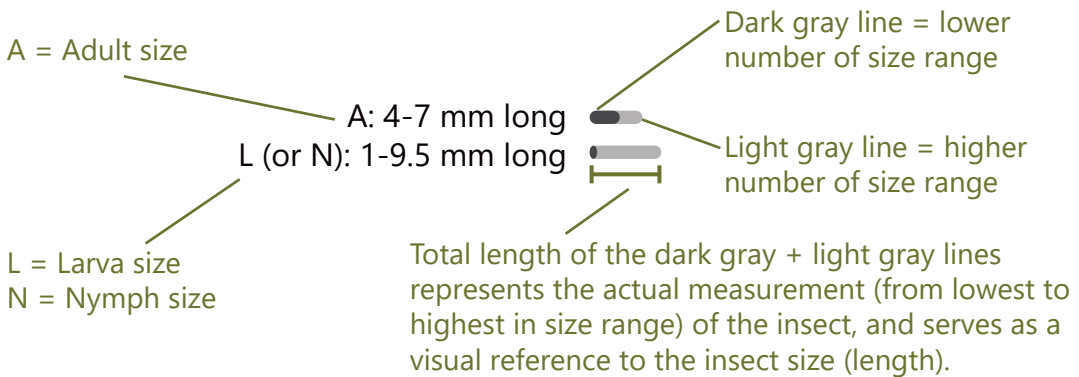
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PREFACE

This guide includes information on insect and disease pests of hemp, organized by pest group. Much of the content is a result of a two-year arthropod and plant disease survey of field-grown hemp operations in northern Utah. Some pests included in this guide were not found in that survey, but may be likely to occur in the future.

Insect Sections (Pests and Beneficials)

At the top of each page, the size range of the insect is provided in millimeters along with a visual bar, and is interpreted as follows:



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PAVEMENT ANT

Tetramorium caespitum

A: 2.5-3.5 mm long ●

Hosts: Field- and greenhouse-grown hemp, fruits, seeds, fatty and greasy substances, dead or live insects, dead animals, and sweets.

Appearance: Worker ants are all the same small size and light to dark brown with fine grooves lining the head and thorax. Pavement ants have two nodes between the middle and rear body sections. Queen and male winged ants are larger than workers.

Damage Symptoms: Ants have been known to feed on the base of seedlings and seedling roots, resulting in wilting and plant death. If nests are located directly below the host plant, the result can be reduced plant vigor, poor rooting, wilting, and death.

Damaging Lifestage(s): Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- 4 to 5 generations annually.
- Overwinter in nests located below ground.
- Pavement ants are typically active from late winter through late fall.
- Ants fly for mating most commonly in the spring through early summer, especially after rain events.
- Pavement ants are one of the most abundant ant species in Utah, especially in urban areas.

Time for Concern: When plants are establishing root systems in the field.

When and Where to Scout:

- Watch for wilting of young plants not caused by lack of water, and inspect soil around base of plant.
- Watch for winged ants in spring through early summer.

Threat Level: Low. Pavement ants typically do not feed on crops and plants unless there are no other food resources.

Occurrence in Utah: Ants are very common and have been found damaging Utah hemp plants in both field and greenhouse settings.

Management:

- Ensure ants are not present before planting.
- Locate and destroy nests.
- Some insecticide sprays and one bait are approved to protect young plants.

When to Consider Treatment: If populations are present during early growth stages of the plant or if economic damage begins to occur.

Look-alikes: Many other species of ants



Adult worker pavement ant.

Joseph Berger, Bugwood.org



Winged adult pavement ant.

Joseph Berger, Bugwood.org



Introduced decay caused by ant feeding at crown of plant.

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Plant wilting and yellowing due to ant damage.

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Ant feeding damage at crown of plant.

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Ant feeding damage at crown of plant.

Cody Zesiger

CANNABIS APHID

Phorodon cannabis

A: 1.9-2.7 mm long ●

Hosts: Field- and greenhouse-grown hemp.

Appearance: Aphids can generally be recognized by a pair of cornicles (tailpipe-like appendages at the posterior end of the body), a pear-shaped body, and fairly long antennae. Aphid color may vary depending on the season and life stage, ranging from cream and pale yellow (early season aphids) to light green, pale pink, and light brown (late season aphids). Winged aphids may have dark spots on the body and wingless forms may have a pale yellow stripe separated by a thin green stripe along the back. As aphids grow and molt, they leave behind white shed skins.

Damage Symptoms: Adults and nymphs feed on the fluids of host plants using piercing-sucking (straw-like) mouthparts. Under high aphid pressure, leaves will yellow and plant growth will slow, causing wilting and reduced vigor. The presence of honeydew—a shiny, sticky fluid excreted by aphids—and shed skins, can be diagnostic of infestation. Damage tends to be worse in late summer and early fall as populations build on plants.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph | Adult (winged or wingless)
- Multiple generations per growing season.
- Aphids give live birth to clones during the growing season (asexual), while eggs are produced in the fall (sexual).

- Overwintering eggs are laid on the host plant or in nearby crop debris in late summer and hatch in the spring.
- Overwintering aphid eggs have a greater success of survival in indoor cultivation.

Time for Concern: Spring through the end of the growing season.

When and Where to Scout:

- Inspect the undersides of leaves and along stems throughout the growing season.
- Survival of the cannabis aphid occurs more commonly indoors.
- High populations may be seen in outdoor plants in late August and early September.

Threat Level: Will not cause severe economic damage unless present in high populations.

Occurrence in Utah: Typically found in low numbers in outdoor production; higher numbers indoors.

Management:

- Avoid excess nitrogen applications.
- Encourage natural enemies.
- Remove plants in the fall; keep crop areas weed-free.
- Approved insecticides are available, but must contact aphid to be effective.

When to Consider Treatment:

- If populations are high and causing economic damage.

Look-alikes: hop aphid; other aphids



Cannabis aphid eggs can range in color from green to black.

Whitney Cranshaw, Colorado State University, Bugwood.org



Winged cannabis aphid.

USU Extension IPM Program



Shed skins (exoskeletons) of cannabis aphid.

Whitney Cranshaw, Colorado State University, Bugwood.org



Cannabis aphids on stem.

USU Extension IPM Program



Cannabis aphid adult.

USU Extension IPM Program



Honeydew residue caused by aphids on cannabis leaf.

USU Extension IPM Program

RICE ROOT APHID

Rhopalosiphum abdominalis

A: 1.4-2.4 mm long ●

Hosts: Greenhouse-grown hemp was documented as a host in 2011 (not in Utah). These aphids are typically found on small grain hosts in North America.

Appearance: Dark, olive-green insect with a round body. Wingless forms are primarily located on roots and in the soil around host plants. Winged forms may occasionally be found on the above-ground portion of the plant.

Damage Symptoms: Feeding on roots causes reduced vigor, slow growth, wilting, and leaf yellowing.

Damaging Lifestage(s): Nymphs and adults feeding on roots in soil or in hydroponic systems.

Life Cycle:

- Nymph | Adult (winged or wingless)
- Populations in the U.S. reproduce without mating (no eggs). Only female offspring are produced.
- Winged adult females disperse to host plants in spring.
- Female aphids give birth to live young and live for about a month.
- Populations double about every 2 days until mortality increases in winter.

Time for Concern: Has not been observed on hemp outdoors; may be present year-round in greenhouses/hydroponic operations.

When and Where to Scout:

- Periodically examine the soil at the base of the plant and the surfaces of leaves for dark-bodied winged aphids throughout the year.
- Hang yellow sticky traps in the greenhouse to determine presence of winged aphids.

Threat Level: Will not cause severe economic damage unless present in high populations.

Occurrence in Utah: Found rarely in greenhouse hemp production only.

Management:

- Avoid excess levels of nitrogen.
- Encourage natural enemies.
- Manage weeds in or around crop areas, especially grasses and sedges.
- Approved insecticides are available, but need to contact aphids to be effective.

When to Consider Treatment:

- If populations are high and causing economic damage.

Look-alikes: On foliage, other winged aphids



Adult, winged rice root aphid near base of plant.

Whitney Cranshaw, Colorado State University, Bugwood.org



Winged rice root aphid caught on a sticky trap.

Whitney Cranshaw, Colorado State University, Bugwood.org



Adult rice root aphids at base of grain plant.

Whitney Cranshaw, Colorado State University, Bugwood.org

FLEA BEETLE

Palestriped flea beetle (*Systema blanda*)

A: 1.70 mm–4.20 mm ●

Western black flea beetle (*Phyllotreta pusilla*)

Other flea beetles in the *Chrysomelidae* tribe *Alticini*

Hosts: Field-grown hemp plus other hosts that vary by flea beetle species such as cole crops, edible greens, tomato, eggplant, pepper, beets, potato, melons, mustard family plants, canola, and many others.

Appearance: Beetles are tiny with enlarged hind legs for jumping. Adults have metallic bodies that range in color from brown, green, metallic-blue to black; some have stripes or spots. Larvae primarily live in soil and 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. Larval feeding generally does not cause serious damage and may result in a loss of plant vigor when root hairs or fine roots of seedlings are consumed. Young plants/cotyledons are most susceptible to flea beetle damage.

Damaging Lifestage(s): Larva, Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- 1-3 generations per season.
- Overwinter as adults in protected sites.
- Adults emerge in spring and feed on weeds or other hosts.
- Adults feed, mate, and lay eggs in the soil near the base of host plants.
- Larvae feed below-ground on roots.

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

When and Where to Scout:

- Peak adult activity is April to mid-June.
- In spring, monitor young plants twice a week for flea beetles or round holes or pits in leaves.
- Inspect crops for adult flea beetle injury near field borders with weeds, especially mustards.

Threat Level: Medium for young plants. Both larval and adult damage is generally considered to be insignificant to hemp growth, but if high enough numbers of adult flea beetles occur on seedlings, plants can become stunted or be killed.

Occurrence in Utah: Damage commonly found in field production, but rarely warranting treatment.

Management:

- Keep crop area weed-free.
- Eliminate old crop debris and other vegetative debris.
- Plastic mulches can interfere with egg-laying and soil-inhabiting life stages.
- Approved insecticides are available. Apply to foliage when beetles are present, especially on young, susceptible seedlings or plants. Reapply as seedlings/plants grow or as recommended on the label to provide protection.

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

Look-alikes: Other small leaf beetles (family Chrysomelidae) or other beetles



Palestriped flea beetle adult.
USU Extension IPM Program



Western black flea beetle adult.
USU Extension IPM Program




Three examples of flea beetle damage (irregular holes in leaves).
USU Extension IPM Program

BEEYLES

SPOTTED CUCUMBER BEETLE

Diabrotica undecimpunctata

A: 5-9 mm long 

L: 8-12 mm long 

Hosts: Field-grown hemp (adult beetles only) plus many other hosts such as beans, corn, cucurbits (squash, cucumbers, melons, etc.), potato, tomato, small grains, other grasses including weeds, and many flowers.

Appearance: Adults have a black head, legs, and antennae. They have ovoid yellow-green bodies with 12 black spots on the wings. Larvae occur in the soil, and are not known to feed on hemp roots. They are about 8-12 mm, worm-like, yellowish-white, and the head and last segment of the body are dark brown to black.

Damage Symptoms: In hemp, adults chew on leaves, creating irregular-shaped holes. Damage is considered minor.

Damaging Lifestage(s): Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2 generations per season.
- Overwinter as adults in protected outdoor areas.
- Adults lay eggs near host plants (grasses, cucurbits, legumes) and feed on roots in the soil.
- Pupation occurs in the soil about 2 months after egg hatch.
- Adults can be present, feeding on hemp leaves, throughout the growing season.

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

When and Where to Scout:

- Adults become active at temperatures above 50°F in the spring.
- Look for adults on stems, leaves, and flowers.

Threat Level: Low.

Occurrence in Utah: Not yet found as a damaging pest in field-grown hemp.

Management:

- Keep crop area weed free.
- Use plastic or organic mulches and drip irrigation.
- Destroy crop residues after harvest.

When to Consider Treatment: When two or more beetles are found per plant on 25% of plants.

Look-alikes: Western corn rootworm; northern corn root worm, other yellow and black leaf beetles (Coleoptera: Chrysomelidae)



Spotted cucumber beetle adult.
USU Extension IPM Program



Damage to foliage caused by cucumber beetle feeding.
Gerald Holmes, California Polytechnic State University at San Luis Obispo,
Bugwood.org






Spotted cucumber beetle larva feeding on a bean root.
John C. French Sr., Retired, Universities: Auburn, GA, Clemson and U of MO,
Bugwood.org



Spotted cucumber beetle larvae.
John C. French Sr., Retired, Universities: Auburn, GA, Clemson and U of MO,
Bugwood.org

ARMYWORMS

Beet armyworm (<i>Spodoptera exigua</i>).....	L: 32 mm long	
Bertha armyworm (<i>Mamestra configurata</i>).....	L: 38 mm long	
Yellowstriped armyworm (<i>Spodoptera ornithogalli</i>)...	L: 50 mm long	

Hosts: Field-grown hemp plus many other hosts such as alfalfa, artichoke, asparagus, beans, beets, cole crops, carrot, celery, corn, cucumber, garlic, lettuces, melon, onion, parsley, parsnip, pea, pepper, potato, radish, rhubarb, spinach, sweet potato, tomato, grassy weeds, and many herbaceous ornamentals.

Appearance: Larvae are generally light green and marked with thin green-yellow stripes running the length of the body. *Beet armyworms* have a small black spot on each side of the second body segment behind the head. *Yellowstriped armyworms* vary in color from green to black. They have two yellow to orange stripes along the back, a dark spot on the sides of the fourth body segment behind the head, and black triangles along either side of the back. *Bertha armyworms* are green to black with a pale stripe on each side of the body. When disturbed, larvae of all species will curl into a c-shape. Adult moths are mottled gray and brown with light-colored markings on the wings and a wingspan of 25 to 45 mm. Eggs are small, pale white to yellow, ribbed, and usually found on the undersides of leaves in masses of 50 or more; eggs may be partially covered by hairs from the moth.

Damage Symptoms: Larvae feed on leaves with chewing mouthparts, causing skeletonized foliage (young larvae), irregular holes, shredded leaves, or defoliation (older larvae). Young larvae feed in groups while older larvae feed

alone. Webbing (silk) may be associated with the damage. In hemp, larvae may move into maturing buds at high populations.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2-3 generations per growing season.
- Overwinter as pupae in the soil.
- Moths emerge from March to July, mate, and females lay eggs in clusters on host plants.
- Larvae feed for 5-8 weeks before pupating in the soil.
- Larvae of 2nd generation may be seen until early October before pupating in the soil to overwinter.

Time for Concern: Primarily July through September.

When and Where to Scout:

- Scout plants biweekly from field planting to harvest for the presence of egg masses and/or larvae.
- Egg masses and groups of larvae are found on the undersides of leaves.
- Maturing larvae may be found singly towards the center of the plant or may be seen in the soil.

Threat Level: Low to medium.

Occurrence in Utah: Very few caterpillars have been found on field-grown hemp with little foliar damage.

Yellowstriped armyworm was found damaging flower buds in one field in northern Utah.

Management:

- Keep crop area weed-free.
- Till the field in after harvest to expose overwintering pupae.
- Scout plants biweekly throughout the growing season for egg masses and larvae.
- First (spring/early summer) generation larvae are likely to cause little damage; second generation larvae may damage leaves and spread to flower buds.

- Approved insecticides are available. One option is *Bacillus thuringiensis* (Bt), which must be consumed, so it should only be used when caterpillars are less than one-half inch in size.

When to Consider Treatment:

- Larvae of second generation have a greater capacity to cause significant damage to leaves and buds.

Look-alikes: Other larvae in the Noctuidae family



Beet armyworm larva.

John Capinera, University of Florida, Bugwood.org



Bertha armyworm larvae collected from canola.

Canola Council of Canada



Yellowstriped armyworm larva found on hemp.

USU Extension IPM Program




Beet armyworm eggs.

Ronald Smith, Auburn University, Bugwood.org

BEET WEBWORM

Loxostege sticticalis

A: 19-21 mm wingspan 

L: 19-25 mm long 

Hosts: Field-grown hemp plus amaranthus, legumes, beet, spinach, cotton, corn, eggplant, and a variety of weeds.

Appearance: Larvae are primarily green with light stripes and white spots that contain black centers. Adults are brownish-tan moths that have white markings on their wings.

Damage Symptoms: Larvae first feed on leaf surfaces, skeletonizing an area the size of its body. As larvae grow, they roll leaflets or pull leaves together with their silk and feed within a leaf tube. Feeding damage can also include irregular holes, visible webbing, and shredded leaves.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2 generations per year.
- Overwinter as larvae in soil and pupate in late spring.
- Adults emerge in June and females lay egg clusters on the undersides of leaves.
- Larvae disperse and feed on leaves.
- Larvae drop to the ground to pupate in the soil.

Time for Concern: Mid-summer to late fall.

When and Where to Scout:

- Adults fly at night and are rarely seen.
- Look for small egg masses on the undersides of leaves starting in June.
- Larvae can be found beginning in June to early July.

Threat Level: Low. Foliage damage is minor and should not reduce yields.

Occurrence in Utah: Commonly found in field production feeding on random leaflets. Suspected damage to flower buds, but not confirmed.

Management:

- Maintain natural enemies.
- Remove weeds and other plant debris surrounding crop.
- Hand-pick and destroy larvae.
- Approved insecticides are available. One option is *Bacillus thuringiensis* (Bt), which must be consumed, so it should only be used when caterpillars are less than one-half inch in size.

When to Consider Treatment: If chronic infestation has occurred, or if large population sizes are consistently present.

Look-alikes: Other caterpillars



Beet webworm larva on a hemp leaf.
USU Extension IPM Program



Beet webworm adult moth.
Engeser, Wikipedia



Beet webworm larva and feeding damage.
USU Extension IPM Program




Beet webworm webbing appearance.
Whitney Cranshaw, Colorado State University, Bugwood.org



Beet webworm webbing, damage, and frass.
USU Extension IPM Program

CORN EARWORM

Helicoverpa zea

A: 38 mm wingspan 

L: 38 mm long 

Hosts: Field-grown hemp plus 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, and various weeds.

Appearance: Caterpillars are brown-headed, with green, brown, or black bodies that have alternating dark and light stripes running lengthwise. Adult moths are tan-brown and the front wings are marked with a distinct dark spot in the center and darker bands near the outer margins.

Damage Symptoms: Larvae tunnel into and destroy developing buds and seeds, which can negatively affect CBD production. Hemp grown for fiber will be less affected.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2-4 generations per year in Utah may be possible depending on latitude and elevation.
- Pupae overwinter in soil in central and southern Utah, but they do not survive in northern Utah.
- Adults emerge in spring and migrate to northern locations.
- Adults mate and lay eggs singly on multiple host plants.
- Larvae feed on leaves and flower buds.

- When mature, larvae fall from the plant and pupate in the soil.

Time for Concern: During flower bud formation and through harvest.

When and Where to Scout:

- Monitor adult moths with a Heliothis trap and corn earworm pheromone lure starting in July, and check traps every three to five days.
- Each week, inspect plants during flowering stage for larvae or brown frass (excrement) on flower buds.

Threat Level: High for field-grown CBD.

Occurrence in Utah: Damage has been found on flower buds in scattered locations in Utah, but it is not as widespread as in neighboring states.

Management:

- There is no trap threshold for treatment in hemp, so periods of abundant trap catch based on your own historic records will be the critical time for crop protection.
- Approved insecticides are available. One option is *Bacillus thuringiensis* (Bt), which should only be used when caterpillars are less than one-half inch in size. Target developing buds with insecticides.
- Crops will have to be protected throughout the adult flight periods, so continued monitoring and re-applications must occur.

When to Consider Treatment: During the flowering stage, if large numbers are trapped or larvae are found.

Look-alikes: Other caterpillars in the Noctuidae family (cutworms; armyworms)



Corn earworm damage.

Whitney Cranshaw, Colorado State University, Bugwood.org



Corn earworm larva with green coloration.

USU Extension IPM Program



Corn earworm larva with brown coloration.

Purdue University Extension Entomology



Corn earworm larva with brown coloration.

Whitney Cranshaw, Colorado State University, Bugwood.org





Corn earworm trap with pheromone lure.

USU Extension IPM Program

COTTON SQUARE BORER

Strymon melinus

A: 32 mm wingspan 

L: 13 mm long 

Hosts: Field-grown hemp plus many flowers and fruits, seeds and buds of apples, blackberries, corn, cotton, lantana, legumes, and strawberries.

Appearance: Larvae are white to pale green or pale yellow with dense, short hairs on each body segment, giving a velvety appearance. Adults are blue-gray butterflies with small hair-like “tails” extending from the hindwings and an orange patch surrounding a black spot on each wing.

Damage Symptoms: Young larvae feed on leaf surfaces, later boring into stems, leaf midribs, and buds.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2-3 generations produced annually.
- Overwinter as pupa and emerge late in the spring as adults.
- Adults lay single, flat eggs on host foliage.
- Larvae pupate on the host plant by attaching themselves with silk strands.

Time for Concern: Early spring through late fall.

When and Where to Scout:

- Look for single eggs on leaf surfaces during early spring.
- Watch for butterflies during the day.
- Look for larvae on leaf surfaces and towards the center of the plant or near the midribs of leaves.

Threat Level: Low. This is an uncommon pest in hemp and feeding injury does not typically affect overall plant health.

Occurrence in Utah: Not yet detected on hemp in Utah.

Management:

- Keep crop area weed-free.
- Hand-pick and destroy larvae.

When to Consider Treatment: The need for treatment is rare.

Look-alikes: Budworms and other caterpillars



Mature cotton square borer larva.
Whitney Cranshaw, Colorado State University, Bugwood.org



The adult cotton square borer caterpillar is also known as the gray hairstreak.
Kevin D. Arvin, Bugwood.org



Immature cotton square borer larva.
Ronald Smith, Auburn University, Bugwood.org



Mature cotton square borer larva.
Charles Olsen, USDA APHIS PPQ, USDA APHIS PPQ, Bugwood.org



Cotton square borer larva and associated damage on cotton.
John Ruberson, Kansas State University, Bugwood.org



Gray hairstreak butterfly.
Jerry A. Payne, USDA Agricultural Research Service, Bugwood.org

EURASIAN HEMP BORER

Grapholita delineana

A: 11-15 mm wingspan 

L: 6-9 mm long 

Hosts: Field-grown hemp plus hops, knotweed, and other wild plant hosts that include various weeds in the family Polygonaceae (buckwheat family).

Appearance: Larvae range in color from creamy-white with a dark head when young to reddish-orange when mature. Adult moths hold their wings tent-like over their back. They are dull, brownish-gray with white lines on the wings.

Damage Symptoms: Larvae bore into the stems and buds of hemp. Stem damage includes wilting or dieback and slight stalk swelling. Primary damage is most noticeable in mid-to-late summer when larvae tunnel into developing flower buds and stems. Affected plants will have stunted growth, split stems, dieback, and may die. Developing seeds can also be damaged.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2 to 3 generations per growing season.
- Overwinter as caterpillars within the stems and folds of leaves and pupate in spring.
- Adults emerge in mid-spring, mate, and lay eggs on the host plant.
- Larvae feed on the leaf surface and then bore into the stem where they will remain until they pupate and emerge as adults.

Time for Concern: Spring through harvest.

When and Where to Scout:

- Look for larvae on leaves in mid-spring, mid-summer, and late-summer.
- Inspect stems for areas of swelling and frass (excrement) where larvae have entered the stem.
- At harvest, inspect buds and stems for larvae.

Threat Level: Medium if established.

Occurrence in Utah: This pest has only been identified east of the Rocky Mountains and is not known to occur in Utah.

Management:

- Reduce overwintering larvae by removing crop debris, including stems and stalks.
- Keep the field weed-free, especially weeds in the buckwheat family.

When to Consider Treatment:

If needed, an approved insecticide application must coincide with egg hatch to kill larvae before they bore into the stem.

Look-alikes: European corn borer, corn earworm



Eurasian hemp borer damage near hemp flowers.
Whitney Cranshaw, Colorado State University, Bugwood.org



Eurasian hemp borer larva in hemp stem.
Whitney Cranshaw, Colorado State University, Bugwood.org



Late-stage Eurasian hemp borer larva in hemp stem.
Whitney Cranshaw, Colorado State University, Bugwood.org



Eurasian hemp borer damage symptoms.
Whitney Cranshaw, Colorado State University, Bugwood.org



Eurasian hemp borer adult moth.
Whitney Cranshaw, Colorado State University, Bugwood.org

EUROPEAN CORN BORER

Ostrinia nubilalis

A: 24-32 mm wingspan

L: 25 mm long



Hosts: Field-grown hemp plus corn, peppers, potato, snap beans, chrysanthemum, dahlia, gladiolus, hollyhock, zinnia, and many other plants.

Appearance: Larvae are creamy-white to gray with one row of small, round, brown spots in each body segment. Adults range in color from pale yellow-brown to light brown to dark brown with wavy markings on the wings. Eggs are clear-white and are laid in flat masses on the undersides of leaves.

Damage Symptoms: Newly hatched larvae feed in leaf whorls and then bore into the stems. Symptoms include significant structural damage along with wilting, dieback, and reduction of yield.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- Likely 2-3 generations per year in Utah.
- Overwinter as caterpillars in stalks and debris of host plants.
- Pupation occurs inside stems.
- Adults fly from May-June (first generation) and in July-August (second generation).
- Eggs are laid in flat masses on the undersides of leaves.
- Young larvae feed on leaves, then bore into the stem to complete the life cycle.

Time for Concern: Spring through harvest.

When and Where to Scout:

- Monitor for adult moths in May-June and July-August using a pheromone trap. Adult moths indicate the need to scout for egg masses on plants.
- Egg masses laid on leaves.
- Larvae inside stems.
- Damage symptoms such as plant wilting and dieback.

Threat Level: Medium if established.

Occurrence in Utah: This insect has not been identified as a pest in Utah hemp.

Management:

- Remove overwintering larvae by removing crop debris, including stems and stalks.
- Management with insecticides can be difficult for this pest.

When to Consider Treatment: If there is a high population of moths and the signs of damage are seen consistently.

Look-alikes: None



European corn borer larva inside corn.
Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org



Recently hatched European corn borer larvae.
Phil Sloderbeck, Kansas State University, Bugwood.org



European corn borer pupa.
Frank Peairs, Colorado State University, Bugwood.org



Mature European corn borer larva.
Mariusz Sobieski, Bugwood.org



European corn borer adults.
Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

PAINTED LADY (LARVAE)

Vanessa cardui A: 50-89 mm wingspan

L: 25-50 mm long

Hosts: Field grown hemp plus over 300 plant species primarily in the Compositae (aster, daisy, thistle, sunflower family), Malvaceae (mallow family), Boraginaceae (forget-me-not family), and Fabaceae (legume family) families.

Appearance: The larval stage is a spiny, brown/black caterpillar with yellow markings. Larvae are often secluded inside a leaf tent held together by silk. Adult butterflies are orange with black and white markings.

Damage Symptoms: Caterpillars chew leaves, resulting in leaves with ragged holes that are often webbed together with silk.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- Adults migrate to the southwest U.S. or Mexico for winter and migrate back north in spring.
- Several generations per year after arriving in Utah.
- Eggs are laid on host plants.
- Larvae feed on host plants and pupate in protected sites on or off the host.

Time for Concern: Late spring throughout summer.

When and Where to Scout:

- Eggs are laid on top of leaves in early summer.
- Caterpillars will emerge three to five days after eggs are laid.
- Peak feeding occurs in summer.
- Begin scouting late spring to mid-summer for egg-laying adults, eggs, larvae, and feeding damage.

Threat Level: Low. Natural enemies usually keep population sizes minimal and damage to crop yield insignificant.

Occurrence in Utah: This insect occurs in Utah, but has not been identified as a pest in Utah hemp. It has been seen in hemp in neighboring states.

Management:

- Hemp plants can tolerate low levels of damage and no management is necessary.
- Hand-pick and destroy larvae.

When to Consider Treatment: N/A

Look-alikes: None



Painted lady egg.

Whitney Cranshaw, Colorado State University, Bugwood.org



Painted lady larva and associated hemp damage.

Whitney Cranshaw, Colorado State University, Bugwood.org



Painted lady pupa.

Whitney Cranshaw, Colorado State University, Bugwood.org



Painted lady adult butterfly.

Whitney Cranshaw, Colorado State University, Bugwood.org



Feeding damage to hemp foliage is ragged.

Whitney Cranshaw, Colorado State University, Bugwood.org



Painted lady damage to hemp foliage.

Whitney Cranshaw, Colorado State University, Bugwood.org

SALTMARSH CATERPILLAR

Estigmene acrea

A: 45-68 mm wingspan

L: 50-55 mm long

Hosts: Field-grown hemp plus many vegetables such as asparagus, bean, beet, cabbage, carrot, celery, corn, lettuce, onion, pea, tomato, turnips, field crops such as alfalfa, clover, cotton, soybean, sugar beet, tobacco, and various weeds.

Appearance: Larvae are densely-haired “woolly bear” caterpillars that range in coloration from yellow to orange to black and potentially with striping. Adults are moderate-sized moths with spotting on the wings and color ranging from white to black to yellow to orange.

Damage Symptoms: Larvae feed on leaves with chewing mouthparts, causing skeletonized foliage, irregular holes, shredded leaves, or defoliation.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2-3 generations per growing season.
- Overwinter as full-grown larvae within cocoons amongst soil debris.

Time for Concern: Late summer and early autumn.

When and Where to Scout:

- Look on leaves for eggs and larvae starting in late July.

Threat Level: Very low

Occurrence in Utah: This insect occurs in Utah, but has not been identified as a pest in Utah hemp. It has been seen damaging hemp in neighboring states.

Management:

- Keep crop area weed-free.
- Hand-pick and destroy larvae.

When to Consider Treatment: If there is a high population of moths and the signs of damage are seen consistently.

Look-alikes: Yellow woollybear caterpillar



Saltmarsh caterpillar larva.

Alton N. Sparks Jr., University of Georgia, Bugwood.org



Saltmarsh caterpillar adult.

Megan McCarty, Wikipedia



Saltmarsh caterpillar eggs.

Whitney Cranshaw, Colorado State University, Bugwood.org



Mating saltmarsh caterpillar adults.

Megan McCarty, Wikipedia



Saltmarsh caterpillar larva.

Whitney Cranshaw, Colorado State University, Bugwood.org





Saltmarsh caterpillar larva and associated damage on hemp.

Whitney Cranshaw, Colorado State University, Bugwood.org

VARIEGATED CUTWORM

Peridroma saucia

A: 45 mm wingspan 

L: 38 mm long 

Hosts: Field-grown hemp, plus nearly all vegetables, alfalfa, clover, sorghum, strawberry, grains and grasses, and various weeds.

Appearance: Larvae are dull gray to brown with 4 to 5 light spots on the middle of the back. They curl into a ‘C’ when disturbed. Adult moths have brown front wings with light-brown markings including circle- and kidney-shaped spots. The hind wings are dull white.

Damage Symptoms: Unlike most cutworm larvae that cut stems at ground level, variegated cutworms climb plants and chew on leaves, buds, and flowers. In hemp, it primarily feeds on leaves, but could potentially damage hemp flowers. Larvae typically feed at night and return to the ground during the day to hide. They can often be found near the base of plants in protected areas.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2 to 3 overlapping generations per year, starting in early spring, July, and late summer.
- Overwinter as pupae in the soil, larvae in protected areas, or possibly as adults.
- Some adults migrate from southerly locations each spring.
- Larvae pupate in the soil.

Time for Concern: Spring through harvest.

When and Where to Scout:

- Larvae can be seen as early as late January into April.
- Look for larvae hiding in the soil or leaf litter around plants during the day.
- Later in the season, monitor plants for foliage damage.
- Pheromone or black-light traps can be used to monitor adult moths.

Threat Level: Low.

Occurrence in Utah: In general, infestations on any crop are rare and sporadic in Utah.

Management:

- Manage weeds along field edges.
- Approved insecticides are available.

When to Consider Treatment: When variegated cutworm larvae are present.

Look-alikes: Other larvae in the family Noctuidae and other caterpillars



Cutworm eggs.

Frank Peairs, Colorado State University, Bugwood.org



Variegated cutworm larva feeding on hemp plant.

Whitney Cranshaw, Colorado State University, Bugwood.org



Variegated cutworm adult.

USU Extension IPM Program



Cutworm larva stem feeding damage.

W.M. Hantsbarger, Bugwood.org



Cutworm pupa.

Whitney Cranshaw, Colorado State University, Bugwood.org





Variegated cutworm larva foliar feeding damage (on tobacco).

R.J. Reynolds Tobacco Company Slide Set, R.J. Reynolds Tobacco Company, Bugwood.org

YELLOW WOOLLYBEAR

Spilosoma virginica

A: 45 mm wingspan 

L: 50 mm long 

Hosts: Field-grown hemp, plus asparagus, bean, beet, cabbage, carrot, cauliflower, celery, corn, eggplant, onion, parsnip, pea, potato, pumpkin, radish, rhubarb, salsify, squash, sweet potato, turnip, many ornamentals, and a variety of weeds.

Appearance: Larvae are densely-haired caterpillars, though not as dense as other woollybear caterpillars, and range in coloration from rust-colored brown, yellow, to white. Adult moths have a white body and wings with black spots. Eggs are small, yellowish, circular, and laid in masses on leaves. Pupae are covered by a mix of silk webbing and hairs from the larvae.

Damage Symptoms: Young larvae feed gregariously, and can skeletonize foliage. Older larvae are found alone, and chew irregular holes in leaves. Often, caterpillars move around readily on and between plants, causing distributed leaf damage.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2-3 generations per growing season.
- Overwinter as pupae within cocoons amongst soil debris.
- Adults fly from spring through fall, laying egg clusters on host foliage.
- Larvae feed gregariously at first, then begin to distribute by walking to other host plants.
- Pupation occurs in soil debris.

Time for Concern: Summer to mid-autumn.

When and Where to Scout:

- Look for egg clusters on leaf surfaces and the fuzzy larvae starting in mid-summer.
- Larvae can also be found on soil surfaces in search of food.

Threat Level: Low. If present, hemp damage is likely minimal and insignificant to crop yield.

Occurrence in Utah: This insect occurs in Utah, but has not been identified as a pest in Utah hemp. It has been seen damaging hemp in neighboring states.

Management:

- Keep crop area weed-free.
- Hand-pick and destroy larvae.

When to Consider Treatment:

Manage if larval numbers and damage are high. Damage is focused on leaves and distributed over the plant, and plants can typically sustain damage. Large migrations of larvae into a hemp field may warrant management efforts.

Look-alikes: Saltmarsh caterpillar



Yellow woollybear larva with light coloration.
Whitney Cranshaw, Colorado State University, Bugwood.org



Yellow woollybear with dark coloration.
David Cappaert, Bugwood.org



Yellow woollybear cocoon.
Whitney Cranshaw, Colorado State University, Bugwood.org



Yellow woollybear adult.
Royal Tyler, Pro Pest and Lawn Store, Bugwood.org




Yellow woollybear foliar damage on vegetables.
Whitney Cranshaw, Colorado State University, Bugwood.org



Skeletonized foliage caused by yellow woollybear feeding.
Daren Mueller, Iowa State University, Bugwood.org

ZEBRA CATERPILLAR

Melanchra picta

A: 38 mm wingspan 

L: 38 mm long 

Hosts: Field-grown hemp plus many vegetables, flowers, grains, and some trees.

Appearance: Recently-hatched larvae are whitish in color with black spots. As they grow, they develop longitudinal black and cream stripes and black and cream stripes running the length of the body. The head and legs are brown to orange in color. The adult moth has a chestnut or reddish-brown color and the hind wings are whitish with light brown edges. The abdomen is light gray.

Damage Symptoms: Young larvae feed gregariously, causing skeletonized foliage. They disperse around the plant and to other plants as they age.

Damaging Lifestage(s): Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2-3 generations per growing season starting in May and mid-summer.
- Adults lay masses of up to 100 eggs on foliage.
- Young larvae feed gregariously and then disperse on the plant or to new plants.
- Mature larvae drop from the plant and pupate in the soil.
- Overwinter as pupae in soil.

Time for Concern: Late spring until the end of the growing season.

When and Where to Scout:

- Scout for egg clusters on or under leaves and for groups of young larvae starting in June.
- Look for symptoms of foliar damage.
- Most damage is likely to occur in mid-to-late summer.

Threat Level: Low. Foliage damage on hemp is limited and is not expected to affect yield.

Occurrence in Utah: This insect occurs in Utah, but has not been identified as a pest in Utah hemp. It has been seen damaging hemp in neighboring states.

Management:

- Natural enemies typically keep populations below damaging levels.
- Insecticide treatment is not usually required.
- Remove weeds and other plant debris surrounding hemp.
- Hand-pick and destroy larvae.

When to Consider Treatment: If chronic infestation has been experienced, or if large population sizes are consistently present.

Look-alikes: None



Zebra caterpillar and associated damage on hemp.
Whitney Cranshaw, Colorado State University, Bugwood.org



Zebra caterpillar pupae.
Whitney Cranshaw, Colorado State University, Bugwood.org



Zebra caterpillar on hemp plant.
Whitney Cranshaw, Colorado State University, Bugwood.org



Zebra caterpillar adult moth.
Whitney Cranshaw, Colorado State University, Bugwood.org








Zebra caterpillar's distinct coloration.
Whitney Cranshaw, Colorado State University, Bugwood.org



Zebra caterpillar adult moth.
Whitney Cranshaw, Colorado State University, Bugwood.org

GRASSHOPPERS

Clearwing Grasshopper.....A: 19-32 mm long	
<i>(Camnula pellucida)</i>	
Differential Grasshopper.....A: 44.5 mm long	
<i>(Melanoplus differentialis)</i>	
Lakin Grasshopper A: 17.5-22 mm long	
<i>Melanoplus lakinus</i>	
Redlegged Grasshopper..... A: 25.4-38.1 mm long	
<i>(Melanoplus femurrubrum)</i>	
Two-striped Grasshopper..... A: 31.8-50.8 mm long	
<i>(Melanoplus bivittatus)</i>	

Hosts: Field-grown hemp plus many weeds, grasses, shrubs, and vegetables.

Appearance: Adults and nymphs have a robust body, hind legs with enlarged femurs for long-distance jumping, and relatively short antennae. Adults have fully-developed wings for flight and range in size depending on the species. There may be additional species of grasshoppers in hemp fields and surrounding areas; those species may or may not be pests.

Damage Symptoms: Adults and nymphs feed with chewing mouthparts causing random, ragged holes in leaves. Feeding can also occur on stems and other plant parts. Feeding damage can result in distorted growth and increased branching which may reduce yield. If feeding takes place during a plant's initial establishment and early growth, this can result in stunting or plant death.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

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

Time for Concern: Early summer after rangeland hosts become unavailable and feeding may continue all season.

When and Where to Scout:

- Look for nymphs from late May to early July.
- Scout in adjacent fields to assess local populations.
- Monitor plants for feeding damage.
- The number of grasshoppers present in late summer and early fall can be a good indicator of population sizes the following year.

Threat Level: Low to High. Utah's grasshopper populations fluctuate from year to year. Large populations can be economically damaging but outbreaks are hard to predict. Hemp appears to tolerate a moderate population and they tend to avoid flowers.

Occurrence in Utah: Grasshoppers have been found in high numbers in hemp fields, but not causing economic damage.

Management:

- If hemp fields are threatened from grasshopper populations migrating from surrounding land, contact your local extension agricultural

agent or the Utah Department of Agriculture and Food for assistance. Insecticide options may be available for application to surrounding lands depending on the situation.

- Encourage area-wide control, working with adjacent landowners.

When to Consider Treatment: During outbreaks, control usually involves insecticides, but the insecticides on the state-approved list may not provide adequate control of grasshoppers.

Look-alikes: Field crickets, katydids, snowy tree crickets



Clearwing grasshopper adult.

Whitney Cranshaw, Colorado State University, Bugwood.org



Clearwing grasshopper 4th instar nymph.

Sangmi Lee, Grasshoppers of the Western U.S., USDA APHIS PPQ, Bugwood.org



Differential grasshopper adult.

USU Extension IPM Program



Differential grasshopper nymph.

USU Extension IPM Program

GRASSHOPPERS (continued)



Lakin grasshopper adult.
Whitney Cranshaw, Colorado State University, Bugwood.org



Lakin grasshopper nymph.
Sangmi Lee, Grasshoppers of the Western U.S., USDA APHIS PPQ, Bugwood.org



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



Redlegged grasshopper nymph.
Sangmi Lee, Grasshoppers of the Western U.S., USDA APHIS PPQ, Bugwood.org



Twostriped grasshopper adult.
USU Extension IPM Program



Twostriped grasshopper nymph.
USU Extension IPM Program

GRASSHOPPERS (continued)



Grasshopper damage to hemp stem.
Whitney Cranshaw, Colorado State University, Bugwood.org



Grasshopper damage to hemp leaves.
USU Extension IPM Program



Grasshopper damage to hemp stem.
Whitney Cranshaw, Colorado State University, Bugwood.org



Grasshopper feces.
Whitney Cranshaw, Colorado State University, Bugwood.org



Grasshopper damage to hemp stem.
USU Extension IPM Program



Epidermis stripped from the stem due to grasshopper feeding.
USU Extension IPM Program

GRASSHOPPERS

POTATO LEAFHOPPER

Empoasca fabae

A: 3 mm long ●

Hosts: Greenhouse- and field-grown hemp, plus alfalfa, beans, eggplant, potato, and weeds including pigweed and shepherd's purse.

Appearance: Adults are wedge-shaped, light green, and widest at the head with an elongated body. The adult has clear wings and large white eyes. Nymphs are smaller and lack wings. Both adults and nymphs move quickly and can run forward, backward, or sideways, and are capable of jumping.

Damage Symptoms: Adults and nymphs feed with piercing-sucking mouthparts that result in white-flecked injury (stippling) on the foliage. With heavy feeding, leaves may show scorching (browning) at the feeding sites.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph | Adult
- Several overlapping generations per year.
- Overwinter in warmer locations (not northern Utah) and migrate north.
- Females lay eggs in stems or leaves.
- Eggs hatch and nymphs generally feed on the undersides of leaves.

Time for Concern: June through harvest.

When and Where to Scout:

- Monitor for scorched (brown) leaf margins, curling leaves, and stippling, starting in June.
- Look under symptomatic leaves for green flying or jumping insects or for the pale, flightless nymph which readily moves when disturbed.

Threat Level: Low. The feeding injury resulting in light stippling and white flecks on leaves is of little consequence to overall plant health.

Occurrence in Utah: Leafhoppers and leafhopper damage have been observed on hemp in low levels.

Management:

- Manage weeds, as they can harbor leafhoppers.
- If populations and damage are high, approved insecticides are available.

When to Consider Treatment:

Generally, potato leafhopper has not caused enough damage in Utah hemp to warrant treatment.

Look-alikes: Other leafhopper species (e.g. beet leafhopper); symptoms resemble damage from spider mites



Various life stages of potato leafhopper.
USU Extension IPM Program



Potato leafhopper damage to hemp.
Whitney Cranshaw, Colorado State University, Bugwood.org



Potato leafhopper damage to hemp leaf.
USU Extension IPM Program



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

BROAD MITE

Polyphagotarsonemus latus

A: 0.1-0.3 mm long

Hosts: Primarily greenhouse-grown but also field-grown hemp, plus many fruits and crops such as, apple, cantaloupe, castor, chili, citrus, cotton, eggplant, grapes, pear, potato, sesame, legumes, tea, tomato, and several different ornamentals.

Appearance: Broad mites are extremely small mites, only capable of being seen with a 10x hand lens or greater. Adults are oval and round in shape and light yellow to green in coloration. Females can be differentiated from males due to a stripe that crosses the back of the body which males do not have. Males are also smaller and faster than females.

Damage Symptoms: Broad mite feeding can cause malformation of leaves and flower buds that take on a warped and hardened appearance. Feeding can also cause a bronzing effect on leaf color. Plant growth can be stunted and even aborted if feeding happens early enough in the host plant's life.

Damaging Lifestage(s): Larva, Nymph, Adult

Life Cycle:

- Egg | Larva | Nymph | Adult
- Many generations per season.
- Females lay eggs on the undersides of foliage.
- Unlikely to be capable of overwintering outdoors in Utah but can overwinter indoors on host plants.

Time for Concern: It is unlikely that broad mites are present in Utah because these arthropods prefer high humidity and low temperatures, but they may occur inside greenhouses. Spring is the likely time of concern for this pest.

When and Where to Scout:

- Starting early spring, search for damage symptoms (in greenhouses).
- Broad mites prefer shaded areas of host plants.
- Use a 10x hand lens to search leaf surfaces and crevices.

Threat Level: Low.

Occurrence in Utah: Not yet detected in Utah.

Management:

- Apply horticultural oil or insecticidal soap to mites.
- Maintain beneficial arthropods.

When to Consider Treatment: If symptoms are severe and causing economic damage.

Look-alikes: Other mite species



Electron microscope image of a broad mite.

USDA, BIRC, Wikipedia



Broad mite egg.

Nancy Gregory, University of Delaware, Bugwood



Broad mite feeding damage on hemp.

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



Broad mite on hemp.

Bruce Watt, University of Maine, Bugwood.org



Close-up of broad mite.

David B. Langston, University of Georgia, Bugwood.org

MITES

HEMP RUSSET MITE

Aculops cannabicola

A: 0.15-0.2 mm long |

Hosts: Greenhouse- and field-grown hemp.

Appearance: Hemp russet mite is a type of eriophyid mite (family Eriophyidae). Eriophyid mites are tiny, (not visible with a magnifying lens) cigar-shaped, and have a pale-yellow or pale-pink body. Hemp russet mites are only noticed after plant damage appears. Mites are best identified under high magnification using a dissecting microscope. They are usually found on the undersides of leaves.

Damage Symptoms: There is no visible damage when mite populations are low. Mites feed on plant surfaces with piercing-sucking mouthparts, killing individual cells and causing fine spotting or stippling. Symptoms appear during high populations. Feeding on leaves can cause bronzing (russetting), which can be accompanied by reduced leaf size, brittle foliage, and upward leaf-edge curling. Stem feeding can cause stem bronzing.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph | Adult
- Multiple, overlapping generations per year.
- The life cycle is not yet clearly defined, but it appears that mites overwinter in crop debris. In greenhouses, they can survive year-round with a constant food source.

Time for Concern: Summer through harvest.

When and Where to Scout:

- Look for bronzing on lower leaves and stems and other symptoms during hot, dry conditions.
- Use a strong hand lens or microscope to check damaged leaves and surrounding healthy leaves for mites.
- Contact the Utah Plant Pest Diagnostic Lab or your local county Extension office for assistance with diagnosing hemp russet mite.

Threat Level: High. If not controlled, this pest can severely damage plant tissues, reduce crop yield or cause plant death.

Occurrence in Utah: Hemp russet mites have not been found to cause damage to field-grown hemp in Utah, but neighboring states have reported this to be a major pest.

Management:

- Use mite-free seed or starts.
- Remove and destroy infested plant debris.
- Prune and remove infested plants from fields.
- Clean tools used on infested plants before using on healthy plants.
- Promote natural enemies.
- Approved pesticides are available.

When to Consider Treatment: Once identified on plants, insecticide treatment is recommended if cultural practices cannot adequately reduce populations.

Look-alikes: Spider mites, thrips, or physiological conditions that cause leaf curling and yellowing



Hemp russet mite damage.
Whitney Cranshaw, Colorado State University, Bugwood.org



Hemp russet mites.
Whitney Cranshaw, Colorado State University, Bugwood.org



Hemp russet mites on underside of hemp leaf; note the cigar-shape of the mites.
Whitney Cranshaw, Colorado State University, Bugwood.org



Hemp russet mite damage.
Whitney Cranshaw, Colorado State University, Bugwood.org

MITES

TWO-SPOTTED SPIDER MITE

Tetranychus urtica

A: 0.4-0.6 mm long |

Hosts: Greenhouse- and field-grown hemp, plus beans, beets, carrot, corn, cucurbits (cucumber, squash, melon), many deciduous shrubs, many herbs, eggplant, marigolds, pea, pears, pepper, potato, raspberries, roses, sweet potato, tomato, many weeds, and many other plants.

Appearance: Tiny, with a yellowish-clear body and two dark spots on either side of its back. Eggs are very small, spherical, translucent initially, and turn opaque as they age. All life stages most frequently occur on the undersides of leaves.

Damage Symptoms: Leaves become stippled (small yellow spots) and may turn bronze as infestation increases. Generalized bronzing or reddish discoloration on leaves and stems as infestations progress. Leaf margins, and whole leaves in severe cases, may turn brown and die. Plant vigor may be reduced, and premature leaf drop can occur on heavily infested plants. Plants often appear dirty or dusty, especially when webbing is present.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Larva | Nymph | Adult.
- 8 or more generations per year.
- Overwinter as adults in ground cover and weed residue.
- Adults become active in spring, feeding on weeds and laying eggs.

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

When and Where to Scout:

- Monitor for injury symptoms (leaf stippling) during hot, dry conditions.
- Check the undersides of leaves for tiny black specks of debris and slow-moving mites with a hand lens.
- Shake stems over paper or cloth tray and watch for tiny moving dots (spider mites).
- Webbing and a dirty appearance indicates the presence of heavy populations.

Threat Level: High for indoor-grown hemp and moderate for field-grown hemp.

Occurrence in Utah: Two-spotted spider mites are common in Utah, but have only occasionally been found in field-grown hemp.

Management:

- Keep plants healthy; reduce drought stress.
- Prevent dust from settling on foliage as this promotes spider mite survival.
- Approved pesticides are available.

When to Consider Treatment: At first sign of plant damage or when low levels are detected during monitoring. Populations can increase rapidly in hot, dry conditions.

Look-alikes: Predatory mites (but these are fast-moving and pear-shaped); other spider mites, thrips; symptoms resemble leafhopper damage



Two-spotted spider mite adults and eggs.
USU Extension IPM Program



Two-spotted spider mite adults, nymphs and eggs.
Whitney Cranshaw, Colorado State University, Bugwood.org



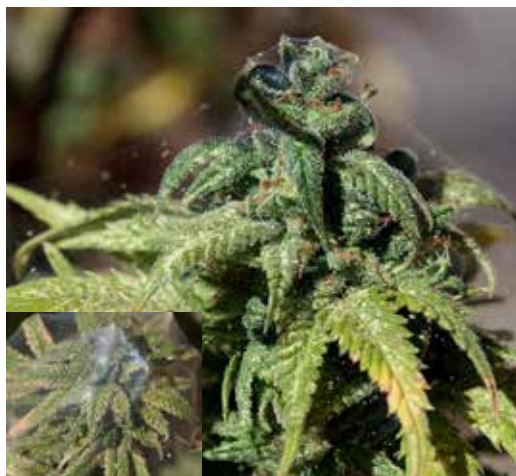
Two-spotted spider mite feeding damage on hemp (stippling).
USU Extension IPM Program



Two-spotted spider mites and webbing on hemp.
Whitney Cranshaw, Colorado State University, Bugwood.org



Two-spotted spider mites on hemp.
USU Extension IPM Program



Two-spotted spider mite feeding damage and webbing on hemp.
Whitney Cranshaw, Colorado State University, Bugwood.org

MITES

FALSE CHINCH BUG

Nysius raphanus

N, A: 2-4 mm long ●

Hosts: Field-grown hemp (primarily for seed) plus brassicas, lettuce, mustard greens, potato, quinoa, radish, turfgrass and weeds such as kochia, mustard family weeds, pigweed, Russian thistle, and sagebrush.

Appearance: On adults, the head, thorax, and anterior portion of the wings are brownish gray and the posterior portion of the wings are whitish-clear. 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 young plants can cause plants to wilt and die rapidly. Outbreaks that destroy plantings usually occur early in the year. On hemp grown for seed, aggregations of adults may occur on the developing seed heads.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph | Adult
- About 3 generations per year.
- Overwinter as nymphs and adults under debris near mustards.
- Adults lay eggs around host plants in soil cracks.
- False chinch bugs migrate from host plants (mustards, etc.) when they dry out, are sprayed with herbicide, or if they are cut. Large migrations of false chinch bugs into a hemp field could coincide with these events.

Time for Concern: July through August.

When and Where to Scout:

- Scout field edges that may contain mustards starting in early spring.
- Look for aggregations on individual plants in July and August.
- Adults and nymphs are most active during cooler mornings or late evenings.

Threat Level: Medium. In hemp, false chinch bug feeding does not seem to be very destructive when populations are low but can cause serious damage when high in numbers. Typical false chinch bug damage in hemp has minimal effect on yield. Spot infestations are sporadic due to their highly migratory behavior, but can cause wilting and plant death, especially on smaller plants.

Occurrence in Utah: On occasion, chinch bugs have invaded new field plantings due to dried weeds in adjacent fields. No economic damage has been reported.

Management:

- Low numbers do not need to be managed.
- Keep plants well-irrigated.

When to Consider Treatment: If economically damaging infestations are present.

Look-alikes: Chinch bug, lygus bug, and other seed and plant bugs; big-eyed bug (beneficial)



False chinch bugs on hemp seeds.

Whitney Cranshaw, Colorado State University, Bugwood.org



False chinch bugs on hemp.

Whitney Cranshaw, Colorado State University, Bugwood.org



False chinch bug egg.

HortNET, The Horticulture and Food Research Institute of New Zealand, Bugwood.org



False chinch bugs on hemp.

Whitney Cranshaw, Colorado State University, Bugwood.org



False chinch bugs on hemp.

Whitney Cranshaw, Colorado State University, Bugwood.org

LYGUS BUG (TARNISHED PLANT BUG)

Pale Legume Bug (<i>Lygus elisus</i>).....	A: 4-5 mm long	
Tarnished plant bug (<i>Lygus lineolaris</i>).....	A: 3.7-6 mm long	
Western tarnished plant bug (<i>Lygus hesperus</i>).....	A: 4.2-5.2 mm long	

Hosts: Field-grown hemp (primarily for seed), plus 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: Depending on species, adults have brown bodies with yellow, black, and red markings, and a yellow or green triangle on the upper center of the back. Nymphs are usually lighter in color with dark spotting on their back, lack wings, and have a more rounded form.

Damage Symptoms: Adults and nymphs feed on plant cells (not sap) with piercing-sucking mouthparts. Feeding on seeds causes them to shrivel and heavy feeding on flowers may cause bud drop or flower abortion. Symptoms on foliage have not been documented.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

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

Time for Concern: Summer to harvest.

When and Where to Scout:

- Visually scout plants or use a sweep net in nearby weeds and regularly examine flowers to monitor for adults and nymphs.
- Monitor weeds surrounding the crop for plant bug activity.

Threat Level: Low to Medium. Hemp grown for CBD oil is not likely to be damaged but plants grown for seed may need closer monitoring.

Occurrence in Utah: Lygus bugs are present in low to average numbers in all hemp fields, but no economic damage has been documented.

Management:

- Remove preferred hosts (flowering weeds, legumes, alfalfa) from field edges.
- Control weeds within the field.

When to Consider Treatment: If feeding damage is high. Thresholds have not been developed for hemp.

Look-alikes: Other plant or seed bugs, false chinch bugs, big-eyed bug (beneficial)



Western tarnished plant bug adult.
Whitney Cranshaw, Colorado State University, Bugwood.org



Pale legume bug adult.
USU Extension IPM Program



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



Tarnished plant bug life stages.
University of Georgia University of Georgia Bugwood.org



Tarnished plant bug adult.
Russ Ottens, University of Georgia, Bugwood.org



Pale legume bug adult.
Whitney Cranshaw, Colorado State University, Bugwood.org

SCENTLESS SEED BUG

Arhysius spp.

A: 4-5 mm long 

Hosts: Field-grown hemp for seed, plus globe mallow (primary host; *Sphaeralcea* spp.) and possibly other plants in the Malvaceae (mallow) family; and weeds in xeric conditions.

Appearance: The head and body of adults are predominantly dull brown with greenish hues. The posterior portion of the wings are clear and the posterior margins of the abdomen are lined with alternating dark and lighter rectangles. Nymphs are smaller, similarly colored, without wings, and rounder in appearance.

Damage Symptoms: Adults and nymphs feed with piercing-sucking mouthparts, primarily on seeds. As host plants die or desiccate, aggregations of adults may move to feed on hemp seeds.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph | Adult
- About 2 generations per year.
- Overwinter as adults.
- Adults lay eggs on host plants.
- Bugs migrate from neighboring host plants when they dry out, are sprayed with herbicide, or if they are cut. Migrations of scentless seed bugs into a hemp field could coincide with these events.

Time for Concern: June through harvest (when seeds are present).

When and Where to Scout:

- Visually scout plants or use a sweep net in nearby weeds for adults and nymphs starting in early spring.
- Monitor weeds (mallows or other) within the hemp crop for plant bug activity.
- Look for aggregations on individual plants when seeds are present.

Threat Level: Low. In hemp, scentless seed bug feeding will likely have minimal effect on hemp seed production. Large numbers may occur if nearby host plants die or are cut down, forcing migration of the insect.

Occurrence in Utah: Not yet reported as a pest on hemp grown for seed.

Management:

- Low numbers do not need to be managed.
- Manage mallow and other weeds in and around the crop.

When to Consider Treatment: Only if large, damaging populations are present. Thresholds have not been developed for hemp.

Look-alikes: Other plant or seed bugs, false chinch bugs, big-eyed bug (beneficial)



Scentless seed bug adult on sunflower.

Judy Gallagher, Wikipedia



Top and underside of scentless seed bug adults.









Hanna Royals, Museum Collections Heteroptera, USDA APHIS PPG, Bugwood.org



Arhysus spp. adult on sunflower.

Whitney Cranshaw, Colorado State University, Bugwood.org

STINK BUGS

Brown marmorated stink bug (<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	
Green stink bug (<i>Chinavia bilaris</i>)	A: 13-19 mm long	
Red shouldered stink bug (<i>Thyanta custator</i>)	A: 9-13 mm long	
Southern green stink bug (<i>Nezara viridula</i>)	A: 11-17 mm long	
Twice-stabbed stink bug (<i>Cosmopepla lintneriana</i>)	A: 5-7 mm long	
Uhler stink bug (<i>Chlorochroa uhleri</i>)	A: 12-16 mm long	

Hosts: Field-grown hemp, plus grasses, wheat, oats, legumes, alfalfa, sorghum, clover, eggplant, asparagus, peach, corn and many more.

Appearance: Adults are shield-shaped, and the wings are thick and leathery on the front half and membranous in the rear portion. Coloration typically varies from green to brown, but other colors may occur. Nymphs are smaller than adults and do not have fully-developed wings (only wing pads). Their coloration is usually different from the adult stage, and changes as nymphs mature. Eggs are barrel-shaped and laid in clusters of 10 to 30 on host leaves.

Damage Symptoms: Nymphs and adults feed on cells with piercing-sucking mouthparts. To date, symptoms have not been documented on hemp, including any flower or seed damage.

Damaging Lifestage(s): Nymph, Adult

Life Cycle: Egg | Nymph | 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.
- Eggs typically laid on host plant leaves.

Time for Concern: Throughout the growing season.

When and Where to Scout:

- Egg clusters and stink bugs can be found on hemp plants starting in mid-summer through harvest.
- Larger populations may occur along field edges.

Threat Level: Low; stink bugs have not caused significant damage to hemp.

Occurrence in Utah: All stink bug species listed above occur in Utah and many have been found on hemp, but not causing economic damage or visible symptoms.

Management: Attract and conserve natural enemies.

When to Consider Treatment: N/A

Look-alikes: Squash bug, beneficial stink bugs, western conifer-seed bug, leaf-footed bug

Brown marmorated stink bug (BMSB)



BMSB adult and feeding damage on a corn leaf; note white bands on legs and antennae.

USU Extension IPM Program



BMSB egg shells and newly hatched nymphs.

Gary Bernon, USDA APHIS, Bugwood.org



BMSB nymph.

USU Extension IPM Program



BMSB nymph.

Susan Ellis, Bugwood.org

Brown stink bug



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

Russ Ottens, University of Georgia, Bugwood.org



Brown stink bug eggs.

Herb Pilcher, USDA Agricultural Research Service, Bugwood.org

STINK BUGS (continued)

Brown stink bug, continued



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



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

Conchuela stink bug



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.



Conchuela stink bug nymphs on hemp.
Whitney Cranshaw, Colorado State University, Bugwood.org

STINK BUGS (continued)

Green stink bug



Green stink bug adult. Note the black dots on the outer edges of the body.

USU Extension IPM Program



Green stink bug egg shells and newly hatched nymphs.

Susan Ellis, Bugwood.org



Green stink bug nymph.

Adam Sisson, Iowa State University, Bugwood.org



Green stink bug nymph.

Herb Pilcher, USDA Agricultural Research Service, Bugwood.org

Red shouldered stink bug has a light green body with orange or red margins on the sides and an orange or red spot near the tip of the abdomen.



Red shouldered stink bug adult.

USU Extension IPM Program



Red shouldered stink bug nymphs.

USU Extension IPM Program

STINK BUGS (continued)

Red shouldered stink bug, continued



Red shouldered stink bug nymphs and eggs.
Whitney Cranshaw, Colorado State University, Bugwood.org



Red shouldered stink bug nymphs.
Herb Pilcher, USDA Agricultural Research Service, Bugwood.org

Southern green stink bug



Southern green stink bug adult.
John N. Dell, Bugwood.org



Southern green stink bug nymph.
Russ Otten, University of Georgia, Bugwood.org



Southern green stink bug nymph.
Russ Otten, University of Georgia, Bugwood.org



Southern green stink bug eggs.
Merle Shepard, Gerald R. Carner, and P.A.C. Ooi, Insects and their Natural Enemies Associated with Vegetables and Soybean in Southeast Asia, Bugwood.org

STINK BUGS (continued)

Twice-stabbed stink bug



Twice-stabbed stink bug adult.
Kevin D. Arvin, Bugwood.org



Twice-stabbed stink bug adults.
Nihola. Wikipedia.org

Uhler stink bug



Uhler stink bug adult.
Ken Schneider



Uhler stink bug adult.
Robert Webster, Wikipedia

Other



Chlorochroa spp. nymphs.
USU Extension IPM Program



Euschistus variolarius (Onespotted stinkbug) adult.
USU Extension IPM Program

STINK BUGS

THRIPS

Onion Thrips (<i>Thrips tabaci</i>).....	A: 1.3 mm long	●
Western Flower Thrips (<i>Frankliniella occidentalis</i>).....	A: 1.5 mm long	●

Hosts: Greenhouse- and field-grown hemp plus 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. Immature thrips (larvae) are elongate and creamy yellow without wings.

Damage Symptoms: Thrips feed with a punch-and-suck behavior causing white flecks or silvery scars on foliage in combination with dark fecal spots. Thrips feeding on developing leaves may cause distortion.

Damaging Lifestage(s): Larvae and adults.

Life Cycle:

- Egg | Larva | 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:

- Monitor foliage for feeding damage (white spots or flecks) that usually occurs along the leaf veins.

Threat Level: Low to medium. Damage to field-grown hemp is usually minor and insignificant to overall plant health. Economic damage is more likely to occur in indoor-grown hemp.

Occurrence in Utah: Both species of thrips are common in Utah. They have been found in field-grown hemp, but not causing economic damage.

Management:

- Plow plant debris under after harvest and remove volunteer host plants.
- Inspect transplants for thrips infestations (using a 10x hand lens) and discard or manage infested plants.
- Remove weeds within hemp fields and around greenhouses.
- Approved insecticides are available.

When to Consider Treatment:

- When thrips damage is seen on multiple plants (no threshold exists for industrial hemp).

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



Thrips damage on hemp.
USU Extension IPM Program



Thrips damage on hemp.
USU Extension IPM Program



Thrips adult and nymphs in the neck of onion.
USU Extension IPM Program



Thrips adult, feeding damage, and excrement (black specks) on early season cucurbit.
USU Extension IPM Program



Microscopic view of onion thrips.
Utah IPM Extension Program



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: Greenhouse-grown hemp (primarily) and field-grown hemp, plus ageratum, aster, beans, begonia, calendula, cucumber, grape, hibiscus, lantana, nicotiana, poinsettia, squash, and tomato.

Appearance: Adults are tiny with bright white wings and yellow-orange heads. Immature stages are inconspicuous with pale, almost translucent, flat bodies that are mostly immobile.

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 shiny, sticky leaves or sooty mold growth on leaves.

Damaging Lifestage(s): Nymph, Adult

Life Cycle:

- Egg | Nymph | Pupa | Adult
- Several generations per year.
- Populations continue from year to year in greenhouses and in warm southern climates.

Time for Concern: During warm weather and on transplants.

When and Where to Scout:

- In the greenhouse, monitor with yellow sticky cards to detect whitefly presence.

- Look for large colonies during warm weather on the underside of lower leaves. Honeydew may also be noticeable on the tops of leaves.
- Before planting, inspect transplants for whiteflies.

Threat Level: High for greenhouse-grown hemp.

Occurrence in Utah: Whiteflies have not yet been found feeding on field-grown hemp in Utah, but whitefly damage has been found in neighboring states.

Management:

- Attract and conserve natural enemies as they often provide adequate control.
- Inspect transplants and remove any with high whitefly populations.
- In greenhouses, use biocontrol (such as hanging cards with *Encarsia* sp.).
- Approved insecticides are available.

When to Consider Treatment: In greenhouse production, consider treating when plants have a threshold of 10 nymphs/leaf.

Look-alikes: Aphid molted skins, leafhopper adults, scale insects



Whitefly adults.
USU Extension IPM Program



Whitefly eggs with a predatory mite.
Bert Man Koppert, Biological Systems



Whitefly nymph.
Whitney Cranshaw, Colorado State University, Bugwood.org



Live and parasitized (black) whitefly nymphs alongside adults.
USU Extension IPM Program

DISEASES AND ABIOTIC DISORDERS

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BUD ROT

Botrytis cinerea and other *Botrytis* species

Hosts: Flower buds of field- and greenhouse-grown hemp as well as foliage, flowers, and fruit of over 200 fruit and vegetable crops, perennials, and annuals.

Symptoms: All plant parts (leaves, stems and flowers) can be affected; however, symptoms on flowers are most common on hemp. Initially, flower parts develop a water-soaked lesion that turns necrotic (dies). This symptom is then accompanied by a gray mat of mycelium surrounding and within flower clusters that forms thousands of spores.

Disease Cycle: *Botrytis* is a fungus that is present worldwide. It invades only through wounds or dying plant parts. The required conditions for spread and infection are cool temperatures (65-75°F), humidity, and moisture (rain or irrigation). Spores germinate and colonize the plant tissue, and these new infections produce thousands of additional spores which become airborne and continue the infection cycle.

Time for Concern: Bud rot may be an issue during flower-bud formation under prolonged (one week or longer) greenhouse humidity or cool outdoor rains.

When and Where to Scout: Look at buds and stems throughout the growing season.

Threat Level: Low in field production and high in greenhouse production.

Occurrence in Utah: The fungus, *Botrytis cinerea* is present in most areas of Utah, but has not been detected as causing bud rot to hemp flowers. This disease has been detected in field-grown hemp in Nevada and Oregon.

Management:

- Prevent injury to hemp flower buds.
- Remove infected plants immediately to reduce inoculum. Wear a mask or be careful to not breathe spores as they may cause an allergic reaction.
- Sanitation is important. Disinfect planting and field tools and greenhouse spaces with a 10-15% household bleach solution.
- Allow proper spacing between plants in the greenhouse and in the field to promote airflow.
- Keep relative humidity in greenhouse to below 50%.
- When drying plant material, ensure proper airflow.

When to Consider Treatment:

Infections cannot be cured, so prevention is key. There are currently no fungicides available for use against bud rot. Sanitation and pest monitoring should be primary tools in any hemp operation.

Look-alikes: Prior feeding by corn earworm and other post-harvest molds can look similar without a microscope to examine spores



Yellowing leaf bract is an early symptom of infection of bud rot.

Zamir Punja, Simon Fraser University



Necrotic areas forming in flowers as bud rot progresses.

Zamir Punja, Simon Fraser University



Botrytis infection moving to hemp foliage.

Zamir Punja, Simon Fraser University



Sporulation on field-grown hemp.

Zamir Punja, Simon Fraser University

FUSARIUM WILT

Fusarium oxysporum f. sp. (formae speciales) *cannabis*, *F. oxysporum* f. sp. *vasinfectum*

Hosts: The term “formae speciales” (f. sp.) means that the pathogen is usually host-specific. Neither *Fusarium* species listed above will infect other plants, with the exception that *F. oxysporum* f. sp. *vasinfectum* can infect cotton.

Symptoms: Hemp plants with Fusarium wilt will initially have chlorotic leaf tips, followed quickly by wilting and death. The vascular tissue in the stem will turn brown. A major difference with this disease versus Fusarium crown rot is that there is no associated root rot with Fusarium wilt.

Disease Cycle: *Fusarium* sp. is a soilborne pathogen. It can survive in the soil for many years as a saprophyte feeding on plant debris or by producing chlamydospores (resting spores). Under saturated soil conditions, chlamydospores germinate and infect the roots of a suitable host plant. The fungus colonizes the vascular system of the plant, leading to wilting. *F. oxysporum* does not cause a root rot. It can be introduced into a greenhouse or field operation by infected transplants, contaminated soil, or equipment. Most *F. oxysporum* grow best at soil temperatures between 77-86°F and soil pH around 6.

Time for Concern: Throughout the growing season.

When and Where to Scout:

- Scout plants biweekly looking for chlorotic leaf tips and wilted plants.
- Monitor soil moisture.

Threat Level: Medium in greenhouses. Low in field-grown hemp unless plants are over-watered or growing in poorly-drained soil.

Occurrence in Utah: *F. oxysporum* is common in Utah, but to date, Fusarium wilt has not been identified on hemp.

Management:

- In field-grown hemp, management of Fusarium diseases requires prevention, because no fungicides are currently registered for this disease on hemp.
- Remove infected plants, including roots, in a timely manner.
- Clean equipment between fields to avoid spreading *Fusarium* to new locations.
- In greenhouses, use new pots and trays, or disinfect reused pots with a 10% -15% bleach solution for about an hour followed by a good rinse with water.
- Prepare potting mix on a plastic tarp to prevent contact with bare ground that may contain *Fusarium* or other soilborne pathogens.
- Monitor soil moisture to prevent over-watering.
- Where Fusarium wilt has been diagnosed, rotate the hemp field to a different crop for 2-3 years.

When to Consider Treatment:

N/A.

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



Initial wilting symptom of Fusarium wilt.

USU Extension IPM Program



Wilt and recovery caused by Fusarium wilt leads to yellow foliage.

USU Extension IPM Program



With fusarium wilt, there is no crown rot present.

USU Extension IPM Program



Healthy plant (top) compared to plant infected with fusarium (bottom).

Shouhua Wang, Nevada Department of Agriculture

FUSARIUM CROWN ROT

Fusarium solani (primarily), *F. equiseti*, and *F. graminearum*

Hosts: Hemp (greenhouse and field-grown), plus many vegetable crops.

Symptoms: Roots are affected by rotting and becoming necrotic (brown). The tissue at the crown discolours and becomes soft right above the soil line. Plants eventually wilt and die. Symptoms can look similar to Fusarium wilt, but with Fusarium wilt, there will be no discoloration of the crown on the outside of the stem and in the phloem, and no root rot.

Disease Cycle: The *Fusarium* species that cause this disease are soilborne pathogens. They each can survive in the soil for many years by living as a saprophyte and feeding on plant debris, or as long-lived chlamydospores (resting spores). As a pathogen, *F. solani* strains can be host-specific but they can survive on roots of other plants such as weeds, making it very difficult to eliminate the pathogen once it has been introduced into a field. It is not known which strain infects hemp in Utah. Most strains grow best at temperatures between 77-86°F.

Time for Concern: Throughout the growing season.

When and Where to Scout:

- Scout plants biweekly, looking for wilted plants and stem-rotting just above the soil line.

Threat Level: Medium.

Occurrence in Utah: Crown rot has been commonly found in Utah hemp fields that are flood irrigated, over-watered, or not rotated to a different crop.

Management:

- In field-grown hemp, management requires prevention, because no fungicides are available.
- Remove infected plants, including roots, in a timely manner.
- Clean field equipment before taking it into another field to avoid the spread to new locations.
- Rotate hemp with other crops to prevent buildup of pathogens in the soil. Avoid rotating with tomatoes and other susceptible crops.
- In greenhouses, use new pots and trays, or disinfect reused pots with a 10% -15% bleach solution for about an hour, followed by a good rinse with water.
- Prepare potting mix on a plastic tarp to prevent contact with bare ground that may contain soilborne pathogens.

When to Consider Treatment:

N/A.

Look-alikes: Pythium crown rot



Plant death caused by Fusarium crown rot.

USU Extension IPM Program



Plant death caused by Fusarium crown rot.

USU Extension IPM Program



Root cross section showing rot caused by Fusarium.

USU Extension IPM Program



Discolored cambium and spongy tissue.

USU Extension IPM Program



Fusarium sporulation (white fuzz) at crown of plant.

USU Extension IPM Program



Purple coloration caused by *Fusarium graminearum*.

USU Extension IPM Program

LEAF SPOT

Bipolaris gigantea (cereals, corn, grasses, rice, other monocots) is widespread in eastern and midwestern U.S.

Cercospora cannabis and other *Cercospora* spp.

Septoria cannabis and other *Septoria* spp.

Hosts: Field-grown hemp plus hundreds of additional host plants (agricultural crops and ornamentals) can be affected by *Cercospora* and *Septoria* fungal leaf spots.

Symptoms: *Cercospora* causes circular to elliptical spots that are gray with dark brown margins. *Septoria* leaf spots first appear on older leaves within the plant canopy where humidity is higher. Lesions start as small brown spots with bright yellow halos and may enlarge and coalesce to irregular blotches. Entire leaves may turn yellow and drop from plant.

Disease Cycle: Leaf spot fungi overwinter in the field as hardy fruiting bodies (such as pycnidia) within previously-infected crop debris. Under cool, wet conditions, the fruiting bodies release spores (conidia) that are rain-splashed or wind-driven to susceptible plant tissue. After landing on a host, spores germinate and infect the foliage. If rainy conditions persist in the spring and summer, leaf-spot pathogens can spread season-long.

Time for Concern: Year-round in greenhouses and in field plantings, only during periods of cool weather, high humidity, and rainy conditions.

When and Where to Scout:

- Start scouting for leaf spots about a month after planting.

- Monitor the older, inner foliage of plants, plants that are in dense plantings, and plants that have been exposed to excessive wetting.

Threat Level: Very low. No cannabinoid yield losses have been observed on plants infected with leaf spots in other states.

Occurrence in Utah: Only found in a few locations in Utah. More commonly found in regions with wetter climates.

Management:

- Remove dead/infected plants and debris or till crop debris to promote death of overwintering fungi.
- Spacing plants properly to promote airflow.
- Maintain good plant health.
- A few fungicides are approved in Utah for leaf spots.

When to Consider Treatment: Not a threat to plant health under Utah's arid outdoor conditions. In greenhouses, consider treatment when more than 10% of the crop is affected and the disease appears to be spreading.

Look-alikes: Nutrient deficiencies, insect feeding



Cercospora leaf spot.

Nancy Gregory, University of Delaware, Bugwood.org



Septoria leaf spot.

aphidcluster, tumblr.com



Spots on leaves may arise from abiotic conditions such as a nutrient deficiency.

USU Extension IPM Program

POWDERY MILDEW

Golovinomyces ambrosiae, *G. chioracearum*
Podosphaera macularis

Hosts: Hemp, plus both powdery mildew genera of hemp occur on other crops in Utah. *G. chioracearum* is found on bindweed and some ornamentals. However, there has been a debate if there are different strains of *G. chioracearum* that are host-specific. To date, we have not seen *G. chioracearum* on field-grown hemp in Utah despite bindweed nearby being covered with powdery mildew. This species has been found on greenhouse hemp. Another powdery mildew reported on hemp is *P. macularis*. It also infects strawberry and hops. Only *G. ambrosiae* has been found on field-grown hemp which also infects many cut flowers.

Symptoms: White, powdery spots that may expand to cover leaves, stems, or flower buds.

Disease Cycle:

Powdery mildew survives as mycelium on green plant tissue in the greenhouse or outside in warmer climates. In colder climates it survives by producing, fruiting structures that contain overwintering spores (chasmothecia). As temperatures warm in the spring, the spores are released and colonize nearby green tissue. After colonizing the tissue, the characteristic white mycelium covers the tissue and new spores are produced. These spores cause new infections and the cycle can continue every 7 to 10 days as long as environmental conditions are favorable.

Time for Concern: Throughout the growing season.

When and Where to Scout:

- Starting a few weeks after planting, inspect hemp leaves for new infections. Start with the lowest leaves of the plant, and check the undersides and the leaf surface for white, powdery areas.

Threat Level: Medium.

Occurrence in Utah: Powdery mildew on field-grown hemp has been very rare in Utah, but common on greenhouse hemp.

Management:

- Space out field or greenhouse plantings to allow for air circulation.
- Drip irrigation will lessen the chance of higher humidity, and reduce infection potential.
- Approved fungicides are available.

When to Consider Treatment: When scouting reveals that approximately 5 to 10% of plants are infested with powdery mildew. This is an estimate based on threshold levels for other crops, and has not been verified on hemp.

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



Powdery mildew with denser spotting on greenhouse-grown hemp.

USU Extension IPM Program



Powdery mildew with lighter spotting on greenhouse-grown hemp.

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Powdery mildew damage on field-grown hemp.

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PYTHIUM ROOT AND CROWN ROT

Pythium aphanidermatum, *P. dissotocum*, *P. myriotylum*, and *P. ultimum*

Hosts: Field and greenhouse hemp, plus *Pythium ultimum* has a large host range including many vegetables and field crops.

Symptoms: *Pythium* species cause a root rot or a crown rot. Plants with root rot are stunted and wilted. Affected roots are rotted, and shed their outer layer, leaving only the core. Crown rot occurs when the pathogen infects the tissue at the crown, girdling the stem. Root rot does not occur in combination with crown rot. With either disease, plants quickly wilt and die.

Disease Cycle: *Pythium* is a soilborne, fungal-like organism that can survive as resting spores until a suitable host is present. Under saturated soil conditions, it produces zoospores that use flagella (hair-like appendages) to swim to host roots. Infection can occur with or without a wound. The pathogen colonizes the roots and/or plant crown, killing the tissue as it feeds, and forms resting spores within the dead tissue for prolonged survival. In Utah, *P. ultimum* can cause infection in soils with temperatures from 68-77°F and *P. dissotocum* causes infection in soils with temperatures between 77-86°F. *Pythium* species can be introduced into a greenhouse or field operation by infected transplants, contaminated soil or irrigation water, or equipment

Time for Concern: Throughout the growing season.

When and Where to Scout:

- After irrigations or rains, check the field for areas of poor drainage.
- Scout plants biweekly looking for stunted, chlorotic, and wilted plants. Examine symptomatic plants for rot at the soil line.
- Plants that look very sickly or that are recently or nearly dead should be dug up. Examine roots for brown discoloration and soft root tissue where the sheath easily slides off the inner core.
- Where root or crown rot has been identified, rotate the field to a different crop.

Threat Level: Low, unless soil conditions are wet.

Occurrence in Utah: *P. myriotylum* prefers warmer conditions and has been found in greenhouse production in Utah. All pathogens have been isolated from hemp in Utah.

Management:

- In field-grown hemp, management of crown and root rot requires prevention, because no fungicides are available.
- Use drip irrigation where possible or improve drainage in poorly-drained areas.
- Remove infected plants, including roots, in a timely manner.

- In greenhouses, use new pots and trays, or disinfect reused pots with a 10% -15% bleach solution for about an hour followed by a good rinse with water.
- Prepare potting mix on a plastic tarp to prevent contact with bare ground

that may contain Pythium or other soilborne pathogens.

When to Consider Treatment:

N/A.

Look-alikes: drought stress, fusarium wilt or crown rot



Cross section of a hemp stem showing dead cambium (brown ring) caused by Pythium.

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Clustered dead hemp plants caused by Pythium rot spread through roots.

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Dead cambium of a pythium-infected hemp plant.

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Pythium on a field-grown hemp plant.

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Brown, dead cambium can be seen after scraping outer layer of the stem of an infected hemp plant.

USU Extension IPM Program

STEM CANKERS

Several fungal species, including *Alternaria* spp., *Neofusicoccum* spp., *Lasiodiplodia* spp., *Phomopsis* spp., and *Sclerotinia sclerotiorum*

Hosts: Many hosts including field-grown hemp and other vegetables. Hemp grown for fiber appears to be more affected by canker diseases.

Symptoms: Stem cankers occur on the main stem or side stems as small, light-to-dark brown lesions of different sizes and shapes. Over time, the lesions enlarge and encircle the stem, killing the epidermis and underlying tissue. All plant parts above the cankered area wilt and then die. Cankers caused by *Sclerotinia* will be associated with profuse, fuzzy, white mycelium and black fruiting bodies (sclerotia) on the affected plant part.

Disease Cycle: Fungi that cause cankers may overwinter in infected crop debris or as survival structures (sclerotia) in the soil. Sclerotia can survive for 5 to 8 years. Once temperatures rise above 60°F and soil moisture is present, the fruiting bodies release spores that are either wind-blown or water-splashed to host tissue. These spores can invade any healthy part of the plant it comes in contact with. Moist conditions in the plant canopy favor infection.

Time for Concern: Later in the season as stems become thicker.

When and Where to Scout:

- Check plants for wilting shoots or stems starting in mid-summer.
- If the rest of the plant is healthy, inspect the stem carefully for signs or symptoms of a canker.

- Use a knife to scrape away the epidermis along the stem to determine if the tissue underneath is brown.

Threat Level: Very low. *Sclerotinia sclerotiorum* does occur in Utah rarely on other crops, and has been found on hemp in Oregon. It is considered a damaging disease of hemp central and eastern North America.

Occurrence in Utah: No stem cankers have been positively identified in Utah.

Management:

- Avoid planting hemp in fields where stem cankers have occurred in the past on other crops.
- Minimize leaf wetness from irrigation and ensure good air circulation.
- Prune out infected plant portions as they are found.
- If *Sclerotinia* has been identified, rotate hemp with non-host crops (grasses, cereals, or onion) for 2 to 8 years to reduce inoculum in the field.

When to Consider Treatment:

Treatment not needed except to prune out affected stem.

Look-alikes: some branches on hemp can spontaneously break at the junction with the stem, but remain attached



Example of stem canker.

Ilaria Alberti, Council for Agricultural Research and Agricultural Economy Analysis



Sign of *Sclerotinia* (on soybean).

Daren Mueller, Iowa State University, Bugwood.org



All tissue dies above the stem canker.

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When scouting, for cankers, look for wilted shoots.

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VERTICILLIUM WILT

Verticillium dahliae and other *Verticillium* species

Hosts: Field-grown hemp plus many other hosts such as raspberries, potato, tomato, peppers, and many ornamental trees, shrubs, and flowers.

Symptoms: The initial symptom is wilting during the day with recovery at night. Over time, the lower foliage becomes chlorotic and scorched, with this symptom progressing up the plant until death. The pathogen clogs and kills the vascular (water-conducting) tissue and this symptom can be seen by cutting the stem at the ground, and slicing into the stem lengthwise above the cut to expose the brown tissue.

Disease Cycle: The fungi that cause *Verticillium* survive as resting spores in the soil for many years or as mycelium in crop debris for a shorter period. When mycelium or resting spores are near the roots of a suitable host, the root exudates cause germination. Infection into the roots requires a tiny wound for entry. After infection, the fungus produces secondary spores (conidia) that travel through and clog the vascular system. This disease spreads under cool, wet soil conditions and can also spread via root-to-root contact.

Time for Concern: Prior to transplanting, investigate the history of the field to determine if *Verticillium* has been present before (even if on other crops). Infections occur under cool, wet

conditions and symptoms appear in hot, dry conditions.

When and Where to Scout:

- Examine transplants before transporting them to the field.
- Starting in early summer, examine plants for unusual wilting and for leaf necrosis that starts at the base of the plant.

Threat Level: Low-moderate. Other plant pathogens are observed more frequently in industrial hemp, but growers should note that there is no cure for *Verticillium* wilt.

Occurrence in Utah: Not yet found as a damaging pest in field-grown hemp. Nevada reports that one grower grew hemp in a field with a history of *Verticillium* wilt, but no wilt disease was found on hemp. *Verticillium* was first noted on hemp in China, so it can potentially be an issue; however, *Fusarium* seems to outcompete other soilborne diseases.

Management:

- Do not plant hemp into fields known to have had *Verticillium*.
- Prevent injury to plant roots during planting and during field maintenance.
- Practice good sanitation and remove diseased plants in a timely manner to prevent spread from plant to plant.
- Where possible, rotate fields out of hemp to other crops.

When to Consider Treatment: There is no treatment to eliminate *Verticillium* spp. from fields except crop rotation or fallowing the field for several years. Plants diagnosed with the disease cannot be cured and should be removed.

Look-alikes: Fusarium wilt, nutrient deficiencies, and drought stress



Foliage turns chlorotic and dies from the bottom up.

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Plants eventually die from Verticillium wilt.

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Cross-section of stem showing brown vascular tissue.

USU Extension IPM Program

ALFALFA MOSAIC VIRUS

Genus *Alfamovirus* in the family Bromoviridae

Hosts: Field-grown hemp plus a wide variety of other hosts such as legumes, plants in the Solanaceae family, ornamentals, and many weeds.

Symptoms: Foliage develops bright yellow blotches interspersed with green, called “mottling.” Leaves can curl and also develop a bronze discoloration. On alfalfa and some other crops, the phloem tissue is killed, resulting in plant death. This symptom has not been documented on hemp. In addition, the effects of this virus on cannabis yield and flower quality have not been determined.

Disease Cycle: Alfalfa mosaic virus is harbored in many virus-infected alfalfa fields and weeds. AMV is spread by several species of aphids, and it is unknown if Cannabis aphid is a vector. Aphids acquire the virus from an infected plant and transmit it to hemp by probing leaf tissues. Aphids with the virus are only able to transmit it for a few minutes to a few hours. Infections usually occur in hemp fields grown near alfalfa, and only on plants closest to the alfalfa.

Time for Concern: Throughout the growing season.

When and Where to Scout: Starting in late spring, observe plants for unusual leaf coloration, especially on plants growing closest to alfalfa fields.

Threat Level: Low.

Occurrence in Utah: Alfalfa mosaic virus has not yet been detected in Utah, but is likely to occur. It has been reported on *Cannabis* in British Columbia, Canada.

Management:

- Avoid planting hemp close to alfalfa, if possible.
- Remove plants with positive diagnosis.

When to Consider Treatment: At this time there is no information available that treatment is needed.

Look-alikes: other viruses, genetic abnormalities, nutrient deficiencies (nitrogen, iron, magnesium), herbicide damage, stunted growth due to poor growing conditions



Suspected alfalfa mosaic virus symptoms in field-grown hemp.

USU Extension IPM Program

ARABIS MOSAIC VIRUS

Genus *Nepovirus* in the family Secoviridae

Hosts: Field-grown hemp plus many other crops such as celery, grape, geranium, hops, horseradish, lilac, lettuce, peach, raspberry, rhubarb, strawberry, and sugar beet.

Symptoms: ArMV causes a range of symptoms including leaf mottling (patterns and mixes of yellow and green shades), twisted and curled foliage, and stunted shoot growth. Symptoms may resemble herbicide damage. Overall plant growth can also be slightly slowed to severely stunted. In many non-hemp host plants, the virus causes no symptoms. The effects of viruses on cannabis yield and flower quality have not been determined.

Disease Cycle: The virus is spread by dagger nematodes (*Xiphinema* spp.) from infected plants to healthy plants. It is then spread further in propagation by taking cuttings from an infected mother plant.

Time for Concern: Starting at the middle of the growing season through to harvest.

When and Where to Scout: Starting in late spring, observe plants for unusual leaf coloration, especially on plants growing closest to alfalfa fields.

Threat Level: Low.

Occurrence in Utah: Arabis mosaic virus was detected on one hemp plant in a single field in northern Utah. It has not been reported widely from other U.S. states, but does occur on hemp in Europe.

Management:

- Plant only certified disease-free material, and only propagate cuttings from healthy plants.
- If there is a concern about nematodes in the field, soil tests are available to determine if *Xiphinema* nematodes are present. There are labs around the country that can do the test.
- Remove plants with positive diagnosis.

When to Consider Treatment: At this time there is no information available that treatment is needed.

Look-alikes: other viruses, genetic abnormalities, nutrient deficiencies (nitrogen, iron, magnesium), herbicide damage, stunted growth due to poor growing conditions



Suspected arabis mosaic virus symptoms in field-grown hemp.

USU Extension IPM Program

CURLY TOP VIRUS

Curtovirus spp.

Hosts: Field-grown hemp plus many vegetables, ornamentals, and weeds.

Disease Cycle: The virus is spread by leafhoppers. Beet leafhoppers (*Circulifer tenellus*) migrate north in early summer from their overwintering locations. They acquire the virus by feeding on infected host plants and then transmit it for their entire life. The virus is transmitted quickly during leafhopper probing and feeding on host plants.

Symptoms: Infected hemp plants become stunted and show a yellow mosaic pattern on leaves or leaves become completely chlorotic.

Time for Concern: Throughout the growing season, but particularly when plants are small.

When and Where to Scout:

- Scout plants biweekly looking for stunting and yellow mosaic or general chlorosis on leaves.
- Plants that have yellow mosaic patterns on their leaves can be submitted to the Utah Plant Pest Diagnostic Lab for testing.
- Scout for beet leafhopper starting in spring by visually inspecting the undersides of leaves, or using yellow sticky cards placed at field edges. Beet leafhoppers often come from weeds surrounding the field, so begin scouting there early in the season.

Threat Level: Medium

Occurrence in Utah: Curly top virus has been detected on field-grown hemp in Utah in low incidence.

Management:

- Exclude or "confuse" leafhoppers by covering crops with row covers.
- Plant hemp further away from susceptible crops like beets or tomatoes to reduce infection.
- Destroy and remove plant debris. Weeds or volunteer plants from previous crops can act as overwintering hosts for leafhoppers and the virus.
- Keep field borders and interiors clear of weeds; this will reduce food sources for incoming infected leafhoppers in the spring and summer.

When to Consider Treatment:

N/A

Look-alikes: tomato spotted wilt virus (early in the season)



Beet leafhoppers vector and spread curly top virus.
G. Oldfield, USDA, Bugwood.org



Curly top virus damage to field-grown hemp plant.
USU Extension IPM Program



Curly top virus damage to field-grown hemp plant.
USU Extension IPM Program



Curly top virus damage to field-grown hemp plant.
USU Extension IPM Program

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

Hosts: Hemp is susceptible.

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.

Additional images of herbicide damage on hemp can be found on the University of California IPM website at herbicidesymptoms.ipm.ucanr.edu. Many images included here are used from that site, with permission.

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 verify, so identify by eliminating other possibilities.
- Look for distorted growth and chlorosis or necrosis on leaves and/or stems.
- Watch for areas where multiple plants of different species show the same symptoms.

Threat Level: Hemp is not killed by minimal exposure to the common broadleaf herbicides 2,4-D or dicamba. With soil-applied herbicides, soil removal may be necessary.

Occurrence in Utah: Typically found in low numbers in outdoor production; higher numbers indoors.

Management:

- 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.
- 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 or plant removal.

Look-alikes: distorted growth on leaves and/or stems, nutrient deficiencies (chlorosis) in leaves, viruses



Extremely thickened stem (fasciation) from an unknown cause but possibly 2,4-d or dicamba herbicide.

USU Extension IPM Program



Excessive growth (fasciation) from an unknown cause but possibly 2,4-d or dicamba herbicide.

USU Extension IPM Program



Brown lesions caused by glufosinate-ammonium.

UC IPM Program



Chlorosis and leaf crinkling caused by glyphosate.

UC IPM Program



Bronzing, necrosis, and chlorosis caused by popanil.

UC IPM Program



Leaf distortion, stacking, and chlorosis caused by rimsulfuron.

UC IPM Program



Distortion, cupping, crinkling, and narrowing of leaf, epinasty, and chlorosis caused by triclopyr.

UC IPM Program

ABIOTIC
DISORDERS

NUTRIENT DEFICIENCIES

Symptoms listed are based on the level of nutrient deficiency, from mild to severe.

The optimal levels of macro- and micro-nutrients for hemp CBD or fiber production may be obtained from your seed company, and much of this information is still being collected in ongoing research. For example, in CBD hemp, the production of cannabinoids may increase or decrease in various parts of the plant due to nutrient availability, and the relationship between them is dependent on several factors, including existing soil nutrient content, plant health and growth stage, and other environmental and physiological signals.

For optimal production and yield, conduct a soil nutrient test in spring to determine deficiencies and excesses and make adjustments as needed. During the summer while plants are in vegetative growth, collect foliar tissue from a random selection of plants as well as any symptomatic plants for nutrient testing and continue to make nutrient application adjustments. The Utah State University Analytical Lab, located in Logan, UT, can conduct both soil and nutrient analyses and the results will guide application of appropriate amendments.

Learn the symptoms of nutrient deficiencies and plan to monitor plants regularly throughout the growing season to prevent them from causing losses to yield.

Nitrogen (N)

Importance: Nitrogen is one of the most important nutrients for hemp. It is responsible for leaf and stem growth and the overall size and vigor of the plant. Higher levels are needed during vegetative growth stages.

Symptoms of Deficiency or Excess:

Nitrogen is highly soluble and easily washed from soils and therefore must be replaced regularly, especially during vegetative plant growth. Mild deficiencies can be common while roots struggle to absorb enough, but this should be alleviated when growth slows.

Deficiency:

- Chlorosis (yellowing) beginning on older leaves starting at leaf tips and moving toward center

- Defoliation of extremely chlorotic older foliage
- Premature flowering
- Decreased flower and seed production

Excess:

- Leaves darken beginning on lowest leaves
- Excess foliage growth
- Weak stems that are prone to breakage
- Reduced resistance to pests, especially aphids

Management:

Deficiency:

- Fertilize with a slightly more concentrated nutrient solution
- Enhance soil health by applying an amendment after harvest such as manure or compost, or plant a cover crop in fall and till in spring



Nitrogen deficiency. Notice the chlorosis moving from the leaf tips inward.
Dutch Passion



Phosphorus deficiency. Notice the purple petioles and bluish-green leaves.
Dutch Passion



Phosphorus deficiency. Notice the bronzing of the leaf.
USU Extension IPM Program



Advanced nitrogen deficiency with more severe yellowing.
Dutch Passion



Phosphorus deficiency with purplish-brown necrotic patches.
Sensi Seeds

NUTRIENT DEFICIENCIES

Nitrogen Management, continued

Excess:

- Where possible, leach soil with water and after leaching, apply a dilute complete fertilizer

Phosphorus (P)

Importance: Phosphorus is important for photosynthesis and metabolic processes. During the hemp life cycle young plants absorb the majority of the plant's phosphorus needs. Most Utah soils have adequate phosphorus content.

Symptoms of Deficiency or Excess:

Deficiencies tend to be common during flowering. They are more extreme in soil that is clayey, poorly drained, and soggy. High pH (>7) makes phosphorus unavailable for absorption in the soil. Cold soil temperatures can also prevent uptake. An excess of phosphorus can occur from repeated applications of manure, especially with drip irrigation that will not leach through the soil.

Deficiency:

- Purple petioles
- Bluish-green leaves
- Slowed plant growth
- Dark copper or dark purple blotches on lower leaves
- Lower leaves curl downward and/or contort
- Necrosis and purple/bronze coloring on heavily affected leaves
- Small flower buds
- Delayed flowering
- Higher susceptibility to insect pests and diseases

Excess:

- Symptoms resemble nutrient deficiencies of iron and zinc

Management:

Deficiency:

- Apply fine, steamed bone meal and an organic source of phosphorus onto the soil before planting
- Ensure balanced levels of all nutrients because phosphorus deficiency can also be caused by excess levels of zinc and iron

Excess:

- Avoid excessive applications, as leaching with water is not effective

Potassium (K)

Importance: Potassium assists with cell division, strong root growth, and other important plant processes. It is important in plant transpiration and is responsible for the turgidity of the plant. Potassium is an important nutrient for overall plant strength.

Symptoms of Deficiency or Excess:

When soil salinity is high (from excess fertilizer or sodium in the water source), potassium becomes unavailable for root absorption, causing deficiency. Cold soil temperature also causes reduced absorption. Conversely, potassium can build up in soils that have had excessive fertilizer applications. An excess of potassium is difficult to diagnose if other nutrient imbalances are also present.



Potassium deficiency showing brown leaf margins, stunted growth, and curled leaves.

USU Extension IPM Program



Boron deficiency. Notice the necrosis between leaf veins.

Dutch Passion



Potassium deficiency starting from leaf tips and margins.

Dutch Passion



Boron deficiency. Note the stunted and twisted new tip growth that appears burned.

Dutch Passion

ABIOTIC DISORDERS



Potassium deficiency under more severe conditions.

Sensi Seeds



Under excess boron, older foliage is affected first with symptoms including interveinal or marginal necrosis.

USU Extension IPM Program

NUTRIENT DEFICIENCIES

Potassium Symptoms, continued

Deficiency:

- Rusty-brown, dehydrated, and up-curved margins and tips of young leaves
- Rust-colored blotches on foliage that turn brown
- Weak stems
- Higher susceptibility to insect and disease pests
- Slowed and diminished flowering

Excess:

- May lead to deficiency of other nutrients (calcium, magnesium, zinc, iron) due to blocked absorption

Management:

Deficiency:

- Where possible, flood the planting rows with clean water to leach toxic salts out of the soil
- Cultivate the soil surface to improve water flow and reduce buildup of salts
- Apply a well-balanced N-P-K fertilizer with higher potassium content

Boron (B)

Importance: Boron assists with calcium uptake and other important plant functions. It is also important in maintaining good plant structure.

Symptoms of Deficiency or Excess:

Boron is absent in extremely poor soils or soils that do not get fertilized. An excess of boron is rare in nature and would only occur with over-application; it is difficult to correct before the crop is mature.

Deficiency:

- Stunted, twisted, and clustered new tip growth that does not expand properly
- Growth shoots that appear burned
- Slowed root growth where root tips swell and become discolored
- Necrotic spots between leaf veins
- Thickened leaves that become brittle and distorted
- Under-developed calyxes and bracts (modified leaves) with small brown spots
- Rust-colored cork tissue on stems
- Overall droopy appearance to the plant due to lack of turgor

Excess:

- Older leaves affected first
- Symptoms are similar to scorching caused by high saline soils
- Yellow leaf margins followed by necrosis

Management:

Deficiency:

- Apply 1 tsp of boric acid or borax soap per gallon of water per plant or use chelated fertilizer rich in boron

Excess:

- Avoid using excessive amounts of boric-acid based insecticides (for ants, for example)

Calcium (Ca)

Importance: Calcium is necessary for cell formation and overall plant growth. It contributes to the overall plant structure.



Calcium deficiency showing leaf spotting on lower leaves.

Dutch Passion



Iron deficiency showing chlorosis beginning on youngest leaves first.

USU Extension IPM Program



Calcium deficiency causing irregular spotting on leaves.

Dutch Passion



Iron deficiency causing advanced leaf chlorosis. Notice how the yellowing moves from the petiole out to the tip.

USU Extension IPM Program



Calcium deficiency causing irregular spotting on leaves.

USU Extension IPM Program



Bronze leaves with small black spotting caused by excess iron.

USU Extension IPM Program

ABIOTIC
DISORDERS

NUTRIENT DEFICIENCIES (continued)

Calcium, continued

Symptoms of Deficiency or Excess:

Calcium deficiency may occur due to application of an imbalanced fertilizer or transport problem within the vascular tissue (caused by conditions that affect the roots such as excess water, salinity, or root damage). It is rare in Utah, and more common where soils have higher acidity.

Deficiency:

- Contorted and curled lower leaves
- Yellowish-brown irregular spots on lower leaves (leaves remain green)
- Slowed flower bud development
- Root tip dieback, contributing to overall plant decline

Excess:

- Slight wilting of leaves
- Stunted growth if excessive during early plant growth stages
- Contributes to deficiencies in potassium, iron, magnesium, or manganese and can interfere with phosphorus uptake

Management:

Deficiency:

- Where possible, leach soil with water to wash out any built-up fertilizer salts that could impair uptake of calcium

Excess:

- Change nutrient solution and leach root zone where possible

Iron (Fe)

Importance: Iron is involved in the synthesis of chlorophyll and other

important enzyme functions.

Symptoms of Deficiency or Excess:

Iron deficiency is the most common nutrient issue with field-grown hemp in Utah. Although iron is present in most Utah's soils, it is not available for root absorption because high soil pH binds the iron in the soil. The problem is exacerbated by excess soil concentrations of phosphorus, manganese, zinc, and copper. In addition, excessive watering, poor soil drainage, high salt content, and cold soil temperatures prevent root uptake of iron. An excess of iron within plants would only occur due to over-application.

Deficiency:

- Interveinal chlorosis beginning on young growth
- Leaf necrosis and leaf drop
- Inhibited growth and reduced yield in severe cases

Excess:

- Bronze leaves with black leaf spots

Management:

Deficiency:

- Avoid over-irrigation, especially in heavy clay soils or when temperatures are cold
- Apply a foliar iron spray (chelated iron or ferrous sulfate) with spreader-sticker for temporary results
- Apply a chelated iron compound (in the form of EDDHA in soils with a pH > 7.2) to soil before planting or via chemigation during plant growth



Magnesium deficiency.
Dutch Passion



Manganese deficiency.
Dutch Passion



Magnesium deficiency. Notice chlorosis is on lower leaves.
Dutch Passion



Manganese deficiency. Notice the necrotic spots on the chlorotic leaf.
Dutch Passion



Magnesium deficiency with severe chlorosis.
Sensi Seeds



Severe manganese deficiency.
Sensi Seeds

ABIOTIC
DISORDERS

NUTRIENT DEFICIENCIES

Magnesium (Mg)

Importance: Magnesium is important for the absorption of light energy and photosynthesis within the plant as well as many other plant processes. It is also used in metabolizing phosphorus.

Symptoms of Deficiency or Excess:

Magnesium deficiency may occur if there is excess potassium or calcium in the soil or if soils are clayey, overly irrigated, acidic, and cold. Plant absorption is reduced if nighttime temperatures are below 64°F and daytime temperatures are below 75°F. An excess of magnesium is uncommon and difficult to diagnose based on visual symptoms.

Deficiency:

- Interveneal chlorosis on older leaves (as opposed to iron deficiency, which appears on new growth)
- Irregular rust-brown spots on leaf margins, tips, and between veins
- Symptomatic leaves curl upward
- Sickly plant with dying and dropping leaves

Excess:

- Rare and slow-acting
- Contributes to calcium deficiency and its related symptoms

Management:

Deficiency:

- For quick results and optimal absorption, apply magnesium sulfate as a foliar spray (2% solution of Epsom salt)

Excess:

- Where possible, leach soil with water

Manganese (Mn)

Importance: Manganese is involved in essential oxidation-reduction processes and is vital to chloroplast function.

Symptoms of Deficiency or Excess:

Deficiency may occur in high pH (>6.5) soils, and in soils with excess iron or a general lack of manganese. Conversely, low humidity can increase plant use of manganese due to increased transpiration. Acidic soils (low pH) which do not occur in Utah field soils, can also cause toxic uptake.

Deficiency:

- Interveneal chlorosis with dark green margins on younger leaves
- Necrotic spots on severely chlorotic leaves
- Slow and stunted plant growth

Excess:

- Chlorosis with dark orange-to-rusty-brown mottling on new growth
- Slow plant growth
- Loss of overall vigor

Management:

Deficiency:

- Where possible, leach soil and add a complete, chelated micronutrient formula

OTHER ABIOTIC ISSUES



Cold temperature damage.

USU Extension IPM Program



Cold temperature damage.

USU Extension IPM Program

ABIOTIC
DISORDERS



Seed genetics can cause unusual growth.

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Size differences between plants caused by seed genetics.

USU Extension IPM Program

OTHER ABIOTIC ISSUES

ABIOTIC
DISORDERS



Seed genetics causing leaf cupping.
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Seed genetics causing different looking plant with leaf cupping.
USU Extension IPM Program



More leaf distortion caused by seed genetics.
USU Extension IPM Program



Stunted plant with large leaves caused by seed genetics.
USU Extension IPM Program

OTHER ABIOTIC ISSUES



Seed genetics causing leaf distortion.

USU Extension IPM Program



Seed genetics causing abnormal new growth.

USU Extension IPM Program

ABIOTIC
DISORDERS



Girdling root in a field-grown hemp plant.

USU Extension IPM Program



Close-up of girdled root on a field-grown hemp plant.

USU Extension IPM Program

OTHER ABIOTIC ISSUES

ABIOTIC DISORDERS



Close-up of girdled roots on a field-grown hemp plant.
USU Extension IPM Program



Poor plant health due to girdling of the roots.
USU Extension IPM Program



Stunted plant caused by roots never expanding from the original transplanted root ball.
USU Extension IPM Program



Stunted plant caused by roots never expanding from the original transplanted root ball.
USU Extension IPM Program

OTHER ABIOTIC ISSUES



These roots that never expanded resulting in plant death.

USU Extension IPM Program



Wind can cause tall, heavy stems to break.

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ABIOTIC
DISORDERS



Chimera causing multiple colors in one plant.

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Chimera causing multiple colors in one plant.


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BENEFICIALS AND NATURAL ENEMIES

Predators.....	106
Parasitoids.....	131

COLLOPS BEETLE

Collops spp.

A: 4-7 mm long 

Prey: aphids, caterpillar eggs and larvae, small *Lygus* nymphs, mites, whiteflies

Appearance: Collops adults are soft-winged beetles with bluish-black bodies and orange or red patches or stripes. Eggs are yellow to pinkish-orange and spindle-shaped. Most eggs are laid in clusters on soil debris and sometimes laid in the plant terminal. Larvae are pink to brownish-red and feed on insects in the soil.

Predacious Lifestage(s):

Larva, Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- Overwinter as adults.
- Generally, one generation per year.

When and Where to Scout:

- Adults may be found feeding on pollen at flowers.
- Collops are common in fields but are infrequent in vegetables.
- Larvae are seldom seen and occur mostly in ground litter.

Value: Collops beetles can be important early to mid-season predators to help suppress the development of economic populations of a wide array of insects.

Top Ways to Attract/Conserve:

- Provide nectar and pollen resources.
- Sensitive to neonicotinoids and broad spectrum insecticides.

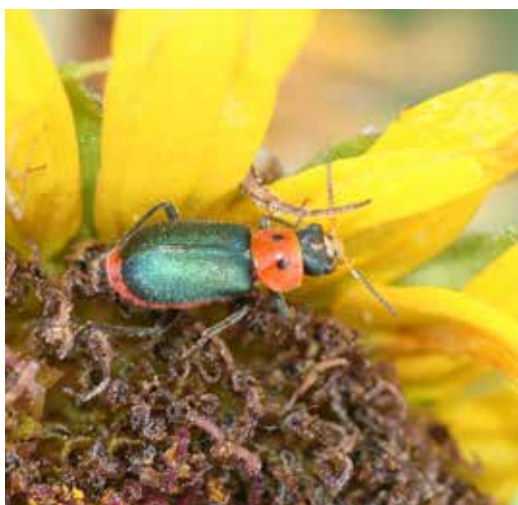
Look-alikes: cereal leaf beetle, asparagus beetle



Collops beetle adult male.
Jessica Louque, Smithers Viscient, Bugwood.org



Collops beetle adult male.
Whitney Cranshaw, Colorado State University, Bugwood.org



Collops beetle adult on a sunflower.
Whitney Cranshaw, Colorado State University, Bugwood.org



Collops beetle adult.
Whitney Cranshaw, Colorado State University, Bugwood.org



Collops beetle adult.
Whitney Cranshaw, Colorado State University, Bugwood.org




Two-lined collops beetle (*Collops vittatus*).
Kansas Department of Agriculture, Bugwood.org

GROUND BEETLES

Approximately 2,500 species in the family Carabidae

A: 4-25 mm long



Prey: wide variety, including aphids, beetles, caterpillars, and grasshoppers, both above- and below-ground

Appearance: Adults are light to dark in color, with round head, hooked jaws, long legs, thread-like antennae, and an extended-oval abdomen. Larvae are long and slender with dark coloration and pincher-like mandibles.

Predacious Lifestage(s):

Larva, Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- Overwinter as adults or larvae within grass clumps. Females lay single or clusters of eggs in soil cracks and crevices. Larvae develop in the soil for 1 to 2 years. Adults may live an additional 1 or more years.
- One generation per year.

When and Where to Scout:

- Adults of most species feed nocturnally, so they are rarely seen.
- All season long, beetles may be found under debris, logs, in soil cracks, or moving along the ground.

Value: Highly valuable, as larvae and adults eat their body weight in prey each day, and larvae (in the soil) often kill more prey than they can eat.

Top Ways to Attract/Conserve:

- Create one or more permanent beetle banks (a long raised strip of bunch grasses) within or around the hemp field for shelter and overwintering habitat.
- Mulch areas of the farm for daytime habitat, and use compost or manure rather than fertilizer.
- Avoid excessive tilling and do not burn crop residue.

Look-alikes: other ground beetles, tiger beetles



Blue-margined ground beetle (*Pasimachus elongatus*).
Whitney Cranshaw, Colorado State University, Bugwood.org



Boat-backed ground beetle (*Scaphinotus viduus*).
PA Department of Conservation and Natural Resources, Forestry, Bugwood.org



Caterpillar hunter ground beetle (*Calosoma wilcoxii*).
PA Department of Conservation and Natural Resources - Forestry, Bugwood.org



Fierce ground beetle (*Pasimachus depressus*).
Whitney Cranshaw, Colorado State University, Bugwood.org





Ground beetle adult.
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Ground beetle larva.
Joseph Berger, Bugwood.org

LADY BEETLES

Convergent lady beetle (*Hippodamia convergens*)
 Multicolored Asian lady beetle (*Harmonia axyridis*)
 Spotted lady beetle (*Coleomegilla maculata*)

A: 4-7 mm long 
 L: 1-9.5 mm long 

Prey: aphids (primary), leafhoppers, mites, thrips, whiteflies, immature lygus, and insect eggs.

Appearance: Adults have convex bodies, ranging from cream to red to black in color, with or without black or red spots. Eggs are laid in clusters and are bright yellow to orange in color and ovoid in shape. Larvae are blue-black to gray with yellow, red, or orange markings.

Predacious Lifestage(s):

Larva, Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- 2 to 3 generations.
- Overwinter as adults in protected sites outdoors or in buildings. They emerge in early spring, seeking out prey. Females lay up to 500 eggs in clusters of up to 50, typically on the undersides of leaves. Larvae feed on prey for 4 to 6 weeks and pupate where they feed.

When and Where to Scout:

- Use a beating tray to estimate populations of adult lady beetles.
- Look for clusters of orange-to-yellow eggs on the bark and undersides of leaves on plants infested with their common prey (aphids).

Value: Highly valuable, as they are active from spring to fall. A single lady beetle can consume up to 5,000 aphids in its lifetime.

Top Ways to Attract/Conserve:

- Large populations of aphids are the best attractant of lady beetles.
- Maintain insectary strips of continuous flowers as alternate food source (pollen, nectar) for adults.
- Bunch grasses or woody areas provide cool, humid habitat for hot, summer days.
- Convergent lady beetles are available for commercial purchase, but would be most effective in enclosed, greenhouse situations.

Look-alikes: Colorado potato beetle



Seven spotted lady beetle (*Coccinella septempunctata*) is a non-native beetle from Europe.
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Thirteen-spotted lady beetle (*Hippodamia tredecimpunctata*) is associated with wet habitats.
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Convergent lady beetle (*Hippodamia convergens*).
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The spider mite destroyer (*Stethorus punctillum*) is a tiny lady beetle relative that targets the two-spotted spider mite and other small mites.
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Lady beetle eggs laid within an aphid colony.
USU Extension IPM Program



Larva of the convergent lady beetle.
USU Extension IPM Program

APHID PREDATORY MIDGE

Aphidoletes spp.

L, A: 2-3 mm long ●

Prey: aphids

Appearance: The adult midge is a tiny fly that resembles a mosquito, with extended antennae and long, drooping legs. Larvae (maggots) are orange and though they are smaller than aphids, their strong mouthparts are able to hold their paralyzed prey upward as the contents are consumed.

Predacious Lifestage(s):

Larva (adults only feed on nectar and honeydew)

Life Cycle:

- Egg | Larva | Pupa | Adult
- Overwinter as larvae in the soil, and pupate and emerge as adults in late spring. The females seek out aphids by detecting the honeydew scent, and lay around 70 tiny, orange eggs within the colonies.
- Three to six generations per year .

When and Where to Scout:

- Midges fly at night, so they are rarely seen.
- Starting in late spring, look for orange, maggot-like larvae among aphid colonies on the undersides of leaves.
- Shriveled, dead aphids remain attached to leaves and are brown to black.

Value: This is a highly beneficial insect, but not commonly found. A single larva consumes 7 to 80 aphids in its lifetime.

Top Ways to Attract/Conserve:

- Midges are more active in high humidity.
- Provide a season-long source of nectar from tiny flowers such as *Lobularia* spp. (alyssum), asters, and herbs. Maintain small populations of aphids to promote buildup of midge population.

Look-alikes: gnats and other midges, mosquitoes, syrphid fly larvae



Aphid predatory midge adult.
www.pirlot.pro



Aphid predatory midge larva feeding on an aphid in
aphid colony.
Whitney Cranshaw, Colorado State University, Bugwood.org




Aphid predatory midge adult.
Koppert Biological Systems



Aphid midge larvae.
Ivia.es

LONG-LEGGED FLY

Many species in the family Dolichopodidae

A: 1-9 mm long 

Prey: soft-bodied arthropods such as springtails, aphids, gnats, midges, other flies, thrips, and insect eggs.

Appearance: Adults are small flies with long legs and are often found resting on plant leaves in the garden. Many are metallic green, blue, or copper in color. Larvae are translucent, white, smooth-bodied maggots, and can be found in moist soil or under bark.

Predacious Lifestage(s):

Larva, Adult

Life Cycle:

- Egg | Larva | Pupa | Adult
- Life cycle is not well-understood, but most likely, they overwinter as pupae in the soil and adults emerge in mid-to late spring.
- Mating occurs after elaborate male displays.
- Multiple generations per year.

When and Where to Scout:

- Look for adult flies resting on shaded plant leaves throughout the growing season.
- Larvae are rarely seen.

Value: Adults are commonly found, but their value in pest reduction is unknown in Utah hemp.

Top Ways to Attract/Conserve:

- Adults prefer shady, moist locations such as woodlands and meadows.
- Adults will also feed on nectar.

Look-alikes: small beneficial wasps



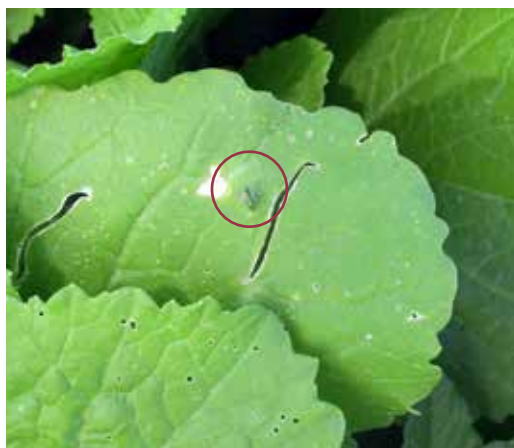
Long-legged fly adult.
Creative commons



Green long-legged fly.
Bob Peterson, North Palm Beach, Florida, Planet, Wikimedia Commons



Long-legged fly.
USU Extension IPM Program



Long-legged fly (circled) showing relative size compared to lettuce leaf.
USU Extension IPM Program





Long-legged fly larva (maggot) on soil.
Jiri Hulcr, Michigan State University, Bugwood.org



Long-legged fly larva.
Gerald J. Lenhard, Louisiana State University, Bugwood.org

SYRPHID FLY (HOVER FLY)

Several hundred species in the family
Syrphidae

A: 4-24 mm long 
L: 1-13 mm long 

Prey: aphids (primary), leafhoppers, spider mites, thrips, and other soft-bodied insects

Appearance: Adults have a hovering flight pattern, and resemble bees with a black and yellow striped abdomen, but have flatter bodies and only one set of wings. Larvae are maggots with a yellow to olive color, tapered body towards the head, and with or without a white stripe down the side. Eggs resemble grains of rice and are laid singly on leaves that harbor prey.

Predacious Lifestage(s):

Larva

Life Cycle:

- Egg | Larva | Pupa | Adult
- Overwinter as larvae or adults in protected areas.
- In spring, adults require pollen and seek out flowers to feed before they can start laying eggs. They find prey via volatile scents released the plants, and lay eggs among them.
- When mature, larvae drop to the ground to pupate.
- Generally, the life cycle is 2 to 4 weeks.
- 3 or more generations per year.

When and Where to Scout:

- Adults can be seen moving quickly from flower to flower. Although they resemble small bees or wasps, their hovering flight pattern is distinctive.

- Starting in mid-spring and throughout the season, search within aphid or thrips colonies to locate the rice-like syrphid eggs or slug-like larvae.
- Another indication of syrphid flies are black, oily smears (excrement) among prey.

Value: Highly important predator, but often under-appreciated because larvae tend to seek shelter during the day, and feed at night. Larvae can consume up to 400 soft-bodied insects in their lifetimes.

Top Ways to Attract/Conserve:

- Syrphid fly adults require pollen and nectar in order to reproduce, so providing a summer-long source of flowers is important. One or more strips of plants with small flowers (alyssum, dill, fennel, mint, etc.) on the edge of hemp fields or between rows is highly beneficial.
- Limit tilling and burning to protect overwintering habitat.
- Because the larvae require populations of aphids or other soft-bodied insects for sustenance, they are in direct competition with lady beetles. This competition may lead to one or the other being dominant on the farm.

Look-alikes: larvae resemble other beneficial maggots such as the aphid predatory midge; adults resemble bees



Syrphid fly adults are not predatory, and require pollen and nectar to survive.

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Syrphid fly larvae are voracious predators of aphids (shown with cabbage aphids).

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Syrphid fly excrement.

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Syrphid fly eating an aphid.

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Syrphid fly eggs are laid among their prey, and resemble a grain of rice.

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Syrphid fly larva eating an aphid.

David Cappaert, Bugwood.org

LACEWINGS

Common green lacewing (*Chrysoperla plorabunda*)
 Golden-eyed lacewing (*Chrysopa oculata*)
 Other lacewings (order Neuroptera)

A: 15-20 mm long 
 L: 1-13 mm long 

Prey: aphids (primary), leafhoppers, spider mites, thrips, and others

Appearance: Adults are green or brown in color with large, lace-like wings that fold along the sides of the body. Eggs are oval white spheres suspended on a stalk about 6 mm in length. Larvae are alligator-shaped with yellow-to-gray mottled coloration and sickle-like mandibles which extend past the head.

Predacious Lifestage(s):

Larva (in some species, adults are also predacious)

Life Cycle:

- Egg | Larva | Pupa | Adult
- 1 to 3 generations per year.
- Overwinter as pupae or adults in leaf litter and other protected areas.
- Adults emerge early in spring to seek out nectar.
- Females lay more than 200 eggs among their prey (either singly or in clusters), and larvae feed for 1-3 weeks before pupating on leaves or in sheltered areas.

When and Where to Scout:

- Adults are active at night, found on flowers, at prey sources, or at lights.
- Beating trays are effective tools to monitor lacewing adults. It is best to sample early in the day while it is still cool.
- When monitoring aphid colonies, also look for lacewing larvae.

Value: Lacewing larvae are highly important due to their abundance, voracious appetite, and early spring activity. Larvae are nicknamed “aphid lions,” and can consume more than 200 aphids per week.

Top Ways to Attract/Conserve:

- Maintain an unsprayed edge habitat for overwintering and alternate prey.
- Provide insectary strips within and around the hemp field to provide nectar and pollen-producing plants for adults.
- Maintain small populations of aphids around the farm to build populations of lacewings and provide honeydew for adults.
- Green lacewings are available commercially for purchase as adults or eggs to establish a population.

Look-alikes: adults are unique in appearance; larvae resemble damsel bug larvae



Green lacewing adult (*Chrysoperla* spp.).

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Green lacewing adult (*Chrysopa* spp.).

Alvesgaspar, Wikipedia.org.



Lacewing eggs are laid on a silky stalk to protect them from predators.

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Lacewing larva.

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Lacewing larva feeding on an aphid (*Chrysoperla* spp.).

Eric Steinert, Wikipedia.org.



Lacewing pupae found within a rolled-leaf.

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PARASITIC NEMATODES ON GRUBS

Many species in the families Steinernematidae and Heterorhabditidae

Prey: primarily soil-dwelling insects such as beetles, caterpillars, fly maggots and pupae, and thrips pupae

Appearance: Nematodes are microscopic, worm-like organisms that occur in the soil. There are hundreds of species, some scavengers, some plant-parasitic, and some that feed on insects. They occur in the top few inches of the soil, and some insect parasitic nematodes are active hunters. To survive, they require a moist environment. Often, nematodes are purchased and released.

Predacious Lifestage(s):

All stages

Life Cycle:

- Overwinters in the soil in various stages. Juvenile nematodes locate a suitable host by ambushing or by seeking them out. They enter the host through its natural openings, and then release gut bacteria that are pathogenic to the insect. The bacteria multiply, and the insect dies within 1 to 2 days. The nematodes inside the insect feed on the bacteria and the insect tissues.
- Adults then mate and lay eggs inside the dead insect, and 3 to 4 generations may occur within each insect. Thousands of juveniles will eventually exit to seek out new hosts.
- Multiple generations per year.

When and Where to Scout:

- They cannot be seen with the naked eye, and insects that are killed, are beneath the soil.
- Look for pests that nematodes could be used to control, such as cutworms, root weevil larvae, and June beetle larvae.

Value: Because they cannot be seen with the naked eye, the benefits of native nematode populations are difficult to measure. Beneficial nematodes are primarily used to augment the native population, and are sold in wettable clay powder packages which hold several million active units each.

Top Ways to Attract/Conserve:

- If applying purchased nematodes, immediate release is ideal; however, nematodes may be refrigerated at 40°F for several months.
- After application, ensure that the soil remains wet for at least 2 hours following application. Nematodes can be killed if soil surface temperature is above 85°F.

Look-alikes: none



Microscopic view of entomopathogenic nematodes.

David Cappaert, Bugwood.org



Entomopathogenic nematodes attacking western flower thrips.

R. Buitenhuis, Vineland



Thousands of nematodes from inside a grub cadaver.

Peggy Greb, USDA



Grub infested with entomopathogenic nematodes.

Purdue University




White grub larva killed by entomopathogenic nematodes next to a healthy larva.

Whitney Cranshaw, Colorado State University, Bugwood.org

BIG-EYED BUG

Geocoris spp.

A: 3-5 mm long 

Prey: aphids, caterpillars, flea beetles, leafhoppers, spider mites, thrips, whiteflies, and eggs and nymphs of plant bugs

Appearance: Adults have a broad head with widely separated bulging eyes, small stout body, and relatively thick antennae. They range in color from shiny black to gray or yellowish with red-brown spots. They attack prey with needle-like mouthparts that pierce and suck up body contents.

Predacious Lifestage(s):

Nymph, Adult

Life Cycle:

- Egg | Nymph | Adult
- Overwinter as adults in ground litter.
- Females lay up to 150 eggs on leaves or plant litter near prey source.
- Nymphs develop to adult in approximately 4 weeks.
- Multiple generations per year.

When and Where to Scout:

- Adults are first seen in spring when other insects such as lygus bugs begin to increase.
- Cylindrical eggs are laid singly on leaves, stems, or within soil crevices during spring and summer.
- Adults and nymphs may be found in plant debris, at the base of hemp stems, or in cracks at the soil surface from spring until the end of the season.

Value: Big-eyed bugs are commonly found in hemp, actively seeking out prey. A single adult bug may consume 80 spider mites per day.

Top Ways to Attract/Conserve:

- Build up populations in cool-season cover crops such as clover.
- Provide permanent, un-tilled plantings of bunch grasses or small shrubby plants for overwintering habitat.
- Nectar and seeds can provide an alternate food source when prey is limited.

Look-alikes: lygus bug, false chinch bug



Big-eyed bug adult feeding on an unidentified insect.
Russ Ottens, University of Georgia, Bugwood.org



Big-eyed bug adult.
Bradley Higbee, Paramount Farming, Bugwood.org



Big-eyed bug adult.
USU Extension IPM Program



Big-eyed bug nymph.
Bradley Higbee, Paramount Farming, Bugwood.org



Big-eyed bug egg.
Jack Kelly Clark, UC Statewide IPM Project




Big-eyed bug nymph.
USU Extension IPM Program

DAMSEL BUG

Nabis spp. plus 3 other genera in the family Nabidae

A: 8-12 mm long 

N: 3-8 mm long 

Prey: aphids, beetle larvae, leafhoppers, moth eggs, and other small insects

Appearance: Adults are tan-colored with long, thin bodies, slender head, and long antennae. Nymphs may resemble ants. This generalist predator actively seeks out prey, pierces it with needle-like mouthparts, and sucks up the body contents.

Predacious Lifestage(s):
Nymph, Adult

Life Cycle:

- Egg | Nymph | Adult
- Overwinter as adults in protected areas of field crops or shrubby areas and become active in late spring.
- Females lay up to 200 eggs, and populations peak in mid to late summer.
- 1 to 5 generations per year.

When and Where to Scout:

- Damsel bugs appear later in the season than other predators; starting in mid-summer.
- They are elusive and rarely seen, and move rapidly when disturbed.

Value: Often seen in hemp fields, actively seeking out prey.

Top Ways to Attract/Conserve:

- Associated with meadows, pasture, alfalfa and other field crops; hemp farms with or near these areas will have more damsel bug activity.
- According to research, damsel bugs are more abundant in no-till systems.

Look-alikes: assassin bug, leaf-footed plant bug, chinch bug



Common damsel bug (*Nabis americana*).

Joseph Berger, Bugwood.org



Common damsel bug nymph.

Phil Sloderbeck, Kansas State University, Bugwood.org



Damsel bugs may lie in wait at flowers for prey.

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Damsel bug feeding on a winged aphid.

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Damsel bug adult.

USU Extension IPM Program




Damsel bug adult.

USU Extension IPM Program

MINUTE PIRATE BUG

Orius spp.

A: 3-6 mm long 

Prey: thrips (primary), insect eggs, spider mites, and aphids

Appearance: Adults are tiny (“minute”) and have a distinctive black and white pattern. Nymphs are yellow to orange and as they mature, the abdomen becomes amber-colored. Their small size requires a 10x hand lens to see.

Predacious Lifestage(s):

Nymph, Adult

Life Cycle:

- Egg | Nymph | Adult
- Overwinter as adults in leaf litter.
- Adults emerge in mid-spring, and females lay up to 130 eggs, embedded singly within leaf tissue.
- Nymphs and adults will feed on prey for 6-7 weeks. They also feed on pollen and plant sap in the absence of prey.
- 2 to 4 generations per year.

When and Where to Scout:

- Beating trays are an effective means of monitoring for the presence of both nymphs and adults.
- Look for adults on hemp flowers, where their primary prey, thrips, reside.

Value: Highly important, especially against thrips and spider mites, as they reproduce very rapidly (15 days) and actively seek out prey. They can consume up to 30 small insects per day. These insects are among the most plentiful beneficials present in hemp.

Top Ways to Attract/Conserve:

- Once established, minute pirate bugs often remain for years. They are somewhat tolerant to most insecticides.
- Maintain unsprayed plantings on the farm that include grasses and woody plant material for shelter, alternate food source, and overwintering habitat.
- Include strips of flowering plants around or within the hemp field to provide pollen and nectar, which adults need to survive.

Look-alikes: big-eyed bug, lygus bug, false chinch bug



Minute pirate bug nymph feeding on a thrips.
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Minute pirate bug adult.
Phil Sloderbeck, Kansas State University, Bugwood.org



Minute pirate bug adult feeding on a thrips.
USU Extension IPM Program



Minute pirate bug feeding on an aphid.
Bradley Higbee, Paramount Farming, Bugwood.org










Minute pirate bug nymph feeding on an aphid.
Bradley Higbee, Paramount Farming, Bugwood.org



Minute pirate bug nymph feeding on a spider mite.
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SPIDERS

Many species. Common spider families include:

Crab spiders (Thomisidae family).....	A: 2-11 mm long	
Jumping spiders (Salticidae family).....	A: 1-22 mm long	
Wolf spiders (Lycosidae family).....	A: 3-35 mm long	
Orb-web spiders (Araneidae)	A: 2-30 mm long	
Funnel-web spiders (Agelenidae family).....	A: 5-18 mm long	
Running crab spiders (Philodromidae family)	A: 5-10 mm long	
Long-jawed orb weavers (Tetragnathidae family)	A: 5-15 mm long	

Prey: a wide variety of arthropods

Appearance: Spiders have 4 pairs of legs. Important groups of pest-eating spiders include wolf spiders, orb weavers, jumping spiders, and sheet-weaving spiders. Wolf spiders chase down their prey at ground level or on plants. Orb weavers can create large vertical webs suspended between plants and they catch more prey than they can consume. Jumping spiders lie in wait within plants and pounce on their prey. Sheet weavers can travel long distances between fields.

Predacious Lifestage(s):

Spiderlings, Adults

Life Cycle:

- Egg | Spiderling | Adult
- Overwinter in protected areas as immatures, adults, or egg masses in silken nests.
- Emergence timing will depend on species and life cycle
- Life cycle from egg to adult can vary greatly in length, but 1-3 years is common.
- Generations per year will vary by species.

Value: Spiders are highly important in natural biocontrol. A research study found that total worldwide consumption by spiders is 400 to 800 million tons of arthropods per year.

Top Ways to Attract/Conserve:

- Maintain undisturbed natural areas containing a mix of woody plants and flowers around or within the farm. These areas will sustain spider populations that will then move into the hemp field.
- Cover crops, stubble residue, and mulches can also support spider activity.
- Avoid tillage.

Look-alikes: other arachnids



Crab spider.

David Cappaert, Bugwood.org



Jumping spider.

David Cappaert, Bugwood.org



Wolf spider.

David Cappaert, Bugwood.org



Running crab spider.

Joseph Berger, Bugwood.org



Funnel-web spider.

Joseph Berger, Bugwood.org





Long-jawed orb-weaver spider.


David Cappaert, Bugwood.org

PARASITOID WASPS

Many species in the families:

Braconidae A: 1-18 mm long 

Chalcidoidea..... A: 2-18 mm long 

Ichneumonidea..... A: 3-50 mm long 

Prey: aphids, caterpillars, leafminers, true bugs, weevils, beetles

Appearance: Parasitoid wasp adults range in size from the head of a pen to several inches, with cream to black coloration. Many wasp species are specific to insect hosts, such as only aphids or only caterpillars, and are sometimes specific to a single insect pest species. Wasp larvae require an insect host for development and pupation. The larva may feed inside the host (endoparasite) or outside the host (ectoparasite).

Predacious Lifestage(s):

Larva (endo- or ectoparasite)

Life Cycle:

- Egg | Larva | Pupa | Adult
- Overwinters as a single larva or pupa inside its host, emerging as an adult in early to mid-spring.
- Females use cues to find their prey, and lay one or more eggs inside or on each insect.
- After egg hatch, the larva feeds on the host and grows.
- Once fully developed (1-2 weeks), the larva pupates either inside or outside the host, and then emerges as an adult.
- 1 or more generations per year.

When and Where to Scout:

- Watch flowers for visiting wasps starting in mid to late spring.
- When practicing regular scouting, watch for parasitized insects, such as aphids (bloated and tan or black) or caterpillars (shriveled).
- On aphids, for example, when 80% of them are parasitized, the parasitoid and aphid populations are balanced.
- Note that parasitoid wasps do not harm humans.

Value: With more than 65,000 species worldwide, parasitic wasps are the most important group of natural enemies of pest insects. They have a high reproductive rate and are often able to prevent economic injury from some pests.

Top Ways to Attract/Conserve:

- Adult wasps require nectar and pollen to survive. Provide a constant source of plants with small, shallow flowers (such as those in the carrot, aster, or mint families) in strips on the edge of the hemp field or between rows.
- Diversify other crops on the farm.
- Woody edge habitat has been shown to increase abundance of parasitoid wasps.

Look-alikes: tiny bees, flying ants



Braconid wasp cocoons on tomato hornworm.
Chazz Hesselein, Alabama Cooperative Extension System, Bugwood.org



Chalcid wasp (*Phaenoglyphus sulcata*).
Whitney Cranshaw, Colorado State University, Bugwood.org



Ichneumonid wasp.
Charles Ray, Auburn University, Bugwood.org



Braconid wasp (*Syngaster lepidus*).
Dong-Hwan Choe, University of California, Bugwood.org



Chalcid wasp.
Charley Eiseman, Bugguide.net



Ichneumonid wasp.
Muhammad Mahdi Karim



Scelionid wasp on stink bug eggs.
USU Extension IPM Program



Trichogramma spp. on armyworm eggs.
Dr. Victor Fursov, Wikimedia. org



Cannabis aphid adult (left) parasitized by a braconid wasp.
Whitney Cranshaw, Colorado State University, Bugwood.org



Cannabis aphid mummy with exit hole from a braconid wasp parasitoid.
Whitney Cranshaw, Colorado State University, Bugwood.org



A borer larva with ectoparasitoid wasp larvae.
USU IPM Extension Program



Winged cannabis aphid (left) and *Aphidius* sp. parasitoid (right) on a sticky yellow trap.
Whitney Cranshaw, Colorado State University, Bugwood.org

PESTICIDES FOR HEMP REGISTERED IN UTAH

The pesticide lists on the following pages include insecticides, fungicides, and herbicides that are approved for use on industrial hemp by Utah Department of Agriculture and Food (UDAF) as of 2022.

The list is subject to change at any time. Always verify pesticide selections with the current products list on the UDAF website.

Pesticide products are grouped by the type of pest they can control or suppress. The active ingredient for each product within each category is provided, as well as notes on limitations of use.

Insecticides	134
Fungicides	150
Herbicides	156

Insecticides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
APHIDS		
Bayer Advanced NATRIA Insecticidal Soap Ready-To-Use	potassium laurate	
Bonide All Seasons Horticultural & Dormant Spray Oil Concentrate, Ready to Spray	mineral oil	Commercial use allowed in greenhouse only.
Bonide Insecticidal Soap Multi-Purpose Insect Control Ready To Use	potassium laurate	Greenhouse use only.
Bonide Rose Rx 3 in 1 Concentrate	clarified hydrophobic extract of neem oil	Greenhouse use only.
Brandt Ecotec Plus	rosemary oil	Greenhouse use only.
Bug Buster-O Extinguish Ant Bait	pyrethrins	Greenhouse only
Dr. Earth Final Stop OMRI Fruit Tree Insect Killer (RTU); Concentrate	rosemary oil	Outdoor use only.
Dr. Earth Final Stop OMRI Vegetable Garden Insect Killer (RTU)	rosemary oil	Only to non-blooming plants
Dr. Earth Final Stop ProActive Yard & Garden Insect Killer (spray)	rosemary oil	
EcoWorks EC	neem oil, cold pressed	
Evergreen Crop Protection EC 60-6	pyrethrins	
Garden Safe Brand Insecticidal Soap Insect Killer	potassium laurate	Outdoor use only.
Kopa Insecticidal Soap	potassiums salts of fatty acid	
Mammoth Cancontrol	thyme oil	
Mite-E-Oil	mineral oil	Greenhouse use only.
M-Pede Insecticide Miticide Fungicide	potassium laurate	Foliar or basal applications.
Natural Guard Brand by Ferti-lome Insecticidal Soap Concentrate	potassium salts of fatty acids	
Natural Guard Brand Neem	clarified hydrophobic extract of neem oil	Only for outdoor use, or transplants intended for outdoor fields
Omni Supreme Spray	mineral oil	

Insecticides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
APHIDS, CONTINUED		
Organocide 3-in-1 Garden Spray Concentrate, Ready to Spray; Ready to Use	sesame oil	Greenhouse use only.
Organocide Bee Safe 3-in-1 Garden Spray Concentrate; RTU	sesame oil	
Ortho Tree & Shrub Fruit Tree Spray Concentrate	clarified hydrophobic extract of neem oil	
Prizefighter	ammonium nonanoate	Many uses including greenhouse
PureCrop1	soybean oil	
Pycana	pyrethrins	Greenhouse use only.
Pyganic Crop Protection EC 1.4 II; 5.0 II	pyrethrins	
Pyrethrum TR Total Release Insecticide	pyrethrins	
Rango	neem oil, cold pressed	
Safer Brand #567 Pyrethrin & Insecticidal Soap Concentrate II	potassium salts of fatty acids	Use prior to flowering only.
Safer Brand Neem Oil Concentrate	clarified hydrophobic extract of neem oil	
Safer Brand Yard & Garden Insect Killer II	potassium salts of fatty acids	
SaferGro Pest Out	cottonseed oil	
SuffOil-X	mineral oil	
Tersus Insecticide	pyrethrins	
Triact 70	clarified hydrophobic extract of neem oil	Older versions cannot be used on cannabis.
Trilogy	sulfur	
TriTek	mineral oil	
Venerate CG; XC	<i>Burkholderia</i> sp. strain a396	
Whitney Farms Insecticidal Soap	potassium laurate	
Xpectro OD	pyrethrins	

Insecticides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
ANTS		
Bonide Diatomaceous Earth Crawling Insect Killer	diatomaceous earth	Greenhouse use only.
Bug Buster-O Extinguish Ant Bait	pyrethrins	Greenhouse only.
Extinguish Professional Ant Bait	s-methoprene	
Ferti-lome Fruit Tree Spray	pyrethrins	
Pyganic Crop Protection EC 1.4 II; 5.0 II	pyrethrins	
Pyrethrum TR Total Release Insecticide	pyrethrins	
Tersus Insecticide	pyrethrins	
BETTERLES		
Aza-Direct Biological Insecticide	azadirachtin	
AzaGuard	azadirachtin	
AzaSol	azadirachtin	
Azatin O Biological Insecticide	azadirachtin	
Azatrol EC Insecticide	azadirachtin	
Azera Insecticide	azadirachtin	
Bayer Advanced NATRIA Insecticidal Soap Ready-To-Use	potassium laurate	
Bonide All Seasons Horticultural & Dormant Spray Oil Concentrate; Ready to Spray	mineral oil	
Bonide Diatomaceous Earth Crawling Insect Killer	diatomaceous earth	Greenhouse use only.
Bonide Rose Rx 3 in 1 Concentrate	clarified hydrophobic extract of neem oil	Greenhouse use only.
Botanigard Maxx	pyrethrins	Greenhouse use only.
Brandt Ecotec Plus	rosemary oil	Greenhouse use only.
Bug Buster-O Extinguish Ant Bait	pyrethrins	Greenhouse use only.
Deadzone	diatomaceous earth	
Dr. Earth Final Stop OMRI Fruit Tree Insect Killer (RTU); Concentrate	rosemary oil	Outdoor use only.
Dr. Earth Final Stop OMRI Rose and Flower Insect Killer (RTU)	rosemary oil	Ground application only to non-blooming plants.

Insecticides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
BEETLES, CONTINUED		
Dr. Earth Final Stop OMRI Vegetable Garden Insect Killer (RTU); Concentrate	rosemary oil	Only on non-blooming plants.
Dr. Earth Final Stop OMRI Yard and Garden Insect Killer (RTU); Concentrate	rosemary oil	
Dr. Earth Final Stop ProActive Yard & Garden Insect Killer (spray)	rosemary oil	
EcoWorks EC	neem oil, cold pressed	
Evergreen Crop Protection EC 60-6	pyrethrins	
Ferti-lome Fruit Tree Spray	pyrethrins	
Grandevo CG; WDG	<i>Chromobacterium</i> sub strain praa4-1 cells	
Leaf Life Gavicide Green 415	mineral oil	Greenhouse use only or transplants intended for field planting.
Mite-E-Oil	mineral oil	Greenhouse use only
Molt-X	azadirachtin	
Natural Guard Brand Neem	clarified hydrophobic extract of neem oil	Only for outdoor use, or transplants intended for outdoor fields.
Neemix 4.5 Insect Growth Regulator	azadirachtin	
Ortho Tree & Shrub Fruit Tree Spray Concentrate	clarified hydrophobic extract of neem oil	
Pycana	pyrethrins	Greenhouse use only.
Pyganic Crop Protection EC 1.4 II; 5.0 II	pyrethrins	
Pyrethrum TR Total Release Insecticide	pyrethrins	
Rango	neem oil, cold pressed	Use prior to flowering.
Safer Brand #567 Pyrethrin & Insecticidal Soap Concentrate II	potassium salts of fatty acids	Use prior to flowering.
Safer Brand Neem Oil Concentrate	clarified hydrophobic extract of neem oil	
Safer Brand Yard & Garden Insect Killer II	potassium salts of fatty acids	

Insecticides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
BEETLES, CONTINUED		
Surround WP Crop Protectant	kaolin	
Tersus Insecticide	pyrethrins	
TriTek	mineral oil	
Whitney Farms Insecticidal Soap	potassium laurate	
Xpectro OD	pyrethrins	
CATERPILLARS		
Agree WG	<i>Bacillus thuringiensis</i> ssp. <i>aizawai</i>	
Aza-Direct Biological Insecticide	azadirachtin	
AzaGuard	azadirachtin	
AzaSol	azadirachtin	
Azatin O Biological Insecticide	azadirachtin	
Azatrol EC Insecticide	azadirachtin	
Azera Insecticide	azadirachtin	
BT Now	<i>Bacillus thuringiensis</i> ssp. <i>kurstaki</i>	Greenhouse use only.
Bug Buster-O Extinguish Ant Bait	pyrethrins	Greenhouse use only.
Deadzone	diatomaceous earth	
Deliver Biological Insecticide	<i>Bacillus thuringiensis</i> ssp. <i>kurstaki</i>	
DiPel DF Biological Insecticide	<i>Bacillus thuringiensis</i> ssp. <i>kurstaki</i>	
DiPel DF Biological Insecticide Dry Flowable	<i>Bacillus thuringiensis</i> ssp. <i>kurstaki</i>	
DiPel PRO DF Biological Insecticide	<i>Bacillus thuringiensis</i> ssp. <i>kurstaki</i>	
Evergreen Crop Protection EC 60-6	pyrethrins	
Ferti-Lome Dipel Dust Biological Insecticide (RTU)	<i>Bacillus thuringiensis</i> ssp. <i>kurstaki</i>	
Ferti-lome Fruit Tree Spray	pyrethrins	

Insecticides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
CATERPILLARS, CONTINUED		
Gemstar LC	Polyhedral occlusion bodies (Obs) of nuclear polyhedrosis virus of <i>Helicoverpa zea</i> (corn earworm)	
Grandevo CG;WDG	<i>Chromobacterium</i> sub strain PRAA4-1 cells	
Javelin WG Biological Insecticide	<i>Bacillus thuringiensis</i> ssp. <i>kurstaki</i>	
Leprotec	<i>Bacillus thuringiensis</i> ssp. <i>kurstaki</i>	
Molt-X	azadirachtin	
Neemix 4.5 Insect Growth Regulator	azadirachtin	
Prizefighter	ammonium nonanoate	
Pycana	pyrethrins	Greenhouse use only.
Pyganic Crop Protection EC 1.4 II; 5.0 II	pyrethrins	
SPEAR-LEP	gs-omega/kappa-hctx-hv1a	Suppression only; combine with a Bt product for greater efficacy.
Tersus Insecticide	pyrethrins	
Thuricide N/G	<i>Bacillus thuringiensis</i> ssp. <i>kurstaki</i>	
Valent Professional Products DiPel Pro DF Biological Insecticide Dry Flowable	<i>Bacillus thuringiensis</i> ssp. <i>kurstaki</i>	
Venerate CG	<i>Burkholderia</i> sp. strain A396	
XenTari Biological Insecticide Dry Flowable	<i>Bacillus thuringiensis</i> ssp. <i>aizawai</i>	

Insecticides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
LEAFHOPPERS		
AzaGuard	azadirachtin	
Azatin O Biological Insecticide	azadirachtin	
Azatrol EC Insecticide	azadirachtin	
Azera Insecticide	azadirachtin	
Bayer Advanced NATRIA Insecticidal Soap Ready-To-Use	potassium laurate	
Bonide Insecticidal Soap Multi-Purpose Insect Control Ready To Use	potassium laurate	Greenhouse use only.
Botanigard Maxx	pyrethrins	Greenhouse use only.
Bug Buster-O Extinguish Ant Bait	pyrethrins	Greenhouse use only.
Captiva	capsicum oleoresin extract	
Captiva Prime	capsicum oleoresin extract	
Deadzone	diatomaceous earth	
Evergreen Crop Protection EC 60-6	pyrethrins	
Ferti-lome Fruit Tree Spray	pyrethrins	
Garden Safe Brand Insecticidal Soap Insect Killer	potassium laurate	
Kopa Insecticidal Soap	potassiums salts of fatty acid	
Molt-X	azadirachtin	
M-Pede Insecticide Miticide Fungicide	potassium laurate	
Natural Guard Brand by Ferti-lome Insecticidal Soap Concentrate	potassium salts of fatty acids	
Neemix 4.5 Insect Growth Regulator	azadirachtin	
Pycana	pyrethrins	Greenhouse use only.
Pyganic Crop Protection EC 1.4 II; 5.0 II	pyrethrins	
Pyrethrum TR Total Release Insecticide	pyrethrins	
Safer Brand #567 Pyrethrin & Insecticidal Soap Concentrate II	potassium salts of fatty acids	Use prior to flowering.

Insecticides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
LEAFHOPPERS, CONTINUED		
Safer Brand Insect Killing Soap Concentrate II	potassium salts of fatty acids	
Safer Brand Insect Killing Soap with Seaweed Extract II	potassium salts of fatty acids	
Safer Brand Yard & Garden Insect Killer II	potassium salts of fatty acids	
Surround WP Crop Protectant	kaolin	
Tersus Insecticide	pyrethrins	
Venerate CG; XC	<i>Burkholderia</i> sp. strain A396	
Xpectro OD	pyrethrins	
MITES-GENERAL		
Bonide Insecticidal Soap Multi-Purpose Insect Control Ready To Use	potassium laurate	Greenhouse use only.
Brandt Ecotec Plus	rosemary oil	Greenhouse use only.
Captiva	capsicum oleoresin extract	
Captiva Prime	capsicum oleoresin extract	
Dr. Earth Final Stop OMRI Fruit Tree Insect Killer (RTU); Concentrate	rosemary oil	Outdoor use only.
Dr. Earth Final Stop OMRI Rose and Flower Insect Killer (RTU)	rosemary oil	Ground application only to non-blooming plants.
Dr. Earth Final Stop OMRI Vegetable Garden Insect Killer (RTU); Conc.	rosemary oil	Before flowering only.
Dr. Earth Final Stop OMRI Yard and Garden Insect Killer (RTU); Conc.	rosemary oil	
Dr. Earth Final Stop ProActive Yard & Garden Insect Killer (spray)	rosemary oil	
EcoWorks EC	neem oil, cold pressed	
Garden Safe Brand Insecticidal Soap Insect Killer	potassium laurate	
Kopa Insecticidal Soap	potassiums salts of fatty acid	

Insecticides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
MITES-GENERAL, CONTINUED		
Leaf Life Gavicide Green 415	mineral oil	Greenhouse use only.
Mammoth Cancontrol	thyme oil	
Mite-E-Oil	mineral oil	Greenhouse use only.
M-Pede Insecticide Miticide Fungicide	potassium laurate	
Natural Guard Brand by Ferti-lome Insecticidal Soap Concentrate	potassium salts of fatty acids	
Omni Supreme Spray	mineral oil	
Organocide 3-in-1 Garden Spray Concentrate, Ready to Spray; Ready to Use	sesame oil	
Organocide Bee Safe 3-in-1 Garden Spray Concentrate; RTU	sesame oil	
Ortho Tree & Shrub Fruit Tree Spray Concentrate	clarified hydrophobic extract of neem oil	
Prizefighter	ammonium nonanoate	Many uses including greenhouse.
PureCrop1	soybean oil	
Rango	neem oil, cold pressed	Before flowering only.
Safer Brand #567 Pyrethrin & Insecticidal Soap Concentrate II	potassium salts of fatty acids	Before flowering only.
Safer Brand Insect Killing Soap Concentrate II	potassium salts of fatty acids	
Safer Brand Insect Killing Soap with Seaweed Extract II	potassium salts of fatty acids	
SaferGro Pest Out	cottonseed oil	
SuffOil-X	mineral oil	
Triact 70	clarified hydrophobic extract of neem oil	Older versions cannot be used on cannabis.
TriTek	mineral oil	
Venerate CG; XC	<i>Burkholderia</i> sp. strain A396	

Insecticides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
SEED/PLANT BUG		
Ancora	<i>Isaria fumosorosea</i>	Toxic to bees.
Botanigard Maxx	pyrethrins	Greenhouse use only.
Bug Buster-O Extinguish Ant Bait	pyrethrins	Greenhouse use only.
Captiva	capsicum oleoresin extract	
Captiva Prime	capsicum oleoresin extract	
Deadzone	diatomaceous earth	
Evergreen Crop Protection EC 60-6	pyrethrins	
Ferti-lome Fruit Tree Spray	pyrethrins	
Grandevo CG; WDG	<i>Chromobacterium</i> sub strain PRAA4-1 Cells	
Prizefighter	ammonium nonanoate	
Pycana	pyrethrins	Greenhouse use only.
Pyganic Crop Protection EC 1.4 II; 5.0 II	pyrethrins	
Surround WP Crop Protectant	kaolin	
Tersus Insecticide	pyrethrins	
Venerate CG	<i>Burkholderia</i> sp.	
Xpectro OD	pyrethrins	
SPIDER MITES		
Ancora	<i>Isaria fumosorosea</i>	Toxic to bees.
Azera Insecticide	azadirachtin	
Bayer Advanced NATRIA Insecticidal Soap Ready-To-Use	potassium laurate	
Bonide All Seasons Horticultural & Dormant Spray Oil Concentrate; Ready to Spray	mineral oil	Greenhouse use only (for commercial).
Bonide Rose Rx 3 in 1 Concentrate	clarified hydrophobic extract of neem oil	Greenhouse use only.
Botanigard Maxx	pyrethrins	Greenhouse use only.

Insecticides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
SPIDER MITES, CONTINUED		
Ferti-lome Fruit Tree Spray	pyrethrins	
Kopa Insecticidal Soap	potassiums salts of fatty acid	
Natural Guard Brand Neem	clarified hydrophobic extract of neem oil	
Ortho Tree & Shrub Fruit Tree Spray Concentrate	clarified hydrophobic extract of neem oil	
Safer Brand Insect Killing Soap with Seaweed Extract II	potassium salts of fatty acids	
Safer Brand Neem Oil Concentrate	clarified hydrophobic extract of neem oil	
Safer Brand Yard & Garden Insect Killer II	potassium salts of fatty acids	
Trilogy	sulfur	
Venerate CG	<i>Burkholderia</i> sp strain A396	
Whitney Farms Insecticidal Soap	potassium laurate	
STINK BUGS		
Azera Insecticide	pyrethrins	
Deadzone	diatomaceous earth	
Ferti-lome Fruit Tree Spray	pyrethrins	
Pyganic Crop Protection EC 1.4 II; 5.0 II	pyrethrins	
Surround WP Crop Protectant	kaolin	
Tersus Insecticide	pyrethrins	
Venerate CG or XC	<i>Burkholderia</i> sp strain A396	
THRIPS		
Ancora	<i>Isaria fumosorosea</i>	Toxic to bees.
Aza-Direct Biological Insecticide	azadirachtin	
AzaGuard	azadirachtin	
AzaSol	azadirachtin	

Insecticides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
THRIPS, CONTINUED		
Azatin O Biological Insecticide	azadirachtin	
Azatrol EC Insecticide	azadirachtin	
Azera Insecticide	azadirachtin	
Bonide All Seasons Horticultural & Dormant Spray Oil Concentrate; Ready to Spray	mineral oil	Greenhouse use only (for commercial).
Bonide Insecticidal Soap Multi-Purpose Insect Control Ready To Use	potassium laurate	Greenhouse use only.
Botanigard Maxx	pyrethrins	Greenhouse use only.
Brandt Ecotec Plus	rosemary oil	Greenhouse use only.
Bug Buster-O Extinguish Ant Bait	pyrethrins	Greenhouse use only.
Captiva	capsicum oleoresin extract	
Captiva Prime	capsicum oleoresin extract	
EcoWorks EC	neem oil, cold pressed	
Garden Safe Brand Insecticidal Soap Insect Killer	potassium laurate	
Grandevo CG; WDG	<i>Chromobacterium</i> sub strain PRAA4-1 Cells	
Leaf Life Gavicide Green 415	mineral oil	Greenhouse use only or transplants intended for field planting.
Mammoth Cancontrol	thyme oil	
Mite-E-Oil	mineral oil	Greenhouse use only.
Molt-X	azadirachtin	
M-Pede Insecticide Miticide Fungicide	potassium laurate	
Natural Guard Brand by Ferti-lome Insecticidal Soap Concentrate	potassium salts of fatty acids	
Omni Supreme Spray	mineral oil	
Organocide 3-in-1 Garden Spray RTU; Concentrate	sesame oil	

Insecticides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
THRIPS, CONTINUED		
Organocide Bee Safe 3-in-1 Garden Spray Concentrate	sesame oil	
Organocide Bee Safe 3-in-1 Garden Spray RTU	potassium sorbate	
Ortho Tree & Shrub Fruit Tree Spray Concentrate	clarified hydrophobic extract of neem oil	
Prizefighter	ammonium nonanoate	
PureCrop1	soybean oil	
Pycana	pyrethrins	Greenhouse use only.
Pyganic Crop Protection EC 1.4 II; 5.0 II	pyrethrins	
Pyrethrum TR Total Release Insecticide	pyrethrins	
Rango	neem oil, cold pressed	
Safer Brand Insect Killing Soap Concentrate II	potassium salts of fatty acids	
Safer Brand Insect Killing Soap with Seaweed Extract II	potassium salts of fatty acids	
Safer Brand Yard & Garden Insect Killer II	potassium salts of fatty acids	
SaferGro Pest Out	cottonseed oil	
Spear T Liquid Concentrate	gs-omega/kappa-hctx-hv1a	
SuffOil-X	mineral oil	
Surround WP Crop Protectant	kaolin	
Trilogy	sulfur	
TriTek	mineral oil	
Venerate CG; XC	<i>Burkholderia</i> sp strain A396	
Whitney Farms Insecticidal Soap	potassium laurate	
Xpectro OD	pyrethrins	

Insecticides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
WHITEFLY		
Ancora	<i>Isaria fumosorosea</i>	Toxic to bees.
AzaGuard	azadirachtin	
AzaSol	azadirachtin	
Azatin O Biological Insecticide	azadirachtin	
Azatrol EC Insecticide	azadirachtin	
Azera Insecticide	azadirachtin	
Bayer Advanced NATRIA Insecticidal Soap Ready-To-Use	potassium laurate	
Bonide All Seasons Horticultural & Dormant Spray Oil Concentrate; Ready to Spray	mineral oil	Greenhouse use only (for commercial.)
Bonide Insecticidal Soap Multi-Purpose Insect Control Ready To Use	potassium laurate	Greenhouse use only.
Bonide Rose Rx 3 in 1 Concentrate	clarified hydrophobic extract of neem oil	Greenhouse use only.
Botanigard Maxx	pyrethrins	Greenhouse use only.
Brandt Ecotec Plus	rosemary oil	Greenhouse use only.
Captiva	capsicum oleoresin extract	
Captiva Prime	capsicum oleoresin extract	
Dr. Earth Final Stop OMRI Fruit Tree Insect Killer (RTU); Concentrate	rosemary oil	Outdoor use only.
Dr. Earth Final Stop OMRI Rose and Flower Insect Killer (RTU)	rosemary oil	Ground application only to non-blooming plants.
Dr. Earth Final Stop OMRI Vegetable Garden Insect Killer (RTU); Concentrate	rosemary oil	Only to non-blooming plants
Dr. Earth Final Stop OMRI Yard and Garden Insect Killer (RTU); Concentrate	rosemary oil	
Dr. Earth Final Stop ProActive Yard & Garden Insect Killer (spray)	rosemary oil	
EcoWorks EC	neem oil, cold pressed	

Insecticides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
WHITEFLY, CONTINUED		
Evergreen Crop Protection EC 60-6	pyrethrins	
Ferti-lome Fruit Tree Spray	pyrethrins	
Garden Safe Brand Insecticidal Soap Insect Killer	potassium laurate	
Grandevo CG; WDG	<i>Chromobacterium</i> sub strain PRAA4-1 Cells	
Kopa Insecticidal Soap	potassiums salts of fatty acid	
Leaf Life Gavicide Green 415	mineral oil	Greenhouse use only.
Mammoth Cancontrol	thyme oil	
Mite-E-Oil	mineral oil	Greenhouse use only.
Molt-X	azadirachtin	
M-Pede Insecticide Miticide Fungicide	potassium laurate	
Natural Guard Brand by Ferti-lome Insecticidal Soap Concentrate	potassium salts of fatty acids	
Natural Guard Brand Neem	clarified hydrophobic extract of neem oil	Only for outdoor hemp or transplants intended for outdoor fields
Neemix 4.5 Insect Growth Regulator	azadirachtin	
Organocide 3-in-1 Garden Spray Concentrate, Ready to Spray/RTU	sesame oil	
Organocide Bee Safe 3-in-1 Garden Spray Concentrate; RTU	sesame oil	
Ortho Tree & Shrub Fruit Tree Spray Concentrate	clarified hydrophobic extract of neem oil	
Prizefighter	ammonium nonanoate	
PureCrop1	soybean oil	
Pycana	pyrethrins	Greenhouse use only.
Pyganic EC 1.4 II, 5.0 II	pyrethrins	
Pyrethrum TR Total Release	pyrethrins	
Rango	neem oil, cold pressed	

Insecticides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
WHITEFLY, CONTINUED		
Safer Brand Insect Killing Soap Concentrate II	potassium salts of fatty acids	
Safer Brand Insect Killing Soap with Seaweed Extract II	potassium salts of fatty acids	
Safer Brand Neem Oil Concentrate	clarified hydrophobic extract of neem oil	
Safer Brand Yard & Garden Insect Killer II	potassium salts of fatty acids	
Spear T Liquid Concentrate	gs-omega/kappa-hctx-hv1a	
SuffOil-X	mineral oil	
Tersus Insecticide	pyrethrins	
Triact 70	clarified hydrophobic extract of neem oil	Older versions cannot be used on cannabis.
Trilogy	sulfur	
TriTek	mineral oil	
Venerate CG; XC	<i>Burkholderia</i> sp strain A396	
Whitney Farms Insecticidal Soap	potassium laurate	
Xpectro OD	pyrethrins	

Fungicides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
BOTRYTIS (GRAY MOLD)		
Bonide Rose Rx 3 in 1 Concentrate	clarified hydrophobic extract of neem oil	Greenhouse use only.
Dr. Earth Final Stop OMRI Disease Control Fungicide (RTU); Concentrate	rosemary oil	
Jet-Ag	hydrogen peroxide	
Mammoth Cancontrol	thyme oil	
Natural Guard Brand Neem	clarified hydrophobic extract of neem oil	Only for outdoor hemp or transplants intended for outdoor fields.
PreFence Biofungicide	<i>Streptomyces</i> sp. Strain K61	
PureCrop1	soybean oil	
Rampart Fungicide	phosphorous acid, mono- and di-potassium salts of	Use allowed prior to final transplant.
Rango	neem oil, cold pressed	
Regalia CG Biofungicide	<i>Reynoutria sachalinensis</i> (knotweed)	Outdoor use only.
Safer Brand Insect Killing Soap Concentrate II	potassium salts of fatty acids	
Serenade Garden Disease Control Concentrate; Ready to Spray	<i>Bacillus subtilis</i> QST713 Strain	
Serifel NG Biological Fungicide	<i>Bacillus subtilis</i> MBI 600	
Triact 70	clarified hydrophobic extract of neem oil	Older versions cannot be used on cannabis.
Trilogy	sulfur	
TriTek	mineral oil	
ZeroTol 2.0	hydrogen peroxide	Greenhouse use only.

Fungicides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
FUSARIUM AND OTHER WILTS		
Amplitude Biofungicide	<i>Bacillus amyloliquefaciens</i> Strain D747	
BioSafe Disease Control RTU	hydrogen peroxide	
Jet-Ag	hydrogen peroxide	
PreFence Biofungicide	<i>Streptomyces</i> sp. strain k61	
PureCrop1	soybean oil	
OxiDate 2.0	hydrogen peroxide	
OxiPhos	phosphorous acid, mono- and di- potassium salts of	Use allowed prior to final transplant.
Rango	neem oil, cold pressed	
Regalia CG Biofungicide	<i>Reynoutria sachalinensis</i> (knotweed)	
Serenade Garden Disease Control Concentrate	<i>Bacillus subtilis</i> qst713 strain	Outdoor use only.
Serifel NG Biological Fungicide	<i>Bacillus subtilis</i> mbi 600	
TerraClean 5.0	hydrogen peroxide	
LEAF SPOTS (CERCOSPORA, SEPTORIA, PSEUDOCERCOSPORA)		
Organocide 3-in-1 Garden Spray, Ready to Spray; Ready to Use	sesame oil	
Organocide Bee Safe 3-in-1 Garden Spray Concentrate; RTU	sesame oil	
OxiDate 2.0	hydrogen peroxide	
OxiPhos	phosphorous acid, mono- and di- potassium salts of	Use allowed prior to final transplant.
Regalia CG Biofungicide	<i>Reynoutria sachalinensis</i> (knotweed)	Outdoor use only.

Fungicides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
LEAF SPOTS (CERCOSPORA, SEPTORIA, PSEUDOCERCOSPORA), CONTINUED		
ReLoad Fungicide	mono- dibasic sodium, potassium, and ammonium phosphites	Greenhouse use only.
Safer Brand Garden Fungicide for Flowers, Fruit, and Vegetables, Concentrate	sulfur	
Safer Brand Insect Killing Soap Concentrate II	potassium salts of fatty acids	
Serenade Garden Disease Control Concentrate, Ready to Spray	<i>Bacillus subtilis</i> qst713 strain	
Triact 70	clarified hydrophobic extract of neem oil	Older versions cannot be used on cannabis.
Triathlon BA	<i>Bacillus amyloliquefaciens</i> strain d747	
Trilogy	sulfur	
ZeroTol 2.0	hydrogen peroxide	Greenhouse use only.
POWDERY MILDEW		
BioSafe Disease Control RTU	hydrogen peroxide	
Bonide All Seasons Horticultural & Dormant Spray Oil Concentrate; Ready to Spray	mineral oil	Greenhouse use only (commercial).
Bonide Insecticidal Soap Multi-Purpose Insect Control Ready To Use	potassium laurate	Greenhouse use only.
Bonide Rose Rx 3 in 1 Concentrate	clarified hydrophobic extract of neem oil	Greenhouse use only.
Dr. Earth Final Stop OMRI Disease Control Fungicide (RTU); Concentrate	rosemary oil	
Jet-Ag	hydrogen peroxide	Cleans up spores but PM can come back in 7 days

Fungicides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
POWDERY MILDEW, CONTINUED		
Kopa Insecticidal Soap	potassium salts of fatty acid	
Mammoth Cancontrol	thyme oil	
Natural Guard Brand by Ferti-lome Insecticidal Soap Concentrate	potassium salts of fatty acids	
Natural Guard Brand Neem	clarified hydrophobic extract of neem oil	
Omni Supreme Spray	mineral oil	
Organocide 3-in-1 Garden Spray Concentrate, Ready to Spray; Ready to Use	sesame oil	
Organocide Bee Safe 3-in-1 Garden Spray Concentrate; RTU	sesame oil	
OxiPhos	phosphorous acid, mono- and di-potassium salts of	Use allowed prior to final transplant.
PureCrop1	soybean oil	
Rango	neem oil, cold pressed	
Regalia CG Biofungicide	<i>Reynoutria sachalinensis</i> (knotweed)	Outdoor use only.
Reliant Systemic Fungicide	phosphorous acid, mono- and di-potassium salts of	Can only be used prior to final transplant.
ReLoad Fungicide	mono- dibasic sodium, potassium, and ammonium phosphites	Greenhouse use only.
Safer Brand Garden Fungicide for Flowers, Fruit, and Vegetables, Concentrate	sulfur	
Safer Brand Insect Killing Soap Concentrate II	potassium salts of fatty acids	
SaferGro Mildew Cure	corn oil	

Fungicides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
POWDERY MILDEW, CONTINUED		
Serenade Garden Disease Control Concentrate	<i>Bacillus subtilis</i> qst713 strain	
Serenade Garden Disease Control Ready to Spray	<i>Bacillus subtilis</i> qst713 strain	
Serifel NG Biological Fungicide	<i>Bacillus subtilis</i> mbi 600	
Summit Year-Round Spray Oil	mineral oil	
Surround WP Crop Protectant	kaolin	
Triact 70	clarified hydrophobic extract of neem oil	Older versions cannot be used on cannabis.
Triathlon BA	<i>Bacillus amyloliquefaciens</i> strain d747	
Trilogy	sulfur	
TriTek	mineral oil	
ZeroTol 2.0	hydrogen peroxide	Greenhouse use only.
ROOT ROTS (DAMPING OFF, PHYTOPHTHORA, PYTHIUM)		
Fosphite Fungicide	phosphorous acid, mono- and di-potassium salts of	Greenhouse use only.
PreFence Biofungicide	<i>Streptomyces</i> sp. strain k61	
Rampart Fungicide	phosphorous acid, mono- and di-potassium salts of	Use allowed prior to final transplant.
Regalia CG Biofungicide	<i>Reynoutria sachalinensis</i> (knotweed)	Outdoor use only.
Reliant Systemic Fungicide	phosphorous acid, mono- and di-potassium salts of	Can only be used prior to final transplant.
RootShield Plus+ Granules Biological Fungicide	<i>Trichoderma harzianum rifai</i> strain krl-ag2	Preventative only.

Fungicides by Pest Group

Utah-Registered Product	Active Ingredient(s)	Notes
ROOT ROTS (DAMPING OFF, PHYTOPHTHORA, PYTHIUM)		
RootShield Plus+ WP Biological Fungicide	<i>Trichoderma harzianum</i> rifai strain krl-ag2	
Serifel NG Biological Fungicide	<i>Bacillus subtilis</i> mbi 600	
TerraClean 5.0	hydrogen peroxide	
Triathlon BA	<i>Bacillus amyloliquefaciens</i> strain d747	
ZeroTol 2.0	hydrogen peroxide	Greenhouse use only.
ZeroTol HC	hydrogen peroxide	
WHITE MOLD/SOUTHERN BLIGHT/SCLEROTIUM		
Amplitude Biofungicide	<i>Bacillus amyloliquefaciens</i> strain d747	
Bonide Rose Rx 3 in 1 Concentrate	clarified hydrophobic extract of neem oil	Greenhouse use only.
Jet-Ag	hydrogen peroxide	
PreFence Biofungicide	<i>Streptomyces</i> sp. strain k61	
Rampart Fungicide	phosphorous acid, mono- and di-potassium salts of	Use allowed prior to final transplant.
Rango	neem oil, cold pressed	
Safer Brand Insect Killing Soap Concentrate II	potassium salts of fatty acids	
Serenade Garden Disease Control Concentrate	<i>Bacillus subtilis</i> qst713 strain	
Trilogy	sulfur	
ZeroTol HC	hydrogen peroxide	

Herbicides by Pest Group

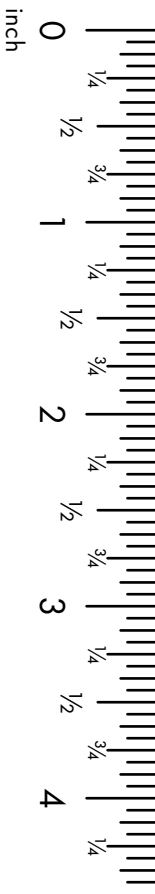
Utah-Registered Product	Active Ingredient(s)	Notes
BROADLEAF WEEDS		
Axe Broad Spectrum Herbicide	ammonium nonanoate	Greenhouse use only. May damage any contacted plant material.
BioSafe Weed & Grass Killer	ammonium nonanoate	
Dr. Earth Final Stop OMRI Weed and Grass Herbicide (RTU)	cinnamon oil	
Prizefighter	ammonium nonanoate	
Suppress Herbicide EC	caprylic acid	Non-selective herbicide, will damage crop tissue
GRASS WEEDS		
Axe Broad Spectrum Herbicide	ammonium nonanoate	Greenhouse use only. May damage any contacted plant material.
BioSafe Weed & Grass Killer	ammonium nonanoate	
Dr. Earth Final Stop OMRI Weed and Grass Herbicide (RTU)	cinnamon oil	Non-Selective herbicide, will damage crop tissue.
FireWorxx	caprylic acid	
Prizefighter	ammonium nonanoate	
Suppress Herbicide EC	caprylic acid	Non-selective herbicide, will damage crop tissue.

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Rulers in Millimeters and Inches





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