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UTAH PESTS QUARTERLY

NEWSLETTER

Utah Plant Pest Diagnostic Laboratory

USU Extension

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Spots on Sycamore Leaves May Not Be a Disease

In 2018, the Utah Plant Pest Diagnostic Lab (UPPDL) saw an increase in the number of sycamore samples submitted. Clients were concerned that their London planetrees (*Platanus* x *acerifolia*) were suffering from anthracnose or a leaf spot disease. The leaf-spotting culprit, however, was identified as sycamore scale (*Stomacoccus platani*).

First described from California, sycamore scale is found in Arizona, Nevada, New Mexico and Utah on species of *Platanus*. Sycamore scale has been in southern Utah for at least a decade. UPPDL records indicate that sycamore scale was first submitted from the St. George area in 2009. The first record of this insect from northern Utah was from Pleasant Grove (Utah County) in 2012. Additional records from Utah county in 2013, 2016 and 2018, and conversations with arborists, indicate that sycamore scale may be an increasing pest along the Wasatch front.

Description and Plant Symptoms

Sycamore scale is very small, less than 1/16 of an inch in length. It is so small, in fact, that most people can't see it with the naked eye. A hand lens or microscope is required to see most life stages, which are yellow-to-orange, oval, egg-like structures. Some immature stages will also be covered with white, cottony wax. Crawler and adult stages have visible legs and antennae, and are mobile, and adults resemble immature thrips. On the bark, eggs and nymphs are often associated with white, cottony wax which can be seen extruding out from under or between bark scales.

Symptoms from sycamore scale can be readily recognized. Damage begins at bud break when scales migrate from the bark to newly expanding foliage. Scales begin to feed on the undersides of leaves causing distortion, stunting, and twisting. The feeding of each individual scale will cause the foliage to form a small, yellow spot that eventually turns brown. Severely infested leaves will have a gradation of yellow to brown spots that may eventually lead to premature leaf drop. Scales can also feed on thin bark tissue of smaller branches and twigs, causing tip dieback and bark cracking, scaling, and roughness.

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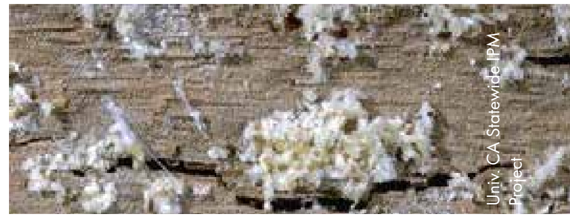

Adult sycamore scales resemble the nymph stage of thrips (top left). Some immature stages are covered with white, cottony wax (top right). Eggs on bark are also covered in a cottony coating (right).

Look-alike damage on sycamore includes anthracnose (left) and sycamore plant bug (right). Anthracnose is a fungal disease that causes blotchy necrosis and wilting. Feeding from sycamore plant bug occurs throughout the area of the leaf (not just along veins) and spots do not turn brown.

Sycamore trees can tolerate moderate levels of scale feeding; however, severe and recurring infestation can cause plant stress or even death. Damage from sycamore scale may be confused with damage from sycamore plant bug or anthracnose.

Life Cycle

In Utah, the number of generations per year for sycamore scale is unknown, but life stages are present on leaves from budbreak to leaf fall, and year-round on bark. In California, 3-5 generations per year are reported. The scale overwinters in bark crevices as immatures. In late winter or early spring, females mature, mate, and lay 50-100 eggs in masses of white, cottony wax on the bark of the main stem or smaller branches. At budbreak, eggs hatch into the first immature stage, called the crawler. These tiny insects migrate from the bark to leaves where they insert their straw-like mouthparts and settle, or they may remain on thin bark. Once in place, the crawlers' legs and antennae become indistinct and their body swells, forming a yellow-to-orange, egg-like structure. The insect will develop through several immature stages (3-5) before molting into an adult. Adults mate and female scales migrate to the bark to lay eggs, though some summer-generation females will lay eggs on leaves.

Management

Sycamore scale is best managed at budbreak by thoroughly covering expanding leaves, and the bark of twigs, branches, and trunk with horticultural oil or insecticidal soap. This timing targets first-generation crawlers and reduces scale numbers and foliar symptoms throughout the summer. Applications made prior to budbreak (when less susceptible life stages are present) or after leaf expansion (when thorough insecticide coverage is difficult), may result in suboptimal control. Homeowners may be able to adequately cover smaller trees, but larger trees will require a professional applicator. If necessary, the oil application may be mixed with a fungicide for control of anthracnose.

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While there is no data showing the efficacy of systemic insecticides on sycamore scale, imidacloprid (soil-applied) will likely provide control and may be the easiest method for homeowners and professionals to use on larger, specimen trees. Imidacloprid-containing products labeled for use on ornamental trees can be purchased at local farm or garden stores. Soil application of imidacloprid for sycamore scale is best made in spring at budbreak. Prior to soil application, remove organic material within a 2-foot zone around the trunk. This includes removing mulch, landscape fabric and turf thatch, etc. Apply the product as a liquid to the soil within 2 feet of the tree trunk; licensed professionals may use soil injection methods. Allow 4-6 weeks for imidacloprid to spread throughout the tree and provide control. Keep soil moist during this period to allow adequate uptake of the chemical.

If sycamore scale damage is observed for the first time in mid-summer, consider waiting until the following spring to begin management. Imidacloprid applied after mid-summer will have difficulty dispersing throughout the tree unless adequate irrigation is provided, and a foliar spray may not cover the undersides of all leaves.

——— Ryan Davis, Arthropod Diagnostician

For more information

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ENTOMOLOGY NEWS AND INFORMATION

Guarding Against Pests Using Host Plant Resistance

When developing a crop-based IPM program, the key tools are to prevent pests from occurring in the first place, and minimizing their impact when they appear. One such preventive measure is selecting plant varieties that have traits that are less favorable for the pest to consume, or that prevent pest reproduction and development. Many plants defend themselves against attacking pests and have adapted ways to overcome being completely eaten. Enhancing these defensive traits has been a useful tool when developing pest-resistant varieties.

Physical plant traits such as dense mats of trichomes (plant hairs) can make it difficult for insects and pathogens to reach the nutritious plant tissue. These hairs are sometimes accompanied by a sticky substance that traps insects or alters their movement. Hairy varieties of beans and strawberries, for instance, reduce feeding and egg-laying by aphids, leaf hoppers, and whiteflies. Moreover, glossy or waxy leaf varieties of cabbage reduce the ability of diamondback moth larvae from mining the leaves, leaving them exposed to predators.

Before feeding on milkweed leaves, monarch caterpillars overcome the plant's defenses by trimming trichomes and severing leaf veins to bleed out the toxic latex.

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Plant breeders use molecular tools to determine mechanisms of plant resistance, such as with a cabbage selection found to be resistant to whitefly (top).

Leafhopper feeding in alfalfa can lead to "hopper burn," a yellowing of plants that can lead to yield losses. In the 1990s, glandular, hairy varieties of alfalfa were bred, which reduced the impacts of leafhoppers (bottom).

Plant-produced chemicals also contribute to defense traits that make plants less suitable as a food source. It has long been known that crushed chrysanthemum flower heads and seeds have insecticidal properties (pyrethrum). Other examples of plant chemicals that deter pests are the soap-like saponins in alfalfa, the bitterness of glucosinolates in mustards, nicotine in tobacco, and cucurbitacins in cucumbers. When plants are attacked by an insect or pathogen, levels of these chemicals become elevated or they are maintained at a high level. This added protection can help slow additional feeding and prevent complete death of the plant.

Plant breeding has been used to select plants with high levels of these chemicals and breed them for these pest resistance attributes. The trade-off, however, is that high concentrations of these chemicals in food crops can lead to a less palatable plant. Plant chemical defense is not foolproof as specialized pests, such as cucumber beetles, can detect these elevated chemicals, alerting them to the location of their plant host. In more complex interactions, the specialized pest may utilize these compounds by sequestering them in their body which protects them from their predators, or they may have ways to metabolize these chemicals. For additional information on interactions between plants and arthropods and plant defenses visit the website, Learn.Genetics.

The Ramirez lab at USU has teamed up with Dr. Richard Clark's lab at the University of Utah through a grant from the National Science Foundation-Plant Genome Research Program to investigate plant defense pathways in cereals that are involved in host plant resistance toward the generalist two-spotted spider mite, which has a wide host range, and the specialist Bank's grass mite.

In a recent article in the journal Frontiers in Plant Science, post-doctoral fellow Dr. Huyen Bui and the team which included USU biology graduate student Gunn Gill and former graduate student Dr. Alice Ruckert, found that cereal plants (maize and barley) responded similarly in plant defense responses to both spider mites, regardless of specialization. However, the team found that a class of defense compounds known as benzoxazinoid defenses provided a mechanism for reducing two-spotted spider mite, a generalist plant feeder. Yet, the specialist Bank's grass mite was unfortunately able to cope with this plant defense and persist on plants with elevated benzoxazinoids.

We are gaining a better understanding of plant resistance mechanisms, plant defense chemicals, and their interactions with pests. With this knowledge, we can improve on their use as a tool in IPM. Indeed, genetic technologies have offered additional tools with transgenic host plant resistance. Perhaps the most well-known being Bt (*Bacillus thuringiensis*) crops that express bacterial proteins harmful to insects when ingested. It is important to evaluate these pest resistance attributes when purchasing seed or buying plants. Often a list of pests the plants show resistance toward will be provided. By considering pest resistant plant varieties when available (examples include the 2019 National Alfalfa Forage Alliance Alfalfa Variety Ratings and Cornell's University Table of Disease Resistant Varieties) in preparation for the cropping season, we may alleviate additional needs for pest management throughout the season.

— Ricardo Ramirez, Extension Entomologist

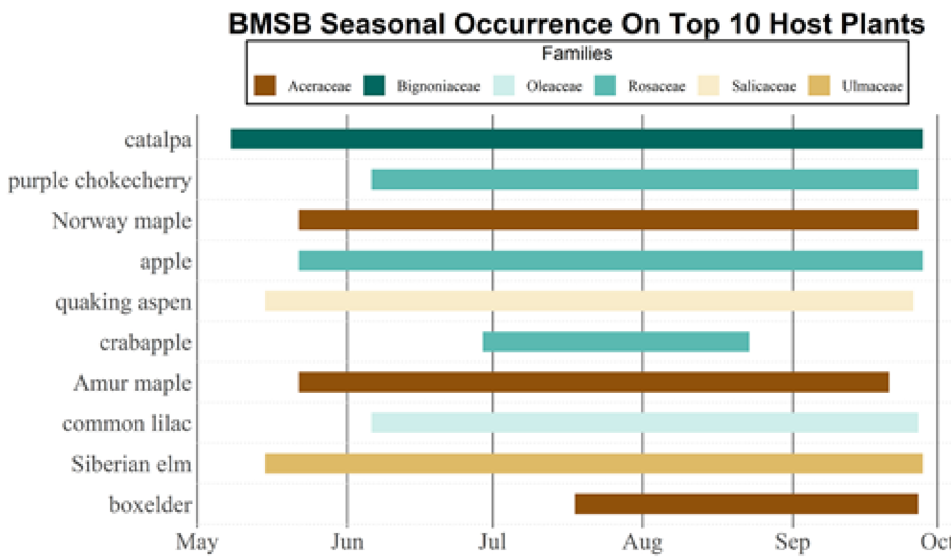
Seasonal Development and Occurrence of Brown Marmorated Stink Bug in Utah

Successful control or management of any insect pest is dependent on an accurate understanding of when the pest is most vulnerable. Phenology, or the seasonal timing of development, helps to understand how to prevent and respond to potential pest damage, including the invasive brown marmorated stink bug (BMSB, *Halyomorpha halys*). BMSB has become an overwhelming insect pest in many U.S. states, feeding on hundreds of different host plants and adapting to a wide array of climatic conditions.

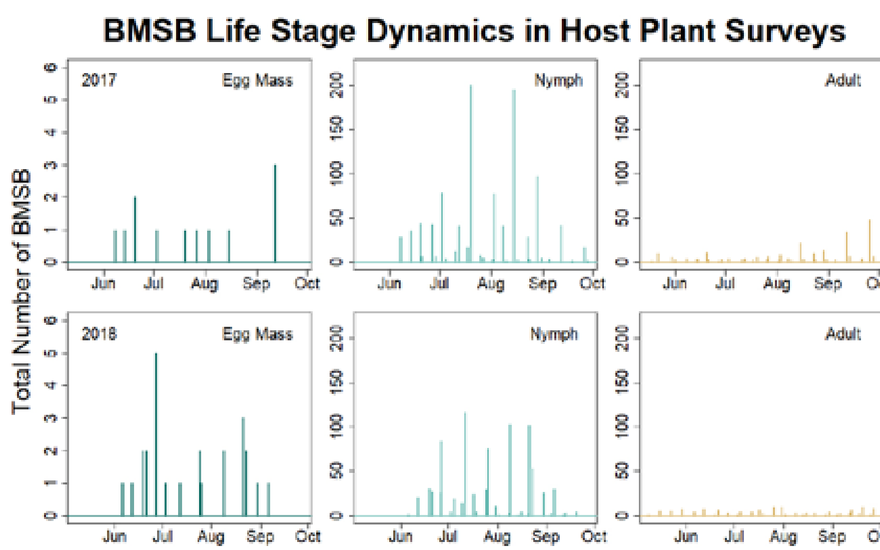
In Utah, BMSB has slowly built in population size since its discovery in 2012, with highest concentrations in and around urban and suburban neighborhoods. BMSB is commonly found on many ornamental shrubs and trees, especially catalpa. The first reports of BMSB damaging crop plants in Utah occurred in 2017, on apple, peach, corn, and squash. In 2018, field research showed that BMSB was also able to feed on tart cherry and cause significant damage to the early season fruit stage, though this damage has not yet been reported outside of experimental conditions.

USU researchers have been focused on understanding BMSB development throughout the year given the arid, hot, and high elevation conditions in Utah. Generally, BMSB adults can be found May through September on a variety of different host plants. The adults are known to emerge from their overwintering shelter in April, but testing is ongoing to narrow down the start and peak emergence dates.

Females reach sexual maturity within two weeks of emerging, which means egg production starts



BMSB observations on the top 10 most common host plants from May to Oct., 2017 and 2018. Each color corresponds to a plant family.



Total number of BMSB observed on plants, by life stage, in the summer of 2017 (top) and 2018 (bottom). Observations were made by visual inspection and beat sheet sampling of 300 plants of varying species on 15 sites in Davis, Salt Lake, Utah, and Weber counties.

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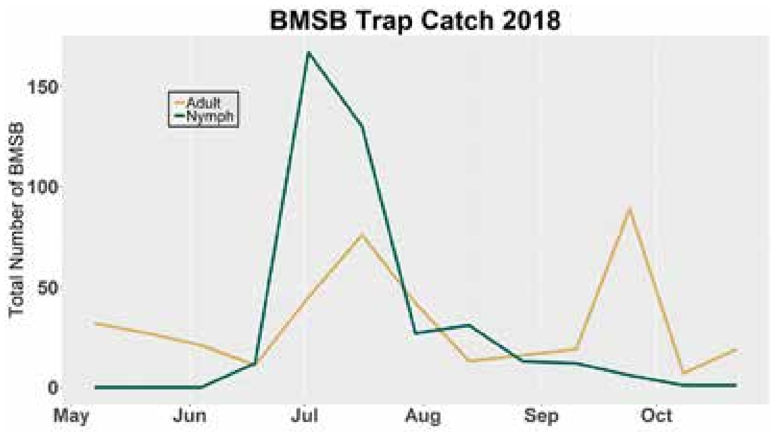
in early to mid-May and can continue through September. They lay eggs in masses of roughly 28, and a single female can produce an average of 224 eggs in her lifetime. Nymphs are first present in June and then reach peak numbers in mid-July. Adult BMSB numbers peak in early July, with a second peak occurring in late September. Population spikes can have real significance for susceptible agricultural crops that ripen in July.

It had been thought that BMSB was limited to a single adult generation in Utah each season, but more recently, we suspect that there is actually a second adult generation that occurs just before the end of September. A second generation could mean more feeding and subsequent damage than was first anticipated for the Intermountain West. Thus far, only a partial second generation has been observed in field testing in Utah.



Total of number of BMSB found in traps from May to October 2018. Traps were spread across Davis, Salt Lake, Utah, and Weber counties.

As with any invasive pest, continual monitoring of BMSB will be of utmost importance as management strategies are developed. To learn more about BMSB, consult the Utah State University fact sheets Brown Marmorated Stink Bug and Brown Marmorated Stink Bug Management for Fruits and Vegetables in Utah.

— Mark Cody Holthouse and Zachary Schumm (USU Biology Graduate Students), Lori Spears (Invasive Species Specialist), and Diane Alston (Entomologist)

For more information:

Skillman, V. P., & Lee, J. C. (2017). Nutrient Content of Brown Marmorated Stink Bug Eggs and Comparisons Between Experimental Uses. Journal of Insect Science, 17(6).

See utahpests.usu.edu/caps/bmsb-host-plants for a current listing of known host plants in Utah

ENTOMOLOGY NEWS AND INFORMATION

Biological Control of Brown Marmorated Stink Bug

Brown marmorated stink bug (BMSB; *Halyomorpha halys*) is an invasive economic and nuisance pest native to eastern Asia that invaded the United States in the late 1990's. In Utah, BMSB is established in five counties (Box Elder, Davis, Salt Lake, Utah, and Weber), and has been detected in Cache and Kane counties. It feeds on a variety of Utah's agricultural commodities and ornamental plants, making it a potential economic concern as populations spread and establish.

BMSB is challenging to manage with insecticides due to its hardiness and mobility. Researchers are surveying for and testing the effectiveness of natural and exotic enemies of BMSB to reduce populations.

In USU studies, cards containing BMSB egg masses were clipped to foliage of stink bug host plants. On this egg mass, a small parasitoid wasp is stinging the eggs.

At USU, researchers are surveying for natural enemies of BMSB with artificially-placed stink bug egg masses

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and yellow sticky cards. A suite of natural enemies have been identified; some of these are under efficacy testing against BMSB eggs in the lab. From these findings, generalist egg predators (e.g. earwigs, lacewings, and katydids) are relatively low in abundance and are not effective, especially in the agricultural landscape. Parasitoid wasps of stink bug eggs are more abundant and diverse. They lay eggs inside a stink bug egg, and the immature wasp feeds on the host egg before emerging as an adult wasp about two weeks later.

We have identified five wasp species that have been able to sting, develop, and emerge inside BMSB eggs in Utah. Three are in the family Eupelmidae and are generalist parasitoids that sting many types of insect eggs: *Anastatus mirabilis, A. persalli, A. reduvii*. Two are in the family Scelionidae, and specialize only on stink bug eggs: *Trissolcus euschisti*, and *T. hullensis*. Unfortunately, none of these species have shown high efficacy, with only 3-18% of wasps completing development and emergence as adults.

We have additionally tested the efficacy of a parasitoid wasp species native to Utah, *Trissolcus utahensis*, and found it was able to sting and kill nearly 89% of developing stink bug eggs in the lab. However, the immature wasps were unable to develop properly inside BMSB eggs. Like *T. utahensis*, most or all native parasitoid wasps will sting and kill the developing stink bugs within the eggs at a moderate to high success rate, but will not complete development into adult wasps, making them inefficient control agents for BMSB.

Parasitoid Wasp Species Currently Found in Utah

Species	Family	Collection Method	Actual Size	Can Emerge from BMSB?
Anastatus mirabilis	Eupelmidae	BMSB Eggs		Yes*
Anastatus persalli	Eupelmidae	BMSB Eggs		Yes*
Anastatus reduvii	Eupelmidae	BMSB Eggs		Yes*
Telenomus podisi	Scelionidae	BMSB Eggs / Sticky Cards		No*
Trissolcus erugatus	Scelionidae	BMSB Eggs / Sticky Cards		No*
Trissolcus euschisti	Scelionidae	BMSB Eggs / Sticky Cards		Yes*
Trissolcus hullensis	Scelionidae	BMSB Eggs / Sticky Cards		Yes*
Trissolcus parma	Scelionidae	Sticky Cards		Unknown
Trissolcus thyante	Scelionidae	Sticky Cards		Unknown
Trissolcus strabus	Scelionidae	Sticky Cards		Unknown
Trissolcus utahensis	Scelionidae	BMSB Eggs / Sticky Cards		No*

*Based on current surveys in Utah

Trissolcus erugatus, a stink bug parasitoid native to Utah has been found stinging BMSB eggs, but cannot develop and emerge properly from them.

Yellow sticky cards were placed in trees to attract various parasitoids.

The samurai wasp (*Trissolcus japonicus*), a wasp native to the homelands of BMSB in eastern Asia, is a highly effective parasitoid at both killing and developing within BMSB eggs, and is a promising biological control agent for BMSB in the U.S. This wasp was originally kept in U.S. quarantine facilities to undergo testing to confirm its effectiveness and ensure that it does not harm native, beneficial stink bug species. However, wild populations began to appear in 2014, and populations have now been found in twelve states (Maryland, Pennsylvania, New Jersey, New York, Delaware, Oregon, Ohio, Virginia, West Virginia, Michigan, California, and Washington). Surveys for biological control agents in Utah are focused on finding this particular parasitoid species. Once it is detected in Utah, redistribution efforts will likely be approved to assist with controlling BMSB populations. Surveys for this wasp will be continuing in Cache, Box Elder, Weber, Davis, Salt Lake, and Utah counties.

— Zachary Schumm and Mark Cody Holthouse (USU Biology Graduate Students), Lori Spears (Invasive Species Specialist), and Diane Alston (Entomologist)

Cytospora Canker of Fruit Trees - What is the Latest Information?

Mature peach orchards in the Intermountain West may be fragmented due to losses from cytospora canker.

Cytospora canker is one of the most common diseases of peach, nectarine, plum, and apricot trees in Utah. It is most damaging to young or stressed trees, and in fact, entire new orchards can be wiped out within a few years. Infected trees in older orchards gradually decline and lose productivity, necessitating replacement in as few as ten years. At the fall 2018 Utah Fruit School, fruit specialist Dr. Ioannis Minas from Colorado State University, presented research work by his colleague, plant pathologist, Dr. Jane Stewart and her graduate student, Stephan Miller, on cytospora biology and management. Peach production in Colorado is similar to Utah's, and their findings will be invaluable to Utah producers.

Cytospora is caused by several species of fungi. A 2018 study in California found 15 *Cytospora* species on stone fruits, while Stewart's research found only one species, *Cytospora leucostoma*, in Colorado peach orchards. It is likely that this same species is also prevalent in Utah, but this has not been confirmed.

The pathogen spreads from tree to tree via spores. The release of spores can happen year-round, and are most often spread by wind-driven rain. Stewart and Miller are investigating possible longer-distance spread by insects. Pruning is also known to spread the disease.

Like spore production, new infections occur at any time of the year, but are least likely during the hottest, driest months. A bark wound is required for infection, and the primary modes of entry in Colorado were found to be pruning cuts (both fresh cuts and old stubs) and bark damaged by cold injury. We have observed this in Utah, as well. Upon infection, the fungus invades and kills the bark and underlying wood. In summer, the fungus slows growth and the tree attempts to grow callus wood around the infection, but is often unsuccessful.

Infection sites are identified by copious, amber-colored gumming and cinnamon-brown-colored phloem tissue beneath the ooze. The cankers that form will kill the twig or branch. Trunk infections may kill the tree within three to five years.

Management

For many years, the primary mode of managing cytospora has been to prune out infected branches. This recommendation still holds true, since the fungi that cause cytospora cankers can survive and sporulate on dead wood for many years, contributing to spread. But when entire trees are affected, it is hard for a grower to make a decision on tree removal, and as a result, the disease stays in the orchard, causing a big part of the problem.

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In his presentation, Minas also reported on Miller's fungicide field trials, which were conducted on Cresthaven peach in Colorado.

- The fungicides, thiophanate-methyl (Topsin) and captan, were found to be effective at preventing infections when applied right after spring and/or summer pruning practices (within a few days). Topsin can only be used twice a season, so it shouldn't be used for anything else. For organic production, lime-sulfur was found to be effective.

- For existing cankers, Miller's research found that covering them was an effective strategy in preventing spore formation. Cankers were sprayed with Topsin or captan (mid-label rate) that was mixed with white latex paint (diluted in water to 50%), or lime-sulfur plus 50% Surround (kaolin clay). They found that initially, spore production declined, but then increased after 3 months. They surmised that the reason for this was due to the paint cracking on the bark surface, leaving exposed areas. Although not tested, a thicker paint dilution may allow for longer protection.

- On uninfected established trees, Topsin or captan (mid-label rate) plus 50% white latex paint applied on the trunk to the lower scaffold limbs provided the best canker prevention over using fungicide alone, paint alone, or using lime-sulfur plus surround.

Colorado State University research has shown that a layer of white paint plus fungicide can be applied over existing cankers to help prevent spore formation.

Although cytospora infections can be associated with fresh pruning cuts, in Utah, they are most often seen around stub cuts (right) or areas affected by cold injury.

For more information

Cornell University, Cytospora Canker of Fruit Trees

Bertrand PF, English H. 1976. Release and dispersal of conidia and ascospores of *Valsa leucostoma*. Phytopathology 66: 987–991.

Miller, S. et al. 2018. Preventive Fungicidal Control of *Cytospora leucostoma* in Peach Orchards in Colorado. Plant Disease. 10.1094

Stewart, Jane, Stephan Miller, Ioannis Minas. 2018. Preventive Control for Cytospora Canker on Peach. CSU Fact Sheet No. 2.954, CSU.

— Marion Murray, IPM Project Leader

PLANT PATHOLOGY NEWS AND INFORMATION

Herbicide Damage in Vegetables

Every year, the Utah Plant Pest Diagnostic Lab receives vegetable samples that have been damaged by herbicide, as the symptoms often resemble plant diseases, especially viruses. There are some clues that can give an indication that the cause may be herbicide damage and not a pathogen or an insect.

One good indicator is that with herbicide damage, symptoms appear rapidly on multiple plants of differing species, while a pathogen does not affect plants this way. Pathogens will cause one or a few plants to show symptoms, and then more plants of the same species will develop symptoms days later. It is never overnight that many plants show the same symptom.

How can vegetable plants come in contact with herbicides? There are many possibilities.

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- The obvious way is a direct application to the plants. This can happen if other pesticides are applied from a sprayer that was previously used for herbicides and not cleaned properly. The best way to avoid accidental herbicide damage is using separate sprayers labeled for herbicides and other pesticides.

- Herbicide exposure may also happen through irrigation water that runs through a canal and is used by several growers, or when pre-emergent herbicides are applied and the interval between application and planting is too short.

- Spray drift can occur when applying herbicides in windy conditions, and can cause exposure to the vegetables without the applicator realizing it. Spray drift can be easily avoided by waiting to spray until wind has died down.

- Some introductions of herbicides are less obvious. If manure or compost is applied to the vegetables, herbicides can be introduced. When weeds killed by herbicides are composted, the herbicides often do not break down during the composting process. Likewise, when animals eat herbicide-treated hay or grass, the herbicides do not break down in the stomach and remain in the manure. When spreading manure or compost contaminated with herbicides, severe damage can occur.

—— Claudia Nischwitz, Extension Plant Pathologist

2, 4-D causes cupped and malformed foliage on tomato.

Damage caused by 2,4-D on peppers.

Quinclorac causes cupping on eggplants.

Glyphosate damage on pepper resembles mottling of a virus.

Glyphosate damage on tomato causes chlorosis of new foliage.

Spray drift of glyphosate can cause malformed potato tubers.

Paraquat causes severe burning of eggplant leaves.

Atrazine can cause marginal necrosis on melon leaves.

Oxyfluorfen on onion causes necrotic leaf spots.

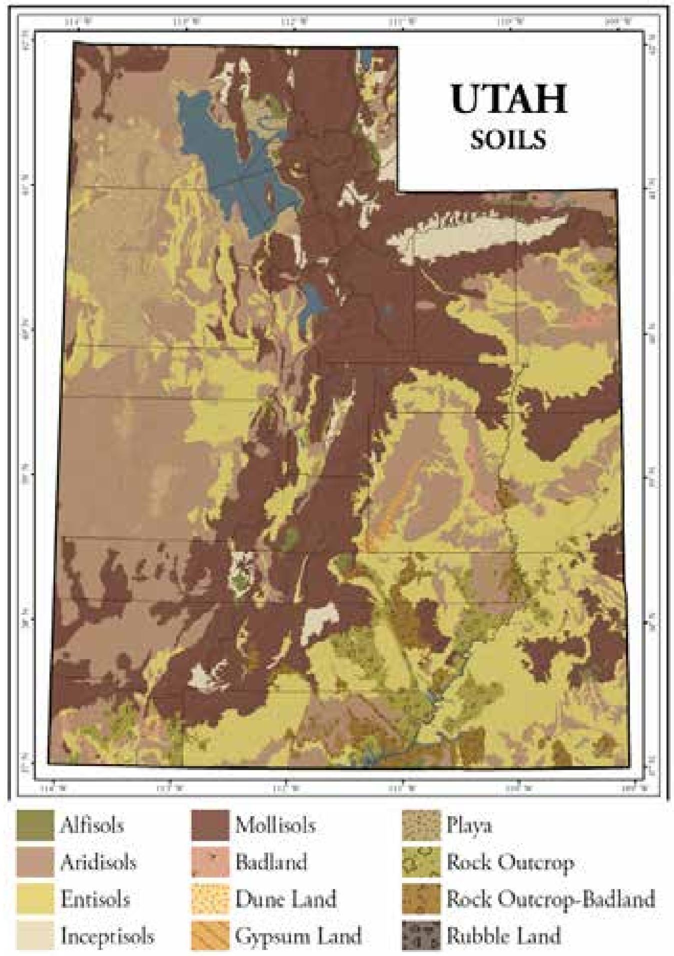
Soil Management for Disease-Free Vegetable Production

Soil management is a critical component to ensuring healthy crop production. There are multiple factors to consider, such as drainage and compaction, organic matter, pH, salinity, and nutrients, especially in terms of activity of plant pathogens in the soil such as fungi, bacteria, and nematodes. Many soil-borne pathogens are difficult to detect and some have the ability to survive for many years. It is important to understand the correlation between soil management and disease incidence and develop strategies to reduce crop losses.

Some issues with Utah soils are low organic matter, high pH, and soil salinity. Alkaline soils contribute to plant nutrient deficiencies and saline soils injure plants; both stressors may make plants more susceptible to plant diseases. Refer to the USDA's Web Soil Survey to obtain basic information about the local soil type such as texture, physical factors, and proper utilization.

Fungal pathogens cause the majority of soil-borne plant diseases in Utah vegetable crops. Fungal pathogens are able to persist within the soil by producing survival structures such as melanized mycelium or drought-resistant fruiting bodies. An example is the fungus *Verticillium albo-atrum* that causes a deadly wilt disease of tomatoes, potatoes, eggplants, and a variety of other vegetables. Verticillium can survive seven years or more in the soil, either as threads which form in large quantities on dying plant residue or seed-like microsclerotia. Verticillium is sensitive to soil moisture and temperature, preferring long term saturation and cool soil temperatures (55°F - 86°F). Therefore, the best soil management practices to prevent Verticillium wilt include good drainage and crop rotation.

Bacterial pathogens are single-celled organisms that have a rigid cell wall but lack a membrane around the nucleus. One example is *Pectobacterium carotovorum,* which causes bacterial rots in multiple crops, especially potato and onion. *P. carotovorum* affects the bulbs or tubers by soaking and softening the inner flesh and causing it to turn a dark brown–black color. This disease is most common when soil temperatures are high (90°F and above) along with the presence of moisture. There is no cure once plants are affected, therefore early management is essential. *P. carotovorum* spreads through water, so furrow, flooding, or overhead irrigation that leaves standing water may contribute to disease incidence.



USDA Natural Resources Conservation Services offers soil maps to determine general soil types for Utah.

Nematodes are tiny non-segmented roundworms. Plant-pathogenic nematodes spend much of their life within the soil. An example is root-knot nematodes, which are found occasionally in Utah. They move into root tips by releasing chemicals that disrupt the plant cells. The subsequent feeding causes galls along the roots. Some management techniques to combat nematode infestations include growing resistant crops, keeping infested fields fallow for 2-3 years, tilling fallow areas during the hot, dry summer months, or soil fumigation in commercial fields. Some specific root-knot nematode species include *Meloidogyne hapla, M. incognita*, and *M. chitwoodi.*

continued on next page

Tips to Diagnose Soil Borne Diseases	Tips for Soil Borne Disease Management
• Familiarize yourself with the soil conditions at your location and study what diseases have historically been present. • Examine all parts of an infected plant, especially the roots and crown. Note any above-ground symptoms. • Correlate disease symptoms found in your crops with any patterns of management practices such as irrigation, crop selection, etc. • Send diseased plant sample to the UPPDL for a diagnosis and thorough management plan.	• Understand what environmental conditions are most favorable for disease infection of your crop. • Ensure the management plan is economical. The value of the crop saved must exceed the cost of control. • Scout your field or garden at least once a week throughout the entire growing season. • Be mindful on the timing of control, and ensure the management strategy is safe, simple, inexpensive to apply, and will be effective in disease reduction.

Soil Management Practices Influencing Disease

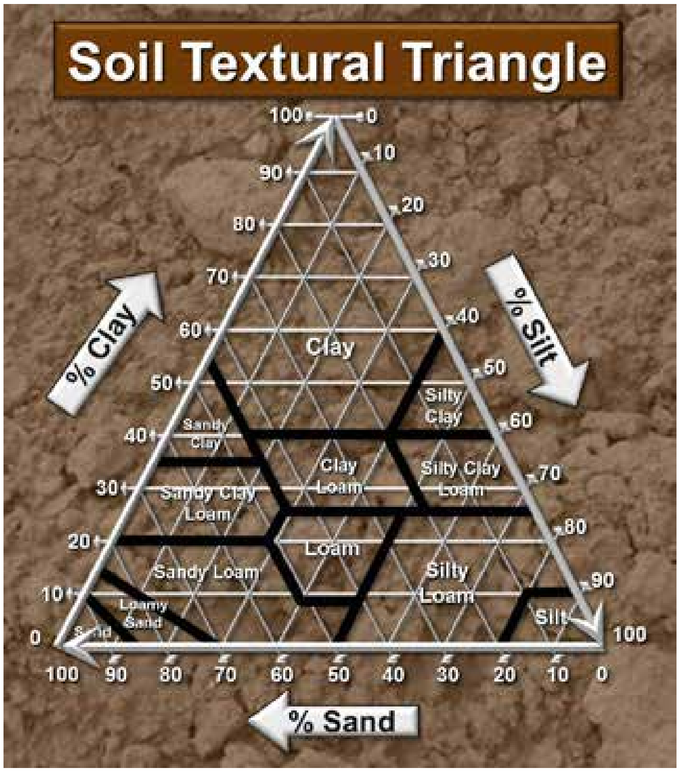
- Soil pH can have a major influence on soil-borne diseases. Most pathogens thrive in acidic soils (pH < 7) but some still survive in alkaline conditions (pH > 7).

- Another possible influence for soil-borne diseases is plant nutrition. Nutrient deficiencies weaken plants, and predispose them to infection. And while the use of nitrogen fertilizer can positively impact growth, crops with excess succulent tissue can be more vulnerable to attack by some pathogens.

- Tillage systems include turning the soil, chopping and incorporating crop residues, destroying weeds, or incorporating applied fertilizer and pesticides. Tilling can cause pathogenic propagules to be moved deeper into the soil, or alternatively, can expose the pathogens to the surface to be killed by drying, the heat, or cold.

- Soil texture and irrigation also impact disease incidence. Soils with larger aggregates allow for better drainage, while high clay and loam soils more likely have slower drainage and allow pathogens such as *Pythium*, *Phytophthora*, and *Aphanomyces* an opportunity to cause infection. Drip irrigation prevents stagnant water and precisely delivers water to plant roots.

Other practices to implement include using disease-free seeds and transplants, crop rotation, sanitation, and proper plant spacing. Soil health and management is something to take into consideration in preparing fields and gardens for the upcoming growing season.



For more information

[Vegetable Diseases Caused by Soil Borne Pathogens]

[USU Extension Series: Solutions to Soil Problems]

[Preparing and Improving Garden Soil]

[USU Extension Website - Irrigation Management for Production]

[USU Dirt Diggers Digest]

[USU Analytical Laboratory]

— Nick Volesky, Vegetable IPM Associate

IPM In The News

Cooperative Success over an Invasive Pest

The European grapevine moth is native to Europe, but has invaded crops worldwide. The 2009 discovery in California caused great concern, so a massive coordinated effort was quickly launched. It involved a network of traps for detection, vineyard inspections, quarantine regulations on farming and vineyard equipment, and mating disruption and insecticide treatments. The effort was a success and kept the moth populations from rising. In fact, it was declared eradicated in 2016. Researchers are hoping to draw lessons from this happy ending to apply to other potential invasions.

Stink Bugs Shall Not Pass

Brown marmorated stink bugs are nuisance home invaders, and are difficult to keep out. Researchers from Virginia Tech and the U.S. Department of Agriculture wondered how small a hole needs to be to exclude them. They placed stink bugs into boxes with varying sizes of holes and slits. The boxes were heated to encourage the stink bugs to escape. The study showed that slits 3 mm wide and holes less than 7 mm wide successfully halted the vast majority of brown marmorated stink bugs (one male adult passed through a 7 mm hole). This can be helpful knowledge to homeowners trying to exclude them.

Electric Weed Killer

The UK-based company, *RootWave*, is planning to launch commercial electric weed killers in 2020 which kill weeds with a high voltage current. RootWave is building a pull-behind unit that uses camera imagery to spot weeds on the go, moving at 3 mph. The machine would then make contact with weeds up to 2" in size, and deliver 5,000 volts to kill the weed without soil disturbance. The company projects that costs will be comparable to, if not cheaper than traditional herbicides.

Speed Plant Breeding

Researches from Great Britain, Australia, and the U.S. have pioneered a technique for identifying beneficial traits from wild plants that can be transferred to domestic crops. AgRenSeq, as the research team calls it, allows users to search a library of resistance genes discovered in wild relatives of modern crops to identify sequences associated with disease-fighting capability. From there, researchers can use laboratory techniques to clone the genes and introduce them into crops. AgRenSeq was successfully used with a wild relative of wheat that is resistant to stem rust. This technique, published in *Nature Biotechnology*, shortens the plant breeding process from decades to months, and reduces the cost from millions to thousands.

A Light Against Powdery Mildew

A team of USDA and university researchers from around the world have been studying the application of UV lights to plants to suppress powdery mildew of strawberries, grapes, hops, and cucumbers. Norwegian researchers found that strawberry powdery mildew has evolved a natural resistance against UV light during the daytime, but by applying UV light at night, researchers were able to bypass the mildew's defense systems. Florida researchers found that applying the lights once or twice weekly was as effective as the best fungicides against strawberry powdery mildew. Cornell researchers found the same results on cucumber. Tests on grapes and hops are still underway.

Hijacking Grapes

Grape phylloxera threatens the grape industry across the globe. Researchers from The University of Toledo discovered that grape phylloxera activates a hormonal signal that causes the plant to form a gall using the same genes that the plant uses to make a flower or fruit. The inner portion of the insect gall is a flower carpel in which the grape phylloxera safely feeds on the plant. With this new understanding, techniques may be developed to stop grape phylloxera by targeting and blocking the hormonal signal.

New Publications, Websites, Apps

To aid in identification and education of BMSB, the Northeastern IPM Center is sending free BMSB kits which include a BMSB specimen and ID guides.

EPA is updating its Residual Time to 25% Bee Mortality (RT25) table with new information. RT25 data help identify pesticide toxicity duration to bees and other insect pollinators after application.

A new video shows fascinating close-ups of BMSB and the parasitoid, Samurai wasp. It was created by PBS, and features the work of researchers at Oregon State University.

Youth and Agriculture helps young people connect with USDA summer outreach programs and volunteering opportunities. In addition, educators can find resources to better include agriculture in the classroom.

Featured Picture of the Quarter

Clover root curculio (CRC; *Sitona hispidulus*) is an important pest of alfalfa. Adult beetles feed on foliage while the more damaging larval stage feeds on roots. They overwinter primarily as eggs which hatch in early spring. The first-stage larvae feed exclusively on nitrogen-fixing root nodules, as shown in this image. In fact, larval hatch in spring is synchronized with peak nodule production, making it difficult to find larvae hidden inside the nodules. As the larvae develop, they feed on increasingly larger roots, eventually feeding on and scarring the taproot. In Northern Utah, larval populations peak around early June.

Because the larvae are hidden in the soil, CRC damage is often overlooked or misdiagnosed, and management with insecticides is ineffective. Research in the Ramirez Lab at USU investigates host plant resistance using a novel hydroponic experimental method.

—— Image by Kaitlin Rim, USU Entomology Graduate Student

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