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NEWSLETTER

Utah Plant Pest Diagnostic Laboratory

USU Extension

IN THIS ISSUE

NEW MEDIA

Combating Verticillium Wilt through Vegetable Grafting

Verticillium dahliae is a soilborne fungal pathogen that causes verticillium wilt of a variety of vegetable crops in Utah, including eggplant, pepper, potato, and melon. The pathogen kills plants by clogging vascular tissue, preventing the movement of water and nutrients, and as a result, can cause significant economic loss.

The challenge to managing the disease is that *Verticillium* resting structures (microsclerotia) can survive in the soil for over a decade without a host. Soil fumigation using high concentrations of metam sodium or methyl-bromide is effective in eradicating the fungus, however, this treatment can be hazardous and is being phased out. In addition, fumigation is not economically viable for Utah farmers.

Therefore, management is reliant on cultural practices such as the use of resistant varieties. Plants have a complex defense system and just as plants evolve to fight diseases, so do pathogens. Globally, *V. dahliae* is grouped into two races that require molecular testing to differentiate.

Certain vegetable varieties with resistance to verticillium wilt may not be desired by consumers. As an alternative, producers may opt to grow grafted vegetables. This centuries-old plant propagation technique helps improve production, plant vigor, and disease susceptibility. Grafting combines desired characteristics of a rootstock and a chosen variety. The rootstock includes the roots and lower stem, and is chosen for

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EXTENSION
UtahStateUniversity

UTAH PESTS TEAM

Diane Alston
Entomologist
Head, Dept. of Biology
diane.alston@usu.edu
435-797-2516

Marion Murray
IPM Project Leader
Utah Pests News Editor
marion.murray@usu.edu
435-797-0776

Claudia Nischwitz
Plant Pathologist
claudia.nischwitz@usu.edu
435-797-7569

Ricardo Ramirez
Entomologist
ricardo.ramirez@usu.edu
435-797-8088

Zach Schumm
Arthropod Diagnostician
zach.schumm@usu.edu
435-797-2435

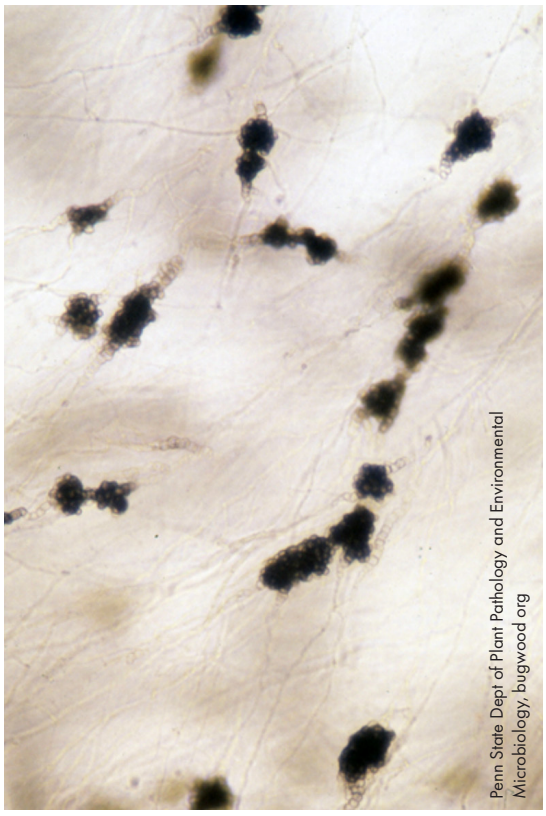
Lori Spears
Prof. Practice Associate Prof.
USU CAPS Coordinator
lori.spears@usu.edu
435-797-0354

Nick Volesky
Vegetable IPM Associate
nick.volesky@usu.edu
435-797-0319

Utah Plant Pest Diagnostic Lab
BNR Room 203
Utah State University
5305 Old Main Hill
Logan, UT 84322

its environmental compatibility, vigor, and disease resistance. The scion is the upper part of the plant, chosen for the desirable qualities of the fruit. To prevent verticillium wilt, the grafted rootstock should be proven to display tolerance or resistance.

Research published in 2015 from Washington State University evaluated grafted watermelon in reducing losses to verticillium wilt in commercial field production. The variety, Crisp'n Sweet was grafted onto the rootstocks of squash hybrid Strong Tosa and bottle gourd Emphasis. Non-grafted Crisp'n Sweet was used as the control. The experiment was replicated at two sites that had an average of 18.0 cfu/g-1 (colony-forming unit) in the soil. Verticillium wilt severity was determined by the total percentage of above-ground plant tissue exhibiting v-shaped leaf lesions, chlorosis, necrosis, and wilting symptoms. At the end of the two-year study, disease severity ratings for both of the grafted Crisp'n Sweet watermelons were significantly lower than for the non-grafted watermelon.



Culture of *Verticillium dahliae*, showing mycelium and spores.

A 2012 study from Shenyang Agricultural University in China investigated disease resistance for Xi'anlu eggplant grafted onto Lydi tomato rootstock. This study specifically looked at disease resistance in the rhizosphere (soil zone where chemicals and microorganisms around plant roots are affected by growth). Characteristics they investigated included the root active-absorbing area (how water is moved from the soil into the roots), chlorophyll content, and various enzyme activities. They found that the grafted eggplants had greater plant height, leaf area, stem diameter, and root volume compared to the non-grafted eggplants. The microbial and enzyme activity measurements in the rhizosphere all indicated that *V. dahliae* infects eggplant roots in the early stage of crop growth, creating a challenge for long-term growth. However, the Lydi tomato rootstock demonstrated very high disease resistance against *V. dahliae*.

Grafting has not yet been widely adopted for commercial vegetable production in Utah. The practice is promising and should be further be tested in Utah soils with high instances of verticillium wilt.

— Nick Volesky, Vegetable IPM Associate

For more information

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Asian Longhorned Beetle - Not Yet in Utah

The Asian longhorned beetle (*left*) adult females lay eggs that resemble grains of rice that she places individually in ½-inch diameter oval or circular craters under the bark (*middle*). Larvae are cylindrical, ribbed, light yellow or white, and can reach up to two inches in length, depending on maturity stage (*right*).

Asian longhorned beetle (ALB; *Anoplophora glabripennis*) is an invasive wood-boring insect that is a threat to many hardwood tree species; among them are maple (preferred host), ash, birch, elm, poplar, willow, and sycamore. It also threatens maple syrup production. ALB was first detected in the U.S. in New York during the 1980s, and probably hitched a ride on wood products from ships originating in Asia. ALB is currently found in parts of Massachusetts, New York, Ohio, and South Carolina, and is considered to have been successfully eradicated from New Jersey and Illinois. It is not known to occur in Utah.

ALB adults are large beetles that are bullet-shaped, 3/4 – 1 1/2 inches in length, and have glossy, smooth black bodies with irregular white spots. The scutellum, or the triangular segment between the forward margins of the wing covers, is black, and the antennae are at least as long as the body and have conspicuous black and white bands. Eggs are 1/4-inch in length, roughly the size of a grain of rice, flat, and creamy-white in color. Larvae are cylindrical, ribbed, light yellow or white, and can reach up to two inches in length.

ALB has one generation per year. Adults emerge from host trees in late spring and can be found throughout the summer, until about the first frost. Adults feed on leaf veins and tender bark for 10 to 20 days before mating. Each female lays up to 90 eggs, which she places individually in ½-inch diameter oval or circular craters (egg-laying pits) on the lower trunk, main branches, or lower crown. As the female chews the craters into the bark, she leaves mandibular (mouthpart) marks that can sometimes be seen around the edges. Eggs hatch within two weeks and the newly emerging larvae feed on the cambium and sapwood, creating large hollow chambers that can be seen in cross-sections of the trunk, and eventually tunnel into the heartwood. ALB typically overwinters as larvae. The following spring, larvae tunnel back toward the cambium, where they pupate. Pupation lasts about 20 days, with adults chewing the rest of the way out of the tree in late spring. Adults may remain on the tree they developed in, or fly short distances to infest new trees. Although both adults and larvae feed on host trees, the larvae cause the most damage.

The whitespotted sawyer beetle can be distinguished from ALB by having a white scutellum.

Besides the actual beetle itself, some symptoms to watch out for include adult exit holes that are perfectly round and nearly dime-sized (3/8 inch in diameter), frass (insect waste that looks like sawdust) deposits at tree trunks and limb bases, dead branches, drooping leaves, and discolored foliage. Keep in mind that there are some native beetles that look very similar to ALB. For example, the whitespotted sawyer (*Monochamus scutellatus*; shown above) is an insect that is native to Utah and every year the Utah Plant Pest Diagnostic Lab receives reports of mistaken identity.

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Surveys for Leafhopper Vectors of Western-X Phytoplasma Reveal a Few Common Species in Utah

X-disease phytoplasma is a type of wall-less bacteria that causes western-x disease. Infection can result in small or deformed fruits in cherry, peach, nectarine, and plum. In addition, it can result in early fall coloring, curled leaves, or leaf shot hole in peaches, nectarine, and plum. Because there is no known cure once a tree has become infected, this disease is a major concern for stone fruit growers in Utah. X-disease phytoplasma can be transmitted by grafting of any kind, or by their only known vector, leafhoppers.

Seven leafhopper species are known to transmit X-disease phytoplasma: *Colladonus geminatus, C. montanus, C. reductus, Euscelidius variegatus, Fiebriella florii, Paraphlepsius irroratus,* and *Scaphytopius acutus*. USU researchers have been searching for these species in Utah to document their presence and abundance. All of them are small (< 1 cm) and quick to jump if disturbed, making them hard to spot without using traps or other monitoring methods such as beat sheet sampling.

As of fall 2020, three vector species have been identified in Utah, in particular from sites in Utah and Cache counties. All collected leafhoppers were also tested for the presence of the phytoplasma, and none were positive.

The most common species found in this study was *C. geminatus*. This insect is brown overall and is hard to identify with the naked eye due to many similar-looking species. However, close inspection with a loupe or other magnification would reveal "a face with a pirate hat and mustache" on the pronotum, the dorsal area of the insect just behind the head.

C. montanus, the second most common species found in Utah, is easy to identify. It has black to brown wings with a yellow stripe behind the head and a large yellow spot at the mid-line where the wings meet. A similar looking and less common species in Utah, *C. reductus*, is often jet black in color, but can sometimes be transparent and without distinct coloration. Regardless of the overall coloration, a yellow stripe is seen behind the head. Notably, *C. reductus* does not possess the large yellow spot on the wings near the mid-line, distinguishing it easily from *C. montanus*.

If you have trees that may be showing symptoms of western-X disease, monitoring for leafhoppers is recommended. They are most abundant in spring and late summer to early fall, especially after harvest. Therefore, transmission of the phytoplasma from a vector is most likely to occur outside of the fruit-growing season when you are no longer managing other insects. Management may need to be implemented before or after you manage for other common pests.

Top: *Colladonus geminatus* (left) showing a "face with a pirate hat and mustache" on the pronotum, and *C. reductus* (right) identified by its solid black wings (sometimes transparent) and yellow stripe behind the head.

Bottom: *Colladonus montanus* is a known vector of western-X phytoplasma, identified by its black-brown colored wings with a large yellow spot on the mid-line where the wings meet.

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Leafhopper Vector Survey, continued

To monitor for leafhoppers, hang yellow sticky traps in symptomatic and border fruit trees about 6 feet from the ground. Check traps every 1-2 weeks for leafhoppers. If you think you may have found one of the three vectors described on the prior page, take high-quality photos and send them to the Utah Plant Pest Diagnostic Lab (UPPDL). If they cannot be identified from photos, the UPPDL can assist you with submitting a proper sample for lab identification.

If an average of one confirmed leafhopper vector is found per orchard sticky trap, it is recommended to spray for leafhoppers. Rotate among insecticide groups, especially post-harvest when populations tend to be the highest, and only select products that are labeled for use against leafhoppers on the host crop. Always be sure to read all label instructions, recommendations, and warnings when applying insecticides.

If you have questions about leafhopper monitoring and management programs specific for your orchard or property, contact the UPPDL.

— Zach Schumm, Arthropod Diagnostician and Claudia Nischwitz, Extension Plant Pathologist

Asian Longhorned Beetle, continued from page 3

The sawyer beetle is about 1 – 1 ¼ inches in length, and can be distinguished from ALB by having a white scutellum, lacking conspicuous black and white bands on the antennae, and being dull black in color. It is primarily a minor pest of coniferous trees, especially white pine, balsam fir, and species of spruce.

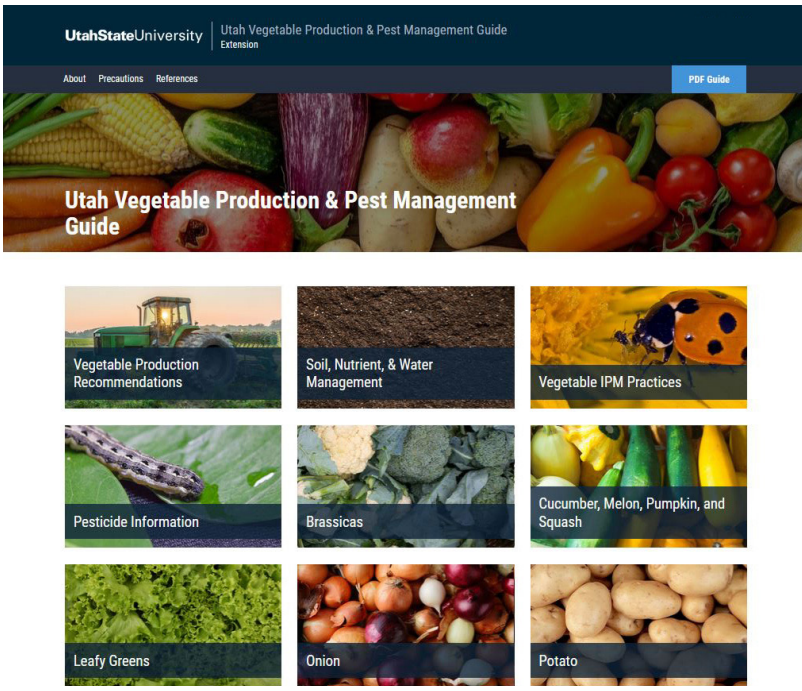
ALB has not been detected in Utah, so there is no current need for control of this insect. Should future infestations be detected in the state, APHIS and state officials will attempt to eradicate the beetles by establishing a quarantine to restrict the movement of ALB and ALB host materials (known as regulated articles). This decreases the chance of ALB spreading to new locations. Currently, the most practical approach for controlling ALB is to detect and eradicate it before it spreads to other areas. Please report any suspected ALB infestations in Utah to the Utah Plant Pest Diagnostic Lab at USU or the Utah Department of Agriculture and Food.

— Lori Spears, USU CAPS Coordinator

GENERAL NEWS AND INFORMATION

New Utah Vegetable Production and Pest Management Website

The Utah State University Extension IPM and Small Farms programs have launched a new website for Vegetable Production and Pest Management. This resource covers a wide variety of crops and all aspects of growing them, including variety selection, soil fertility, planting, transplant production, irrigation, and weed management. In addition, each crop has a thorough list of insects, diseases, and their management, including up-to-date pesticide options for each pest. Full-colored images and descriptions are included throughout the site and in the companion printable book. This resource is the perfect tool for Utah vegetable farmers looking to improve their production and pest management.



extension.usu.edu/vegetableguide

Testing New Products for Fire Blight Management

Apple and pear growers have reported to the Utah Integrated Pest Management (IPM) Program that the deadliest disease they deal with is fire blight, causing up to 10% losses annually. Fire blight is caused by *Erwinia amylovora*, a bacterium that is spread during bloom to cause infection in flowers. The bacteria can travel from the initial floral infection through the phloem to cause shoot, branch, and trunk death (shown at right), and sometimes whole tree death. The disease is unpredictable and difficult to manage due to variable environmental conditions during spring, cultivar and rootstock selection, and density of flower production. An outbreak, if left unmanaged or mismanaged, could reduce crop yields by up to 50%, and if a high-density planting is destroyed, this could cost the grower $5,000 to $10,000 per acre in a single season. It takes several years to rejuvenate the orchard.

The Utah IPM Program received funding in 2020 for a three-year project to evaluate currently-registered conventional and organic products to help reduce fire blight infections. The first year of evaluations occurred in spring and summer 2020, and included two trials—one for products to protect flowers in spring and one for a product to protect pruning cuts in summer.

For the trial to prevent flower infections, we tested the products shown in the table below:

Brand Name	Description	Application Date
Agri-Mycin 50	A commonly-used antibiotic (streptomycin) that is highly effective. *Erwinia* isolates used for this study were tested to be susceptible to streptomycin.	April 30
Kasumin 2L	An antibiotic (kasugamycin) that is almost as effective as streptomycin.	April 30
Serenade Opti	An organic product made from the soil-dwelling bacterium, *Bacillus subtilis*. It works by directly targeting the fire blight bacteria and also by competition for space on flowers.	April 26, 28, and 30
Blossom Protect + Buffer Protect	An organic product made from a yeast (*Aureobasidium pullulans*). It works by competing for space on flowers.	April 26, 28, and 30
Previsto	An organic copper soap product that can be applied to open flowers.	April 30
AgriPhage-Fire Blight	A newly-registered organic product made from a mix of bacteriophages that infect and replicate within bacteria. It must be applied before and after infection	April 29 and 30
Monterey GardenPhos	A conventional product made from phosphorus acid that is applied to the trunk and works by inducing a resistance response within the plant.	April 9 (half-inch green stage)
Water	Untreated control	April 30

The treated trees were located in an apple orchard containing three varieties (Gala, Fuji, and Golden Delicious) at the USU Research Farm in Kaysville, UT. In a randomized block design, one branch from each of 12 trees (four trees representing the three varieties) was inoculated with the fire blight bacteria during full bloom, on April 29, and this process was repeated in three additional blocks. The treatments listed above (except GardenPhos)

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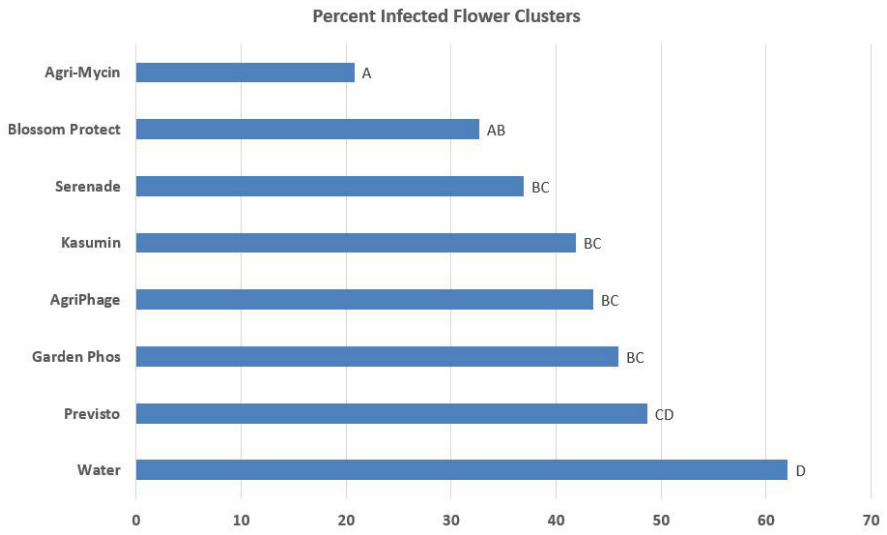
were applied to the same inoculated branches at the appropriate timing and rate, according to the product label, and a water-only treatment was included as a control.

In spring 2020, the weather conditions were ideal for infection (warm and intermittent rain), and the inoculation was successful, leading to meaningful results for this first season of testing.

At two, three, and four weeks post-inoculation, we determined infection rate of the branches as the percent of infected flower clusters out of total flower clusters. The conventional antibiotic, Agri-Mycin provided the best control (23% infection), followed by the organic options, Blossom Protect (35% infection) and Serenade (40% infection). However, statistically, there was no difference in efficacy of Blossom Protect, Serenade, Kasumin (42%), AgriPhage (44%), and GardenPhos (46%). The water-treated control trees had significantly more infection, at 61%. All results are shown at the top right.



Results of application of various fire blight products to prevent fire blight infection, as compared to a water-only treatment.

Results of application of various fire blight products to prevent fire blight infection, as compared to a water-only treatment.

Where trees are infected with fire blight, the recommendation is to prune out the disease by removing 12-14 inches of healthy-appearing branch beyond the visible symptoms. This practice is not always possible, especially if the infection is near the trunk or a large scaffold limb, or orchard workers have excessive fire blight to remove. If not pruned out completely, the fire blight bacteria will continue growing near the pruning cut. Therefore, we tested a product called Actigard to determine if it could prevent this regrowth.

On June 2, the bloom experiment ended, and that day, we pruned out the copious fire blight-infected branches from the treated trees, using the recommended pruning protocol.

Actigard was applied immediately after pruning, using a hand-sprayer, and directing the spray to the pruning cuts, along the branch bark to the trunk, and along the trunk bark for about two feet. Actigard was applied to the trunks and pruning cuts of 42 trees, and water was applied to the trunks and pruning cuts of 42 trees as a control.

At one, two, and three months later, we inspected all trees for new fire blight symptoms near pruning cuts. Where infected branches were found, we measured the length of expansion, and then determined the percent of the cuts with fire blight regrowth on each tree.

We found good results with the use of Actigard. On trees treated with Actigard, 4% of the cut branches started growing fire blight again. On trees treated with water, 9% of branches started growing fire blight again, and on three of those branches, the infection spread into large branches or into the main stem. We are still analyzing data to determine significance, and will repeat this study over the next two years. Actigard is somewhat expensive, and sold in a size for application to a larger orchard. If shown to be effective, this product could be used to "save" a young, valuable apple or pear orchard that experienced high infection that spring.

— Marion Murray, IPM Project Leader and Claudia Nischwitz, Extension Plant Pathologist

Planning Next Season's Garden

As many gardeners start planning for the coming growing season, there are a few things to consider that can go a long way to ensure that plants are healthy.

To Prevent Damping-off

Damping-off is a common seedling disease that can be easily avoided. There are several different organisms that cause the disease including *Pythium* and *Rhizoctonia*. Both of these survive on plant debris, in soil, and on wooden benches, and are worse where the planting soil is kept too wet. Both pathogens infect the roots of seedlings and grow into the stem. Plants typically have dark brown to black roots and will fall over.

To minimize infection, it is essential to use clean pots, tools, and media for seed-starting.

- Clean benches, pots, trays, and planting tools with a 10% bleach solution, and remove all dirt from the previous year. Soak trays, pots, and tools for half hour to an hour and then rinse well with water to remove residual bleach.
- The surface where pots and trays are placed should also be disinfected with a 10% bleach solution and kept free of plant debris.
- Sterile media should be used for sowing seed to minimize infection.
- Placing pots and trays in individual saucers will isolate infection. If plants in one pot or tray develop symptoms, this will prevent spread of the pathogens.
- Seedlings should be kept moist but never be excessively watered or left sitting in water.
- If plants are grown in trays or pots on the ground, place them on a sheet of plastic. Both *Pythium* and *Rhizoctonia* are common soil pathogens and can come into contact with seedling roots as the roots grow into the ground or water carries pathogens into the trays.

Purchasing Transplants

When purchasing vegetable or ornamental transplants, it is important to inspect the plants. Transplants should be healthy and vigorous. If plants are yellow or stunted, it could indicate a lack of fertilizer or something more serious such as root rot or root infection with nematodes. Planting infected transplants in yards and fields could introduce nematodes or pathogens that contribute to problems in the coming years. Other symptoms to look for are leaves with spots or signs of powdery mildew or rust. For example, the black spot fungus (*Diplocarpon rosae*) can survive on stems and buds during winter and infect new leaves and neighboring rose plants.

Rotate Crops

In vegetable gardens, crop rotation is important to reduce disease incidence. When the same plant species, for example tomato, is planted year after year in the same location, pathogens such as *Fusarium* can build up large populations in the soil. Instead of losing one plant in previous years, all tomato plants can be lost. *Fusarium* species are often very specific to one host plant. Species of other pathogens like *Pythium, Rhizoctonia, Verticillium,* or *Phytophthora* can infect multiple plant species. If it is known that one of these pathogens caused a problem in the previous year, determine its host range before planting. A Google search for the specific species of a pathogen and host range can provide this information or you can email claudia.nischwitz@usu.edu.

Whenever possible, using varieties resistant to specific pathogens is best. Many seed companies provide information on their seed packets indicating disease resistance, for example a tomato variety would have some of the following letters or variant thereof that indicate resistance to those pathogens:

- Va or Vd - Verticillium Wilt
- Fol or F - Fusarium Wilt (two F's indicate resistance to both races 1 and 2)
- N - Nematodes
- A - Alternaria Stem Canker
- TMV - Tobacco Mosaic Virus
- St - Stemphylium (gray leaf)
- LB - Late Blight
- TSWV – Tomato spotted wilt virus

Compost Issues

If you plan to create your own seedling planting media from compost, have the mix tested by the USU Analytical Lab to determine nutrient levels. Excessive levels of phosphorus or other nutrients can kill seedlings by burning the roots. In addition, it is good to know the origins of the compost. Grass clippings from lawns that had been treated with herbicides, or manure from animals grazing on a pasture treated with herbicides can introduce herbicide residues into your compost. Some herbicides do not degrade quickly and symptoms of herbicide damage on older plants or death of seedlings or lack of germination of seed can occur.

— Claudia Nischwitz, Extension Plant Pathologist

IPM In The News

Mycovirus Magic

Rapeseed is an important crop used in the making of animal feeds, biodiesel, and canola oil, but is affected by the world-wide fungal pathogen, *Sclerotinia sclerotiorum*, which can kill a whole plant within just a few days. Researchers at Huazhong Agricultural University in China discovered a mycovirus (a virus that attacks fungi) that reduces the virulence of *Sclerotinia* and actually turns it into a beneficial organism within the plant. The scientists inoculated the seed of rapeseed with virus-infected fungal fragments and observed a boost in the plants' immune system, an 18 percent increase in weight, and increased root growth. The fungal fragments remain within the plant throughout its life, and helped with resistance to other diseases.

Farm Design Affects Pesticide Use

Researchers at University of California, Santa Barbara looked at 13 years of land use and insecticide application data from Kern County, California, a valuable agricultural area. The authors report in *Nature Sustainability* that larger and less diverse croplands led to a greater level and variability of insecticides while crop diversity had the opposite effect. They conclude that the results could not only help farmers make more informed decisions about field size and crop diversity, but also guide policy with the aim of decreasing insecticide use.

Two Pesticides Affect Bees

Two agricultural insecticides have been found to be toxic to bees in a review study by researchers at The University of Texas at Austin, and published in *Proceedings of the Royal Society B*. Sulfoxaflor (Transform WG) was banned by the EPA in 2016, and then approved in most circumstances, with restrictions on applying it to blooming plants that may attract bees. The second insecticide reviewed, flupyradifurone (Sivanto), does not have the blooming plant restrictions on the label. The researchers analyzed 19 studies from the past five years on these two chemicals and found that they cause mortality in bees and beneficial insects, reduce reproductive ability, and make pollinators less efficient foragers, similar to neonicotinoids.

Virus Protein Blocks Defenses

Recent studies of interactions between plants and viral proteins have helped understand plant resistance. To combat invading viruses, plants utilize a method called gene silencing. Some viruses have adapted an ability to block this defense system. Scientists at the University of Helsinki discovered the protein in potato virus A that is not only responsible for blocking gene silencing, but can also cause the plant's defense system to go against its intended purpose, in favor of the pathogen. The results offer new targets for breeding resistance against the potato virus in host plants.

New Trichoderma Plant Disease

In 2018, corn crops in southern Germany were affected by a disease outbreak that appeared be caused by a *Trichoderma* species. On the diseased plants, cobs germinated prematurely and gray-green spores formed on the corn kernels and within the husks. *Trichoderma* species are fungi that act as decomposers or antagonists of other microorganisms, and strains of *Trichoderma harzianum* are used in many biofungicide products. *Trichoderma* has never been known to be a plant pathogen. Researchers at the University of Göttingen collected 18 strains from the diseased corn plants and identified the causal agent as a plant pathogenic strain from a relatively new species, *Trichoderma afroharzianum*. Within this species, the new pathogenic strain seemed to have evolved to cause this newly discovered disease of corn.

New Approach for Plant Diseases

Scientists from Martin Luther University Halle-Wittenberg and the University of the State of Paraná in Brazil have discovered that the application of acetohydroxamic acid onto plant foliage helps to prevent fungal spores from penetrating into the plant. This substance is traditionally used to treat harmful bacteria in the human stomach, and is known to inhibit the breakdown of urea. This foliar treatment was tested against the diseases corn anthracnose, powdery mildew in cereal crops, late blight in potato, and rust in corn and beans. The authors report in *Phytopathology* that they have developed a completely new approach to plant disease prevention that uses an existing active ingredient and thus could be quicker to commercialize.

Repellent for Walnut Twig Beetle

Walnut twig beetle carries a deadly fungal pathogen that causes the disease, thousand cankers. In their trapping program and through additional investigation, researchers at University of California, Davis found that the sticky substance, Tanglefoot, actually repels the beetles. After discovering that using this product on their monitoring traps was not catching any beetles, they examined the individual compounds of Tanglefoot. The chemical limonene almost completely repelled the beetles while pinenes were about half as effective. The next step is to figure out whether, and how, limonene can be used to protect individual trees and orchards.

Featured Picture of the Quarter

The disease, tomato big bud, is rare but not new to Utah. However, in summer of 2020, it was found in several northern Utah tomato fields. It is caused by a phytoplasma that is transmitted by beet leafhopper.

The primary symptom is enlarged flower buds (circled) that have green petals and do not form fruit. In addition, leaves are small, curled upwards, and yellowish-green or purple. Plants are stunted and grow upright and fruits that do develop are hard, tough, and woody.

The disease has also been found on pepper, but it is unknown which weeds it overwinters on in Utah.

— Image by Claudia Nischwitz, Plant Pathologist

New Publications, Websites, Apps

Federal Conservation Resources for Sustainable Farming and Ranching, explains conservation programs administered by the Natural Resources Conservation Service (NRCS) and Farm Service Agency (FSA).

A Review of the Biology, Ecology, and Management of Plum Curculio, compiles current knowledge of the plum curculio including biology, life history, behavior, and management.

Microbial Inoculants explains how biofertilizers or biostimulants enhance soil health and offers practical recommendations, including factors to consider before buying and using these products.

AgEvidence is a visualization dashboard of data from nearly 300 research papers and insights focusing on the environmental and agronomic impacts of cover crops, tillage management, pest management, and nutrient management practices used in growing corn and soybean in the Midwest.

A newly revised bulletin from SARE, A Whole-Farm Approach to Managing Pests, discusses ecological approaches to pest management and highlights cases of farmers using innovative methods to manage pests.

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