UTAH PLANT HEALTH

Extension
UtahStateUniversity

Utah IPM Program and Utah Plant Pest Diagnostic Laboratory

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IN THIS ISSUE

NEW MEDIA

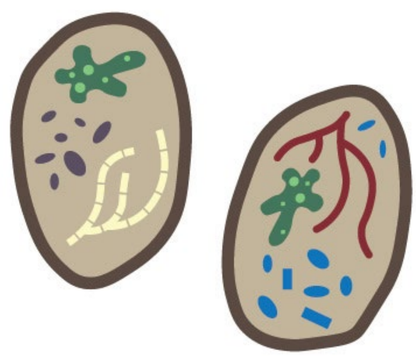
[Utah Vegetable Production Guide]

Hemp Seed Testing Reveals the Good and the Bad

Worldwide, several hundred organisms have been identified on or in *Cannabis* (hemp) as a pathogen, human toxin, or beneficial. In 2020-22, our team documented the major pests of hemp found in Utah through extensive field surveys. One disease most commonly identified was Fusarium crown rot. The pathogen (*Fusarium solani* and others) can be spread on seeds, so our next step was to determine the incidence of this and other pathogens on purchased hemp seeds. Since hemp is a plant that produces complex chemicals, it turns out that its seeds are a treasure trove of microorganisms, both good and bad.

The Good – Seedborne Endophytes

Plants, including *Cannabis*, host distinct microbial communities on and inside their tissues. Their seeds also harbor microorganisms, and some are beneficial to germinating seedlings, promoting protection against environmental and biotic stresses. These microbial communities that internally inhabit plant tissues are referred to as endophytes and play a crucial role in plant development and growth.



Endophytes live inside another organism without causing harm, and often with mutual benefits. They can produce various plant hormones, enzymes, antimicrobial compounds, and other metabolites that may improve plant biomass and yield.

Endophytes enter seeds in various ways. One mechanism is when seeds acquire endophytes from the external environment. The other mechanism is internal. Endophytes primarily originate from soil and may be introduced into the plant through small root wounds. From there, the transmission of endophytes into seed from parent plants occurs through vascular tissues or through flower parts, including pollen. The benefits of inherited seedborne endophytes and the transport mechanism of these organisms from the parent plant to seeds and then to the following generations, is only recently being explored by scientists.

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The Bad – Seedborne Pathogens

Seedborne pathogens survive on the seed and infect the seed or developing plants. The plant may show symptoms or are killed upon germination, they may not show symptoms of the disease at all, or they may not show symptoms until mature or when environmental conditions cause plant stress.

Pathogens either survive on the outside of the seed or within seed tissues (seed coat, endosperm, or embryo). They primarily include fungi, bacteria, and viruses. Examples of seedborne diseases of hemp include Pythium root rot, Fusarium rot, and Arabis mosaic virus (which was found on hemp in Utah). Some organisms on hemp seed are not plant pathogens but have the potential to produce toxins that are harmful or are pathogenic to humans.

Seeds bearing external pathogens become infected through surface contamination of the mother plant or surrounding environment. Seeds with internal pathogens become infected in multiple ways:

- Pathogens can infect flower parts and as the seed forms, the pathogen becomes incorporated into the seed tissue, infecting new seedlings.
- Some pathogens such as viruses or wilts can spread systemically through the entire plant, moving through the vascular system to developing seeds.
- In some cases, pathogens can be transmitted through pollen. If a pathogen infects the pollen grains, it can be carried to the ovules during pollination, resulting in infected seeds. This is particularly common with certain viral pathogens that can move from the pollen into the developing seed tissues.

Detection Results of Pathogens and Endophytes

We have tested untreated seed sourced from six commercial suppliers in the western U.S. representing over 25 varieties. We incubated seeds on sterilized potato dextrose agar plates in 85 °F for two to five days under darkness and examined the plates for the growth of bacteria and fungi. We have so far tested 181 seeds and have identified 15 organisms to genus and 7 to species.

Bacillus subtilis endophyte growing from three seeds on top and right, inhibiting growth of *Fusarium* from the seed on the lower left.

We identify fungi and bacteria either visually or using molecular tools. Visually, we used morphological characters, such as growth pattern on the plates, size and shape of fungal fruiting bodies, and size, shape, and arrangement of spores or cells. Molecularly, we extracted and sequenced DNA and used GenBank for identification.

Findings - Pathogens and Related

Alternaria is an opportunistic fungal pathogen that can cause diseases in many plant species. It is ubiquitous worldwide.

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Aspergillus ochraceus is a fungus that produces toxins. It causes a human infection called pulmonary aspergillosis that has been reported in cannabis users.

Aspergillus niger can be a source of beneficial metabolites (antibiotics and enzymes), but there are pathogenic strains that also cause lung infections in humans and diseases in plants. Aspergillus infection in hemp plants can ruin the post-harvest crop due to contamination by toxins.

Fusarium is a fungal pathogen that causes tissue browning, internal canker or rot, whitish mold growth, foliage wilt, and plant death. We identified several species.

Penicillium olsonii is a fungal post-harvest pathogen that causes bud rot of dried hemp material. It can be found in hemp tissues during field growth without causing symptoms. It occurs on decaying plant material and is easily found in air samples where hemp plants are grown.

Penicillium citrinum is also commonly found in hemp tissues during field growth. It is not a pathogen of hemp, but instead contains toxins that are harmful to humans if consumed or smoked. It has a worldwide distribution and occurs in soils, cereals, spices, and indoor environments.

Pantoea spp. are bacteria that occur naturally in soil or on the surfaces of plants or other structures. In some cases, it can be a beneficial endophyte by inhibiting some plant pathogens. However, in humans, it can cause chest tightness when breathed in (smoked), or a rash on skin (such as pruning or manipulating hemp plants).

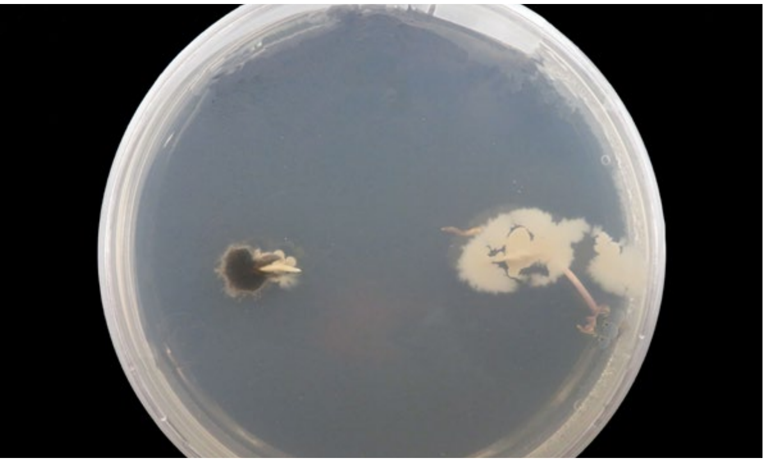
Rhizopus oryzae is a fungal pathogen that can cause soft rot of fruit and vegetables and also infects grains or seeds. It causes poor seed germination or damping-off of younger seedlings.

Findings - Endophytes

Bacillus subtillis is antagonistic against other organisms, including pathogens like *Alternaria, Fusarium*, and *Penicillium*, and this organism occurs in commercially-available fungicides. On our agar plates, whenever *B. subtilis* was present, other microbes grew slowly or not at all on the plate. Another benefit to plants is that *B. subtilis* (and other Bacilli) forms a protective barrier on the seed surface, enhancing germination and seedling survival. This species has recently been shown to be inherited from the mother plant to the seed.

Priestia megaterium is a beneficial endophytic bacterium that is "famous" in biotechnology, with numerous patents and applications in industry. It occurs not only in soil and plants, but in honey, wine, raw meat, fish, sea water, and human mouths.

Paenibacillus spp. occurs naturally in soil and the plant rhizosphere. Certain species are known for promoting plant growth and being used as microbial products in agriculture and medicine. This genus has recently been shown to be inherited from the mother plant to the seed.



A species of *Alternaria* showing black spores (far left) and a species of *Penicillium* (right) showing bluish colored spores. Both are pathogens that grew from commercially-sourced seed.

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HEMP PEST SURVEY

In the field survey conducted in 2020-22, we identified eight plant diseases and 41 arthropods. The plant diseases were Arabis mosaic virus, curly top virus, Fusarium crown rot (3 species), powdery mildew, and Pythium crown rot (2 species). The majority of the arthropods identified were either beneficial insects or insects of no consequence to hemp. The identified pests included cannabis aphid, rice root aphid, pavement ant, grasshoppers (4 species), caterpillars (beet webworm, yellowstriped armyworm, and corn earworm), leafhoppers (2 species), flea beetles (2 species), two-spotted spider mite, false chinch bug, lygus bug, stink bugs (3 species), and western flower thrips. In our observations, only grasshoppers and corn earworm caused economic damage, and this was minor.

Although our survey identified several plant pests, it was clear that the majority of plant problems of field-grown hemp were abiotic, and included plant deformities due to genetic variation from seed-started plants, chlorosis from nutrient deficiencies, wilt and scorch from over- or under-watering, poor growth due to girdling roots, and weed competition.

The few hemp growers that remain licensed in Utah are mostly now growing the crop in controlled environments (greenhouses, high tunnels) and starting plants from clones, reducing biotic and abiotic stresses.

Hemp plant struggling due to abiotic causes (***left***). Beet webworm on flower bud (***top right***). Hemp plant dying from Fusarium crown rot (***lower right***) adjacent to a hemp plant struggling from abiotic causes.

—— Marion Murray, IPM Specialist, Claudia Nischwitz, Plant Pathologist, and Megan Kast, IPM Associate

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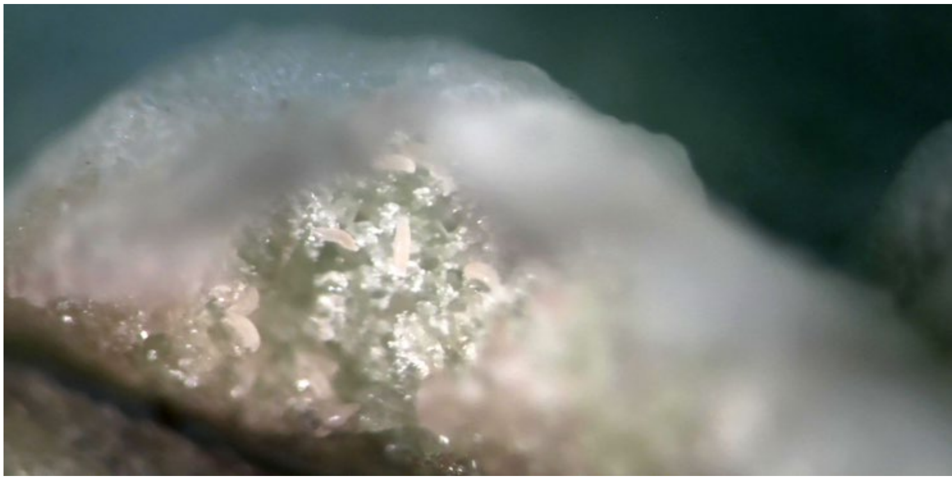
Goji Berry Gall Mite



In June 2024, goji berry plants (*Lycium barbarum*) in northern Utah were discovered with yellow galls (blister-like swellings) on the foliage. When the galls were opened, microscopic arthropods called eriophyid mites were found inside. Eriophyid mites are worm-shaped mites representing hundreds of species that occur worldwide. They reproduce by parthenogenesis and because their generations overlap considerably, hundreds of mites of different stages live within each gall.

USDA Animal and Plant Health Inspection Service identified the mites as *Aceria pallida* Kiefer, the goji berry gall mite. This is the first report of a new species of goji berry gall mite occurring in Utah. To date, the occurrence of *A. pallida* in the U.S. is only known from the Carolina wolfberry (*Lycium carolinanum*) and pale wolfberry (*Lycium pallidum*) in the southeastern United States. Currently, there are no management recommendations available.

In 2012, a different species of gall mite (*Aceria tyingae*) was found in Utah also on goji berry, and causing the same symptoms.

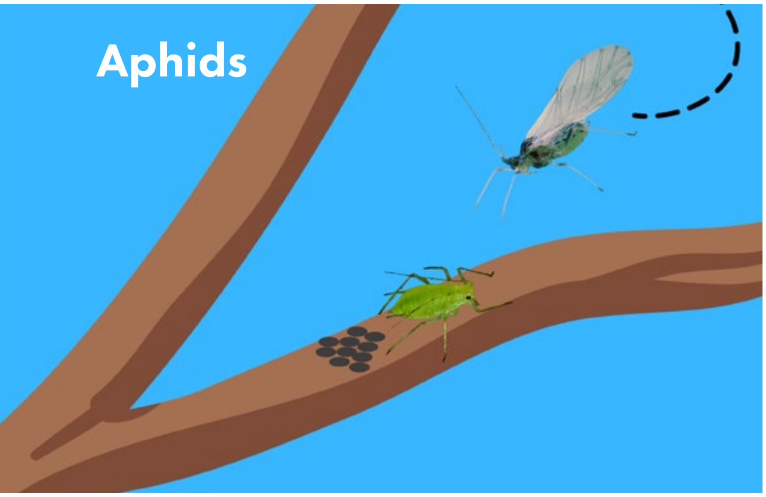
We are conducting a survey of goji berry and the related pale wolfberry to determine the distribution of the mite across the state. If you live in Utah and have goji berry or pale wolfberry in your yard and see some of the galls, please, email Claudia Nischwitz (claudia.nischwitz@usu.edu).

— Claudia Nischwitz,
Extension Plant Pathologist

Winter Survival Tactics of Insect Pests

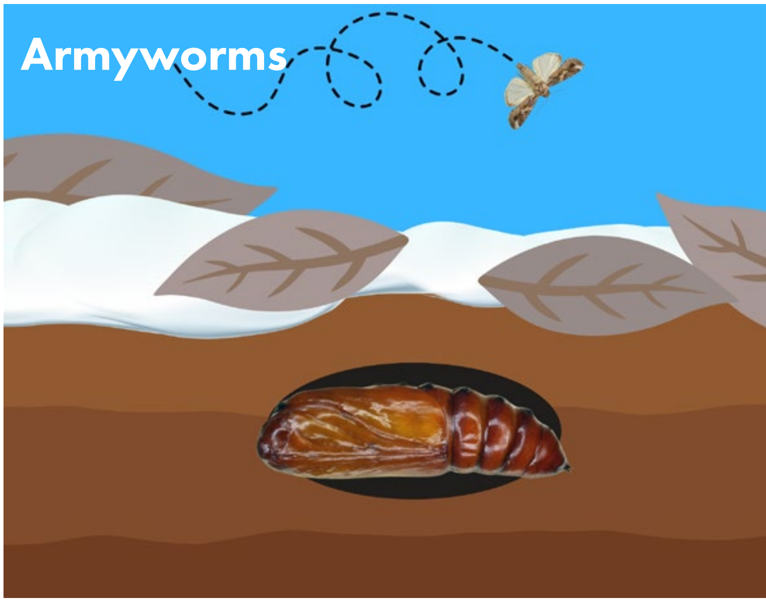
Farmers and gardeners invest significant labor, time, and resources throughout the growing season managing pests. As fall and winter approach, it can feel like a well-deserved break as the season ends and arthropod and plant disease problems seem to disappear. But what really happens to these pests during the cooler winter months? Despite the temporary reprieve, they inevitably return the following season to once again challenge crops.

Many insects have developed various strategies to survive cold and freezing temperatures, a process known as overwintering. Some insect species enter a state of dormancy called diapause, during which their metabolic rate slows down significantly, enabling them to endure harsh conditions. Other species seek shelter in plant debris, under bark, in the soil, or even inside human-made structures to escape the cold. Additionally, some insects may migrate to warmer areas. Overwintering can occur at different life stages depending on the species and survival strategy, including eggs, larvae, pupae, or the adult stage, where they remain until favorable conditions return.



Aphids are a diverse group with many species. They cause damage by piercing and sucking plants, leading to distorted growth, yellowing, and excretion of honeydew, along with potentially transmitting viruses.

Many aphid species in colder climates alternate between a primary winter host and secondary summer hosts. For most of the season, all aphids are females and give birth to clones (asexual). In late summer, females produce offspring that bear wings at maturity. These winged aphids return to their primary woody host to continue feeding. As temperatures cool, the females produce males and females that are able to mate and reproduce sexually. Those females lay eggs in cracks and crevices that can survive sub-zero temperatures.



Armyworms are a varied group of insects belonging to the Noctuidae family, comprising numerous species. They have a wide range of host plants, including agricultural crops. During their damaging larval stage, they voraciously feed on all parts of the plant, causing severe damage and potential crop loss.

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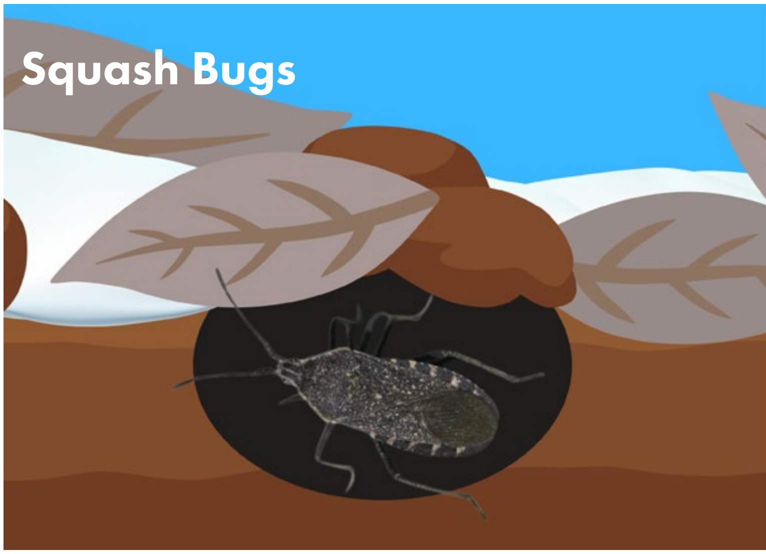
Some species overwinter by entering a state of diapause, primarily as pupae, depending on the species and regional climate conditions. In temperate regions, the larvae burrow into the soil, undergoing metamorphosis into the pupal stage, where they remain dormant throughout the winter months. This period continues until rising soil temperatures and longer daylight prompt their emergence as adult moths in the spring, initiating the next generation. Species in warmer climates bypass diapause entirely, continuing their reproductive cycles year-round.

This difference allows earwigs a lengthened period of development.

Adult female and male earwigs spend winter as brooding pairs in the soil. In fall, females dig tunnels about one inch deep to form nests. These nest structures can vary, ranging from a single tunnel to more complex formations with multiple chambers. When spring arrives, the female banishes the male and seals off the nest for egg-laying and development.

Earwigs are a common pest in Utah's specialty crops, known for their destructive feeding on foliage, flowers, and fruit. They overwinter in the soil, where temperatures rarely reach their supercooling point, but they are still limited to well-protected areas with deep snow cover. Although earwigs are freeze-intolerant, they can rapidly cold-harden, likely by producing glycerol.

Unlike some insects, earwigs do not enter a full diapause in the fall. Instead, they enter a quiescent state, allowing for rapid development as soon as temperatures become favorable in spring. In contrast, diapausing insects must accumulate a threshold of warmth before breaking diapause and resuming development, which extends their period of inactivity.



The **squash bug** is a notorious cucurbit pest. Their feeding disrupts the plant's xylem flow, leading to wilting and potential dieback.

In early fall, adult squash bugs enter reproductive diapause. During this period, they stop breeding and convert more food into fat, resulting in an enlarged body. Both males and females experience a reduction in respiration, about half the rate of non-diapause bugs during the summer. As the weather cools, adults seek suitable overwintering sites such as cloddy soil, plant debris, or human-made structures, usually located not far from where the original host crops were. Adults become active again in May and June to seek out host plants for feeding.

Nick Volesky, Vegetable IPM Associate

Bacterial Bulb Rots in Utah

Utah State University is part of a national and international effort through a USDA Specialty Crops Research Initiative grant to manage bacterial pathogens that cause bulb rots and reduce the associated yield losses. Researchers from 12 states in the U.S. and the University of Pretoria, South Africa, are participating in the project. Due to the usually dry climate in Utah, we do not see many bulb rot samples come to the Utah Plant Pest Diagnostic lab. Part of the SCRI grant includes surveying commercial onion fields throughout the growing season to collect samples of plants with symptoms of bacterial diseases to identify the bacterial pathogens causing the infections. During last year's survey, we found four diseases that had not been reported in Utah previously, although the pathogens probably have been in Utah for a long time.

Bacterial Leaf Necrosis (Occasionally bulb rot)

Bacterial leaf necrosis is caused by another species of *Pantoea agglomerans*. In contrast to center rot, bacterial leaf necrosis causes lesions that result in quickly dying leaf tissue. Tissue further away from the lesion may remain green. It can cause a bulb rot where the bacteria move from the point of infection to the neck, colonizing the bulb. Decaying scales are often light brown. There is little known about the disease cycle of the bacterial leaf necrosis pathogen, but the pathogen can survive on weeds, can be seedborne, and is found in the gut of thrips. A study in Georgia showed that thrips can transmit *P. agglomerans* to onion seedlings.

Center Rot

Center rot is caused by two species of *Pantoea* – *P. allii*, which we found in Utah in 2020, and *P. ananatis*. *Pantoea* species are common in the guts of thrips, including onion thrips. The bacteria can also be seedborne and can be found as epiphytes (bacteria surviving on the plant surface) on weeds. Infection occurs frequently when thrips feed on onion leaves near the neck, creating wounds. The thrips also defecate on the leaves, and bacteria in the

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feces may be washed into the wounds by irrigation water or rain, entering the leaf. The disease usually starts on the center leaves in the neck with small, water-soaked lesions that rapidly expand into bleached white streaks that can kill the leaves. When the bulb is cut open, the scales associated with the affected leaves usually have a wet brown rot.

Disease development occurs during high temperatures (82-95 °F) combined with rain or overhead irrigation that provide the necessary moisture for infection. Management of center rot is difficult. Good weed control to reduce *Pantoea* reservoirs, as well as reducing thrips populations, can reduce disease incidence. Since the pathogens can be seedborne, pathogen-free seed or transplants should be used.

Internal Brown Rot

The causal agent for internal brown rot is *Pseudomonas aeruginosa*. The bacteria enter through wounds in the neck area. The field in Utah which the infected bulb was found in 2020 had been hit by hail earlier in the summer. Symptoms of the disease are more commonly found in storage than in the field. It is possible that infection occurs during harvest.

The bacteria can live as epiphytes on weeds and are moved by splashing water over short distances. The infected scales turn brown and a soft rot develops. There are few management recommendations. Good weed control to reduce inoculum that could splash on onion plants can reduce disease incidence, and using drip or furrow irrigation instead of overhead irrigation can provide some control.

Slippery Skin

Slippery skin is caused by *Burkholderia gladioli*. *Burkholderia* is a soilborne bacterium that infects onion leaves and bulbs through wounds caused by hail or insect feeding. Early during the bulb infection process, only one or two fleshy scales may be infected, and appear water-soaked with a yellow-brown discoloration. Infection does not spread directly between adjacent scales but other fleshy scales can be infected when the bacterium reaches the basal plate. Eventually, the scales become dried up and shriveled in appearance. To minimize disease incidence, injury to plants should be minimized, and onions should be harvested at the optimum maturity and stored at temperatures of 36 °F or less. There is no evidence the slippery skin pathogen can be seedborne in onion.

All of these bacteria are splash-dispersed, and infection of bulbs is favored by moisture in the necks of onion plants, particularly once the tops start to fall over. Production practices that speed up drying of the necks after tops start to fall over all help reduce the incidence of bulbs that become infected. This includes avoiding late applications or excessive amounts of fertilizer, terminating irrigation in a timely manner, and undercutting bulbs to speed up field curing and limit the risk of the bacteria moving from infected leaves down the neck and into the bulb.

This work is supported by the USDA Specialty Crops Research Initiative Award 2019-51181-30013 from the USDA National Institute of Food and Agriculture. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

— Claudia Nischwitz, Extension Plant Pathologist

The Plant Health Team Welcomes New Arthropod Diagnostician

We are excited to welcome Dr. Ernane Vieira-Neto to the Utah Plant Pest Diagnostic Lab. Ernane is an ecologist who has been interested in multiple entomological subjects for nearly two decades. Originally from Brazil, where he's earned his B.S. in Biological Sciences and M.S. in Ecology, Ernane earned his Ph.D. from the University of Florida studying the population dynamics and spread of ants along roadsides. For the last 2 years he has been a postdoctoral fellow at Utah State University researching interactions between insects and plants in multiple contexts.

Ernane is eager to join Utah State University Extension and provide outreach as part of the Plant Health team. His goal is to provide support to growers and homeowners about how to safely and effectively manage pests with fewer pesticides using integrated pest management and alternative control options. He says that conducting research is great, but being able to help people directly with their immediate concerns is very rewarding!

Ernane can be reached at ernane.vieira-neto@usu.edu or 435-797-2435.

Correct Submission of Plant and Insect Samples for Diagnostic Purposes

The Utah Plant Pest Diagnostic Lab (UPPDL) receives hundreds of insect and plant disease samples each year and unfortunately, some of them are too destroyed to identify. Our goal is to provide quick and accurate diagnoses of plant problems or insect identifications, and to meet that end, appropriate samples in good condition are essential. Our website (extension.usu.edu/planthealth/uppdl) provides useful information on how to correctly submit a sample.

The "Submit a sample" section of the website includes videos demonstrating the process. If you are unsure what type of sample needs to be collected, please email us (uppdl@usu.edu) with pictures of the affected plants or click on the link "Photo diagnostics or general inquiries" to submit more information. We can then determine what type of sample is needed.

Example of a bad plant disease sample

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General guidelines for shipping samples:

- Send samples that exhibit the symptoms you are concerned about. If you send only a healthy plant or healthy turf sample, we cannot identify the problem.
- Send the appropriate amount of sample, following the guidelines on the website. With too little material, we cannot conduct the necessary analyses and too much increases shipping costs and may affect the delivery.
- Write legibly on the sample submission form. If we cannot read the email address, it could delay our response since we must wait for you to contact us.
- Place all samples except mushrooms in a Ziploc bag without a moist paper towel. If a moist paper towel is included inside the bag, the sample become moldy during shipping, preventing identification of the main problem. Place mushroom samples in paper bags.
- Remove as much of the soil as possible from plant roots (except turf). During shipping, the soil will spread and contaminate leaves and stems in the same bag, making identification more difficult.

Other important considerations:

- All samples should be fresh. Please do not keep them for days or months in a hot car or refrigerator before sending it to us. The samples deteriorate in the heat and being stored in the bag makes identification of the cause of the problem nearly impossible.
- Send samples, if possible, by FedEx or UPS overnight or two-day delivery as long as they are guaranteed to **arrive by Friday morning**. Otherwise, they sit over the weekend and deteriorate.
- When using U.S. Postal Service (USPS), shipping by Express will still take at least two days to reach the diagnostic lab or three days from southern Utah. (In southern Utah, mail goes first to Las Vegas for sorting before arriving in Logan, adding an extra day to the process.)
- Package tracking for USPS may be incorrect. Once your package reaches the Logan post office, tracking will say, “Delivered. Individual picked up at postal facility.” This does not mean it has reached the UPPDL. Mail from the Logan post office is then delivered to a central location at Utah State University between 1 and 4 pm and is then delivered to campus the following morning. Therefore, **plan for an extra day when using USPS shipping to ensure arrival by Friday morning**.

Please note: The UPPDL does not issue refunds

- The diagnosis may not be what you suspect. For example, you may assume a fungal or viral pathogen is causing the plant symptoms when instead, it is an abiotic cause (herbicide damage, hail etc.).
- If a check is submitted with the sample, we deposit the check once we start working on the sample. Therefore, we are unable to “rip up the check” if the diagnosis is not as expected.

No matter the outcome, we spend significant time evaluating and processing samples (culturing for pathogens, testing for viruses), and payment is still required if no insect pest or pathogen is detected. In all cases (even for abiotic causes), we provide management advice on improving the plant health or preventing the issue.

If you prefer to drop a sample off at the diagnostic lab, please contact us beforehand for an appointment. We are frequently conducting field work and do not always have somebody available in the diagnostic lab. We also have a sample drop-off box in front of the diagnostic lab door (address link) for specific cases in which an appointment was not possible and nobody is present. In these rare instances, please include a completed sample submission form with your information and the symptoms you are concerned about along with the appropriately packed sample. Please do not just put the sample in the box without any information, as we may need to discard it.

After we receive a sample with its form, we may request additional information or samples, and a timely response will allow us to serve you faster. There is no need to get upset with us, we are trying to diagnose the problem your plant has and the additional information or sample will help. We conduct diagnoses as rapidly as possible and having the most comprehensive information and samples results in the best outcome.

— Claudia Nischwitz, Extension Plant Pathologist and Ernane Vieira-Neto, Arthropod Diagnostician

IPM In The News

Public is Important in Detecting Invasive Pests

A recent study from the University of Maryland published in *Journal of Environmental Management* highlights the critical role of public surveillance in safeguarding agriculture and ecosystems from harmful insect pests. The authors analyzed over 100 recent pest introductions and data from 3,000 U.S. counties, and found that the likelihood of pest establishment is greater in more populated areas and close to ports, reflecting entry points and pathways for pest introduction. The study summarizes key risk factors and emphasizes the importance of community involvement in early detection efforts.

Drought Hormone Shields Plants Against Spider Mites

Scientists have discovered that plants use the same hormone, abscisic acid, to defend against both drought and nutrient-sucking pests like spider mites. Research from the University of Cambridge and Spanish collaborators revealed that within hours of mite infestation, plants close their leaf stomates to conserve water and block pest entry. This research, published in *Plant Physiology*, could inform future crop breeding programs for better pest control.

Genetic Approach to Controlling Mosquitoes

Mosquitoes are the nemesis of humans through biting and carrying diseases. Researchers from Virginia Tech have discovered a novel method to reduce mosquito populations, potentially offering an alternative to insecticides. Through crossbreeding the *Aedes aegypti* mosquito (a significant global disease vector) with a related species, *A. mascarensis*, researchers found that about 10 percent of the offspring were males with both male and female traits, rendering them unable to reproduce. The study, published in *Communications Biology*, could pave the way for developing strategies to create all-male mosquito populations, reducing the number of disease-carrying females and aiding in the control of diseases like Zika and dengue.

Fungal Pathogens Triggered to Self-Destruct

Fungal diseases account for significant crop losses and pose risks to humans. Scientists at the University of Exeter have discovered that the widely-used azole fungicides, essential for protecting crops and treating human infections, cause fungal pathogens to self-destruct. The study, published in *Communications Biology*, found that azoles don't just disrupt cell membranes but instead trigger a "suicide" program within the fungi. This process involves heightened mitochondrial activity leading to toxic by-products and self-digestion of cellular components, ultimately killing the pathogen. While this discovery could enhance strategies to combat fungal diseases, it also sheds light on the growing issue of azole resistance.

Some Frogs can Develop Rapid Pesticide Tolerance

Although there is a large body of research on pests evolving tolerances for the pesticides meant to destroy them, there have been considerably fewer studies on how non-target animals in these ecosystems may do the same. Scientists at Rensselaer Polytechnic Institute tested 15 populations of wood frogs from western Pennsylvania and eastern New York against low concentrations of the pesticides, carbaryl, chlorpyrifos, and diazinon. They found that nearly half exhibited a tolerance to all three ingredients within days, potentially influencing future generations. The research emphasizes the need for further investigation into how tolerance develops in various animals and its long-term ecological consequences.

Nanotechnology for Agriculture Efficiency

Current agrochemical delivery methods are inefficient, with up to 50% of fertilizers lost to the environment and only 5% of pesticides reaching their intended targets. To address this, researchers from University of California Riverside and Carnegie Mellon University published a review in *Nature Nanotechnology*, exploring how advanced nanotech strategies could enhance the delivery of pesticides to targeted plant cells, improving efficiency and reducing environmental impact. The researchers propose using nanocarrier molecules to direct agrochemicals precisely where needed and suggest employing artificial intelligence to create "digital twins" of plants for better design and testing of these technologies. This approach aims to boost crop resilience, minimize waste, and address the pressing need for increased food production.

Trying to Save our Chocolate

A rapidly spreading plant virus, known as cacao swollen shoot virus disease (CSSVD), has been spreading through Ghana cacao trees, causing up to 50% loss of harvest. Insecticides are not working against the mealybug vectors and there are no resistant cultivars. One promising avenue is the use of

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Featured Picture of the Quarter

Red firebug (resembling boxelder bug) was first seen in Utah in the Salt Lake City area in 2008 and has since moved northward to southern Idaho. Where conditions are good, the populations thrive since females can lay hundreds of eggs.

They congregate in cool, wet areas, and feed on aphid honeydew, seeds, other insects (including brothers and sisters), and foliage of some ornamentals.

Many life stages are shown in the picture on the left, from young nymphs with small wing pads to adults. In fall, they will be looking for protective sites (including buildings) for overwintering.

— Image by Marion Murray, IPM Specialist

IPM in the News, continued

cacao trees "vaccinated" with a mild strain of the virus. This route is expensive for a full orchard, so researchers from multiple institutions, including at the University of Kansas, developed a mathematical model to determine a spacing of vaccinated and unvaccinated trees, so the orchard can be mixed. This could potentially help farmers protect their crops and sustain chocolate production amidst the crisis.

Calcium Boosts Potato Resistance to Bacterial Wilt

Bacterial wilt causes worldwide losses of potatoes costing $19 billion per year. A recent study published in *Applied and Environmental Microbiology* reveals that calcium significantly enhances potato plants' resistance to bacterial wilt. Researchers from the University of the Republic in Uruguay discovered that calcium not only strengthens plant defenses but also inhibits the growth, biofilm formation, and motility of the bacterial pathogen Ralstonia solanacearum. This breakthrough suggests that calcium amendments to soil could be a key component of integrated disease management strategies for bacterial diseases. The study opens new avenues for research into calcium's role in plant defense and disease control.

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