UTAH PESTS News

Utah Plant Pest Diagnostic Laboratory and USU Extension Vol. X, Fall 2016

What's Inside

News Highlights

NEW FACT SHEETS

Barley yellow dwarf virus (BYDV)

Improving Organic Peach Orchard Fertility with Nitrogen-Fixing Ground Covers in Capitol Reef National Park: A Case Study

utahpests.usu.edu

Tall Fescue for Home Lawns

Turf-type tall fescue

Kentucky bluegrass

Most lawns in Utah are comprised of cultivars of Kentucky bluegrass (KBG), perennial ryegrass and fine fescue. While these species have many great qualities that make them suitable for use in Utah, they also have downsides that may cause you to consider other options when renovating or establishing a lawn. In particular, when mismanaged, KBG is susceptible to diseases like summer patch and necrotic ring spot. For lawns plagued with these diseases, turf-type tall fescue (TF) is a viable alternative to KBG, ryegrass, fine fescues, and other cool-season species for home lawns in Utah.

In 2016, the Utah Plant Pest Diagnostic Lab received more turf samples than usual. Of the 300 samples, 80 (27%) were turfgrass. Many turf diseases were diagnosed this year and many samples had multiple issues. Of the diseased turf samples, 75% had summer patch or necrotic ring spot. Also of interest was the occurrence of anthracnose in samples. We believe this is mostly a secondary issue affecting turf leaves only. From the data, we can see that KBG lawns were hard-hit with root diseases this year.

As part of a root disease management program for low- to moderate-use home lawns, we recommend refining cultural practices. Most important is to determine proper watering by calibrating irrigation systems by requesting a free Water Check through USU at cwel.usu.edu/watercheck. Other practices include maintaining a mowing height of 3 inches, maintaining sharp mowing blades, core aeration, thatch management, and proper fertilization. In some cases, overseeding with disease-resistant species or cultivars, or complete lawn renovation may be required.

Diagnoses of Turf Samples in 2016
(Note: 80 total, many with multiple issues)

Diagnosis	Samples	% Total
Summer patch/ Necrotic ring spot	60	75%
Non-living cause	16	20%
Anthracnose	14	18%
Curvularia blight	6	8%
Insects (billbug, sod webworm, chinch bugs)	6	8%
Snow mold	4	5%
Ascochyta	3	4%
Cyanobacteria	3	4%
Alternaria	1	1%
Fairy ring	1	1%
Melting out	1	1%

While planting or overseeding with disease-resistant KBG cultivars is an option for summer patch and necrotic ring spot management, it is important to remember that resistance does not equal immunity. If cultural practices are not altered, even resistant cultivars of KBG can succumb to summer patch and necrotic ring spot. Because of familiarity, wide availability, and a high quality lawn, many people choose KBG. If overseeding or starting a lawn from scratch, however, Utahns should consider turf-type tall fescue (TF). Because of their growth habit and requirements, the newer TF cultivars could reduce the use of fungicides, insecticides, fertilizers and water in Utah.

continued on next page

UTAH PESTS Team

Diane Alston
Entomologist
diane.alston@usu.edu
435-797-2516

Cami Cannon
Vegetable IPM Associate
cami.cannon@usu.edu
435-797-2435

Ryan Davis
Arthropod Diagnostician
School IPM Associate
ryan.davis@usu.edu
435-797-2435

Marion Murray
IPM Project Leader
Editor, Utah Pests News
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

Lori Spears
USU CAPS Coordinator
lori.spears@usu.edu
801-668-4056

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

UTAH PESTS News
is published quarterly.

To subscribe, click here.

utahpests.usu.edu

EXTENSION
UtahStateUniversity

Tall Fescue for Home Lawns, continued from previous page

Characteristics of Utah's Commonly Used Cool-season Grasses

		Resistance Level (Fair to Excellent)				
Species	**Growth**	**Heat**	**Drought**	**Shade**	**Diseases***	**Insects**
Kentucky bluegrass	Rhizomatous	Good	Good	Fair	Fair	Fair
Perennial ryegrass	Bunchgrass	Fair	Fair	Poor	Excellent	Good
Fine fescue	Rhizomatous; bunchgrass	Fair	Very good	Very good to excellent	Good	Good
Tall fescue	Bunchgrass; weakly rhizomatous	Very good	Very good	Very good	Excellent	Very good

*Summer patch and necrotic ring spot

Of the turf species used in Utah, the TF cultivars score consistently well in all important categories to our state. They do well in a wide range of soil types, have deep rooting, require less fertilizer, and may require less water than KBG. These attributes make TF more resistant to summer patch and necrotic ring spot. Although dwarf TF cultivars require less mowing, they are not as drought-tolerant as non-dwarf cultivars.

There may be many reasons for a bias toward KBG in Utah. One reason is the perception that TF is coarse-textured, unsightly, and looks weedy when present among other turf species. This aesthetic stigma surrounding TF is likely because of its history. The original cultivars – 'Alta' and 'Kentucky 31' – were released as range grasses for cattle grazing. Those pasture grasses are coarse-textured bunch grasses that are not desirable for lawns. Since the early 1960's, breeding programs have developed TF cultivars with fine-textured leaves, improved density and uniformity, improved self-repair, attractive color, fast spring green-up, low thatch development, and drought, heat, sun, shade, pH, disease and insect tolerance. Today's cultivars are visually very similar to KBG, but with many advantages, including tolerance of summer patch and necrotic ring spot.

Tall fescues aren't completely without issue. They are susceptible to other diseases such as brown patch and rhizoctonia blight; however, these are not prevalent in Utah's low- to moderate-use home lawns. Another minor issue with TF is its bunchgrass growth habit. Tall fescues do not grow or spread via stolons (above-ground runners) and some cultivars are only weakly rhizomatous (underground runners). Though newer TF cultivars have good density and increased tillering, stress and time may create a thinning, bunchy lawn in some situations. As should be done when any turfgrass species requires maintenance, TF lawns should be overseeded every few years or as needed to maintain a dense, competitive lawn.

The National Turf Evaluation Program evaluates many turfgrass species and cultivars. One test site is located in Cache County at the Utah Agricultural Experiment Station's Greenville Farm. This site tests turfgrass species and varieties for their performance and quality under northern Utah's conditions. A few TF cultivars that performed well in 2015 include: Thunderstruck, Regenerate, Rebounder, Raptor III, and Avenger II. Many other cultivars are available, and a mix of cultivars is recommended to reap the greatest amount of benefits.

If you are battling summer patch or necrotic ring spot, or are looking for new turf cultivars to renovate or establish a lawn, TF should be at the top of your list. Fall is the perfect time for proper establishment. Check local garden centers, seed suppliers or online vendors for recent, high quality TF cultivar mixes suitable to Utah's environment.

Ryan Davis, Arthropod Diagnostician

High Plains Virus and Wheat Streak Mosaic Virus in Small Grains and Corn

Both High plains virus (HPV) and Wheat streak mosaic virus (WSMV) are transmitted by the wheat curl mite. The wheat curl mite is a microscopic eriophyid mite. The mite overwinters in the egg stage in the crown of newly-sown winter wheat. In spring, the mites hatch and acquire the virus by feeding on infected plants. They complete their life cycle in 7 to 10 days, allowing for multiple generations per year and high potential for infestations. HPV is also seed-transmitted in corn. In small grains, it is common to find both viruses in a single plant.

The symptoms in small grains are yellow streaking and stippling of leaves. Plants infected during fall have greater yield loss than plants infected in later growth stages. In winter wheat, yield losses in other states have been reported above 60% when wheat was infected in the fall. Spring infection of winter wheat resulted in 10 to 15% yield loss.

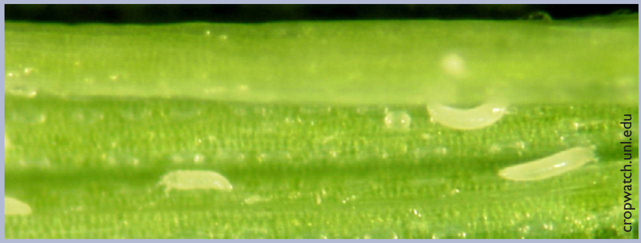
In corn, symptoms include yellow stippling on leaves and in some cases, white streaks. The plants are stunted and often do not produce ears.

The viruses and the mites survive in volunteer wheat and grasses on field edges. When the plants start to senesce, the mites crawl to the tip of the plant and let the wind carry them to new host plants. In Utah, virus infections are only a problem in small grains when fields have been strip-tilled or are within a mile of corn or small grains fields that have been strip-tilled.

Management of HPV and WSMV is difficult. There are no insecticides that are effective in controlling the mites. The best options to minimize effects of the viruses are to till or plow fields and remove volunteer wheat and grass hosts. In areas with multiple growers using strip-till, everyone within a mile radius would have to change to plowing or tilling for effective reduction in disease incidence. Plowing and removing grass hosts is effective because the mite cannot survive for more than eight hours without green plant tissue.

Recently, symptomatic sweet corn was diagnosed with HPV in Utah. The pattern in the field suggested the virus was seedborne. No mites were detected on the corn leaves, and the nearby wheat looked healthy. Greenhouse grow-out tests showed that the virus was present in some of the seedlings.

Claudia Nischwitz, Extension Plant Pathologist



Top: The wheat curl mite is a microscopic eriophyid mite that vectors high plains virus (HPV) and wheat streak mosaic virus (WSMV) on corn and small grains. As the mite feeds, it causes the leaf blade to curl along the edge.

Bottom images: Both HPV and WSMV cause yellow streaking on foliage. On corn, streaking on lower leaves is scattered, becoming more frequent on upper leaves, and coalescing to form a general chlorosis.

Seven Current and Future Uses of Drones for Agricultural Plant Health

Drone technology is perfectly suited for farms and rural areas, where it is easier to remain within the new FAA guidelines under the Small Unmanned Aircraft System (UAS) Rule. The rule went into effect in late August 2016, regulating the operation of drones weighing up to 55 lb. In general, non-recreational operators must have a Remote Pilot Airman Certificate (through an online test) or be supervised by someone with the certificate. The drones can only fly during the day, must stay under 400 feet, cannot fly over people not involved in the operation, and must always be in the line-of-sight of the operator. (Pilots can apply for a waiver to these rules through an online form. Complete information can be found here.)

Years of research have already been dedicated to developing highly sophisticated agricultural drones that gather plant and soil data or perform specialized tasks. The Association for Unmanned Vehicle Systems International, the trade group for drone technology, predicts that 80% of the commercial market for drones will be for agricultural uses. Priced at $1,500 to $25,000 or more, many larger farms are already using the multicopter versions, either through contract providers, or by the farmers themselves. A short online poll by Pest Control Technology found that 4% of respondents are currently using drones and 54% are considering purchasing one. The full potential of drones has yet to be realized, with some countries far ahead of the U.S. in implementation.

Crop Monitoring

Typically, monitoring is conducted by walking orchards or fields and conducting visual inspections. The size of some farms limits the chances of finding insect, disease, or weed infestations or nutrient deficiencies. Drone cameras, specialized software, and GPS gather data that help to determine plant and soil health. They can survey a crop every week, every day, or even every hour.

- At Utah State University, Entomologist Diane Alston and her colleagues used aerial imagery from a USU Extension drone, plus data collected from the ground, to help detect the effect of surrounding plants on the occurrence of onion thrips and Iris yellow spot virus in onion fields. They found that onions next to alfalfa and weeds were less healthy than those next to corn, wheat, or pasture. Click here for an onion field video taken from the drone.
- Also at USU, Irrigation Specialist, Niel Allen worked with the AggieAir company to research vineyard crop monitoring. Allen's project focused on vineyards in California, identifying exact locations of dead or diseased plants, determining irrigation needs, and monitoring canopy volume for pruning practices. His ongoing research includes developing a method to produce timely output of remotely-sensed data to develop yield maps and prescription maps for precision application of pesticides. (A prescription map is a georeferenced map that can be used by GPS-guided precision farm equipment).
- AggieAir represents a fleet of drones developed at USU that can perform health checks of crops, among a host of other services. The onboard cameras include visual, near-infrared, and thermal digital cameras that collect data with a resolution of up to 6 inches.
- Researchers at Penn State have been experimenting with drones to detect soybean cyst nematode, a disease that can go undetected for weeks, causing thousands of dollars in losses in the process.
- Engineers at University of Florida are utilizing drones equipped with special equipment to gauge stress in citrus trees for early detection of the deadly disease, citrus greening, or Huanglongbing (HLB).
- A 3-year, $1.74 million project is underway at Kansas State University and Australia to determine the accuracy of using drones as a quick and efficient method to detect Russian wheat aphid and stripe rust in wheat before outbreaks happen.

Targeted Distribution of Chemicals

The advantages of using a drone to apply pesticides or nutrients include reduced chemical usage, reduced human exposure to pesticides, preventing operators from having to

continued on next page

Seven Current and Future Uses of Drones for Agricultural Plant Health, continued from previous page

drive on steep/slippery slopes, reduced crop damage and soil compaction, and greater fuel efficiency.

- MIT and a tech firm collaborated to develop specialized software for precise dispersal of pesticides that takes into account wind, temperature, and humidity. The pesticide is contained within a biodegradable controlled-release device. In the U.S., Yamaha drones were approved by the FAA in 2015 for pesticide applications and the new software is currently being tested in California vineyards.

- Chinese drone manufacturer DJI recently announced the release of the Agras MG-1 in China and Korea. It can spray an area of 1.2 acres in 10 minutes. DJI claims that it is 40 to 60 times more efficient than tractor spraying.

- For decades, Japan has used drones to disperse pesticides on rice fields. In recent years, a Japanese university and tech firm collaborated to develop Agri Drone, which is now being used in research trials. The innovation is that it can be used at night via autonomous patrol. (In the U.S., night flight is currently not allowed, and an operator is always required). Agri Drone utilizes infrared and thermal cameras to shoot targeted doses of pesticides where insects are congregating. So far, the system has been trialed on 50 different types of insect pests on soybean and potato.

Insect Trapping

Drones may also be useful in trapping insects for monitoring purposes, or even insect control. This type of operation would require almost daily, autonomous flight.

- Japan's Agri Drone (mentioned above) is also equipped with a suspended "bug zapper." Instead of using pesticides, the drone can be assigned the task of delivering an electric payload to the points at which moth pests are congregating.

- Microsoft has recently partnered with several U.S. universities to use drones to monitor for disease-carrying mosquitoes. The drones collect mosquitoes with baited traps that include a sensor that sorts the mosquitoes from non-target insects, and a preservative to maintain the mosquitoes for lab testing.

Monitoring with Sensors

New research is venturing into using miniaturized and specialized sensors that can detect a variety of conditions related to plant health, including real-time weather conditions and measurement of plants' health status based on release of volatile organic compounds. The challenges are to reduce the size, weight, and power of the sensors while maintaining their accuracy and reliability.

Distribution of Biological Control Agents

Research has been underway for several years to determine the effectiveness of drones for releasing biocontrol agents for insect and weed control.

- West Virginia University developed 'bug bombs' (small pods) for drone-aided delivery of biocontrols for weeds in large, hard-to-reach areas in grape vineyards. The bug bombs were tested in drone-drops from as high as 100 feet, and each time, up to 90% of the beneficial insects successfully survived. The effects on the weeds can then be monitored by the drones to a resolution of 3 inches.

- University of Queensland in Australia tested drone delivery of beneficial mites on corn. The results showed that the drone was capable of delivering mites to 12 acres in just 15 minutes.

Bird Control

Birds can be a major pest of some crops, in particular fruits. Some drone companies have manufactured specialist drones which mimic birds of prey to scare smaller birds.

- The ProHawk UAV, made by Bird-X, is the first drone of its class made specifically for bird control. The helicopter-type system combines a sonic bird repeller with autonomous flight GPS technology and design.

Irrigation Monitoring

Proper irrigation is crucial to maintaining plant health, and will be especially important over the next several decades as water availability in the West may be inconsistent. Monitoring and information technologies are emerging that show promise in reducing water losses.

- AggieAir drones (mentioned above) are involved in several university research projects to develop new methods to measure agricultural water use at a spatial resolution of 6 inches. They are looking at ways to provide information about when and where to apply precise quantities of water at varying rates throughout the field rather than the same rate everywhere, which can lead to waste.

Marion Murray, IPM Project Leader

Identifying Mechanisms of Resistance to Emerald Ash Borer

The emerald ash borer [(EAB) *Agrilus planipennis*] is a tiny green beetle from Asia that has killed tens of millions of ash trees in the U.S., and is considered the most destructive forest pest ever seen in North America. It threatens all native ash species (*Fraxinus* spp.) and will attack small, large, stressed, and even healthy trees. It was first discovered in the U.S. in 2002 in Michigan, and has since spread to nearly 30 states. EAB has not yet been found in Utah, but was found in Colorado in 2013, representing its western-most occurrence in the country.

EAB larvae are the primary damaging life stage and are responsible for killing trees. They chew through bark into the phloem and sapwood, creating serpentine-shaped and excrement-filled galleries which disrupt the flow of nutrients and water to the tree. Although adults typically fly short distances (up to 2 miles), EAB is primarily introduced to new locations through movement and delivery of infested materials, such as firewood and nursery stock.

Researchers have been trying to figure out how best to prevent ash trees from succumbing to EAB, including conducting insecticide trials and identifying and testing biological control agents (read the Utah Pests Newsletter article about EAB biocontrol here). Others have focused on understanding defense mechanisms in ash trees and how plant defense compounds alter EAB's behavior (read more about plant defense traits here).

Specifically, studies have sought to identify what is allowing ash species from Asia (EAB's native home) to survive attack and what defensive capabilities are lacking in native North American ash species. Native species (white, green and black ash) are highly susceptible to EAB, whereas Asian species (Manchurian ash) are more resistant and appear to be susceptible only when stressed. Further, Asian species are less preferred for adult feeding and oviposition (egg-laying) and more resistant to larval feeding than susceptible North American hosts. Results have shown that North American species are not producing some chemicals fast enough, or in high enough amounts, to protect themselves from EAB. Yet some North American ash species can become more resistant to EAB after induction with methyl jasomonate. Methyl jasomonate is associated with increased bark concentrations of verbascosidae, lignin, and trypsin inhibitors, and ultimately decreased survival and/or growth of EAB larvae or decreased adult emergence – results that are comparable to levels achieved by insecticides.

Plant defense responses to attack by insect herbivores have been studied in a variety of agricultural systems, such as turf and other ornamentals, field crops, and fruits and vegetables. Researchers hope that by better understanding biochemical defense strategies in host plants, they will be able to develop resistant plant varieties and promote new tools in integrated pest management.

Homeowners who have ash trees in their yards can also take steps to protect them. Click here to see Colorado's recommendations in "Managing Emerald Ash Borer: Decision Guide". It is also recommended to stay away from ash when designing new plantings. USU's treebrowser.org is a wonderful, interactive tool to determine a variety of alternatives to ash trees.

We are encouraging the public to be aware of the signs and symptoms of an EAB infestation (read the USU Extension Fact Sheet on EAB here). If you think an insect looks suspicious or you see signs of damage, please contact the Utah Plant Pest Diagnostic Lab so that someone can inspect the tree in question. The earlier we detect EAB in Utah, the more management options will be available to us.

Lori Spears, USU CAPS Coordinator

References

Haavik, L. 2016. Ash and Emerald Ash Borer: How do Trees Defend Themselves from a Deadly Beetle? Entomology Today. Article published September 13, 2016.

Villari, C., D.A. Herms, J.G.A. Whitehill, D. Cipollini, and P. Bonello. 2016. Progress and gaps in understanding mechanisms of ash tree resistance to emerald ash borer, a model for wood-boring insects that kill angiosperms. New Phytologist 209: 63-79.

Whitehill, J.G., C. Rigsby, D. Cipollini, D.A. Herms, and P. Bonello. 2014. Decreased emergence of emerald ash borer from ash treated with methyl jasmonate is associated with induction of general defense traits and the toxic phenolic compound verbascoside. Oecologica 176: 1047-1059.

The Mystery of the Hummingbirds and 'Chigger' Bites

As an entomologist, I do not like to be outsmarted by arthropods, but they sure got me this summer. In late July and August, I experienced unidentified bites to my skin, especially below my collarbone, on my belly and under my armpits. They reminded me of chigger bites that I had experienced from walking in the woods of North Carolina. I looked up chiggers in Utah on the Internet, and to my surprise I found a BYU publication from 1955 that described 38 species of chigger mites in Utah. I had never encountered chiggers in Utah, so I was amazed. Most of the described species were collected from rodents. I speculated that I had picked them up while on one of the local Bear River Mountain trails. However, to my surprise, I kept getting new bites – up to nearly 30 bites at once in early August. And boy did they itch! I was not a happy entomologist.

USU Arthropod Diagnostician Ryan Davis kindly let me bend his ear about my mysterious bites and gave me lots of ideas of possible culprits. I began to wonder if I was suffering from delusional parasitosis (I readily admit that I am crazy), but I had the welts to prove that something was biting me. I started thinking about all the possible sources of rodents and other critters around my house. We had bats that would night-roost under the deck roof, so I thought that perhaps bat bugs (related to bed bugs) might be entering my bedroom at night and biting me. I also thought that I might have brought back bed bugs from a trip. I fastidiously cleaned my house, and washed all linens and chair covers in scalding hot water. The bites continued …

I was getting downright ornery now from all of the itchy bites, and still no diagnosis. I went back to Ryan and we discussed other potential culprits. He mentioned straw itch mite (I hadn't been hanging out in grain fields recently), house mouse mite (I do get some mice, but they don't hang out in my house during the summer when it is nice weather outside), tropical rat mite (what a horrible thought that I might have Norway rats in my house), scabies mites (no way!), and several kinds of fowl mites. Hmm, I don't raise chickens or other fowl. The dogma on fowl mites moving from wild birds onto humans is under the scenario of a bird's nest built under the eaves or in the attic, and when the nestlings fledge, the fowl mites crawl into the house looking for new sources of blood. I don't have an attic in my home, and I inspected all the eaves and soffits and didn't see any likely places where a bird's nest could be located. So this diagnosis didn't seem to hold up.

The mystery continues on the next page

Silverleaf of Squash

When zucchini or summer squash leaves turn silver, instead of suspecting a disease, growers should check for whiteflies (*Bemisia tabaci*). The upper surface of the leaves looks like they have been spray-painted silver. The silver appearance of the leaves is a reaction to whitefly feeding. Silverleaf causes reduced yields and lower quality fruit. Whiteflies should be controlled using insecticides.

Claudia Nischwitz, Plant Pathologist

Top: The right leaf of this squash is normal, while the left leaf was fed on by whiteflies.

Bottom: Silverleaf whitefly adults and empty pupal cases.

Mystery of Hummingbird and 'Chigger' Bites, continued from previous page

So that evening while I was sitting in my usual deck chair under the hummingbird feeder that now had hundreds of hummingbird visits per hour due to the fledglings leaving their nests, it hit me – could fowl mites be crawling off the birds onto the feeder and then falling down onto my patio furniture? My husband runs 4-5 feeders each summer and goes through over 100 lb of sugar, so needless to say, he feeds lots of hummers. He checked the sugar-access holes in one of the feeders, and sure enough, he found some small mites. However, flower mites are known to hitch rides on birds, and they do not bite people, so this wasn't a definitive diagnosis yet.

I went back to Ryan the next day and "borrowed" a glue board. I placed the trap under the hummingbird feeder, and voila, next day, I found northern fowl mites stuck in the adhesive. The mites were falling down onto my favorite Adirondack chair where I sat most evenings to enjoy the sunsets. I was the main person who sat in this chair, and so the fowl mites found me. Actually, several family members later fessed up that they had a few itchy bites too, but just thought they were mosquito bites. I was vindicated - I wasn't crazy after all! Instead I had a severe infestation of fowl mites - yuck. Who would have guessed? Not this entomologist.

So the morals to my strange story are 1) just because you are an entomologist, don't assume you know very much about animal behavior, 2) don't believe all you read on the Internet (fowl mites can indeed infest hummingbird feeders), 3) when you have an arthropod mystery, go talk to an experienced diagnostician like Ryan because he can really help you out, and 4) ask your spouse to move the hummingbird feeder away from the porch – it can make a world of difference in avoiding fowl mite bites. Oh, and Ryan, I never did pay you my $7 sample fee did I?

I hope you all had a wonderful summer! Mine was noteworthy for this entomological mystery, but now the case is solved.

Diane Alston, Entomologist

Top left: Northern Fowl Mite, *Ornithonyssus sylviarum*, caught on a sticky card underneath a hummingbird feeder.

Left: Calliope hummingbird nest.

Top right: Hummingbird feeders should be cleaned regularly.

Genes, Drought, and Pest Management

The news of a possible $66 billion Monsanto and Bayer merger—one of the largest transactions on record—has brought the connection of pesticides and plant breeding/genetically engineered seeds to the forefront. In recent years, we have seen glyphosate-resistant alfalfa (Roundup Ready) become available to growers for weed management. And the Bt (*Bacillus thuringiensis*) gene in corn and other crops has been a component of insect management for some time now. These biotechnologies have even been combined as "stacked" traits in crops, particularly corn. With these innovations have come the good (tools for pest management), the bad (higher fees for technology use and pest-resistance issues), and the ugly (public scrutiny for GMOs in foods).

Not all of the plant biotechnology and advanced breeding techniques have been tied to pesticides. Drought conditions have been expected to be more frequent and water availability continues to be strained. The summer of 2016 was one of the warmest on record. These global effects have not gone unnoticed as drought-tolerant corn hybrids and drought-tolerance traits for other crops are being widely tested and have been hitting the market from several suppliers. Development of plants that can withstand water-stress and still produce a decent crop fills a need, given the drought forecast.

Although drought-tolerant crop technology is not a pest management tool, it may have some major implications for pest management. Spider mites are a classic case because mites can build up quickly when plants are drought-stressed. During warm, dry conditions, spider mites have short generation times and feed more because low humidity evaporates excess water that they excrete. In addition, water-stressed plants can lead to increases in the availability of amino acids that favor spider mites.

Spider mites use a stylet to pierce and suck out leaf cell contents giving a stippled look and causing eventual leaf desiccation. Despite their tiny size, they can cause major economic damage as their populations build. Drought can also cause major yield losses (***top***).

In field trials conducted at Greenville Research Farm in Logan, Utah, PhD candidate Alice Ruckert (USU Biology-Ramirez

continued on next page

Genes, Drought, and Pest Management, continued from previous page

Lab) has recorded increased leaf surface temperatures in corn when plants were water-stressed compared to corn that received optimal irrigation, and corresponding increases in Banks grass mites. Given that drought-tolerant corn hybrids may be able to handle water-stressed environments, Ruckert evaluated how Banks grass mites responded to water-stressed corn with and without drought-tolerance traits.

As expected, corn varieties without drought-tolerance had more Banks grass mites in water-stressed treatments compared to corn with optimal irrigation. What was intriguing was that the drought-tolerant corn hybrids that were water-stressed had fewer mites than corn varieties without drought-tolerance under the same stress conditions. In addition, drought-tolerant corn hybrids in water-stress treatments had similar mite densities to optimally irrigated corn with and without the drought-tolerance trait. This suggests that drought-tolerance traits may be a component of pest management, particularly for pests that flourish under drought-conditions, another example being chinch bugs in turfgrass. The next step is to investigate the mechanisms that drive these changes and whether these effects are confined to a single pest or more broadly, across multiple pest types.

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 which plant defense pathways in corn and barley respond to the generalist two-spotted spider mite, which has a wide host range, and the specialist Bank's grass mite.

Using genomic and genetic methods, the team will also examine how variation in these pathways are altered by drought stress and how this impacts plant resistance to mites. So far, genes related to jasmonic acid biosynthesis and signaling have had the strongest responses to mite-feeding in barley and corn, a similar plant defense response typically seen with chewing insects. A closer examination found that Banks grass mite had a stronger magnitude of gene expression in barley than two-spotted spider mite, but the opposite effect was found in corn.

By knowing the exact similarities and differences in gene expression by each mite species, the team can evaluate the impact of drought stress on these base line observation. As more plant traits are investigated, such as salinity-tolerance in wheat among others, it will be important to determine how this affects pest management. It is important to be mindful that development of plant traits for improved crop yields in stressed environments may interact with pests too and by understanding the underlying mechanisms we may use this to our advantage in pest management.

Ricardo Ramirez, Extension Entomologist

Increasing Interest in Trap Crops

Over the last two decades, there has been heightened interest in trap crops. Over 150 scientific publications since 1991 are evidence of an increased research effort on trap cropping. Trap cropping is a knowledge-intensive form of pest management and includes several methods. When trap crops are successfully implemented, they can provide sustainable and long-term management solutions to control difficult pests. Trap cropping may offer a hopeful alternative to pesticides for organic growers and farmers interested in biologically-based pest management programs.

The concept of insect control by trap cropping has been known for centuries and is still implemented today. Trap crops are plants that are highly attractive to certain pests, and are planted near the target crop to "lure" the pests away from the target crop.

Several methods of trap cropping have been classified and are based on: 1) characteristics of the trap crop plant; 2) deployment of the trap crop; and 3) assisted trap cropping. Examples of trap cropping may fit into one or more of these methods, and a combination may improve the effectiveness of trap cropping.

1. Methods based on the characteristics of the trap crop

a. *Conventional trap cropping* – a trap crop planted next to a higher value crop to move pests away from the main crop where they can be concentrated and economically destroyed

b. *Dead-end trap cropping* – the trap crop is highly attractive to the pest and serves as a sink that prevents pest movement to the main crop later in the season

continued on next page

Increasing Interest in Trap Crops, continued from previous page

c. *Genetically engineered trap cropping* – trap crops that are genetically engineered to express specific characteristics that improve their ability to "trap" pests and diseases

2. Methods based on the deployment of the trap crop

a. *Perimeter trap cropping* – trap crops planted around the border of the main crop

b. *Sequential trap cropping* – trap crops are planted earlier and/or later than the main crop to enhance attractiveness to targeted pest

c. *Multiple trap cropping* – several species of trap crops planted simultaneously to manage several pests or enhance control of one pest

d. *Push-pull trap cropping* – a trap crop (pull component) combined with a repellent intercrop (push component) to pull pests toward the trap crop and push them away from the main crop

3. Other methods

a. *Biological control-assisted trap cropping* – trap crops that enhance populations of natural enemies within the field (usually working in combination with other modalities)

b. *Semiochemically assisted trap cropping* – trap crops with enhanced attractiveness through semiochemicals or regular crops acting as trap crops after the application of semiochemicals

Success of trap cropping ultimately depends on the combination of insect and trap crop characteristics and practical considerations. One of the most well-known examples of successful trap cropping is the use of alfalfa as a trap crop for lygus bugs in cotton. This was used in the 1960s and led to the development of integrated pest management (IPM) in the central valley of California.

Squash has been successfully used as a trap crop for squash bugs in commercial production of watermelon and cucurbits.

With benefits of reduced dependence on insecticides (especially when insecticide options are limited), low cost of trap crop seed, conservation of natural enemies, and better crop and environmental quality, trap cropping has become particularly attractive to organic growers and farmers interested in biologically based pest management programs. One way we can continue to move forward with the enhancement of trap crops is to expand our concept of trap cropping to include the diverse modalities defined above and continually educate ourselves and others on the benefits and successes of trap crops.

Cami Cannon, Vegetable IPM Associate

Resources

- Trap Cropping in Insect Pest Management
- Trap Cropping in Vegetable Production: One Tool for Managing Pests
- Trap Cropping May Offer Organic Growers and Alternative to Pesticides
- Trap Cropping in Pest Management

Examples of Trap Cropping in Vegetable Insect Pest Management

Pest to be controlled	Main crop	Trap Crop
Colorado potato beetle	Potato	Potato
Diamondback moth	Cabbage	Indian mustard, wild mustard, yellow rocket, collards
Flea beetle	Crucifers	Yellow rocket (bittercress)
	Broccoli, Collards	Wild mustard
Lygus	Strawberry	Daisy and yarrow
Squash bug	Watermelon, Cucurbits	Squash
Striped cucumber beetle	Cucurbits	Cucurbits, squash
Western flower thrips	Lettuce	Crownbeard and other wildflowers

Information in table from: Concepts and Applications of Trap Cropping in Pest Management, by Shelton and Badenes-Perez

In the National News

LONG-TERM WILD BEE DECLINE IN ENGLAND

In an 18-year study of 62 wild bee species across England, entomologists concluded in *Nature Communications* that there is an association between long-term bee decline and use of neonicotinoid insecticides. The authors focused on bees which foraged primarily on oilseed rape, comparing locations of these bees and their changing populations with growing patterns of oilseed rape across England. The study took place from 1994-2011, and over this period there was an increase of 200,000 hectares of oilseed rape sown. The authors found major changes in bee populations starting in 2002, with the start of clothianidin seed treatment. They found a decline in the number of populations by 10%. Five of the species showed declines of 20% or more, with the worst affected declining by 30%. The authors caution that cause and effect has yet to be determined, as the decline in bee populations could also be due to land diverted to agriculture and loss of habitat. They recommend a holistic approach to managing bee populations and producing healthy crops.

NEW PEST OF FIG

California's warm weather and many international shipping yards result in avenues for invasive pests to get a foothold. The ficus leaf-rolling psyllid (FLRP) is the newest of these invaders, first spotted in Los Angeles in February of 2016. FLRP primarily attacks fig (*Ficus* sp.) plants, causing galls in the form of leaf rolls. Adults are greenish to brown in color with red eyes and are almost 3 mm in length. According to entomologist Gevork Arakelian at UC Davis, all the recent new pests of ficus other than psyllids were first found in Hawaii or Florida. This is the first time that a new fig pest arrived in California first.

NEW BACTERIAL DISEASE OF CORN

Bacterial leaf streak of corn, caused by *Xanthomonas vasicola* pv. *vasculorum*, was confirmed for the first time in the U.S. in Nebraska in 2016 and soon afterward, was confirmed in Colorado, Illinois, Iowa, and Kansas. Previously, the disease was only known to occur on corn in South Africa. The disease has been observed on field corn, seed corn, popcorn, and sweet corn in Nebraska. The pathogen biology and disease epidemiology have not been studied enough to be well understood. Its potential impact on yield is not known in commercially-available hybrids. The pathogen survives in infected corn debris from previous seasons and is thought to infect the plant through natural openings in the leaves. Irrigation and wind-driven rain, as well as warm temperatures, are thought to exacerbate the disease. Click here for images.

CERTAIN NEONICOTINOIDS POSE LOW RISK TO HONEY BEES

According to a new study by Washington State University researchers, the neonicotinoid pesticides, clothianidin and thiamethoxam, were not found in toxic levels to bees in natural settings. In their one-year study, the trace amounts of these pesticides that were detected (occurring in 50% of study apiaries in agricultural settings and in <5% of urban and rural landscapes) contained levels that were not high enough to cause harm to honey bees. Previous tests have relied on calculating risk, while this study based its findings on specific hazard, a more accurate representation of the circumstances found in natural settings. The study emphasized that following labelled instructions and avoiding spraying during peak pollination times is still crucial to avoiding harm to beneficial insect populations.

TRAVELING BEES HAVE MORE STRESS AND SHORTER LIVES

North Carolina State University entomologists report in Scientific Reports that commercial honey bees that are transported from one location to another have shorter lives than stationary bees. Bee colonies moved from California to Maine were compared to stationary apiaries in North Carolina. The travelling bees had greater oxidative stress and a shorter lifespan of 1 day. When the scientists conducted a similar experiment with local bees that travelled 35-60 miles on multiple trips compared to stationary bees, the results were similar. One day doesn't seem long, but considering a bee's average lifespan is 20 days, it is significant. The authors say this is analogous to 14 years off of a 70-year human lifespan. The primary scientist on the study hopes to use the data in conjunction with other bee studies to help understand the higher mortality rates nationwide.

INSECT GUT BACTERIA FOR BIOREMEDIATION

Scientists at the Universitat de València's Cavanilles Institute studied the gut bacteria of moths that feed on toxic plants in the Albufera Lake in Valencia, Spain. They found that the bacteria is capable of degrading these toxic plant compounds via crystallization and direct degradation. The research was focused on two moth species which feed exclusively on latex-rich *Euphorbia* sp. and alkaloid-rich sea daffodil. Understanding how the bacteria work may prove invaluable to the biotechnology industry where the specialized bacteria could be used to remove latex- and alkaloid-based toxic compounds accumulating in natural areas.

Featured Picture of the Quarter

This image illustrates the importance of removing old plant debris from the garden. In late spring, 10 squash bugs were revealed on this overturned, dried-up pumpkin that was left in the field from last year. There were several other squash bugs under old vines and other debris at this location.

Squash bugs are notoriously difficult to manage, and proper garden clean-up can help in reducing the population.

-Image by Dennis Worwood, USU Extension Emery County Director, Agriculture

New Publications

- The book, Biochar for Environmental Management, was recently updated. The text represents the most comprehensive compilation of current knowledge on all aspects of biochar, including new uses of biochar in composting and potting mixes, the effects of biochar on soil carbon cycles, changes in water availability and soil water dynamics, recent discoveries on historical biochar use in the Amazon, and sustainability and certification.
- The ATTRA Sustainable Agriculture Program posted a new publication on Botanical Control Formulations of Aphids, listing four groupings of bioinsecticides.
- The book, New Horizons in Insect Science: Towards Sustainable Pest Management, gathers together newer aspects of insect sciences like taxonomy, DNA barcoding, physiology, toxicology, vectors and their management, molecular biology, RNA interference in pest management, semiochemicals and pest management using host plant resistance and biological control, appropriated especially for the developing world.

UTAH PESTS people and programs are supported by:

EXTENSION UtahStateUniversity | WPDN Western Plant Diagnostic Network | NPDN National Plant Diagnostic Network | APHIS | NIFA | UDAF Utah Department of Agriculture and Food