New to IPM

For over 30 years, the University of Missouri IPM program has served the agriculture, horticulture, and urban pest management sectors in educating Missouri’s citizens on responsible and sustainable pest management methods. An interlinked community of state faculty specialists, regional extension specialists, the MU Soil Testing and Plant Diagnostic Service, and MU IPM staff strive to deliver timely updates of ongoing and potential pest problems, and the research-based approaches to controlling them. Coordinating our efforts with our partners at Lincoln University broadens the reach of the land grant mission of the two institutions, and allows the collective to accomplish even more. In 2016, we unveiled a new IPM website for Missouri that acts as a modernized communication vehicle for our pest monitoring program, newsletter articles, and social media information. Our state and regional specialists are engaged in an array of research programs that aren’t just a reaction to current problems, but also proactively plan for future pest threats. I hope you enjoy this 2017 update of our observations and activities, and look forward to serving you again in 2018.

Lee Miller
Associate Professor
Division of Plant Sciences

About IPM

Integrated pest management (IPM) is a sustainable approach to managing insect, pathogens, and weed pests through a coordinated decision-making/action-taking process. The goal of IPM is to mitigate pest damage while protecting human health, environmental quality, and economic viability. The MU IPM program is partially funded by a federal grant. It is multidisciplinary and involves a large team of scientists and extension specialists.

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Entomologist

Dr. Kevin Rice is the new MU Extension entomologist.

Kevin received a bachelor’s degree in biology from the University of North Carolina at Asheville and a master’s degree from Auburn University. At Auburn, he studied the effects of red imported fire ants on native arthropod assemblages in natural systems.

After graduating from Auburn University, he received a temporary position at the USDA-ARS lab in Maricopa, Ariz. and investigated pest and predator movement in field crops.

Rice served as an area extension agent with the University of Arizona shortly there after, working closely with field crop growers and industry stakeholders.

Kevin then moved to Ohio State University, where he completed his doctorate degree in entomology. His dissertation examined the effects of invasive emerald ash borer on a native plant species chemical defense, growth and reproductive allocation. This affected the development and survival of native swallowtails consuming these host plants.

His post-doctoral work at Penn State and the USDA-ARS focused on economic damage created by invasive herbivores in field, vegetable and orchard crops.

You can reach Kevin at RiceRev@missouri.edu, 573-882-2838.

Director of the MU Plant Diagnostic Clinic

Dr. Josephine Ezeri-Mgbechi became the new Director of the MU Plant Diagnostic Clinic in January. She comes from Montana State University where her research included a statewide survey of bee diseases and research on soybean pathogens.

She earned her bachelor’s degree in microbiology and her master’s degree in plant pathology from Nigeria. She earned her doctoral degree from Washington State University.

The University of Missouri Plant Diagnostic Clinic has served Missouri since 1965. The clinic assists county Extension specialists, commercial businesses and private citizens with their pest problems. The PDC is capable of plant disease diagnosis, identification of unknown plants and insects. Besides clinic staff, a diverse group of Plant Sciences faculty specializing in agronomy, entomology, horticulture, or plant pathology assist with identification of pests as needed.

The clinic is open year round to receive samples.

Josephine can be reached at the clinic by emailing plantclinic@missouri.edu or by calling 573-882-3019.
New to IPM (continued)

Plant Pathologist

Dr. Kaitlyn Bissonnette is the new plant pathologist for row crops in University of Missouri Extension. She began her duties on Oct. 16, and fills the position previously held by Dr. Laura Sweets who retired.

Kaitlyn conducted her postdoctoral research at Iowa State University, working on applied management of soybean cyst nematode with nematode-protectant seed treatments.

She completed her PhD at the University of Illinois. Her research focused on the use of integrated disease management practices to manage Fusarium mycotoxins in Missouri. SCN numbers are growing in Missouri as farmers devote more acres to soybean production. SCN infests about 75 percent of Missouri fields, according to a recent survey by MU researcher Melissa Mitchum. Many of these fields have high SCN egg counts.

SCN populations are changing also. Traditional management practices for SCN - crop rotation and SCN resistant varieties - are not as effective as they once were. "Seed treatments are an emerging tool in the SCN management toolbox that can be used as a supplement to traditional SCN management practices. They have the potential to change the way we manage SCN," says Bissonnette.

New University of Missouri Extension plant pathologist Kaitlyn Bissonnette brings research on soybean cyst nematode (SCN) management to Missouri.

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SCN populations are changing also. Traditional management practices for SCN - crop rotation and SCN resistant varieties - are not as effective as they once were. "Seed treatments are an emerging tool in the SCN management toolbox that can be used as a supplement to traditional SCN management practices. They have the potential to change the way we manage SCN," says Bissonnette.

While seed treatments show promise, they do not give season-long control. Performance depends upon soil conditions, temperature and rainfall. In addition, they are expensive.

According to more than 25 years of Iowa State University Extension research by Greg Tylka, the number of soybean varieties that are SCN-resistant soybean varieties is increasing.

Numbers grew from less than 25 in 1991 to more than 950 in 2016. However, nearly all varieties are PI 88788. What complicates that problem is that resistance is inconsistent among varieties, says Bissonnette. Additionally, very few commercial soybean varieties are described as SCN susceptible. This makes it difficult to rotate resistance sources.

Eggs within cysts (dead females) can survive up to 10 years in the soil, even when rotating to non-host crops such as corn and planting SCN-resistant seed varieties. When in the presence of a soybean host, they can reproduce, often with 3–6 cycles in one growing season.

SCN-resistant varieties help to reduce SCN reproduction during the growing season, but do not eliminate their reproduction entirely. Those nematodes that reproduced on the SCN-resistant variety can then produce eggs that can reproduce on SCN-resistant varieties with the same resistance source. Over time, the population of nematodes in the soil changes in order to survive when farmers continually plant resistant varieties with the same resistance source.

As a result, SCN-resistant seed varieties become less effective in the fight against SCN. "Can anyone say glyphosate?" Bissonnette says, referring to the development of glyphosate-resistant weed populations after repeated use of glyphosate for weed control.

Bissonnette and her colleagues recommend "Rotate, Rotate, Rotate" to manage SCN:

• ROTATE with a non-host crop such as corn, alfalfa or small grains
• ROTATE to resistant varieties. When numbers are high, do not plant a susceptible variety
• ROTATE resistance sources (i.e. Peking, PI88788, Hartwig)

Multiple university researchers report that SCN egg numbers can be reduced between 5 and 50 percent in the first year after corn in rotation. However, the effectiveness of rotation drops in the second and third year of the rotation. This makes it important to manage SCN while egg numbers are low, Bissonnette says.

She and other Iowa researchers, along with the Iowa Soybean Association, tested Clariva and Ilevo seed treatments for SCN management in University small plot experiments and in statewide strip trials. They measured reproductive factor and yield changes per acre.

They found variability in both SCN reproduction and yield in individual test plots and by location. Some reductions in SCN reproduction were significant, she says, but inconsistent.

For more information, you can reach Kaitlyn at bissonnettek@missouri.edu or follow her on Twitter at @kmbiss.
Temperature inversions are stable air masses in which cooler air is near the earth’s surface and warmer air is on top. Inversions are common throughout the growing season. Inversions may occur at different times of the day, but they typically start between 6 and 7 p.m. during early months and 7 to 8 p.m. in later summer. They also happen at times when farmers may have once thought it safe to spray: when skies are clear and the wind is still.

Off-target movement of herbicides due to temperature inversions is thought to happen when herbicide particles are suspended in the stable air mass. Another possibility is that herbicide droplets may initially land on the intended target but then volatilize, or evaporate, into an inversion, Bish says.

Bish says there are four main indicators of temperature inversion: a clear night sky, wind speeds under 3 miles per hour, presence of dew or frost, and a low-lying horizontal fog.

Bish noted that inversions are not the only possible component in herbicide drift. Volatility and physical drift due to wind, droplet size, sprayer speed and boom height can also contribute to off-target herbicide movement.

Missouri Mesonet provides real-time weather data from stations across the state. Click on the “Temperature Inversion Potential” option. You can also watch Bish’s YouTube videos on temperature inversions at [youtu.be/vDUWsKKEgYY](https://youtu.be/vDUWsKKEgYY) and [youtu.be/3Qce-mbgqys](https://youtu.be/3Qce-mbgqys).

Presentation slides on “Knowing When to Spray Monitoring the Weather” are available at [weedscience.missouri.edu](http://weedscience.missouri.edu). Select the “slideshows” link.

MU Plant Sciences researcher Mandy Bish says these weather stations read air temperatures at three ground heights. MU Extension climatologist Pat Guinan and systems administrator John Travlos collaborated with Bish and MU Extension weed scientist Kevin Bradley to select and equip stations in multiple cropping districts in the state. Reports from each station feed immediately to the free Missouri Mesonet website at [mesonet.missouri.edu](http://mesonet.missouri.edu). This information indicates whether conditions are right for temperature inversions that contribute to chemical drift.

Weed scientist Kevin Bradley and his team of researchers also educated farmers and pesticide applicators about the increased importance of proper cleanout and upkeep of sprayers in 2017.

The availability of dicamba-tolerant soybean increases the need to maintain and clean the sprayer system properly between applications, says researcher Mandy Bish.

This is especially true on post applications. “One specific concern about dicamba and 2,4-D in the spray tank is that although they are water soluble, similar to glyphosate, they act as weak acids and require more effort and care in effectively being removed from the spray tank,” Bish says. “Additionally, glyphosate is very effective in dissolving remnant dicamba residue left in the sprayer.”

She showed reduced node percentage on non-dicamba tolerant soybean plants treated with glyphosate from a tank that previously contained dicamba. Results varied from as low as 2% to as high as 45%, depending upon hose choice and cleaning solution.

Bish stresses that it takes very small amounts of dicamba to injure non-tolerant soybean, so it is important to check the inductor, end caps, nozzles and filters for particulates.

Bish also reported that an IPM survey of 2,300 Missouri applicators (with 69 percent responding) showed that 60 percent said they regularly check and cleanout the spray tank three times following application of one herbicide and before mixing another herbicide.

Bish noted that these procedures may have worked in recent years when applying glyphosate over large acreages, but there is a need for additional caution and effort now to minimize off-target herbicide injury to soybean and other plants.

She said it is important to check the inductor, end caps, nozzles and filters for particulates.
MU brought together industry leaders, farmers and scientists to open conversations about how new products could benefit farmers when used according to label instructions.

MU weed scientists and researchers worked with the Missouri Department of Agriculture (MDA) and other agencies to document dicamba damage to row crops, specialty crops, fruits, vegetables, trees and ornamentals. In August, state agriculture departments around the United States reported 2,708 dicamba-related injury investigations. This included 3.6 million acres of soybeans with dicamba damage.

MDA investigated more than 280 dicamba-related injury reports over 325,000 acres of soybean in 54 Missouri counties in 2017.

MU Extension, with funding from Missouri Soybean Association, updated nine weather stations to give real-time information to alert chemical applicators to inversions. MDA placed a ban on dicamba use in July. MDA lifted the ban with restrictions, including spraying during certain times of the day and under specific wind speeds.

In October, the Environmental Protection Agency announced an agreement with Monsanto, BASF and DuPont to minimize potential for off-target movement of dicamba and ensure use of three pesticides — DuPont’s FeXapan, Monsanto’s Engenia and BASF’s XtendiMax. MDA issued a 24c Special Local Need label for Engenia on Nov. 10 and XtendiMax, and FeXapan on Dec. 11. All three labels contain the same restrictions.

MDA also announced Missouri-specific restrictions for Engenia, XtendiMax and FeXapan:

1. Restricted use pesticide for sale to and use only by certified private and/or certified commercial applicators from applying this product.
2. Training requirement — Prior to purchase and/or use of these products, certified private and/or certified commercial applicators must complete dicamba training provided by MU Extension. Five in-person training sessions and web-based training were offered.
3. Dicamba notice of application form — certified private and/or certified commercial applicators must complete an online Notice of Application form each day before application.
4. Application timing — products cannot be applied before 7:30 a.m. or after 5:30 p.m.
5. Cutoff dates — Use of these chemicals in dicamba-tolerant soybeans and dicamba-tolerant cotton is prohibited after June 1, 2018, in certain southeast Missouri counties and after July 15 in remaining counties.

The MU extension weed science program led by Dr. Kevin Bradley made 31 presentations on dicamba from January to September 2017, and at the annual MU Extension Crop Management Conference. MU specialists and administrators met numerous times with dicamba company representatives, agency partners, and agri-businesses to present the dicamba dilemma and offer recommendations based upon unbiased research.

University of Missouri researchers, under the direction of MU Extension weed scientist Kevin Bradley, are finding that pigweed seed is popping up in birdseed in alarming numbers.

“IT’s pretty shocking,” graduate student Eric Oseland told those attending the annual Integrated Pest Management field day recently. Presence of pigweed seed, especially Palmer amaranth, alarms the agriculture community.

Bradley calls Palmer amaranth the No. 1 weed to watch in Missouri. Last year, weed scientists found multi-herbicide-resistant Palmer amaranth in Missouri.

Oseland recommends MU Extension’s 1D Weeds app to identify weeds (weedID.missouri.edu). Samples also may be sent to MU’s Plant Diagnostic Clinic (plantclinic.missouri.edu). Related news release: “MU studies pollinator mixes as one source of Palmer amaranth seed” (March 9, 2017) extension.missouri.edu/n/3039.
Japanese beetles

The invasive Japanese beetle, *Popillia japonica* (Coleoptera: Scarabaeidae), possesses a pest management challenge for crop farmers, in particular organic producers. Considering that organic options for the management of this pest are limited, developing a mass trapping system to control this pest is a relatively new approach. The mass trapping system developed has proven effective at suppressing cucumber beetles from in commercial farms, and they can be implemented as part of a broader IPM program aimed at managing cucumber beetles.

Cucumber beetles

Spotted (*Diabrotica undecimpunctata howardi*) and striped (*Acalymma vittatum*) cucumber beetles (Coleoptera: Chrysomelidae) are the most significant insect pests of cucurbit crops in most areas of the U.S. including the Midwest (OPPOSITE-BOTTOM). When deployed in a cucurbit field, cucumber beetles are drawn to odor-baited traps, away from the cash crop. Upon entering the trap, beetles are killed by their consumption of a carbaryl-based bait. The three components of the trap are: (1) an empty juice/milk jug, (2) a commercial, floral-based lure, and (3) a stub pill composed of carbaryl (Sevin), paraffin wax, and powdered buffalo gourd. The mass trapping system developed has proven effective at suppressing cucumber beetles in small fruit orchards. Therefore, they represent an alternative to minimize *P. japonica* damage to crops with little or no insecticides applied to the crop.

Effective mass trapping systems developed to control native and invasive insect pests in Missouri.

Dr. Jaime C. Piñero
LINCOLN UNIVERSITY IPM

Mass trapping is a behaviorally-based method of reducing pest numbers by luring them in large numbers to a trap or device that contains an attractant (usually a food component or a pheromone, in some cases in combination with attractive colors) and then killing the pests either, with a toxicant or a mechanism that prevents them from leaving the traps. Effective mass trapping systems have been developed for some insect pests. In Missouri, two mass trapping systems have been developed against native and invasive insect pest species.

Overall, results indicate that the mass trapping system developed is effective at suppressing cucumber beetles from cucurbit plants. Some Missouri producers are currently evaluating the performance of this mass trapping system.

The mass trapping systems developed for organic management of *P. japonica* are highly selective, inexpensive, and low-maintenance and they were effective at capturing beetles while reducing beetle densities in small fruit orchards. Therefore, they represent an alternative to minimize *P. japonica* damage to crops with little or no insecticides applied to the crop.

Missouri farmers have expressed the need for an organic management tool for Japanese beetles.

**Table:** Mass trapping results in Missouri farms, 2012–2017

<table>
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<th>Farm</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>Total</th>
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<td>92,300</td>
<td>873,400</td>
<td>1,062,000</td>
<td>2,649,300</td>
<td>2,091,000</td>
<td>8,315,000</td>
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<tr>
<td>LU Busby</td>
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<td>102,400</td>
<td>817,050</td>
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<td>2,802,600</td>
<td>672,000</td>
<td>6,631,850</td>
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<tr>
<td><strong>Total</strong></td>
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<td>1,690,450</td>
<td>2,413,000</td>
<td>5,451,900</td>
<td>2,763,000</td>
<td>15,544,850</td>
</tr>
</tbody>
</table>

**References:**

Piñero, J.C. *A Comparative Assessment of the Response of Two Species of Cucumber Beetles (Coleoptera: Chrysomelidae) to Visual and Olfactory Cues and Projects for Mass Trapping.* Journal of Economic Entomology (Accepted).

In 2017, University of Missouri Extension horticulturists began a hops yard at Bradford Research Center, Columbia. A specialty crop grant from the Missouri Department of Agriculture funds the hops project.

Horticulturists Patrick Byers and Jim Quinn head the project. They held three field days at the hops yard at Bradford Research Center. Growers, home brewers and commercial brewers were among those in attendance at the well-attended events.

Hops are not new to Missouri agriculture. They have grown here since early Colonial times. According to a U.S. Department of Agriculture report released at the end of 2016, hop acreage in the U.S. grew 72 percent over the last five years. In April, Byers and Quinn planted 10 varieties of hops at the 1/4-acre hop yard at MU's Bradford Research Center. Hops are a perennial plant grown vertically. Varieties planted at the research farm climb up to 15 feet on string trellises. Other varieties grow taller. Crown cost about $5 each. Byers and Quinn planted hops rhizomes 4 feet apart on raised beds. Hops need well-aerated, nutrient-rich soil that drains well. Plants need regular watering, with drip irrigation systems preferred. It takes about three years to create a good hop yard. Plants can produce for up to 10 years. The first year's yield was small, as was expected. Most plants reach full production by the third year. The hop yard is conveniently located for public viewing at the farm entrance.

Like many new vineyard owners, Holden faced challenges from drought, deer, birds, pests and disease. That's where Volenberg and MU Extension come in.

"Dean has been very helpful. University of Missouri Extension is a lifeline for a lot of farmers in the state," says Holden, who signed legislation in 2003 making Norton the official grape of Missouri. "MU Extension is a way to educate the entire state's population on agriculture." Volenberg heads MU's Grape and Wine Institute (GWI). His efforts with GWI include regular email alerts on diseases and pests, educational newsletters, an annual symposium and conference, and face-to-face visits.

MU Extension viticulturist Dean Volenberg provides services to grape growers across the state, including Missouri's 3rd Governor, Gov. Bob Holden. Holden grows Norton grapes at his weekend hideaway at Fredericksburg. Volenberg regularly visits with Holden as the ex-governor learns the nuances of growing grapes on rolling hills overlooking the Gasconade River.

Stone Hill Winery uses the grapes to make the Governor's Reserve Holden Vineyard Norton. The wine represents Missouri agriculture in every way. Made with Missouri grapes at a Missouri winery, it ages 24 months in white oak barrels made by cooper in Higher, Mo. Staves for the barrels come from the state's white oak forests.

With the help of Stone Hill staff, the Holden planted 107 vines of Norton in 2007. They and others handpick the harvest each year.

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The Yangs are part of the growing Hmong population in southwestern Missouri. The most recent U.S. Census data shows 210 Hmong residents in McDonald County and another 137 in Newton County. Barry County reports 169. The area’s Hmong population has skyrocketed since 2000, when only 26 Hmong lived in Missouri.

Members of the Hmong community came to America from Southeast Asia, mostly Thailand, Vietnam and Laos. Many received asylum as refugees in the U.S. after the Vietnam War because of their aid to American soldiers and the CIA. Yang’s father was part of a Hmong resistance movement to communism in Laos during the Vietnam War.

The oldest of seven children, Fae was a month old when the family found refuge in Massachusetts in 1980. The family moved there and in Wisconsin before moving to southwestern Missouri and warmer climates. 

They yearned to return to their agrarian culture, and MU and LU Extension were there to help.

“MU and LU Extension bring the expertise,” says Nichole. “It has been a fruitful collaboration.” Nichole and volunteers like providing a personal connection between vendors and sellers.

Byers, MU horticulturist Robert Balek, LU small farm specialist Nahshon Bishop and LU farm outreach worker David Middleton are part of the team that works with Webb City Farmers Market volunteers and vendors such as Karen Scott of Oakwoods Farm, Grantly Scott mentors Yang on garden techniques such as succession planting and record-keeping to improve profits.

Yang appreciates the team, which mentors him so that he can pass his knowledge on to future generations and to those for whom language remains a barrier.

He describes it as moving backward to go forward. “Backwards in the sense of small, local farmers growing for their families and surrounding community. Forward in the sense that one day, with enough small local farmers, we might just feed the world, or at least our surrounding community. Forward in the sense of small, local farmers growing for their families and their communities. Backwards in the sense of small, local farmers growing for their families and their communities. Backwards in the sense of small, local farmers growing for their families and their communities.”

In this guide, climatologists define the median date as the date when there is a 50 percent chance a frost or freeze temperature will occur before or after a given date. The median date contour maps use the same data as the median date point maps, but with contoured regions of the state.

Extreme date point maps give the latest spring and earliest fall frost and freeze dates using weather stations with more than 100 years of temperature observations.

The weather station and probability table shows data and probability thresholds for weather stations across the state. You may search for the location nearest you by using the weather station search tool, Guinan said.

Find the guide at ipm.missouri.edu/FrostFreezeGuide. Download a free frost/freeze possibilities guide from the MU College of Agriculture, Food and Natural Resources at extension2.missouri.edu/ipm1033.