ARS WEED SCIENCE

Research News and Highlights

Summer 2024

AREA RESEARCH UPDATES

NORTHEAST

Tree of Heaven (TOH), *Ailanthus altissima,* an invasive species introduced into the US in the late 1700s, is now present in many regions. The invasive tree species thrives in disturbed areas with poor soil, grows clonally, and produces large numbers of seed for further spread. Unfortunately, TOH also support survivorship and development of a recently introduced invasive planthopper, spotted lanternfly (SLF), *Lycorma delicatula.* SLF first arrived in eastern Pennsylvania in 2014 and has since spread to 16 additional states throughout the eastern half of the US. This invasive insect prefers TOH as a feeding host season-long, is more fecund when TOH is part of their diet, and is often present in extremely high densities on trunks that lead to a large pest reservoir in unmanaged habitats. Unfortunately, SLF will disperse from TOH, especially when trees become less acceptable due to intense feeding leading to reduced tree vigor, to feed on other hosts including wine grapes. SLF dispersal into vineyards has resulted in increased insecticide inputs, reduced yields, and increased winter injury. A team of ARS scientists at Kearneysville, WV and university collaborators are developing biological control agents for SLF and TOH to suppress populations of both invasive species to increase ecosystem health, mitigate yield losses, and alleviate impacts on native pollinators and plant species.

MIDWEST

The impact of climate change on vegetable crops, which are more sensitive to environmental stressors than staple cereal crops and are essential to human health, has received little study. ARS researchers in Urbana, Illinois, used a sweet corn dataset collected on 16,040 fields across a 27-year period to unravel the significance of local weather anomalies on sweet corn yield. High temperatures (>86 degrees F) during flowering resulted in significant yield losses in sweet corn which were exacerbated under rainfed conditions. This result is cause for concern given predictions of increased frequency of hotter and drier mid-season growing conditions in much of the U.S. Corn Belt. The research underscores the critical importance of prioritizing crop adaptation strategies to high temperature to sustain production of this very popular crop.

PLAINS

Flowering rush is a highly invasive aquatic weed affecting waterbodies and waterways across North America. ARS researchers at Sidney, Montana, are leading the first North American quarantine rearing program, in collaboration with Agriculture and Agri-Food Canada and the Centre for Agriculture and

Bioscience International, for *Bagous nodulosus*, a new candidate biological control agent recently permitted for field release in Canada. Initial colony establishment has been successful, and a first generation of lab-reared insects has been shared with Canadian colleagues to develop additional rearing and research populations in anticipation of release programs. If permitted for release in the U.S., these agents have the potential to reduce the cover and abundance of flowering rush infestations and enhance water, irrigation, and recreation resources.

PACIFIC WEST

New technology provides the ability to forecast short-term, site-specific weather conditions to predict forage production. Climate and weather directly affect plant production across rangeland ecosystems. Forecasting rangeland plant production could provide valuable management information pertaining to livestock purchasing decisions, restoration planning, wildfire fuel loads, and wildlife management decisions. ARS researchers in Burns, Oregon, and Boise, Idaho, developed plant production models using climate data that reliably identify key plant group production responses to weather inputs across time and space. These climate forecasts and plant production models produce significant plant production forecasts with lead times of up to seven months. The ability to predict production using short-term weather forecasts is in the early stages of adoption by federal and state land management agencies and ultimately will be useful to private livestock producers and conservationists interested in better managing rangeland landscapes.

SOUTHEAST

The triketone class of herbicides plays an important role in controlling weeds, especially in crops such as corn, soybean and wheat. The main herbicides in this class are mesotrione and sulcotrione which are analogs of the allelochemical leptospermone from the bottlebrush plant. However, the degradation products of mesotrione and sulcotrione can negatively affect aquatic plants and microorganisms. The benzoic rings resulting from the degradation of these herbicides are responsible for the toxic effects. To develop more environmentally friendly triketone herbicides, ARS researchers in Oxford, Mississippi, made a series of structurally related triketone analogs originating from malonic acid, a naturally occurring compound found in many fruits and vegetables. Bioassay results indicated that these newly synthesized compounds exhibited strong herbicidal activity. Unlike mesotrione and sulcotrione, these compounds lack benzoic rings. The new chemical entities (keto-diesters) provide a new class of herbicides and their mode of action is likely similar to that of mesotrione and sulcotrione. In addition, several keto diether-based compounds developed were found to reduce potential leaching in plant leaves compared to commercial triketone herbicides. A patent is being filed and should allow for commercial production for use by growers and producers in a wide range of cropping systems.

OFFICE OF NATIONAL PROGRAMS

AREAWIDE PEST MANAGEMENT

In 1993, USDA's Agricultural Research Service in concert with a USDA IPM Working Group, developed a partnership framework for an Areawide Pest Management (AWPM) initiative that would include the federal, state, and private sectors as partners. On September 27, 1993, key pest management representatives from the USDA, university research and extension, and several state Departments of Agriculture participated in an organizational meeting in Beltsville, Maryland. At this meeting, participants identified key pests and cropping systems for which environmentally sound pest management technologies were available for implementation on an area-wide basis. The following year, Congress allocated funding that would support projects through the AWPM program, which has recently been in jeopardy.

Research at ARS has advanced the AWPM approach and resulted in: 1) innovations in advanced pest monitoring; 2) the use of predictive models to target vulnerable pest life stages; 3) new spray technologies to reduce off-target drift; 4) new planting systems; 5) population-suppression strategies such as mating disruption; 6) the use of disease resistant cultivars; 7) advances in scientific knowledge of pest and host biology and ecology; and 8) the use of biological controls, biopesticides, and biotechnology.

Invasive insects, weeds, and diseases result in economic losses and management costs totaling more than $63 billion annually in the United States and invasive pathogens and pests might become the first trillion-dollar threat to agriculture and natural lands. To counter these threats, the most reliable and sustainable approach is IPM. When implemented, particularly at regional scales, areawide IPM plays a major role in protecting not only the environment, but human health. ARS partnerships with APHIS, NIFA, and other federal departments are contributing to new knowledge on IPM through basic and applied research, which is resulting in improved areawide IPM practices implemented across vast acreages.

RESEARCH SPOTLIGHT

DR. MARTY WILLIAMS

Martin Williams, PhD
Weed Ecologist
ARS Global Change and
Photosynthesis Research Unit
Urbana, Illinois

The WSN reached out to Marty to get his thoughts on weather extremes, weed dynamics, and herbicide resistance to name a few and his advice to those thinking about a career in weed science. Marty is a weed ecologist at the ARS Global Change and Photosynthesis Research Unit in Urbana, IL.

WSN: Hi Marty. How are you? Enjoying the weather so far?

Marty: What a crazy start to a field season. Some of the first field experiments we planted this spring were flooded out. And every time field conditions almost became suitable, it rained again. It has been eerily representative of Brad Tomasek's MSc thesis chapter on projected changes in field workability for Illinois that we published in 2017. We have since caught up on planting field experiments. Interestingly in the same paper cited above, we discovered summer drought metrics were expected to increase under every greenhouse gas emissions scenario. So, for now, we're hoping the rains return in moderation. Time will tell.

WSN: That does sound wild. Not really tracking the 30-year average that we've been using for decades. Are you seeing more 100-year events in terms of drought and if so, how are growers coping in the Midwest?

Marty: I believe the latest climate assessment for Illinois was published in 2021. In that report, Illinois has gotten warmer and wetter. Warming has been driven more by nighttime temps than daytime temps, which is most noticeable in the summer. Changes in precipitation vary seasonally, with greater winter and spring precipitation, and less summer precipitation. Interestingly, intense rainfall events (>2") occur more often. Based on changes in both temp and precipitation, risk of short-term droughts is expected to increase. For sure, weather is at the top of growers' minds. Illinois has some fantastic soils for rainfed crop production, but they're not immune to the challenges of farming in a changing climate. Many fields are tiled, or being retiled, which can help with intense rainfall events. We've seen a trend in earlier plantings - when possible - especially for soybean. We're also seeing changes in specialty crop production. Warming temperatures are shifting plant hardiness zones northwards. At the same time, certain crops are becoming more difficult to grow. For instance, commercial sweet corn production in the state has plummeted in recent years. Perhaps no surprise, as Daljeet Dhaliwal's PhD work found just how risky it is to grow sweet corn under rainfed conditions in the Midwest. So perhaps 'coping' for some is as profound as not growing certain - even long-established - crops.

WSN: So, what about weeds? Since you've been in the Midwest, what changes have you seen in terms of species and their impacts? Have some faded and others taken their place? Which ones have moved in?

Marty: I share your interest in the trajectories of individual weed species over time. I find enjoyment in finding older literature on the problem weeds of yesteryear, and whether they remain a problem today or not. It seems common lambsquarters has been around and problematic for over a century. Wild buckwheat was among the most problematic weeds in major vegetable crops of the Midwest in the 1960's; however, it didn't show up in our multiple surveys of Midwestern fields since the 2000s. Most of your readers are familiar with waterhemp. It appears to have become a problem beginning in the 1990s and is now a poster child of multiple herbicide resistance. Such trends make me wonder about the adaptations that have occurred in species that now thrive. And not just herbicide resistance, but other traits as well. What genetically inherited traits have played an important role in their success? Moreover, can we use such knowledge to improve how we manage the weeds? For traits related to stress tolerance (i.e. flooding, drought, heat, etc.), can we use such knowledge to help our crops adapt to climate change? With recent advances in weed genomics as well as other tools in population genetics, bioinformatics, machine learning, and more, there are some exciting new and important opportunities for those who study weeds.

WSN: Wow! You've really spanned the ages to over 60 years ago and topics to our modern molecular approaches. I know you spent some time earlier in your career in eastern Washington. What have you noticed through your research that is different about weeds there compared to where you are now in Illinois? What about how growers approach them in terms of management – any social differences, as well?

Marty: Haha! Let me be clear, I haven't been studying weeds for 60 years! In comparing the inland Northwest to the Midwest, the first thing that jumps out to me is that it is easier to do field research on irrigated crops in the Northwest. Being able to control water supply is hugely helpful. Timing of field events was very predictable. While the Northwest is still at the mercy of mother nature (e.g. winter snowpack to keep the irrigation flowing in the summer), the Midwest weather throws a direct punch, and often. The diversity of weed problems in the Northwest is more striking, too. The orographic effects create a wide range of environmental conditions over relatively short distances. Crop diversity is large, therefore crop and weed management tactics are all over the board. This diverse landscape results in a host of complex weed issues not just in cropping systems but also in aquatic environments, forests, riparian areas, and rangelands. For many growers, herbicides are the first line of defense against weeds. My sense, and I have no data to support this, is that growers in the Northwest are more amenable to diversified weed management compared to the Midwest. This is born out of necessity. Many crops grown in the Northwest have fewer registered herbicides compared to corn and soybean of the Midwest. Genetically modified herbicide tolerant crops are the exception, not the norm. Crop rotations further restrict herbicide use. Weeds are no less of a problem in the Northwest, so it makes sense that if one has limited herbicide options, they would think and act 'outside the box' for solutions to persistent weed problems.

WSN: Hey, not a lot of people have been doing research on weeds for 60 years, so no misunderstanding there! It's just that we as a collective see so much change, but we seldom take time to reflect on it as you did. Speaking of change, you talked about grower approaches across regions, and it would be interesting to hear your take on the effects of the Endangered Species Act and what it's going to do to herbicide use and how growers might have to change their approach.

Marty: I know that EPA's action on ESA is on the minds of many. It certainly sounds like significant changes in herbicide use are possible. While the details of these changes remain to be seen, it's not hard to envision a potential collision course for specific products. ESA isn't about a cost-benefit analysis. Critical habitat of endangered species can't be compromised by the actions of federal agencies, such as EPA's registration of herbicides. Consider dicamba in recent years. Following the launch of dicamba-tolerant soybean, off-target injury complaints have marred the technology. It's one thing to frame dicamba vapor drift as applicator error or a relatively minor problem for non-DT soybean, but it's quite another issue if you consider the landscape as a whole, which sometimes contains endangered species. While the days of over-the-top dicamba applications in DT soybean are numbered, the issue illustrates the scope that EPA must now act.

WSN: Great points. Another issue is the cost of implementing practices to meet the proposed ESA standards and how are growers and practitioners going to pay for them. The good thing is that EPA is engaging in what appears to be an open and transparent discussion to find an agreeable solution. Time will tell. Do you ever see a period in the future when herbicide resistance will not be an issue?

Marty: I try to be a glass half-full kind of guy, but I don't see HR going away in my lifetime. That being said, HR also reflects the power of natural selection in plants. Pretty impressive.

WSN: You're probably right, although these new robots that keep coming out are pretty impressive, as well, in what they can do and their selectivity. It's been really great visiting with you. Before we finish, do you have any advice for the those in weed science or are considering it as a possible career?

Marty: I agree, there are exciting developments in physical weed control technology. I look forward to seeing the tools that gain traction for the long haul. Advice? Go for it. There is a confluence of factors that make for an exciting and challenging time in weed science. Perhaps the stakes have never been higher. Wherever your passion lies - research, development, teaching, or other - if you want to help solve important problems, we need you.

WSN: Well said. Thanks, Marty.

ARS WEED SCIENCE MEETINGS AND OUTREACH

2022 WSSA-ARS Weed Science Webinar Series

- All 10 webinars from the series were recorded and are now available free for viewing at this ARS website.

2024 ARS National Program 304 Plant Protection and Quarantine

- Retrospective review in preparation for the 2025-2030 Action Plan (on-going).

Educational Videos/Guides:

- Biocontrol against a thirsty invasive grass in arid regions of the U.S. (Albany, CA)
- Cheating cheatgrass (Reno, NV)
- The Sagebrush Sea – innovative Restoration (Burns, OR)
- Wildfire mitigation (Reno, NV)
- Cover crops for weed control: the keys for success (Beltsville, MD)

ARS WEED SCIENCE POSITIONS

New Hires (TBD)

- Weed Ecologist – ARS Columbia Plateau Conservation Research Center, Pendleton, OR
- Weed Scientist – ARS Northwest Sustainable Agroecosystems Research, Pullman, WA

Current Openings

- Weed Scientist/Geneticist – ARS Global Change & Photosynthesis Research Unit, Urbana, IL
- Weed Scientist – ARS Center for Agricultural Resources Research, Fort Collins, CO (TBD)
- Weed Ecologist – ARS Pest Management Research Unit, Sidney, MT (TBD)

SELECT ARS PAPERS

(recently published by researchers in weed science)

- **Wheeler GS**, Minteer CR, Palacios J, **Halbritter DA**, David AS (2024) Pruning Brazilian peppertrees to augment field populations of the biological control agent *Pseudophilothrips ichini*. Biological Control. https://doi.org/10.1016/j.biocontrol.2024.105550
- **Halbritter DA**, **Rayamajhi MB**, Madeira P, Leidi JG, Telmadarrehei T, Minteer C (2024) Isolation and reinoculation of a gall-inducing fungus in the invasive Brazilian peppertree (*Schinus terebinthifolia*) in Florida. Invasive Plant Science and Management. https://doi:10.1017/inp.2024.3
- McAvoy TJ, Mays R, Goldstein S, **Dray FA**, Du YZ, Reardon R, Salom SM (2023) Additional host range testing of *Eucryptorrhynchus brandti* (Coleoptera: Curculionidae) for the biological control of tree-of-heaven, *Ailanthus altissima* (Simaroubaceae) in the U.S.A. Biocontrol Science and Technology, 18–43. https://doi.org/10.1080/09583157.2023.2294219
- Bitume EV, Rogers DV, **Pratt PD**, Goolsby JA, **Moran PJ** (2024) Establishment of the wasp *Tetramesa romana* for biological control of *Arundo donax* in northern California and the role of release plot manipulation. Biological Control https://doi.org/10.1016/j.biocontrol.2024.105489
- **Gaskin JF**, **West N**, **Rector BG** (2024) Population structure of three invasive congeneric teasel (*Dipsacus*) species. Invasive Plant Science and Management. 17:37-45. https://doi:10.1017/inp.2024.5
- Donovan VM, Beck JL, **Wonkka CL**, Roberts CP, Allen CR, Twidwell D (2024) Declining pronghorn (*Antilocapra americana*) population productivity caused by woody encroachment and oil and gas development. Global Ecology and Conservation. https://doi.org/10.1016/j.gecco.2024.e02848
- Baughman O, Rios R, Duquette C, **Boyd C**, Riginos C, Eshleman M, Kildisheva O (2024) Evaluating different rates of activated carbon in commercially produced seed coatings in laboratory and field trials. Restoration Ecology e14132. https://doi.org/10.1111/rec.14132
- Case MF, **Davies KW**, **Boyd CS**, Aoyama L, Merson J, Penkauskas C, Hallett LM (2024) Cross-scale analysis reveals interacting predictors of annual and perennial cover in Northern Great Basin Rangelands. Ecological Applications 34(4):e2953. https://doi.org/10.1002/eap.2953
- **Copeland SM**, **Davies KW**, **Boyd CS** (2024) Sagebrush ecosystems are more than artemisia: the complex issue of degraded understories in the Great Basin. Rangeland Ecology and Management. https://doi.org/10.1016/j.rama.2024.03.007
- **O'Connor RC**, Fox VG, **Hamerlynck EP** (2024) Photosynthetic resilience of *Elymus elymoides* and *Pseudoroegneria spicata* seedlings following acute water stress. Rangeland Ecology and Management. https://doi.org/10.1016/j.rama.2024.03.012
- Schantz MC, **Hardegree SP**, **Sheley RL**, Abatzoglou JT, Hegewisch KC, Elias EE, James JJ, Moffet CA (2024) Optimized NMME climate forecasts for rangeland management applications in the Western United States. Rangeland Ecology and Management. https://doi.org/10.1016/j.rama.2024.03.008
- **Davies KW**, **Boyd CS**, **Svejcar LN**, Martyn TE, **Bates JD** (2024) Post-fire management decisions have consequences: drill-seeding disturbance and effects of co-seeding introduced with native bunchgrasses. Global Ecology and Conservation. https://doi.org/10.1016/j.gecco.2024.e03021
- **Davies KW**, **Boyd CS**, **Bates JD**, **Svejcar LN**, **Porensky LM** (2024) Ecological benefits of strategically applied livestock grazing in sagebrush communities. Ecosphere 15(5):e4859. https://doi.org/10.1002/ecs2.4859
- Soltani A, Ospanov M, Ibrahim ZA, **Bajsa-Hirschel J**, **Cantrell CL**, Cizdziel JV, Khan IA, Ibrahim MA (2024) Menthalactone from *Mentha piperita* L., a monocot-selective bioherbicide. International Journal of Plant Biology. 15:293-303. https://doi.org/10.3390/ijpb15020025

- Huddell A, Needelman B, Law EP, Ackroyd VJ, Bagavathiannan MV, Bradley K, Davis AS, Evans JA, Everman WJ, Flessner M, Jordan N, Schwartz-Lazaro LM, Leon RG, Lindquist J, Norsworthy JK, Shergill LS, VanGessel M, **Mirsky SB** (2024) Early-season biomass and weather enable robust cereal rye cover crop biomass predictions. Agricultural & Environmental Letters. 9, e20121. https://doi.org/10.1002/ael2.20121
- **Fulcher MR**, **Tancos MA**, **Mueller RC**, Tannières M (2024) Importance of pathobiomes to the success of microbial weed biocontrol agents. Biological Control https://doi.org/10.1016/j.biocontrol.2024.105498
- Croghan L, Smith AG, **Tancos MA**, Anderson NO, Becker RL (2023) Benefits and risks of gene drives for invasive plant management - the case for common tansy. Frontiers Agronomy. https://doi.org/10.3389/fagro.2023.1290781
- **Fulcher M**, Staley C (2024) Fungal plant pathogen *Colletotrichum shisoi* identified as a potential biological control agent of invasive *Perilla frutescens* in the United States. Biocontrol Science and Technology. 34:375–388. https://doi.org/10.1080/09583157.2024.2343110
- **Fulcher MR**, Little RC (2024) Development and application of the fungal plant pathogen *Colletotrichum shisoi* to control invasive *Perilla frutescens*. Biological Control. https://doi.org/10.1016/j.biocontrol.2024.105543