

Station News

The Connecticut Agricultural Experiment Station
Volume 13 Issue 10 | October 2023



The mission of The Connecticut Agricultural Experiment Station is to develop, advance, and disseminate scientific knowledge, improve agricultural productivity and environmental quality, protect plants, and enhance human health and well-being through research for the benefit of Connecticut residents and the nation. Seeking solutions across a variety of disciplines for the benefit of urban, suburban, and rural communities, Station scientists remain committed to "Putting Science to Work for Society", a motto as relevant today as it was at our founding in 1875.



CAES

The Connecticut Agricultural Experiment Station

Putting Science to Work for Society since 1875

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JASON C. WHITE, PH.D., met with Professor Saion Sinha of the University of New Haven and of 12-15 Molecular Diagnostics to discuss collaborative research (September 1); met by Teams with staff of the Department of Consumer Protection Division of Drug Control to discuss the Adult Use Cannabis testing program (September 1); along with **SARA THOMAS, PH.D.**, **SARA NASON, PH.D.**, and **NUBIA ZUVERZA-MENA, PH.D.**, participated in a Zoom call with collaborators from the University of Minnesota and Yale University to discuss progress on a joint NIEHS grant on PFAS phytoremediation (September 5); hosted Caitlin Peruccio of Representative Rosa DeLauro's Washington DC staff and gave her a tour of the Station and of several programs (September 6); participated by Zoom in the weekly all hands call for the NSF Center for Sustainable Nanotechnology (CSN) (September 6, 13, & 20); met by Teams with Diwa Ratnam of Katana Agriscience to discuss collaborative work (September 7); met by Teams with collaborators of the University of Minnesota and Katana Agriscience to discuss collaborative experiments (September 7 & 22); met by Zoom with collaborators at the University of Minnesota to discuss a collaborative PFAS remediation proposal to 3M (September 7); hosted Professor Julia Kuzovkina of the University of Connecticut and a group of Masters students in Plant Science that are taking a "Leadership in Extension and Public Engagement" (September 8); along with **YI WANG, PH.D.**, participated in a Zoom call with collaborators at the University of Massachusetts to discuss progress on a joint USDA proposal on nanoscale sulfur (September 8); participated in the PhD candidacy exam of Leopoldo Posada Escobar of the University of Maryland Baltimore County (Jason White is on his PhD committee) (September 11); along with **SARA NASON, PH.D.**, participated in a Teams meeting for the PFAS testing Laboratory Capacity and Capability discussion group (September 12); along with **CHRISTIAN DIMKPA, PH.D.**, and **SHITAL VAIDYA, PH.D.**, hosted a Zoom call with collaborators at Johns Hopkins University to discuss progress on a joint USDA nanoscale phosphorus project (September 12); hosted the monthly CSN Nanochemistry-Plant working group call (September 12); gave an invited lecture titled "Nano-enabled agriculture: A path to global food security in a changing climate" at the University of Massachusetts Stockbridge School of Agriculture and met with both faculty and graduate students to discuss collaborative work (September 18); met with staff of the Yale School of Public Health to discuss joint funding (September 19); participated by Teams in the first meeting of the Rodenticide Working Group chaired by Representative Joe Gresko of Stratford (September 19); hosted Chris Connors, Ph.D., of the University of Connecticut Technology Commercialization Services office for a CAES Seminar (September 20); participated in the Farmland Preservation Advisory Board meeting (September 21); participated in the Multistate Activities Committee (MAC) meeting of Northeastern Regional Association of State Agricultural Experiment Station Directors (NERA) (September 21); hosted Lorrie Jones, granddaughter of former CAES scientist Donald Jones (September 21); participated in the monthly CSN Faculty meeting (September 22); gave a welcome message to the first annual CAES Postdoctoral Symposium (September 22); along with **NUBIA ZUVERZA MENA, PH.D.**, and **TRUNG BUI, PH.D.**, participated in a monthly USDA grant meeting on micro-nanoplastics with collaborators at Rutgers University and the New Jersey Institute of Technology (September 25); met by Zoom with Professor Howard Fairbrother of Johns Hopkins University to discuss collaborative research (September 25);

along with staff of the Department of Analytical Chemistry met by Teams with staff of the Department of Energy and Environmental Protection (DEEP) to discuss PCB sample analysis (September 25); along with **NUBIA ZUVERZA MENA, PH.D.**, hosted an undergraduate student from Central Connecticut State University that is interested in a CAES research internship (September 26); travelled to Milwaukee, Wisconsin, and participated in the bi-annual in person CSN all staff meeting (September 27-29).

PUBLICATIONS:

1. Sun, M., Cai, Z., Li, X., Xu, X., Qian, K., Li, H., Guo, Y., Liang, A., Han, L., Shang, H., Jia, W., Ma, C., **White, J. C.**, and Xing, B. (2023). Nanoscale ZnO improves the amino acids and lipids in tomato fruits and the subsequent assimilation in a simulated human gastrointestinal tract model. *ACS Nano*. DOI: [10.1021/acsnano.3c04990](https://doi.org/10.1021/acsnano.3c04990).

Abstract: With the widespread use of nano-enabled agrochemicals, it is essential to evaluate the food safety of nanomaterial (NM)-treated vegetable crops in full life cycle studies, as well as the potential impacts on human health. Tomato seedlings were foliar sprayed with 50 mg/L of ZnO NMs (ZnO QDs and ZnO NPs) once per week over 11 weeks. In comparison with the control, the addition of ZnO QDs significantly increased the contents of lycopene, amino acids, Zn, B and Fe by 40.5%, 15.1%, 44.5%, 76.2% and 12.8%, respectively, in tomato fruits. Metabolomic analysis in tomato fruits showed that ZnO NMs significantly upregulated the biosynthesis of unsaturated fatty acids and sphingolipid metabolism and elevated the levels of linoleic and arachidonic acid. The the ZnO NM-treated tomato fruits were then digested in a human gastrointestinal track (GIT) model. The results of essential mineral release suggest that the ZnO QD treatment increased the bioaccessibility of K, Zn and Cu by 14.8-35.1% relative to the control. Additionally, both types of ZnO NMs had no impact on the α -amylase and trypsin activities and significantly enhanced pepsin activity over the control. The metabolomic profiles of digested fruits in the intestinal fluid demonstrated that ZnO NMs did not interfere the normal process of human digestion. Importantly, ZnO NM treatments increased the nutritional value (e.g., glycerophospholipids, carbohydrates, amino acids and peptides, and phenylpropanoids compounds) of digested tomato fruits. This study provides suggests that nanoscale Zn may be used to increase the nutritional value of treated vegetable crops and could be an important tool for efforts to sustainably increase food quality and security.

2. Zhang, K., Zhao, R., Duan, Y., Fan, L., Fang, Y., Han, J., **White, J. C.**, and Shen, Y. (2023). *Bidens pilosa* root exudates modulate *Pteris multifida* gametophyte development: A proteomic investigation. *Indus. Crops Prod.* 205, 117499. DOI: [10.1016/j.indcrop.2023.117499](https://doi.org/10.1016/j.indcrop.2023.117499)

Abstract: Invasive plant species pose a major threat to native flora, in part due to the allelopathic effects of root exudates. The Novel Weapon Hypothesis (NWH) implicates root exudates as a primary factor for successful take over and destruction of native flora by invasive species. However, the precise mechanisms by which invasive species root exudates mediate this impact are unclear. This study aims to compare and evaluate the specific allelochemical impacts of root exudates from the invasive *Bidens pilosa* on the native fern

Pteris multifida under invasive pressure. Specifically, after 10 days' exposure, a label-free proteomics was applied to analyze the proteins and responsive pathway in *Pteris multifida* Poir. gametophyte upon exposure to two major *Bidens pilosa* L. root exudates, undecane and palmitic acid. And each treatment has three biological replicates. The data show that 2183 proteins were detected in the untreated *Pteris multifida* gametophyte; 1911 proteins in the gametophyte treated with the undecane, and 2148 proteins in the gametophyte treated with palmitic acid. After exposure for 10 days, undecane treated gametophytes exhibited morphological anomalies and exhibited chlorosis; palmitic acid exposure induced no such effects, although development was delayed relative to the control. Using GO functional protein analysis and KEGG pathways detection, it was found that the root exudates played different roles on gametophyte growth. Undecane down regulated fatty acid biosynthesis, damaging the cell and chloroplast membrane, and ultimately leading to cell death. Palmitic acid down regulated flavonoid biosynthesis, compromising the gametophyte photosystem and increasing oxidative stress risk. Undecane inhibited growth by downregulating fatty acid biosynthesis while palmitic acid delayed development by downregulating flavonoids. The specific exudate profiles likely facilitate *Bidens pilosa* invasion, indicating targeted management of key allelochemicals may mitigate invasive impacts on native species.

3. Lewis, R. E., Huang, C.-H., White, J. C., and Haynes, C. L. (2023). Using ^{19}F NMR to investigate cationic carbon dot association with per- and polyfluoroalkyl substances (PFAS). *ACS Nanosci. Au.* 3(5). DOI: [10.1021/acsnanoscienceau.3c00022](https://doi.org/10.1021/acsnanoscienceau.3c00022)

Abstract: There is much concern about per- and polyfluoroalkyl substances (PFAS) based on their environmental persistence and toxicity, resulting in an urgent need for remediation technologies. This study focused on determining if nanoscale polymeric carbon dots are a viable sorbent material for PFAS and developing fluorine nuclear magnetic resonance spectroscopy (^{19}F NMR) methods to probe interactions between carbon dots and PFAS at the molecular scale. Positively charged carbon dots (PEI-CDs) were synthesized using branched polyethyleneimine to target anionic PFAS by promoting electrostatic interactions. PEI-CDs were exposed to perfluorooctanoic acid (PFOA) to assess their potential as a PFAS sorbent material. After exposure to PFOA, the average size of the PEI-CDs increased (1.6 ± 0.5 nm to 7.8 ± 1.8 nm) and the surface charge decreased ($+38.6 \pm 1.1$ mV to $+26.4 \pm 0.8$ mV), both of which are consistent with contaminant sorption. ^{19}F NMR methods were developed to gain further insight into PEI-CD affinity towards PFAS without any complex sample preparation. Changes in PFOA peak intensity and chemical shift were monitored at various PEI-CD concentrations to establish binding curves and determine the chemical exchange regime. ^{19}F NMR spectral analysis indicates slow-intermediate chemical exchange between PFOA and CDs, demonstrating a high affinity interaction. The α -fluorine had the greatest change in chemical shift and highest affinity, suggesting electrostatic interactions are the dominant sorption mechanism. PEI-CDs demonstrated affinity for a wide range of analytes when exposed to a mixture of 24-PFAS, with a slight preference towards perfluoroalkyl sulfonates. Overall, this study shows that PEI-CDs are an effective PFAS sorbent material and establishes ^{19}F NMR as a suitable method to screen for novel sorbent materials and elucidate interaction mechanisms.

4. Sakhno, Y., Esposti, L. D., Adamiano, A., Borgatta, J., Cahill, M., Vaidya, S.,

White, J. C., Iafisco, M., and Jaisi, D. (2023). Citrate-stabilized amorphous calcium phosphate nanoparticles doped with micronutrients as a highly efficient nanofertilizer for environmental sustainability. *ACS Agric. Sci. Technol.* DOI: [10.1021/acsagscitech.3c00117](https://doi.org/10.1021/acsagscitech.3c00117)

Abstract: Increasing global use of phosphorus (P) fertilizers for crop production has generated a series of unintended negative consequences. In response, there is a growing interest in developing new fertilizers—among which amorphous calcium phosphate (ACP) is a viable alternative because of its tunable solubility for P release, high specific surface area, and ability to be doped with vital microelements essential for crops. Herein, we prepared a series of citrate-stabilized ACP nanoparticles (ACPcs) doped with micronutrients (B, Cu, Mg, and Zn) and analyzed their dissolution and release rates of P and micronutrients. Comparative analysis of residual ACPcs, dissolved ions, and pH of eluted buffer showed a strong positive correlation among proton absorption capacity of ACPcs, change in pH of the eluted buffer, and P release rate. The competitive advantage of ACPs against conventional fertilizer (monocalcium phosphate, MCP) providing P nutrition to plants was tested in lettuce (*Lactuca sativa*) in a greenhouse study. The results show that non-doped ACPc stimulates higher lettuce crop yield (by 20%) than MCP and that multi-micronutrient doping in ACPcs enhanced the yield than that in single micronutrient doping. More importantly, P resource use efficiency (RUE), calculated by accounting for crop yield and P lost in leachate, was significantly higher in all ACPc than MCP and was about a log order higher in undoped and multi-micronutrient doped ACPcs. These results demonstrate that the multi-micronutrient doping in ACPc is a more efficient and sustainable way of fertilizing crops than conventional fertilizers.

PAUL AIKPOKPODION, PH.D., presented a talk titled “Pesticides use in Cacao phyto-sanitation, contamination and remediation” in the monthly seminar series of the Connecticut Agricultural Experiment Station in Jones Auditorium (~50 attendees) (September 6).

ANUJA BHARADWAJ, PH.D., gave a talk at the UCONN seminar series titled “Analysis of marijuana products for cannabinoids.” (September 1).

TRUNG BUI, PH.D., gave a talk titled “Sequestration of PFAS in soil using biochar-based materials” at the first 1st Annual CAES Postdoctoral Research Symposium and awarded with “Best Poster Runner-Up” (September 22).

JINGYI ZHOU, PH.D., presented a poster titled “Effect of foliar exposure of soybean (*Glycine max*) plants to Cu under drought stress during flowering stage” at the 1st Annual CAES Postdoc Research Symposium and awarded with “Best Poster Runner-Up” (September 22); presented a poster titled “Characterization of wastewater effluents by liquid chromatography-high resolution mass spectrometry and evaluation of wastewater reuse for plant growth” at the 19th Annual Workshop on Emerging HRMS & LC-MS/MS Applications in Environmental Analysis & Food Safety, University at Buffalo, NY (September 24-25).

NUBIA ZUVERZA-MENA, PH.D. met online with former CAES visiting researcher Vera-Reyes, Ph.D., from Mexico to discuss further collaboration (September 1); Along with **SARA THOMAS, PH.D.**, **JASON WHITE, PH.D.**, and **SARA NASON, PH.D.**, participated in our monthly meeting with collaborators from Yale University and the University of Minnesota regarding our project to improve PFAS phytoremediation with nano-materials (September 5); met with **FAISAL QASEEM, PH.D.**, to discuss data dissemination on soil elemental analysis (September 8); attended the monthly quality assurance (QA) meeting along with staff from the Analytical Chemistry department (September 15); along with **SARA THOMAS, PH.D.**, and **SARA NASON, PH.D.**, participated in a video call with collaborators at Princeton to define experimental details for **SARA THOMAS’s** post-doctoral stay (NIH KC Donnelly Externship) at Peter Jaffe’s lab towards breaking down PFAS in plant tissues (September 19); attended the 1st Annual Postdoctoral Research Symposium where her research contributions were showcased in a presentation and posters (September 22). Along with **JASON WHITE, PH.D.**, and **TRUNG BUI, PH.D.**, participated in our monthly meeting with collaborators from Rutgers University and NJ Institute of Technology regarding our food safety project on the impact of plastics in crops and human health funded by USDA (September 25) and held biweekly meetings along with **TRUNG BUI, PH.D.**, and collaborators as they develop a review on the interactions of plastics with other contaminants; held regular one-on-one meetings with visiting researchers or postdoctoral scientists for training or guidance on individual projects.

PUBLICATIONS:

1. Pavlicevic, M., Elmer, W., Zuverza-Mena, N., Abdelraheem, W., Patel, R., Dimkpa, C., O’Keefe T., Haynes, C. L., Pagano, L., Caldara, M., Marmioli, M., Maestri, E., Marmioli, N., and White, J. C. (2023). Nanoparticles and biochar with adsorbed plant growth-promoting rhizobacteria alleviate Fusarium wilt damage on tomato and watermelon. *Plant Physiology & Biochemistry*, 203, 108052. DOI: [10.1016/j.plaphy.2023.108052](https://doi.org/10.1016/j.plaphy.2023.108052)

Abstract: The addition of biochars and nanoparticles with adsorbed *Azotobacter vine-landii* and *Bacillus megaterium* alleviated damage from Fusarium infection in both tomato (*Solanum lycopersicum*) and watermelon (*Citrullus lanatus*) plants. Tomato and watermelon plants were grown in greenhouse for 28 and 30 days (respectively) and were treated with either nanoparticles (chitosan-coated mesoporous silica or nanoclay) or varying biochars (biochar produced by pyrolysis, gasification and pyrogasification). Treatments with nanoparticles and biochars were applied in two variants – with or without adsorbed plant-growth promoting bacteria (PGPR). Chitosan-coated mesoporous silica nanoparticles with adsorbed bacteria increased chlorophyll content in infected tomato and watermelon plants (1.12 times and 1.63 times, respectively) to a greater extent than nanoclay with adsorbed bacteria (1.10 times and 1.38 times, respectively). However, the impact on other endpoints (viability of plant cells, phosphorus and nitrogen content, as well antioxidative status) was species-specific. In all cases, plants treated with adsorbed bacteria responded better than plants without bacteria. For example, the content of antioxidative compounds in diseased watermelon plants increased nearly 46% upon addition of Aries biochar and by approximately 52% upon addition of Aries biochar with adsorbed bacteria. The overall effect on disease suppression was due to combination of the antifungal effects of both nanoparticles (and biochars) and plant-growth promoting bacteria. These findings suggest that nanoparticles or biochars with adsorbed PGPR could be viewed as a novel and sustainable solution for management of Fusarium wilt.



PAUL AIKPOKPODION, PH.D., presenting his talk titled, “Pesticides use in Cacao phytosanitation, contamination and remediation,” as part of the CAES Seminar Series on September 6, 2023, in Jones Auditorium.



GRANTS AWARDED:

1. SCOTT C. WILLIAMS, PH.D. and **MEGAN A. LINSKE, PH.D.** were awarded a subcontract with Genesis Laboratories, Inc. on the Centers for Disease Control and Prevention contract “Field Trial of Fipronil-Laced Oral Bait for Control of Ticks on White-Tailed Deer” #75D30123R72772 (**September 2023–August 2026, \$80,000**).

DEPARTMENTAL RESEARCH UPDATES:

GOUDARZ MOLAEI, PH.D., attended a Lyme disease-Anaplasmosis case discussion (conference) at Yale School of Medicine and presented a short talk, “Ticks & Tick-Borne Diseases As A Serious Public Health Concern” (September 6); presented an invited talk, “Emerging Ticks & Tick-Borne Diseases As A Serious Public Health Concern” (September 11), presented an invited talk, “Vector-Host-Pathogen Interactions and Vector-borne Disease Surveillance Programs in Connecticut” to the Biology Department, University of Bridgeport (September 25)

PHILIP ARMSTRONG, PH.D., presented a talk, “Phylogenetic Analysis of EEE virus during the 2019 Outbreak in the Northeastern U.S.” to the Vector Borne Disease One Health Sharing Table Meeting for the Public Health Agency of Canada (September 12).

ANGELA BRANSFIELD, PH.D., met with an aide from U.S. Congresswoman Rosa DeLauro's office to talk about research conducted in the Biosafety Level 3 laboratory (September 6); accompanied an inspector from the Connecticut Department of Health through the two biosafety level 3 laboratories on the New Haven campus (September 14); participated *via Zoom* at Yale University's Biosafety Committee meeting (September 21); and participated in the Federal Select Agent Program’s Responsible Official webinar “Effluent Decontamination Systems (EDS): General Maintenance; Common Observations/Citation Analysis CY2022” (September 21).

MARK CREIGHTON visited Temple Israel in Westport, CT during their Rash Hashanah event with his educational hive and spoke with attendees over the course of a few hours (September 16).

HANY DWECK, PH.D., reviewed a multistate research proposal (September 8); wrote a Q&A interview for Current Biology (September 11); discussed and agreed on a collaborative project with Professor John Losey and Todd Uginé, Ph.D., of Cornell University on a five-year NSF grant (September 11).

KELSEY FISHER, PH.D., presented “Monarchs in Motion” for Earthplace’s Environmental Learning Series in Westport, CT (September 7); served as a panelist for the Entomological Society of America Early Career Professional Career Track Webinar series for State/County Government (September 12); served as an Entomological Society of America Science Policy Fellow in Washington DC and met with staff from Health & Bioscience Innovation Practice Group, USDA NIFA, Smithsonian Institution Entomological Collec-

tions, US FS, USDA APHIS, DOI, CDC, DARPA, NIH (September 18-20); and virtually met with and discussed research and priorities update for monarch butterfly conservation with Nicole Alt, the director of the Center for Pollinator Conservation with the US Fish and Wildlife Service (September 26).

MEGAN LINSKE, PH.D., participated in a call with Banfield Bio, Inc. and North Carolina State University to discuss updates in field and laboratory trials (September 6 & 20); was invited to present recent advances in the systemic acaricide delivery trials and current systemic acaricide efficacy field study to the Entomology and Ecology Team at the Centers for Disease Control and Prevention (CDC) (September 12); participated in a call with collaborating members of MaineHealth to discuss the culmination of the first field season of the CDC-funded, five year systemic acaricide study (September 19); participated in a planning call with Genesis Labs, Inc. and White Buffalo, Inc. to discuss newly funded project on deer targeted systemic acaricide development and application (September 19); participated in a call with staff from the CDC Division of Vector-Borne Diseases on progress made on a funded integrated tick management project (September 20); participated in the master's committee meeting for Ms. Sandra M. Zapata-Ramirez from Western Connecticut State University (September 21).

GALE RIDGE, PH.D., spoke about bed bug biology and management to service personnel and staff at St. Mary's Home, West Hartford (September 6); interviewed about Asian jumping worms for the Winstead Citizen and Windsor Journal (September 7), interviewed about the spotted lanternfly by the Hearst Connecticut Media Group (September 7); identified a Pigeon bug, *Cimex columbarius* from a home in New Haven. Origin, Europe (September 15); served as a guest speaker via Zoom on arthropods of medical concern in the northeast (conference), particularly the brown recluse and other medically significant spiders to staffs from poison control centers in Delaware, Pennsylvania, New York, and the New England states as part of their ECHO (Extension for Community Healthcare Outcomes), and video of the talk was forwarded to groups in Canada, Australia, and India (September 19).

CLAIRE RUTLEDGE, PH.D., was interviewed by the Hearst Media on spotted lanternfly in Connecticut, (September 7), resulting in the article "Why are lanternflies being spotted more in Connecticut? They're hungry." (September 8), CT Insider <https://www.ctinsider.com/news/article/spotted-lanternflies-invasive-ct-summer-fall-18354555.php>; helped to administer the oral portion of the Arborist Licensing Exam at Lockwood Farm, Hamden CT (September 13); gave a short on-air interview with the "Brian & Company" morning show on station WTIC about spotted lanternfly (September 15); presented information on spotted lanternfly and emerald ash borer at the Tree Wardens Association of Connecticut Annual Picnic, Clinton, CT (September 15); taught TWACs, Tree Warden School on insects, CAES, New Haven, CT (September 21); participated as a poster judge in the first annual Post-Doctoral student symposium, CAES, New Haven, CT; and Presented "Spotted Lanternfly in Connecticut" Greenwich Audubon Center, Greenwich, CT (September 30).

VICTORIA SMITH, PH.D., was interviewed by the Greenwich Sentinel, regarding spotted lanternfly (September 11).

TRACY ZARRILLO attended a virtual meeting with researchers from the University of Massachusetts, Pennsylvania State University, University of Georgia, and the USDA Forest Service to discuss our collaboration regarding bees in eastern forests (September 6); was invited to become a member of the Invertebrate Taxa Team for the upcoming 2025 revision of the Connecticut State Action Wildlife Plan by Terwilliger Consulting, Inc. and CT-DEEP and attended a virtual training webinar to learn about the project (September 26); attended a viewing of the film “My Garden of a Thousand Bees” hosted by the Glastonbury Pollinator Pathway at the Welles-Turner Memorial Library and was available to answer questions about Connecticut wild bees after the film (September 28); and was interviewed by Susan Freinkel about the rediscovery of *Andrena rehni* in Connecticut for Smithsonian Magazine (September 29).

CHRIS MAIER, PH.D., (Emeritus) was appointed to the Invertebrate Taxonomic Team of DEEP to assist with developing a new State Wildlife Action Plan (September 11); and displayed a new entomological book and a series of flower flies (in the genus *Spilomyia*) which are spectacular Batesian mimics of stinging Hymenoptera at a meeting of the Connecticut Entomological Society at the CAES (September 15).

KIMBERLY STONER, PH.D., (Emeritus) staffed a table at the CT Green Expo at Edgerton Park in New Haven, representing CT NOFA (September 9); participated as a member of the Steering Committee in a retreat of the Working Lands Alliance at the DeKoven House in Middletown (September 19).



HANY DWECK, PH.D., wrote a Q&A interview for Current Biology, and his interview and photo appeared in the journal: <https://www.sciencedirect.com/science/article/pii/S0960982223010552?dgcid=author>



The CAES Postdoctoral Association hosted the 1st Annual Postdoctoral Research Symposium on September 22, 2023. Participation was open to CAES Postdoctoral Scientists and all trainees at the station including interns, master's students, and PhD students. Six abstracts were selected for talks and fourteen abstracts were selected for a poster session by a panel including **PhDs: NASSIFATOU TITTIKPIA** (Analytical Chemistry),

ITAMAR SHABTAI (Environmental Sciences and Forestry), **HANY DWECK** (Entomology), and **RAQUEL ROCHA** (Plant Pathology And Ecology). **DAVID GIESBRECHT, PH.D.** (Entomology) won "Best Presentation" for his talk titled "Identifying genetic markers of pyrethroid resistance in *Culex pipiens* mosquitoes in the Northeastern USA" and **REBECCA JOHNSON, PH.D.** (Entomology) won "Best Presentation Runner-Up" for her talk titled "Multiple blood feeding alters the DENV blocking ability of Wolbachia in *Aedes aegypti*." **MOHAMED-AMINE HASSANI, PH.D.** (Plant Pathology and Ecology) won "Best Poster" for his poster titled "Impact of inter-species interactions between flower microbiota commensals and a floral pathogen on disease incidence and pathogen activity" and **JINGYI ZHOU, PH.D.** (Analytical Chemistry) won "Best Poster Runner-Up" for her poster titled "Effect of foliar exposure of soybean (*Glycine max*) plants to Cu under drought stress during flowering stage." Judges for oral presentations included **PhDs: KELSEY FISHER** (Entomology), **LEIGH WHITTINGHILL** (Environmental Sciences and Forestry), **ANUJA BHARADWAJ** (Analytical Chemistry), and **Neil Schultes** (Plant Pathology and Ecology). Poster presentation judges included **PhDs: KELSEY FISHER, CLAIRE RUTLEDGE,** and **HANY DWECK** (Entomology), **LEIGH WHITTINGHILL, SUSANNA KERIÖ, BLAIRE STEVEN** and **SCOTT WILLIAMS** (Environmental Sciences and Forestry), **ANUJA BHARADWAJ** (Analytical Chemistry), and **RAQUEL ROCHA, RAVIKUMAR PATEL** and **NEIL SCHULTES** (Plant Pathology and Ecology). The day was capped off with a Keynote Lockwood Lecture by John Carlson, Ph.D., Eugene Higgins Professor of Molecular, Cellular and Developmental Biology, Yale University titled "Chemoreception in Insect Vectors of Disease." The event was well attended with ~60-70 people in the audience at all times during the day.

DEPARTMENTAL RESEARCH UPDATES

SCOTT C. WILLIAMS participated in a Zoom meeting with University of Connecticut Master's Degree student Samantha Lewis on her proposed thesis and agreed to sit on her graduate committee (September 5); participated in a collaborative Zoom call with members of the Banfield Biologic NIH SBIR-funded tick repellent fabric team (September 6); invited to speak virtually at the Entomology and Ecology Team meeting of the Division of Vector-Borne Diseases of the Centers for Disease Control and Prevention about CAES's work on systemic acaricidal treatment of wildlife reservoirs for tick management (September 12); hosted a Zoom meeting with members of the MaineHealth team on progress on a collaborative research grant (September 19); participated in a Zoom call with collaborative partners Genesis Laboratories, Inc. and White Buffalo, Inc. discussing recently award CDC contract "Field Trial of Fipronil-Laced Oral Bait for Control of Ticks on White-Tailed Deer" (September 19); participated in a collaborative Zoom call with members of the Banfield Biologic NIH SBIR-funded tick repellent fabric team (September 20); participated in a Zoom call with staff from the CDC Division of Vector-Borne Diseases on progress made on a funded integrated tick management project (September 20); participated in a collaborative Zoom call with members of the newly formed Centers for Disease Control and Prevention-funded Training and Evaluation Center (partnering with Cornell University, Penn State University, University of Maryland, MaineHealth) about steps forward toward evaluation of a rodent-targeted vaccine for Lyme disease prevention (September 27).

JOSEPH P. BARSKY served as a judge for the FFA Regional Agriscience Fair in Springfield, MA (September 15); interviewed by Jennifer Aherns of Connecticut Public Radio about the status of the 2023 acorn mast crop (September 28).

GREGORY BUGBEE gave a talk titled "Survey Methods for Aquatic Plants" to the Northeast Aquatic Plant Management Society Plant Camp at UCONN -Avery Point (40 participants) (September 12); gave a talk titled "The Aquatic Vegetation of Cedar Lake, Chester, CT" to The Northeast Aquatic Plant Management Society Plant Camp at Camp Hazen (40 participants) (September 13); judged the Future Farmers of America Northeast Regional Science Fair at the Big E (September 15); interviewed by Mark Branhill of Bird Notes on Hydrilla in the Connecticut River (September 18); gave a virtual seminar titled "Plants/Agriculture" to the Federated Garden Club Environmental School (40 participants) (September 21); interviewed by Debra Atkins of the Lakeville Journal on Hydrilla in Connecticut (September 21).

JEREMIAH FOLEY, IV, PH.D., was interviewed by Amelia Nierenberg of the New York Times on the state of the *Hydrilla* infestation in the Connecticut River (September 6); joined a research collaboration with Susan Wilde, Ph.D., of the University of Georgia Warnell School of Forestry and Natural Resources to document the presence of a deadly avian cyanobacteria neurotoxin, aetokthonotoxin (September 12–14); lead a research project at the USDA-Invasive Plant Research Laboratory in Florida focused on effective integration of herbicides and insect-based biological control methods for combating the water-lettuce (*Pistia stratiotes*) (September 20–24).

SUSANNA KERIÖ, PH.D., gave a talk on "Basic Tree Biology and Physiology" at the Connecticut Tree Warden Association's Tree Warden School (47 participants) (September 7); attended the NE1833 Multistate Chestnut Research Project meeting in Chattanooga, TN and presented a talk on "Chestnut Research in CAES" (18 participants) (September 7-10); met with Annie Mixsell (New Haven Tree System Coordinator) and Miche Palmer (Program Manager for GreenSkills, Yale Urban Resource Initiative) to plan a research project on mycorrhizal inoculations of urban trees (September 12); hosted John Scrivani (Virginia Chapter of The American Chestnut Foundation) for a visit to Lockwood Farm (September 12); administered the arborist exams at Lockwood Farm (September 13); attended a Zoom meeting to plan the 2024 Connecticut Urban Forest Council/Forest Forum Conference (September 18).

SARA NASON, PH.D., participated in the CT PFAS testing Laboratory Capacity and Capability discussion group meeting (September 12); attended meetings for the Best Practices for Non-Targeted Analysis working group (September 13, 14, 19, 22, & 28); started a CAES weekly writing club (September 14, 21, & 28); met with stakeholders from commercial laboratories to discuss how non-targeted analysis with high resolution mass spectrometry can be used in their field (September 22).

ITAMAR SHABTAI, PH.D., hosted a Zoom call with members of the Northwest Connecticut Land Conservancy to advise on quantifiable metrics of soil health improvements (September 12); organized a meeting with participants of the NC1178 Multi-state Hatch project to coordinate submission of a renewal proposal (September 28).

ELISABETH WARD, PH.D., met with the staff of congressman Joe Courtney (CT-2) along with Alison Adams (Director, Forest Ecosystem Monitoring Cooperative) to discuss forest health research and priorities in eastern Connecticut (September 1); presented a talk and guided walk on tree identification for the Connecticut Tree Warden School (47 participants) (September 7); participated in the monthly State Coordinators meeting for the Forest Ecosystem Monitoring Cooperative (September 7); attended "Urban Forests: Solutions for a Changing Climate" conference at the Hixon Center for Urban Sustainability at Yale (September 15); co-led silviculture and forest stand dynamics workshop along with Dr. Jeffrey Ward (CAES), Andrea Urbano (CT DEEP), and Casey Cordes (Regional Water Authority) for the Connecticut Forest & Park Association Master Woodland Managers Program (15 participants) (September 16).

LEIGH WHITTINGHILL, PH.D., acted as a judge at the FFA Agriscience Fair at the Big E (September 15); attended the quarterly CT Council on Soil and Water Conservation meeting and reported on CEAS activities (September 21); met with the farm and community garden managers from Gather New Haven and a manager at Yale Farm about research projects (September 27); visited the Southern Connecticut State University Community Garden (September 27).

PUBLICATIONS

1. Poudel, P. **Whittinghill, L. J.**, Kobayashi, H., and Lucas, S. (2023). Evaluating the effects of *Bacillus subtilis* treatment and planting depth on saffron (*Crocus sativus* L.) production in a green roof system. *HortScience*, 58(10), 1267–1274. DOI: [10.21273/HORTSCI17220-23](https://doi.org/10.21273/HORTSCI17220-23)

Abstract: Given the current urbanization context and rising interest in green roof systems, growing a high-value crop such as saffron crocus in green roof medium could be an opportunity to use the benefits of both the crop and the green roof system; the drainage, aeration, and sand-like texture of green roof media make it suited for saffron production, and the saffron market price could make green roof production commercially viable. Various factors, including plant diseases and planting depth, could affect saffron production. Therefore, this research was conducted to evaluate the effects of planting depth and biofungicide treatments using *Bacillus subtilis* on saffron production in a green roof system. A completely randomized factorial block design was used with planting depth (10 cm and 15 cm) and *B. subtilis* strain QST 713 biofungicide treatments (an untreated control, 15.6×10^9 cfu/L, and 31.2×10^9 cfu/L) as independent variables. In 2019, fresh flower yield, fresh stigma yield, and dry stigma yield were calculated during harvesting, and additional data on flower number, tepal length and width, stigma length, and harvest time were collected in 2020. All variables were analyzed using analysis of variance (ANOVA) with planting depth and biofungicide treatments as fixed effects using R. Fresh stigma yield and dry stigma yield were higher in the 10-cm planting depth in 2019. Results were opposite in 2020: flower number, fresh flower yield, fresh stigma yield, dry stigma yield, and harvest time were higher in the 15-cm planting depth than the 10-cm planting depth. *B. subtilis* treatments did not affect any studied variable in 2020, but in 2019, the higher level of fungicide treatment resulted in lower fresh flower yield and dry stigma yield. There was no effect of biofungicide treatment and planting depth on tepal length, tepal width, and stigma length in both years. This study showed that growing saffron crocus on green roofs is feasible and even resulted in higher yield than field production in many saffron-producing regions and countries. In addition, results indicated that shallow planting might be suitable for annual production, whereas deeper planting could be ideal for perennial production based on the objective. Our findings demonstrated the feasibility of saffron production in the green roof system and suggest further research to develop best management practices.

2. Ferraro, K. M., Welker, L. **Ward, E. B.**, Schmitz, O. J., and Bradford, M. A. (2023). Plant mycorrhizal associations mediate the zoogeochimical effects of calving subsidies by a forest ungulate. *Journal of Animal Ecology*. Early View. DOI: [10.1111/1365-2656.14002](https://doi.org/10.1111/1365-2656.14002)

Abstract: Animals interact with and impact ecosystem biogeochemical cycling—processes known as zoogeochimistry. While the deposition of various animal materials (e.g. carcasses and faeces) has been shown to create nutrient hotspots and alter nutrient cycling and storage, the inputs from parturition (i.e. calving) have yet to be explored. We examine the effects of ungulate parturition, which often occurs synchronously during spring green-up and therefore aligns with increased plant nitrogen demand in temperate biomes.

3. Rosen Vollmar, A. K., Lin, E. Z., **Nason, S. L.**, Santiago, K., Johnson, C. H., Ma, X., Godri Pollitt, K. J., and Deziel, N. C. (2023). Per- and polyfluoroalkyl substances (PFAS) and thyroid hormone measurements in dried blood spots and neonatal characteristics: a pilot study. *Journal of Exposure Science and Environmental Epidemiology*. DOI: [10.1038/s41370-023-00603-4](https://doi.org/10.1038/s41370-023-00603-4).

Abstract: Pediatric thyroid diseases have been increasing in recent years. Environmental risk factors such as exposures to chemical contaminants may play a role but are largely unexplored. Archived neonatal dried blood spots (DBS) offer an innovative approach to investigate environmental exposures and effects.



WASHINGTON DA SILVA, PH.D., had Zoom meetings with Prof. Marcia Michelle Ambrosio from the Universidade Federal Rural do Semi-Árido in Brazil and with Dr. Fereshteh Shahoveisi from the University of Maryland to discuss ideas in using dsRNAs to control fungal plant pathogens (September 11). **The da Silva Lab** members participated in the 1st annual CAES Postdoctoral Symposium held at Jones Auditorium at CAES on September 22, 2023: **Juliana Milagres** gave a presentation titled “Application of exogenous dsRNA for the control of potato virus Y” and the other members presented posters - **Prof. Francisco Faggion** (Mechanical inoculation of plant viruses via high-pressure spray systems), **Rania Eltanbouly** (Nucleic Acid Condensation: An Important Step for Plant Gene Delivery via Nanocarriers), **Raja Muthuramalingam, Ph.D.**, (Overcoming challenges in plant genetic engineering: Targeted gene delivery with nanocarriers), and **Maria Helena Diogenes** (Routes of Infection of *Fusarium* spp. in Melon).

YONGHAO LI, PH.D., participated in the National Plant Diagnostic Network Online Communication & Web Portal Committee meeting via Zoom (8 adults) (September 13); attended the Plant Diagnostic Network Northeast Regional meeting via Zoom (September 14); presented a poster “Common Tree Diseases” at the Tree Warden Association of Connecticut Fall Workshop in Madison (50 adults) (September 15); interviewed by Ms. Abby Weiss at Hearst Connecticut Media about anthracnose of maple and contributed an image to the article “Here’s why maple leaves in Connecticut are turning brown and falling early, according to experts” in CT Insider published on September 21 (September 19); taught the “Tree Diseases” class for the CT Tree Warden School in New Haven (40 adults) (September 21).

FELICIA MILLETT participated in the NEPDN Monthly Meeting via Zoom (15 adults) (September 14); participated in the NPDN Proficiency Committee virtual Meeting (6 adults) (September 19); contributed an image of maple anthracnose to the article authored by Abby Weiss at Hearst Connecticut Media “Here’s why maple leaves in Connecticut are turning brown and falling early, according to experts” published in CT Insider (September 21); and joined the Workshops and Field trips Sub-Committee for the 2024 NPDN National Meeting; visited the Plant Health Clinic at the University of Arkansas and met with Sherrie Smith and Jason Pavel for a tour of the diagnostic lab facility, Fayetteville, AR (September 27).

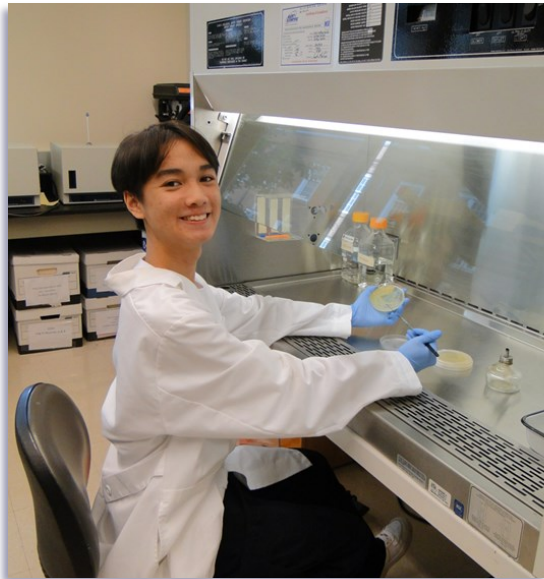
NEIL SCHULTES, PH.D., served as a judge for oral and poster presentations and along with **RAQUEL ROCHA, PH.D.**, and **RAVI PATEL, PH.D.**, served as judges for poster presentations at the CAES Postdoctoral Symposium (September 22).

Other judges participating in the CAES Postdoctoral Symposium for oral presentations included **PhDs: KELSEY FISHER** (Entomology), **LEIGH WHITTINGHILL** (Environmental Sciences and Forestry) and **ANUJA BHARADWAJ** (Analytical Chemistry) and for poster presentations, **KELSEY FISHER, CLAIRE RUTLEDGE** and **HANY DWECK** (Entomology), **LEIGH WHITTINGHILL, SUSANNA KEIRÖ, BLAIRE STEVEN** and **SCOTT WILLIAMS** (Environmental Sciences and Forestry), **ANUJA BHARADWAJ** (Analytical Chemistry).

QUAN ZENG, PH.D., met Bruno Fulchi of Agroventure LLC and discussed about research collaboration (September 6); presented an invited seminar “How bacteria talk to each other in plant rhizosphere, and what that implies for plant health and fitness?” at the seminar series of Department of Plant Science and Landscape Architecture, University of Connecticut (30 adults) (September 22), participated in a grant panel meeting of USDA-NIFA (25 adults) (September 29).

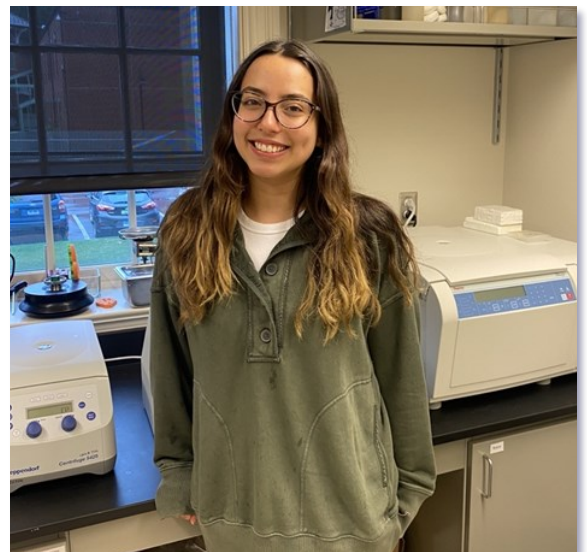
ROBERT MARRA, PH.D., was interviewed by Paige Curtis on beech leaf disease for National Audubon Magazine: <https://www.audubon.org/news/fast-spreading-disease-threatens-foundational-tree-eastern-forests> (September 5 & 20); administered the arborist certification oral examination (September 13); attended the annual summer meeting of the CT Tree Wardens Association at Hammonasset State Park, and presented on beech leaf disease and oak wilt (50 adults) (September 15).

NEW STUDENTS, STAFF, AND VOLUNTEERS:



Andrew Ung, a senior at Fairfield Warde High School, started volunteering as an intern at the CAES Plant Disease Information Office in August. He is currently interested in learning more about botany and plant pathology and gaining experience while practicing lab technique under the supervision of **YONGHAO LI, PH.D.**, and **FELICIA MILLETT**. He aims to be a future researcher and is concurrently taking arboriculture classes while helping out at the Station. He enjoys playing violin and tutoring biology in his free time.

Maria-Jose (Majo) Estrada is a junior at Albertus Magnus College pursuing a B.S. in Biology. She started volunteering at CAES in July in the department of Plant Pathology and Ecology under the supervision of **QUAN ZENG, PH.D.** She will be working on determining the mechanisms for how yeast induce immunity to fire blight in apple trees.



DEWEI LI, PH.D., presented an online seminar on “New fungal species and new diseases” to The Annual meeting of Wuhan Society of Forestry (60 attendees) (September 28) via Tencent Meeting.

RICHARD COWLES, PH.D., demonstrated “Make your own deer repellent,” to the Maine Christmas Tree Association Fall Meeting, Newburgh, ME, (60 participants) (September 9). Co-presented with **JAMES LAMONDIA, PH.D.**, “Opening a can of worms: careers in nematology,” to the Biology Department, Eastern Connecticut State University, Willimantic (30 attendees) (September 29). Demonstrated “Make your own deer repellent,” and “Managing conifer root aphids, white grubs, and phytophthora with root dips at planting,” to the NH/VT Christmas Tree Growers’ Association Fall Meeting, Hampton Falls, NH, (60 participants) (September 30).

ROSE HISKES assisted Peter Picone, DEEP Wildlife on a free Invasive and Native Plant Walk and Talk at Robbins Swamp Wildlife Management Area, Canaan, (15 attendees) (August 27). She conducted a site visit to Mill Woods Pond Park, Wethersfield, with tree Warden Brian Kenny to examine a dead hickory tree. The tree had been stuck by lightning (September 12). Taught a class on invasive plants to the Federated Garden Club school via Zoom (25 attendees) (September 14). Along with **KATHERINE DUGAS** and **JACOB RICKER**, staffed the CAES information booth at the Big E, Springfield, MA (September 19).

JAMES LAMONDIA, PH.D., (Emeritus) accepted the Century Farm Award for Horton Farms as a part of the CAES Plant Science Day (August 5); conducted a tour of tobacco plots and breeding lines with Lewis Flowers (Universal Leaf) (August 9); and presented a webinar ‘Battling Boxwood Blight’ as a part of the Boxwood Blight Insight Group webinar series hosted by the Horticultural Research Institute (250 attendees) (August 23). presented a seminar at Eastern Connecticut State University on Nematology and Beech Leaf Disease with **RICHARD COWLES, PH.D.**, (25 attendees) (September 29).

PUBLICATIONS:

1. Li, H., Liao, Y.-C.-Z., Li, D.-W., and Zhu, L.-H. (2023). First report of *Erysiphe alphitoides* causing powdery mildew of *Cocculus orbiculatus* in China. *Plant Disease*, 107(7), 2260. DOI: [10.1094/PDIS-11-22-2675-PDN](https://doi.org/10.1094/PDIS-11-22-2675-PDN)

Abstract: *Cocculus orbiculatus* (L.) DC (Menispermaceae) is a vine traditionally used as a medicinal herb in Asia and grows primarily in wet tropical biomes. In late April 2022, typical symptoms of powdery mildew were observed on leaves of *C. orbiculatus* on the campus of Nanjing Forestry University, China. Approximately 90% of the plants were infected. Superficial mycelia and conidia were amphigenous on the leaves, pale yellow, and severe infections caused necrotic discoloration of the leaves. Infected leaves were collected to identify the pathogen. Hyphae were hyaline and branched. Conidiophores were solitary, unbranched, straight, cylindrical, smooth, hyaline, $69.3 \pm 11.1 \times 7.9 \pm 0.6 \mu\text{m}$ ($n = 50$).

Foot cells were mostly cylindrical, straight, rarely curved, smooth, hyaline, $53.2 \pm 6.2 \times 7.5 \pm 0.4 \mu\text{m}$ ($n = 50$). Appressoria were lobulate, solitary or in opposite pairs, hyaline to pale yellow. Conidia were single, ellipsoid, oval or doliform, hyaline or pale yellow, $38.6 \pm 2.3 \times 20.9 \pm 0.8 \mu\text{m}$ ($n = 50$). Conidial germ tubes developed at a subterminal position. No chasmothecia were observed. Representative specimens were deposited in the NJFU Herbarium (NF50000010). Based on these morphological characteristics, this fungus (MFJ 1-1) was provisionally identified as *Erysiphe alphitoides* (Takamatsu et al. 2007). To verify the identification of the pathogen, mycelia and conidia were obtained from diseased leaves and genomic DNA of the fungus (MFJ 1-1) was extracted. The internal transcribed spacer region (ITS) and large subunit (LSU) gene were amplified with primers ITS1/ITS4 and LR0R/LR5, respectively (Rehner and Samuels 1994; White et al. 1990). The sequences were deposited in GenBank (ON612134 for ITS, ON620080 for LSU). BLAST results showed that the ITS and LSU sequences were highly similar to *E. alphitoides* (ITS: KF734882, identities = 632/633 [99%]; LSU: MK357414, identities = 890/893 [99%]). Phylogenetic analyses with the concatenated sequences using Bayesian inference and maximum likelihood placed the isolate in the clade of *E. alphitoides*. Pathogenicity was confirmed by gently pressing infected leaves onto five leaves per plant, and three healthy plants were inoculated. Three uninoculated plants served as controls. The plants were placed in a growth chamber with a 16 h photoperiod at $22 \pm 2^\circ\text{C}$, 70% of relative humidity. Symptoms developed 10 days after inoculation, whereas the control leaves remained symptomless. The powdery mildew developing on the inoculated plants was identified as *E. alphitoides* based on morphological characters and ITS sequences. This fungus has a worldwide distribution and a broad host range. Recently, *Ipomoea obscura* (Pan et al. 2020) and *Aegle marmelos* (Banerjee et al. 2020) have been found to be additional hosts. To our knowledge, this is the first report of powdery mildew caused by *E. alphitoides* on *C. orbiculatus* in the world. This finding provides crucial information for developing effective strategies to monitor and manage this disease.

Aulakh, J. S. Frequency (topramezone) and Mission (flazasulfuron) herbicides evaluation in balsam fir transplant beds. *The Real Tree Line*.

Aulakh, J. S., Witcher, A., and Kumar, V. Weed and ornamental plant response to oxyfluorfen + prodiamine. *Agronomy*.

Earnest, R., Hahn, A., Feriancek, N. M., Brandt, M., Filler, R. B., Zhao, Z., Breban, M. I., Vogels, C. B. F., Chen, N. F. G., Koch, R. T., Porzucek, A. J., Sodeinde, A., Garbiel, A., Keanna, C., Litwak, H., **Stuber, H. R., Cantoni, J. L., Pitzer, V. E., Castillo, X. A. O., Goodman, L. B., Wilen, C. B., Linske, M. A., Williams, S. C.,** and Grubaugh, N. D. Survey of white-footed mice in Connecticut, USA, reveals low SARS-CoV-2 seroprevalence and infection with divergent betacoronaviruses. *Nature Communications*.

Ferraro, K. M., Welker, L., **Ward, E. B.,** Schmitz, O. J., and Bradford, M. A. Plant mycorrhizal associations mediate the zoogeochemical effects of calving subsidies by a forest ungulate. *Journal of Animal Ecology*.

Hanna, E., Astete, C. E., Price, T., **Tamez, C.,** Mendez, O., Garcia, G., Fannyuy, K., **White, J. C.,** and Sabliov, C. M. Antifungal efficacy of nanodelivered azoxystrobin against *Rhizoctonia solani* in soybean (*Glycine max*). *ACS Agricultural Science and Technology*.

Hillen, A. P., **Foley, J. R. IV,** Gross, A. D., Mayfield, A. E. III, Williams, J., Xia, K., and Salom, S. M. The impact of imidacloprid on the subterranean survivorship of *Laricobius* (Coleoptera: Derodontidae), a biological control agent of *Adelges tsugae* (Hemiptera: Adelgidae). *Integrated Pest Management*.

Lowry, G. V., Giraldo, J. P., Steinmetz, N., Avellan, A., Demirer, G. S., Ristroph, K., Wang, G. J., Hendren, C. O., Alibi, C. A., Caparco, A., **Da Silva, W.,** Gonzalez, I., Greiger, K., Jeon, S.-J., Khodakovskaya, M. V., Kumar, V., Muthuramalingam, R., Poffenbarger, H. J., Tilton, R. D., and **White, J. C.** Opportunities and challenges to realizing nano-enabled precision delivery in plants. *Nature Nanotechnology*.

Pavlicevic, M., **Elmer, W., Zuverza-Mena, N.,** Abdelraheem, W., Patel, R., **Dimkpa, C.,** O'Keefe, T., Haynes, C., Pagano, L., Caldara, M., Marmioli, M., Maestri, E., Marmioli, N., and **White, J. C.** Nanoparticles and biochar with adsorbed plant growth-promoting rhizobacteria alleviate Fusarium wilt damage on tomato and watermelon. *Plant Physiology and Biochemistry*.

Sun, Y., Jiang, Y., Li, Y., Zhu, G., Wang, Q., Zhao, W., Wang, Q., **Wang, Y.,** Parkash Dhankher, O., **White, J. C.,** Rui, Y., and Zhang, P. Unlocking the potential of nanoscale sulfur in sustainable agriculture. *Chemical Science*.

Zhou, J., Zhang, S., Hui, D., Vancov, T., Fang, Y., Tang, C., Jiang, Z., Ge, T., Cai, Y., Yu, B., **White, J. C.,** and Li, Y. Heterotrophic respiration in a subtropical forest soil: Differential impacts with pyrogenic and fresh organic matter amendment. *Global Change Biology*.



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