Station News

The Connecticut Agricultural Experiment Station
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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

This Issue

Administration	2
Analytical Chemistry	6
Entomology	8
Environmental Science and Forestry	10
Plant Pathology and Ecology	12
Valley Laboratory	16
Journal Articles Approved	17

ADMINISTRATION

DR. JASON C. WHITE along with **DR. SARA NASON** participated in the monthly call of the PFAS Testing Laboratory working group (July 1, 13); along with **DR. WADE ELMER** participated in a monthly conference call with collaborators at the University of Massachusetts Amherst to discuss progress on a USDA nanosulfur grant (July 1); hosted the quarterly CAES Safety Committee meeting (July 1); participated remotely in the PhD Dissertation defense of Jesus Cantu of the University of Texas El Paso (July 5); participated in a Zoom meeting with Christin Arnini, the Mentor Coordinator and Director for Scientific Review Committee of the New Haven Science Fair (July 5); along with **DR. SARA NASON** and **DR. NUBIA ZUVERZA-MENA** participated in Zoom call with collaborators at Yale University and the University of Minnesota to discuss progress on a joint NIEHS grant (July 6); along with **DR. CHRISTIAN DIMKPA** and **DR. NUBIA ZUVERZA-MENA** met with Felipe Franco de Oliveira and Vanessa Takeshita, who are both PhD students from University of São Paulo and are staying at CAES for nine months (July 6); participated in the weekly all-hands Zoom call for the NSF Center for Sustainable Nanotechnology (July 6, 13, 20, 27); hosted a Zoom call with collaborators at the University of Massachusetts to discuss a USDA report on toxic metals resulting from a workshop we hosted (July 6); participated in the monthly CSN Faculty meeting (July 7); met with Rania Eltanbouly of Alexandria University in Egypt to discuss future collaborative work (July 8); hosted a Zoom call with staff at Lucent BioSciences Inc. to discuss collaboration research on nano-enabled agriculture (July 9); participated in the monthly FDA LFFM Human and Animal Food Program Zoom call (July 11); hosted the monthly Zoom call for the CSN Nanochemistry-Plant working group (July 12); along with **DR. SHITAL VAIDYA, DR. CHRISTIAN DIMKPA** and **DR. WADE ELMER** hosted a Zoom call with collaborators at Johns Hopkins University to discuss progress on a joint USDA research project (July 12); hosted Professors from the University of Massachusetts and Haryana Agricultural University in India, and gave a tour of CAES facilities and programs (July 13); participated in a CSN Faculty Strategic Planning Zoom meeting (July 14); participated in the monthly CSN Plant-biosurfaces Zoom call (July 15, 29); hosted a Zoom call with Professor Laura Harrington of Cornell University to discuss CDC Center of Excellence funding (July 18); participated in the CSN External Advisory Board meeting (July 18); participated in the bi-monthly Experiment Station Associates Zoom meeting and gave a CAES Director's report (July 20); participated in the monthly Farmland Preservation Advisory Board meeting (July 21); hosted a Zoom call with Eric Ostivich of the University of Wisconsin Milwaukee to discuss his PhD research (July 22); participated in a Northeastern Regional Association of State Agricultural Experiment Station Directors (NERA) Multistate Activities Committee (July 27); participated in an Organizing Committee meeting for the upcoming annual FDA LFFM meeting (July 27); hosted the monthly CAES J-visa awardee meeting (July 28); participated remotely in the PhD Dissertation defense of Yuqing Ye of the University of Texas El Paso (July 28); participated remotely in the PhD Dissertation defense of Xiaoxiao Yao of the University of Minnesota (July 28); and participated remotely in the PhD Dissertation defense of Carolina Valdes Bracamontes of the University of Texas El Paso (July 29).

PUBLICATIONS

1. Lui, Y., Kornig, C. G., Qi, B., Schmutzler, O., Staufer, T., Sanchez Cano, C., Magel, E., White, J. C., Feliu, N., Gruner, F., and Parak, W. J. (2022). Size- and ligand-dependent transport of nanoparticles in *Matricaria chamomilla* as demonstrated by mass spectroscopy and X-ray fluorescence imaging. *ACS Nano. In press.*

Abstract: *Matricaria chamomilla* flowers were incubated with gold nanoparticles of different size ranging from 1.4 nm to 94 nm and after different incubation times of 6, 12, 24, and 24 h, and the gold distribution in the flowers was destructively measured by inductively coupled plasma mass spectrometry (ICP-MS), and nondestructively by X-ray fluorescence imaging (XFI) with high lateral resolution. As a control, the bio-distribution of iodine ions or of iodine-containing organic molecules (iohexol) was determined, in order to demonstrate the feasibility of mapping the distribution of several elements in parallel. The results show a clear size-dependent transport of the nanoparticles. In addition, the surface chemistry also plays a decisive role in disposition. Only the 1.6 nm nanoparticles coated with acetylcysteine could be efficiently transported through the stem of the flowers into the petals. In this case, almost 80% of the nanoparticles which were found within each flower here were located in the petals. The study also highlights the potential of XFI for in situ recording of in vivo analyte biodistribution.

2. Kong, M., Liang, J., **White, J. C.**, **Elmer, W. H.**, **Wang, Y.**, Xu, H., He, W., **Shen, Y.**, and Gao, X. (2022). Biochar nanoparticle-induced plant immunity and its application with the elicitor methoxyindole in *Nicotiana benthamiana*. *Environ. Sci.: Nano*. DOI: 10.1039/D1EN00953B.

Abstract: The exogenous application of nanoscale biochar has great potential in agriculture to improve crop resistance to pathogens, although the mechanisms underlying this physiological response are unclear. We investigated the potential of nanoscale and conventional biochar amendment to induce resistance in Nicotiana benthamiana upon infection with the pathogen Phytophthora nicotianae. Nanoscale biochar synthesized at 350°C (400 mg L-1) from the corn straw with the particle size of ~160 nm had a beneficial role in the active immunity of N. benthamiana through the ethylene pathway to provide resistance to P. nicotianae infection; in leaf assays, lesion diameters were reduced by 9.26% as compared to controls. Mechanistically, a 20.3% increase in reactive oxygen species (ROS) from biochar NPs amendment activated the ethylene pathway, followed by SA-induced systemic acquired resistance (SAR) expression. The SA-induced immunity increased over 10-fold in the two biochar NPs treatments. In addition, the biochar NPs induced PR1-a to a significantly greater extent than did regular biochar particles. In an experiment with the plant elicitor 5-methoxyindole, biochar NPs served as a unique delivery platform to improve plant growth; over 105.3% in the shoot length and 41.2% in the root length after seed treatment with biochar NPs and 5-methoxyindole compared to the untreated controls. This study demonstrates the successful use of exogenous nanoscale biochar amendment to stimulate plant defense responses and subsequent resistance to the important pathogen P. nicotianae. This approach holds great promise as a new plant protection strategy in sustainable nano-enabled agriculture.

3. Zhi, Y., Li, X., Lian, F., Wang, C., **White, J. C.**, Wang, Z., and Xing, B. (2022). Nanoscale iron trioxide catalyzes the synthesis of auxins analogs in artificial humic acids to enhance rice growth. *Sci. Tot. Environ. 848.* DOI: 10.1016/j.scitotenv.2022.157536

Abstract: Hydrothermal strategies using catalysts have been developed as an efficient technology for converting biomass such as corn stalks into valuable humic acids. This study investigates the composition shifts of humic acids under the action of two iron-based catalysts. The results show that nanoscale Fe2O3 not only accelerated the decomposition of macromolecular biomass but also promoted the condensation of monomers to humic acids, including increased content of growth hormone analogs such as vanillin and methionine sulfoxide. When used as an amendment for rice growth, the artificial humic acids significantly increased the germination rate, water and nutrient absorption of roots, volume and activity of roots, photosynthesis rate and nutrient accumulation, and stress resistance. The data indicate that artificial humic acids are a cost-effective and environmentally friendly approach to sustainably improve the soil carbon pool and enhance agricultural production while simultaneously alleviating environmental stress.

4. Wang, Y., Deng, C., Sharma, S., **Wang, Z.**, Navarro, G., Li, C., **Dimkpa, C.**, Zhao, L., **Steven. B. T.**, Wang, Z., **LaReau, J.**, Parkash Dhankher, O., Xing, B., Gardea-Torresdey, J., **Elmer, W.**, and **White, J. C.** (2022). Therapeutic delivery of nanoscale sulfur to suppress disease in tomato: In vitro imaging and orthogonal mechanistic investigation. *ACS Nano*. *16* (7), 11204–11217. DOI: 10.1021/acsnano.2c04073

Abstract: Nanoscale sulfur can be a multi-functional agricultural amendment to enhance crop nutrition and suppress disease. Pristine (nS) and stearic acid coated (cS) sulfur nanoparticles were added to soil planted with tomato (Solanum lycopersicum) at 200 ppm and infested with Fusarium oxysporum. Bulk sulfur (bS), ionic sulfate (iS), and healthy controls were included. Orthogonal endpoints were measured in two greenhouse experiments, including agronomic and photosynthetic parameters, disease severity/suppression, mechanistic biochemical and molecular endpoints including the time-dependent expression of 13 genes related to two S bioassimilation and pathogenesis-response, and metabolomic profiles. Disease reduced plant biomass by up to 87%, but nS and cS amendment significantly reduced disease measured by AUDPC by 54 and 56%, respectively. An increase in planta S accumulation was evident, with size-specific translocation ratios suggesting different uptake mechanisms. In vivo two-photon microscopy and time-dependent gene expression revealed a nanoscale-specific elemental S bioassimilation pathway within the plant that is separate from traditional sulfate accumulation. These findings correlate well with time-dependent metabolomic profiling, which exhibited increased disease resistance and plant immunity related metabolites only with nanoscale treatment. The linked gene expression and metabolomics data demonstrate a time-sensitive physiological window where nanoscale stimulation of plant immunity will be effective. These findings provide mechanistic understandings of non-metal nanomaterial-based suppression of plant disease, and significantly advance sustainable nano-enabled agricultural strategies to increase food production.

5. Prakash Giri, V., Pandey, S., Kumari, M., Tripathi, A., Katiyar, R., **White, J. C.,** and Mishra, A. (2022). Hybridization of chitosan and biosynthesized silver nanoparticles to enhance antimicrobial activity against phytopathogens in tomato (*Solanum lycopersicum*). *ACS Agric. Sci. Technol*. *2*(4), 719-733. DOI: 10.1021/acsagscitech.1c00252

Abstract: Chitosan hybridized biogenic silver nanoparticles (Ch@BSNP) were synthesized by extracellular metabolites of T. viride. Chitosan hybridization and T. viride derived-compounds associated with the particles were confirmed by XRD, EDX, and GC-MS analysis. The particles had a zeta potential 19.2±0.20 mV, and the hydrodynamic size was 97.74±1.55 nm with PDI index 0.198±0.04. TEM analysis revealed particles of spherical shape and actual size range be-

tween 30-35 nm. Potential antimicrobial activity was investigated against three bacterial phytopathogens viz: P. syringae, E. chrysanthemi, and X. campestris. Exposure to Ch@BSNP significantly decreased the size of bacterial cells in broth assay. Increased fungicidal activity of Ch@BSNP was also observed against four plant pathogens viz: S. rolfsii, R. solani, A. alternata and A. brassicicola. The Ch@BSNP also demonstrated lower toxicity on non-cancerous human cell line. In a greenhouse study(?), treatment with Ch@BSNP reduced leaf spot disease incidence in tomato by up to 60% and also enhanced several physical and physiological attributes. This observed beneficial effects and overall biocompatibility of Ch@BSNP suggest that this material may be a safe and effective antimicrobial bio-agent for sustainable nano-enabled agriculture.

6. Cantu, J. M., Ye, Y., Hernandez-Viezcas, J. A., Zuverza-Mena, N., White, J. C., Gardea-Torresdey, J. L. (2022). Tomato fruit nutritional quality is altered by the foliar application of various metal oxide nanomaterials. *Nanomaterials*, *12*(14). DOI: 10.3390/nano12142349

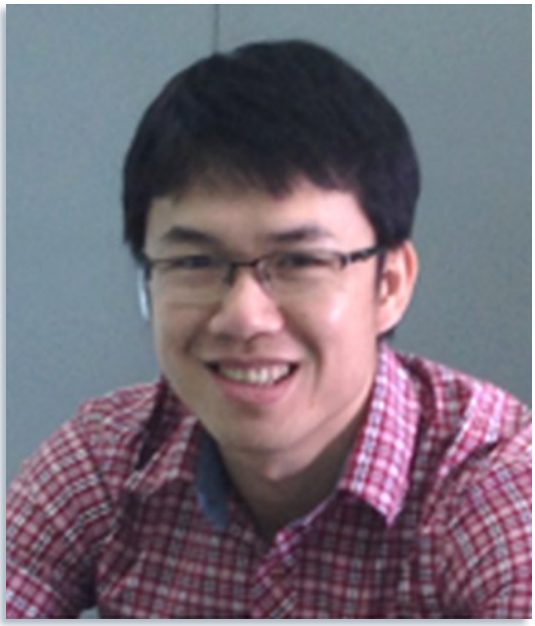
Abstract: Carbohydrates and phytonutrients play an important role in tomato fruit's nutritional quality. In the current study, hybrid ferrite, Mn3O4, and ZnO nanomaterials (NMs) were synthesized, characterized, and applied to tomato plants via foliar application to investigate their effects on the nutritional quality of tomato fruits. Variable results were found after NM exposure. For instance, the lycopene content was initially reduced at 0 stored days by MnFe2O4, ZnFe2O4, and Zn0.5Mn0.5Fe2O4; however, after being stored for 15 days, there was no statistical difference between the treatments and the control. Moreover, the β-carotene content was also reduced by Zn0.5Mn0.5Fe2O4, Mn3O4, and ZnO. The effects of the Mn3O4 and ZnO carried over and inhibited the β-carotene after the fruit was stored. On the other hand, the total phenolic compounds were increased by ZnFe2O¬4, Zn¬0.5Mn0.5Fe2O4, and ZnO after 15 days of storage. Additionally, the sugar content in the fruit was enhanced by 118 and 111 % when plants were exposed to Mn3O4 and ZnO, respectively. This study demonstrates both beneficial and detrimental effects of various NMs in tomato fruit quality and highlights the need for caution in such nanoscale applications during crop growth.

ANALYTICAL CHEMISTRY

MS. KITTY PRAPAYOTIN-RIVEROS Attended the ORA DX Sample Collections Trainings hosted by FDA for ORAPP (The Office of Regulatory Affairs Data Exchange Partners Portal): Including ORA DX Program Overview, ORAPP Demo, ORA DX Rel 12.0 Enhancements for Collections, Collections Overview, Collections Submission (July 28-29).

DR. BRIAN EITZER was the moderator of a session titled "QA for Pesticide Analysis" at the 58th Annual North American Chemical Residue Workshop held online (July 25-29).

NEW STUDENTS, STAFF, AND VOLUNTEERS



DR. TRUNG BUI started his postdoctoral research at the Department of Analytical Chemistry, CAES since July 12, 2022. Prior, Dr. Bui was a lecturer (faculty) at the Faculty of Chemical and Food Technology, Ho Chi Minh city, University of Technology and Science in Vietnam. He contributed to laboratory research projects and teaching activities as an advisor or co-advisor. He taught courses in Basic and Advanced Analytical Chemistry and Advanced water treatment for undergraduate and graduate students. His research expanded on new challenges in advanced materials applied to water and soil monitoring and remediation, including the preparation of materials derived from agricultural by-products/waste (such as rice husk, biomass, chitosan, cellulose, etc.) that are considered as eco-friendly and cost-effective alternatives; application in heavy metal removal (arsenic, nickel, cadmium); resource recovery (gold, phosphorous); and microplastics removal. In addition, Dr. Bui has been involved with extracting bioactive polyphenolic compounds from agricultural by-products applied to food storage.

At CAES, Dr. Bui will conduct research on the analysis of organic (mycotoxins, pesticides) and elemental (heavy/toxic metals) contaminants in various food and environmental (e.g., soil, liquid) matrices. Additional investigations focused on metal oxide nanoparticle detection in food and environmental samples are anticipated. Currently, he is participating in a project of investigating the accumulation and microscopic localization of polystyrene nanoparticles (PS) in lettuce when interacting with pollutants (arsenic and boscalid) during growth. The interactions between PS and pollutants affecting their accumulation in plants would be important to evaluate the impact of farming techniques on agricultural products' quality and safety.

DR. SARA THOMAS recently joined The CAES as a post-doctoral scientist. Sara completed her PhD in Environmental Science and Engineering from the University of South Australia (UniSA). At CAES Sara will work on an NIEHS-funded project titled "PFAS phytoremediation enhanced by nanoparticle" under the supervision of **Dr. Jason White**, **Dr. Sara Nason** and, **Dr. Nubia Zuverza-Mena**. She also has extensive experience in material synthesis and analytical chemistry.

MR. FELIPE FRANCO DE OLIVEIRA arrived at CAES in July 2022 and will stay for a year conducting research at the Department of Analytical Chemistry. He attended Mato Grosso State University in Brazil to obtain his B.S. in Agronomy. His M.S. degree was earned at the University of Sao Paulo, Brazil, where he is currently a Ph.D. student focusing on Phytopathology. During this period, he will use nanotechnology to improve the effectiveness of insecticides to control the whitefly (*Bemisia tabaci*), which is a vector of various plant viruses. The goal of his work is to identify strategies to stop or minimize the chances of whitefly in transmitting these viruses to tomato plants.

MS. VANESSA TAKESHITA Vanessa arrived at CAES in July 2022 and will stay for a year conducting research at the Department of Analytical Chemistry. She is an Agronomist (Mato Grosso State University - UNEMAT, 2017), with a M.S. degree in sciences, focusing on Chemistry in Agriculture and the Environment (Center for Nuclear Energy in Agriculture – CENA, University of São Paulo – USP, 2019). She is currently a Ph.D. student (CENA / USP) focused on the behavior of nanoherbicides in soil and plants. In Brazil, she investigated the dynamics of herbicides in the environment using radioisotopes. At CAES, she will develop a new nanoherbicide to improve the efficacy and environmental safety of pesticides application. The specific aim of her research is to study the distribution of nanoherbicide in soil-plant systems and measure the effects on microbial communities and crop plants."

ENTOMOLOGY

DR. GOUDARZ MOLAEI was interviewed by NBC Connecticut on the tick bite-associated Alpha gal syndrome in Connecticut and human health risks (July 1); was invited to visit the U.S. Forest Services in Hamden, CT, and discuss collaborations between this agency and the CAES Department of Entomology (July 7); and directed the CAES-TTL where 333 submissions were processed and blood-engorged adult blacklegged ticks were tested for Lyme disease, babesiosis and anaplasmosis, and results were reported.

DR. VICTORIA SMITH was interviewed by the Inside Investigator, regarding spotted lanternfly in CT (July 18); participated in the summer Connecticut Tree Protective Association meeting, held at the Farmington Club, with a table display "Be On The Lookout: Spotted Lanternfly and Box Tree Moth" (July 21); and attended the Connecticut Nursery and Landscape Association summer meeting, held at Prides Corner Farms in Lebanon (July 27).

DR. PHILIP ARMSTRONG was interviewed by Patch Media about the current mosquito season and the projected risk for West Nile virus transmission this year (July 20), and by WTIC, Fox 61, and NBC Connecticut about the first detections of West Nile virus from mosquito pools in Connecticut (July 26-27).

MS. TIA BLEVINS attended the summer meeting of the Connecticut Tree Protective Association (CPTA) held in Farmington (July 21), and the summer symposium of the Connecticut Nursery and Landscape Association (CNLA) held at Prides Corner Farms in Lebanon (July 27).

DR. DOUGLAS BRACKNEY was interviewed by The Researcher, an online Flipboard style research platform. The subject of the interview was "Frequency matters: How successive feeding episodes by blood-feeding insect vectors influences disease transmission" https://www.researcher-app.com/paper/12272094 (July 27).

MS. ANGELA BRANSFIELD participated in the Federal Select Agent Program's Responsible Official webinar, *The Future of FSAP Inspections; Preparing for a Successful Inspection Experience* (July 20) and participated via Zoom in Yale's Biosafety Committee meeting (July 21).

MR. MARK CREIGHTON was interviewed by the Hartford Courant on the state of bee Keeping in Connecticut and health issues facing bees today (July 6) and the story appeared on the front page of the newspaper (July 11); presented invited talks to: 1) the Danbury Rotary on Beekeeping in Connecticut on beekeeping in Connecticut (July 13), and 2) at the Backyard Beekeepers Association meeting in Weston, CT on the role of the State Bee Inspector and the several health issues facing beekeepers (July 26).

MS. KATHERINE DUGAS presented a talk on "Insects in the environment" at the Pollinator Pathway Garden in Cheshire (July 20).

DR. MEGAN LINSKE participated in a networking call with Dr. Richard Poche of Genesis Labs Inc. to provide an update on the CAES collaborative novel rodent targeted tick treatment project (July 5); participated in a collaborative meeting with members of the New Haven Science Fair Mentor Coordination Committee to discuss the establishment of a girl's STEM program (July 5); participated in the CAES Postdoctoral Association meeting as outgoing chairperson to discuss bylaws (July 6); participated in the Wildlife Society's (TWS) Diversity, Equity,

and Inclusivity (DEI) members' meeting to discuss plans for the upcoming national meeting in Spokane, Washington (July 18); and participated in the 2022 Leadership Institute (LI) planning call for the upcoming training program as an LI alumni and mentor (July 21).

Dr. GALE RIDGE was interviewed by the Hartford Courant about the health of insect populations in New England (July 01), and by the Westport Journal about fireflies (July 15); and participated in a virtual jumping worm conference organized by the University of Vermont (July 23).

Dr. CLAIRE RUTLEDGE held field trainings for new Wasp Watchers in Middletown, Willington, Portland and Killingworth, CT (July 5, 6, 12); and helped to run the Connecticut Tree Protective Association summer meeting in Farmington, CT (July 21).

Mr. JOHN SHEPARD was interviewed by the Hartford Courant on the potential effects of climate change on populations of mosquitoes in Connecticut (July 1); and provided updates from the CT Mosquito Trapping and Arbovirus Surveillance Program as part of Arbovirus Situational Awareness conference calls organized by the Northeast Regional Center for Excellence in Vector-Borne Diseases (July 11, 18, 25).

Dr. KIRBY STAFFORD III participated as a member in a meeting of the Tick-Borne Disease Working Group (July 19-20); and presented on ticks and tick-borne diseases for the Hartford Master Gardeners Virtual Hot Topics series (July 19).

PUBLICATIONS:

1. Khalil, N., Dugas, K. D., Cantoni, J. L., Stafford, K. C. III, and **Molaei*, G.** (2022). Anomalous Morphologies in *Ixodes scapularis* Feeding on Human Hosts. *Ticks and Tick-Borne Diseases*, *13*(5). DOI: 10.1016/j.ttbdis.2022.101993

Abstract: Cases of anomalous morphologies in the blacklegged tick, *Ixodes scapularis*, have been reported in both field-collected and human-biting specimen in the Northeastern and Midwestern United States, complicating the identification of this medically important tick species. We herein describe four cases of morphological anomalies in *I. scapularis* females exhibiting nanism and abnormally small genital apertures. We also report a female *I. scapularis* displaying slight asymmetry in the lower abdomen oriented toward the right side and an abnormal anal groove completely enclosing the anus. The identity of each specimen was confirmed using taxonomic keys, high resolution light and scanning electron microscopy imaging, and DNA sequencing of the 18S rRNA gene. All specimens described in this study were found parasitizing human hosts and were submitted to the Connecticut Agricultural Experiment Station-Tick Testing Laboratory in 2021 for species identification and pathogen screening. Here, we also discuss recent reports of teratological abnormalities in *I. scapularis* as well as likely causes for such deformities and potential implications.

2. Gloria-Soria, A., Faraji, A., Hamik, J., White, G., Amsberry, S., Donahue, M., Buss, B., Pless, E., Cosme, L. V. and Powell, J. R. (2022). Origins of high latitude introductions of *Aedes aegypti* to Nebraska and Utah during 2019. *Infection, Genetics and Evolution*, *103*. DOI: 10.1016/j.meegid.2022.105333

Abstract: *Aedes aegypti* (L.), the yellow fever mosquito, is also an important vector of dengue and Zika viruses, and an invasive species in North America. *Aedes aegypti* inhabits tropical and

sub-tropical areas of the world and in North America is primarily distributed throughout the southern US states and Mexico. The northern range of *Ae. aegypti* is limited by cold winter months and establishment in these areas has been mostly unsuccessful. However, frequent introductions of *Ae. aegypti* to temperate, non-endemic areas during the warmer months can lead to seasonal activity and disease outbreaks. Two *Ae. aegypti* incursions were reported in the late summer of 2019 into York, Nebraska and Moab, Utah. These states had no history of established populations of this mosquito and no evidence of previous seasonal activity. We genotyped a subset of individuals from each location at 12 microsatellite loci and ~ 14,000 single nucleotide polymorphic markers to determine their genetic affinities to other populations worldwide and investigate their potential source of introduction. Our results support a single origin for each of the introductions from different sources. *Aedes aegypti* from Utah likely derived from Tucson, Arizona, or a nearby location. Nebraska specimen results were not as conclusive, but point to an origin from southcentral or southeastern US. In addition to an effective, efficient, and sustainable control of invasive mosquitoes, such as *Ae. aegypti*, identifying the potential routes of introduction will be key to prevent future incursions and assess their potential health threat based on the ability of the source population to transmit a particular virus and its insecticide resistance profile, which may complicate vector control.

ENVIRONMENTAL SCIENCE AND FORESTRY

GRANTS AWARDED

1. PI: **DR. SCOTT C. WILLIAMS** (CAES), Co-PIs: **DR. MEGAN A. LINSKE**, **DR. GOUDARZ MOLAEI**, and **DR. DOUG E. BRACKNEY** (CAES), Dr. Robert Smith, Dr. Susan Elias, and Mr. Charles Lubelczyk (Maine Medical Center Research Institute), and Dr. Maria Diuk-Wasser (Columbia University). "Suppression of Host-Seeking *Ixodes scapularis* Abundances and Interruption of Pathogen Transmission Through Orally Delivered Systemic Acaricide Treatment of White-tailed Deer and *Peromyscus* spp." $5,000,000 award from the Centers for Disease Control and Prevention, September 1, 2022 – August 31, 2027.

The proposed research will orally deliver existing commercially available acaricide formulations to systemically treat the major *Ixodes scapularis* reproductive host (white-tailed deer) and major pathogen reservoir (small rodents with a focus on *Peromyscus* spp.) both singly and in combination. We will use Cydectin® (moxidectin), which has a 0-day withdrawal period for human consumption, to coat whole corn to dose deer and will use Kaput® (0.005% fipronil) to dose small rodents at three different locations with varying known diversities of alternative terrestrial mammalian hosts. Specific aims include: 1) Evaluation of the efficacy and reproducibility of this strategy in the suppression of *Borrelia burgdorferi*-infected host-seeking *I. scapularis* nymphs in multiple high-risk settings. 2) Optimization and standardization of the implementation of systemic acaricide treatment of white-tailed deer and *Peromyscus* spp. to reduce the abundance of host-seeking *I. scapularis* nymphs infected with human pathogens. 3) Development of standard operating procedures for systemic acaricidal host treatment to be used by homeowners or vector control professionals within communities at risk for exposure to Lyme disease spirochetes and other *I. scapularis*-borne pathogens.

DR. SCOTT WILLIAMS participated in a conference call with Genesis Laboratories, Inc. on upcoming research funding collaboration (July 5); participated in a Zoom call with Drs. Maria Diuk-Wasser and Daniel Carrascal (Columbia University) about future research collaboration in modeling tick data (July 8); Participated in a Zoom call with CDC about budget logistics on a recent grant award (July 11); participated in a conference call with Genesis Laboratories, Inc. on ongoing research efforts (July 20).

MR. JOSEPH BARSKY Attended the Connecticut Tree Protective Association Summer Meeting in Farmington (July 21).

MR. GREGORY BUGBEE gave a talk titled "Managing Nuisance Aquatic Vegetation in Highland Lake" at the annual meeting of the Highland Lake Watershed Association at Little Red barn Brewers in Winsted (100 attendees) (July 9); with **MS. SUMMER STEBBINS**, gave an Invasive Aquatic Plant Seminar to a Limnology class at Western Connecticut State University (20 attendees) (July 12); gave a talk titled "Controlling Variable Watermilfoil with ProcellaCOR" at the annual meeting of the Crystal Lake Protective Association at the Ellington Town Beach (50 attendees) (July 20); gave a talk titled "Aquatic Vegetation Update – Bashan Lake" at the annual meeting of the Bashan Lake Association at the East Haddam Grange (75 attendees) (July 22).

DR. SUSANNA KERIÖ hosted a collaborative research meeting with colleagues from The American Chestnut Foundation (July 19); presented an invited lecture titled "Impact of Mycorrhizae on Landscape Tree Health" at the Connecticut Tree Protective Association summer meeting (40 attendees) (July 21); provided expertise on best tree planting practices during a site visit to a chestnut orchard in Bethany (July 29).

DR. ITAMAR SHABTAI met with a colleague from Cornell University to discuss method development for metabolomics analysis of maize root exude in a joint project (July 11); met with colleagues from Purdue University and USDA-ARS to discuss a USDA-NIFA-AFRI grant proposal (July 20); attended a Zoom call with colleagues from the Hebrew University of Jerusalem, Israel to discuss a manuscript summarizing their work on an adsorbent which removed dissolved organic matter from surface waters (July 27).

DR. LEIGH WHITTINGHILL met with Jacqueline Jamsheed of Elms College to discuss her work in the economics of urban agriculture at the municipal level and discuss potential future collaborations and network sharing (July 11).

PUBLICATIONS

1. Steven, B. (2022). Phototrophic Mats of the Desert: The Bacteria of the Biological Soil Crust Community. In: Ramond, J. B., and Cowan, D. A. (Eds.), *Microbiology of Hot Deserts*. (vol. 244, pp. 65-88). Springer. DOI: 10.1007/978-3-030-98415-1_3

Abstract: Biological soil crusts (biocrusts) are surface soil communities that can be made up of cyanobacteria, lichens, heterotrophic bacteria, archaea, algae, mosses, liverworts, and fungi. These communities play important ecological roles, especially in global drylands, where they can colonize patches of soil between the sparsely distributed vegetation. In the early stages of development, bacteria play a central role in the colonization and development of biocrusts. Thus, this chapter focuses on those keystone bacterial populations that establish and nourish biocrusts. This chapter is not meant to be a comprehensive review of biocrusts, as this would

require substantially more space than allotted to a single book chapter. Instead, the goal of this chapter is to introduce biocrusts to the non-specialist, in hopes that their importance and roles in desert ecology will be recognized, particularly in hot deserts where they have been critically understudied.

NEW STUDENTS, VOLUNTEERS, AND STAFF

MS. JADE LEE is a volunteer in the Department of Environmental Science and Forestry. She is working with **Mr. Alex Waller**, **Dr. Philip Zhengyang Wang**, and **Dr. Joseph Pignatello** on a project testing bioavailability of a slow-release form of phosphate nutrient that is bound to biochar. She is a rising sophomore at Amity Regional High School in Woodbridge, Connecticut, where she participates in her school's Science Research Program. In her free time, she enjoys reading and playing the cello.

PLANT PATHOLOGY AND ECOLOGY

GRANT UPDATES

The proposal, "Exploring Grower Interest in Microbial Predation and the Impact on Nutrient and Microbial Turnover in Organic Production" was recommended for $46,600 funding by the USDA Organic Agriculture Research and Extension Initiative. The grant will provide one year of planning support to develop a larger OREI proposal. PD: Dr. Samuel Martins, University of Florida, Co-PDs include **DRS. LINDSAY TRIPLETT** and **STEPHEN TAERUM**.

DR. YONGHAO LI participated in the National Plant Diagnostic Network Northeast Regional Meeting via Zoom (12 adults) (July 19); staffed the Station booth at the Connecticut Tree Protective Association Summer Meeting in Farmington (July 21); participated in the National Plant Diagnostic Network Online Communication & Web Portal Committee meeting via Zoom (6 adults) (July 22); presented "All About Fungi and Fungicides – Every Gardener Needs to Know" for the Wellness Program at Conning via WebEx (39 adults) (July 28).

DR. QUAN ZENG attended the 4th International Erwinia Workshop (IEW 2022) in Assisi, Italy and delivered an oral presentation entitled "Expression of the Type III Secretion System Genes in Epiphytic *Erwinia amylovora* Cells on Apple Stigmas Benefits Endophytic Infection at the Hypanthium" (70 adults) (July 2); attended the 14th International Conference on Plant Pathogenic Bacteria (ICPPB) in Assisi, Italy (July 3-8) and presented a poster titled "Glandular and non-glandular trichomes are colonization sites and host entry points of the fire blight pathogen on

apple leaves" (250 adults) (July 5); gave an oral presentation titled "Colonization of yeast-like fungi on apple flowers induces host immunity and prevents fire blight infection" (250 adults) (July 7). participated in the Bacteriology Committee Meeting of the American Phytopathological Society (37 adults) (July 25). The poster "Glandular and non-glandular trichomes are colonization sites and host entry points of the fire blight pathogen on apple leaves" presented at ICPPB was awarded the Best Poster Award (€200 and certificate) (July 28).

DR. NEIL SCHULTES spent two weeks (July 10–25) in the laboratory of Dr. Timothy McNellis in the Dept. of Plant Pathology and Environmental Microbiology at Penn State University performing virulence tests with apple fruitlets and *Erwinia amylovora* mutants generated during his sabbatical leave in fall 2021.

DR. ROBERT MARRA was interviewed by K&J Media Services for an educational video about beech leaf disease at West Rock Ridge State Park and in the lab (July 8); was interviewed by Heather Jensen of The Daily Nutmeg for an upcoming article about beech leaf disease (July 11); gave an oral presentation titled "Four Important Tree Diseases You Should Know About," (chestnut blight, beech bark disease, beech leaf disease, and oak wilt) as part of Great Mountain Forest's Forest Health Lecture Series, at the Norfolk Downs Shelter, Norfolk Historic District (70 adults) (July 16); participated in the semi-monthly Zoom meeting of the Beech Leaf Disease Working Group (60 adults) (July 19); staffed a table with information and posters about beech leaf disease and oak wilt at the annual summer meeting of the CT Tree Protective Association (750 adults) (July 21).

PUBLICATIONS

1. Fearer, C. J., Conrad, A. O., **Marra, R. E.**, Georskey, C., Villari, C., Slot, J., and Bonello, P. (2022). A combined approach for early in-field detection of beech leaf disease using near-infrared spectroscopy and machine learning. *Frontiers in Forests and Global Change*, *5*. DOI: 10.3389/ffgc.2022.934545

Abstract: The ability to detect diseased trees before symptoms emerge is key in forest health management because it allows for more timely and targeted intervention. The objective of this study was to develop an in-field approach for early and rapid detection of beech leaf disease (BLD), an emerging disease of American beech trees, based on supervised classification models of leaf near-infrared (NIR) spectral profiles. To validate the effectiveness of the method we also utilized a qPCR-based protocol for the quantification of the newly identified foliar nematode identified as the putative causal agent of BLD, *Litylenchus crenatae* ssp. *mccannii* (LCM). NIR spectra were collected in May, July, and September of 2021 and analyzed using support vector machine and random forest algorithms. For the May and July datasets, the models accurately predicted pre-symptomatic leaves (highest testing accuracy = 100%), but also accurately discriminated the spectra based on geographic location (highest testing accuracy = 90%). Therefore, we could not conclude that spectral differences were due to pathogen presence alone. However, the September dataset removed location as a factor and the models accurately discriminated pre-symptomatic from naïve samples (highest testing accuracy = 95.9%). Five spectral bands (2,220, 2,400, 2,346, 1,750, and 1,424 nm), selected using variable selection models, were shared across all models, indicating consistency with respect to phytochemical induction by LCM infection of pre-symptomatic leaves. Our results demonstrate that this technique holds high promise as an in-field diagnostic tool for BLD.

2. Elmer, W. H., Roberts, E. L., Silady, R., and **Triplett, L. R.** (2022). Lesson plans for a four-part activity introducing field plot experimentation to undergraduate researchers. *Plant Health Instructor*. DOI: 10.1094 /PH I-L -2022-0623-01

Abstract: This paper is a guide to a group exercise designed to complement a 9-week summer undergraduate internship program. The goals of the activity are to expose and demystify the process of field experimentation for students, build practice and confidence in experimental design and execution, and increase awareness of applied agricultural research. It is completed in four meetings of roughly 90 minutes each, plus several hours of instructor preparation time. This activity was designed for our typical cohort of REEU students: highly motivated life-sciences majors with no previous research experience and little prior knowledge of experimental design or statistical analysis. The activity could be adapted to a variety of skill levels and experimental designs. A detailed description of the rationale, learning outcomes, and recommendations based on this activity can be found in the accompanying paper.

3. Roberts, E. L., **Elmer, W. H.**, Silady, R., and **Triplett, L. R.** (2022). Introduction to field plot experimentation: A four-part enrichment activity to enhance summer undergraduate research programs. *Plant Health Instructor*. DOI: 10.1094 /PH I-T -2022-0623-01 .

Abstract: REEU and similar agriculture-oriented programs could provide a valuable opportunity to expose a greater number of undergraduates to concepts of phytopathology field research. In 2017, we initiated a USDA-REEU funded program, the Summer Undergraduate Fellows in Plant Health and Protection (hereafter "Plant Health Fellows") at Southern Connecticut State University and the Connecticut Agricultural Experiment Station. Because most of the mentored research would be lab-centered, we sought to ensure that every participant in the program would have some exposure to field research. To accomplish this goal, we designed a field plot experiment to be performed as a group enrichment activity, in addition to individual mentored projects conducted by each student. In this paper, we describe the goals of the field project activity, learning outcomes, and recommendations for implementing a similar activity in other summer research programs. Specific lesson plans will be reported in an accompanying article. The group project was conducted through four activities that were introduced in four separate meetings: experimental design, plot setup, data collection, and data analysis. Specific learning objectives were tied to each of the four activities. Materials and lesson plans with specific learning objectives are detailed in the accompanying laboratory activity article.

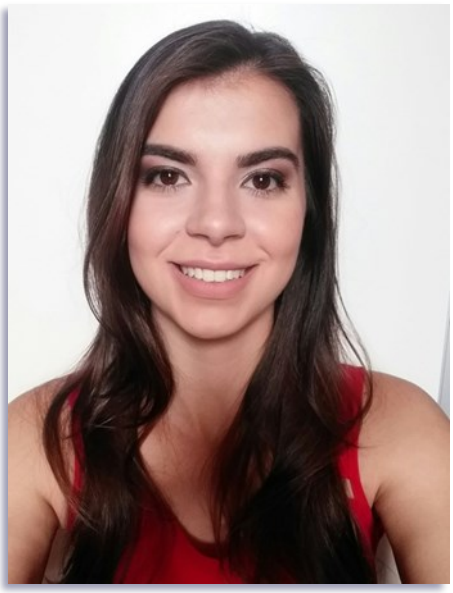
4. Nogueira, G. A., Conrado, A. S., Freires, A. L. A., Souza, J. J. F., Figueiredo, F. R. A., Barroso, K. A., Araújo, M. B. M., Nascimento, L. V., Lima, J. S. S., Neto, F. B., **da Silva, W. L.**, and Ambrósio, M. M. Q. (2022). Aggressivity of different *Fusarium* species causing fruit rot in melons in Brazil. *Plant Disease*. DOI: 10.1094/PDIS-04-22-0728-SR

Abstract: Brazil is one of the largest melon (*Cucumis melo*) producers in the world and most of the production is exported to international markets. Currently, over 15% of the Brazilian melon shipments are lost during export transportation due to Fusarium fruit rot, which is jeopardizing the livelihood of the Brazilian melon producers. Herein, we focused on understanding the aggressivity of five different species of Fusarium causing fruit rot on the main types of melon produced in Brazil. We also investigated the correlation between pathogenicity and fruit quality. Experiments were performed under a completely randomized experimental design, in a 5x8 factorial scheme, using two methodologies for inoculation: deposition of discs of culture media containing fungal structures and deposition of spore suspensions in needle-punctured lesions.

The fungal species used were *Fusarium falciforme, F. sulawesiense, F. pernambucanum, F. kalimantanense*, and Fusarium sp. Fruits of two hybrids from four types of melons, Canary (Goldex and Gold Mine), Piel de Sapo (Grand Prix and Flecha Verde), Galia (McLaren and DRG3228), and Cantaloupe (SV1044 and Bonsai), were used. Disease severity was assessed by measuring the lesions, disease severity index, fruit firmness, and degrees Brix of fruits. The five Fusarium spp. caused rot in the fruits of all melon hybrids studied and the aggressivity of those fungal species varied with the type/hybrid of melon fruits studied. Fruits of the hybrids McLaren and Bonsai presented the largest lesions among all melon hybrids, and hybrids of Canary type (Gold Mine and Goldex) were the most tolerant to rot caused by the Fusarium species investigated. Furthermore, the greater the severity of Fusarium fruit rot, the lower the pulp firmness of the melon fruits but degrees Brix did not correlate with the onset of the disease.

5. Elmer, W., Hines, D., and **Schultes, N. P.** First report of *Fusarium libertatis*, a member of the *Fusarium oxysporum* species complex, causing vascular disease of Jade plant (*Crassula ovata*) in Connecticut, USA". *Plant Disease*. *In press*.

NEW STUDENTS, STAFF, AND VOLUNTEERS



MS. VITORIA TEDARDI, a doctorate student in the Department of Plant Pathology at the Universidade Federal de Lavras (UFLA) in Brazil, joined the da Silva Lab as an intern. Under the guidance of **Dr. Washington da Silva,** she will work on screening siRNA molecules from tobacco plants infected with potato virus Y (PVY) as a potential tool to control PVY infection in Solanaceous crops.

VALLEY LABORATORY

DR. JATINDER S. AULAKH talked about weed management at the Connecticut Christmas Tree Growers twilight meeting at Totoket Tree Farm in Branford, CT (~50 attendees) (July 19); and submitted an article titled, "Horsenettle (*Solanum carolinense* L.) Control in Christmas Trees" to the Real Tree Line Magazine of the Connecticut Christmas Tree Growers Association (July 26).

DR. CAROLE CHEAH gave a talk on hemlock woolly adelgid and biological control opportunities with *Sasajiscymnus tsugae* to staff at McLeans Game Refuge, Simsbury and went on a tour to assess their hemlocks for HWA damage (6 attendees) (July 14); guided and released S. tsugae to mitigate HWA infestations at the Helen Butler Riverfront Trail, Town of New Hartford with volunteers from the New Hartford Land Trust (4 attendees) (July 22).

DR. RICHARD COWLES presented "Insect and disease management" at the Massachusetts Christmas Tree Growers' Association field meeting in Huntington, MA (40 attendees) (July 16). He presented "Insect management" at the CCTGA twilight meeting, North Branford (40 attendees) (July 19).

MS. ROSE HISKES participated in a Connecticut Invasive Plant Working Group (CIPWG) Symposium planning committee meeting via Zoom (16 attendees) (July 7).

PUBLICATIONS

1. Monteiro, J. S., Sotão, H. M. P., Santos Ferreira, M. C. D., Rodrigues, F. D. J., Xavier, W. K. S., **Li, D.-W.**, and Castañeda-Ruiz, R. F. (2022). *Vesiculophora diversiseptata* gen. & sp. nov. and *Anapleurothecium clavatum* & *Podosporium simile* spp. nov. from the Brazilian Amazon. *Mycotaxon*, *137*, 227-237. DOI: 10.5248/137.227

Abstract: Three asexual fungi are described and illustrated from the Brazilian Amazon: *Vesiculophora diversiseptata* as a new genus and species; and *Anapleurothecium clavatum* and *Podosporium simile* as new species. *Vesiculophora diversiseptata* is characterized by its conidiophores becoming scorpioid after successive subacroauxic extensions and monoblastic conidiogenous cells that produce heteroseptate, brown phragmoconidia; *A. clavatum* is distinguished by its ellipsoidal to clavate, 3-euseptate, brown conidia; and *P. simile* is characterized by its synnematous conidiomata with monotretic conidiogenous cells and brown, 3–11-eusepatate, mainly obclavate, verrucose conidia. Additionally, *Pleurothecium leptospermi* is transferred to Anapleurothecium.

2. Huang, L., He, J., Tian, C.-M., **Li, D.-W.** (2022). Bambusicolous fungi, diseases and insect pests of bamboo. In Asiegbu, F. O. and Kovalchuk, A. (Eds.), *Forest Microbiology: Tree diseases and pests* (pp. 415-440). *Elsevier*. DOI: 10.1016/B978-0-443-18694-3.00006-7

JOURNAL ARTICLES APPROVED JULY 2022

He, J., Sun, M.-L., **Li, D.-W**., Zhu, L.-H., Ye, J.-R., Huang, L. A real-time PCR for detection of Chinese fir anthracnose pathogens using TaqMan probe to target ApMat gene. *Pest Management Science*.

Monteiro, J. S., Sotão, H. M. P., Ferreira, M. C. S., Rodrigues, F. J., Xavier, W. K. S., **Li, D.-W.**, and Castañeda-Ruiz, R. F. *Vesiculophora diversiseptata* gen. & sp. nov. and *Anapleurothecium clavatum* & *Podosporium simile* spp. nov. from the Brazilian Amazon. *Mycotaxon*.

Zhang, K., Zhao, R., Duan, Y., Fan, L., Fang, Y., Han, J., **White, J. C.**, and Shen, Y. Proteomic analysis demonstrates that *Bidens pilosa* root exudates differentially impact *Pteris multifida* gametophyte growth. *Geoderma*.

Wang, Y., **Deng, C.**, Shen, Y., Borgatta, J., **Dimkpa, C. O.**, Xing, B., Parkash Dhankher, O., **Wang, Z.**, **White, J. C.**, and **Elmer, W. E.** Surface coated sulfur nanoparticles suppress Fusarium disease in field grown tomato: Increased yield and nutrient biofortification. *Journal of Agricultural and Food Chemistry*.

Poudel, P., **Whittinghill, L.**, Kobayashi, H., and Lucas, S. Evaluating the effect of different growing systems and biofungicide treatment on saffron production in Kentucky. *HortScience*.

Whittinghill, L. and Sarr, S. Sustainable Urban Agriculture: A Case Study of Louisville, Kentucky's Largest City. *Urban Science*.

Pagano, L., Rossi, R., **White, J. C.**, Marmiroli, N., and Marmiroli, M. Nanomaterials biotransformation: In planta mechanisms of action. *Environmental Pollution*.

Cui, Z. **LaReau, J.**, **Zeng, Q.**, and **Steven, B**. *Curtobacterium mali* sp. nov., isolated from apple flower stigmas, Connecticut, U.S.A. *International Journal of Systematic and Evolutionary Microbiology*.

Elmer, W. H., **Zuverza-Mena, N.**, and **White, J. C.** Suppression of Fusarium crown and root rot with nanoscale micronutrients. *Acta Horticulture*.

Noman, M., Ahmed, T., **White, J. C.**, Shahid, M., Nazir, M. M., Azizullah, Li, D., and Song, F. Foliar application of bio-engineered copper nanoparticles alleviates bacterial fruit blotch progression in watermelon (*Citrullus lanatus* L.) by multiple mechanisms. *Journal of Hazardous Materials*.

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