Station News

The Connecticut Agricultural Experiment Station
Volume 13 Issue 1 | January 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

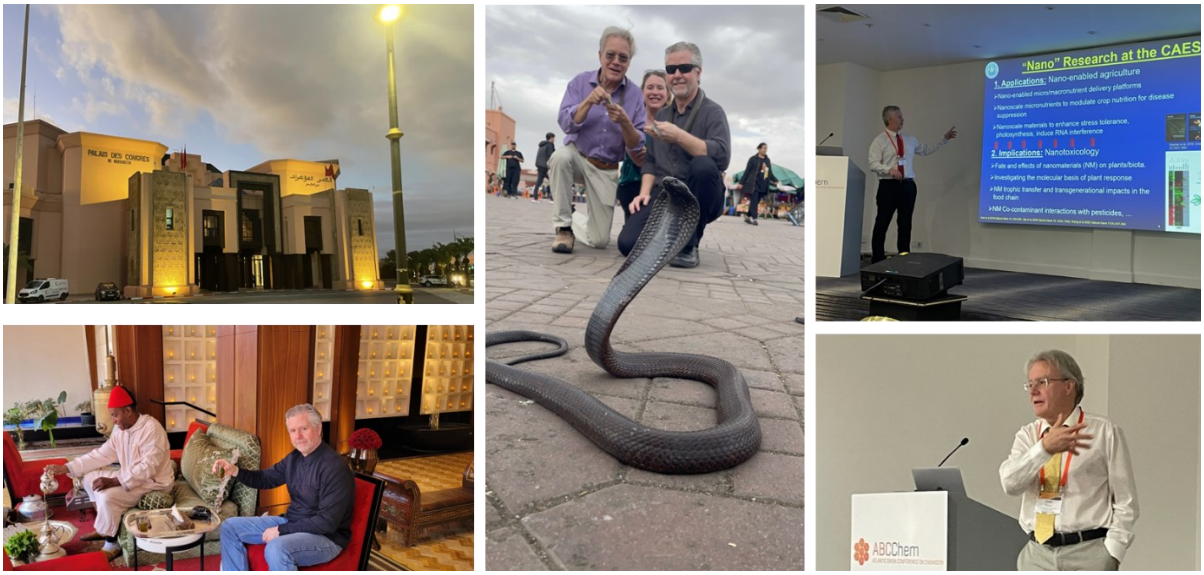
The Connecticut Agricultural Experiment Station

Putting Science to Work for Society since 1875

This Issue

ADMINISTRATION

DR. JASON C. WHITE visited the University of Texas El Paso and gave a presentation for the Department of Chemistry and Biochemistry Seminar Series titled "Nanotechnology-enabled agriculture: A path to global food security?" (December 2-4); met with Professor John Fortner of Yale University School of Engineering and Applied Science to discuss collaborative research (December 5); attended the monthly Laboratory Preparedness meeting at the CT Department of Public Health (December 5); met by Zoom with FDA communications staff to record a testimonial for the LFFM program that funds state laboratories for food safety and defense (December 6); participated in the weekly Center for Sustainable Nanotechnology (CSN) all hands Zoom call (December 7); along with **DRS. SARA NASON, NUBIA ZUVERZA-MENA** and **SARA THOMAS** participated in a Zoom call with collaborators at Yale University and the University of Minnesota to discuss progress on a joint NIEHS grant (December 7); attended the PFAS Task Force Action Plan Meeting at the Legislative Office Building in Hartford and gave an update on CAES projects (December 8); participated in the monthly CSN Faculty meeting (December 8); spoke by Teams with DCP Drug Control Staff concerning sample collection and analysis as part of the CT Adult Use Cannabis program (December 8); attended the Atlantic Basin Conference on Chemistry (ABCChem) in Marrakech, Morocco, and gave a presentation titled "Nanoscale sulfur uniquely suppresses fungal disease and increases biomass and yield of crop plants" (December 13-16); along with **MR. MICHAEL LAST** participated in a Zoom call with Albertus Magnus College administration to discuss potential use of the off campus housing for CAES visitors (December 19); participated in a Zoom call with collaborators at Purdue University, the University of Central Florida and the University of Florida to discuss a joint USDA proposal (December 19); hosted the quarterly CAES Safety Committee meeting (December 20); along with **DR. CHAOYI DENG** participated in a Zoom call with collaborators at the University of Minnesota to discuss a collaborative paper (December 21); along with **DRS. SHITAL VAIDYA, CHRISTIAN DIMKPA** and **WADE ELMER** hosted a Zoom call with collaborators at Johns Hopkins University to discuss progress on a joint USDA research project (December 21); participated in a Zoom call with collaborators at Auburn University and Johns Hopkins University to discuss a joint research proposal (December 23); along with **DR. CHRISTIAN DIMKPA** spoke with Dr. Minha Naseer about a new post-doctoral opportunity at CAES through the CSN (December 23); and hosted the monthly CAES J-Visa recipient meeting (December 28).



Dr. Jason C. White and **Dr. Wade Elmer** at the Atlantic Basin Conference on Chemistry (ABCChem) in Marrakech, Morocco.

PUBLICATIONS

1. Zhang, S., Zhou, J., Chen, J., Ge, T., Cai, Y., Yu, B., Wang, H., **White, J. C.**, and Li, Y. (2023). Changes in soil CO_2 and N_2O emissions in response to urea and biochar-based urea in an intensively managed Moso bamboo forest. *Soil Tillage Research*. DOI: 10.1016/j.still.2022.105625

Abstract: The application of biochar-based fertilizers is an effective strategy for enhancing plant growth and soil organic carbon stocks; however, the impacts of such practices on soil CO_2 and N_2O emissions and associated mechanisms in subtropical forests are poorly understood. A two-year field trial was conducted to determine effects of urea and biochar-based urea on variations in soil CO_2 and N_2O emissions, as well as various soil environmental factors in a subtropical Moso bamboo forest. Five treatments were established: a control (without fertilization), urea with low and high application rates (100 and 300 kg N ha^{-1}, LU and HU), and biochar-based urea with low and high application rates (100 and 300 kg N ha^{-1}, LBU and HBU). The soil CO_2 emissions were increased by LU, HU, and HBU treatments during the first year compared to controls ($P < 0.05$). However, this stimulatory response was observed only under the HU treatment during the second year. The soil N_2O emissions increased under the LU and HU treatments during the first year but were decreased under HBU ($P < 0.05$); during the second year, only HU had a stimulatory effect. Importantly, the soil CO_2 emissions and their Q_{10} values under the biochar-based urea treatment were lower than those with urea ($P < 0.05$). The application of urea increased contents of NH_4^+-N, NO_3^--N, water soluble organic C/N (WSOC/WSON), as well as activities of invertase, β-glucosidase, urease, and protease ($P < 0.05$). In comparison, application of biochar-based urea enhanced contents of WSOC, NH_4^+-N, and NO_3^--N but decreased WSON and activities of β-glucosidase, urease, and protease ($P < 0.05$). In conclusion, compared with urea, application of biochar-based urea provided more advantages for mitigating soil CO_2/N_2O emissions in subtropical forest ecosystems.

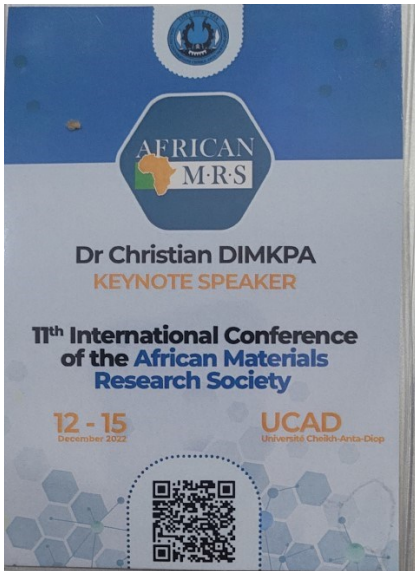
2. Xiong, Z., Zhang, X., **White, J. C.**, Liu, L., Sun, W., Zhang, S., Zeng, J., Deng, S., Liu, D., Zhao, Q., and Xing, B. (In press). Transcriptome analysis reveals the growth promotion mechanism of Enteropathogenic *Escherichia coli* induced by black phosphorus nanosheets. *ACS Nano.*

Abstract: With the extensive production and application of black phosphorus (BP) nanosheets, release to the environment is inevitable, which raises concerns about fate and effects of this two-dimensional (2D) material on sensitive receptors such as environmental microbes. Although the bacterial toxicity of BP nanosheets has been demonstrated, whether biological response differs in pathogenic and non-pathogenic strains of a microorganism is unknown. Here, enteropathogenic Escherichia coli (EPEC) and non-pathogenic *Escherichia coli* DH5α (E. coli DH5α), *Escherichia coli* k12 (*E. coli* k12), and *Bacillus tropicus* (*B. tropicus*) are used to comparatively study the microbial toxicity of BP nanosheets. Upon exposure to BP nanosheets across a range of doses from 10 to 100 μg mL-1 for 12 h, EPEC experienced enhanced growth, *E. coli* DH5α and *E. coli* k12 were not affected, whereas *B. tropicus* exhibited clear toxicity. By combining transcriptome sequencing, proteome analysis, and other sensitive biological techniques, the mechanism of BP-induced growth promotion for EPEC was uncovered. Briefly, BP nanosheets activate the anti-oxidation system to resist oxidative stress, promote protein synthesis and secretion to attenuate membrane damage, enhance the energy supply, and activate growth-related pathways. None of these impacts were evident with non-pathogenic strains. By describing the mechanism of strain-dependent microbial effects, this study not only highlights the potential risks of BP nanosheets to the environment and to human health, but also calls attention to the importance of model strain selection when evaluating the hazard and toxicity of emerging nanomaterials.

3. Ma, C., Han, L., Shang, H., Hao, Y., Xu, X., **White, J. C.**, Wang, Z., and Xing, B. (In press). Nanomaterials in agricultural soils: Ecotoxicity and application. *Curr. Opin. Environ. Sci. Health.*

Abstract: Engineered nanomaterials (NMs) at appropriate doses have demonstrated positive roles in defending against and alleviating biotic (e.g. fungi, bacteria, viruses, etc.) and abiotic (salt, drought, temperature, etc.) stresses in agricultural environments. In comparison with conventional bulk particles or ionic forms, the unique physicochemical properties of NMs more effectively trigger defense systems in stressed crops and subsequently strengthen plant immunity and growth. More importantly, the use of nanoscale agrichemicals could significantly reduce the overall application rates to the field and minimize the secondary soil and water contamination caused by traditional agrichemicals. Additionally, NMs, as novel amendments, can also efficiently remediate soil-borne heavy metals and emerging organic pollutants by increasing pollutant immobilization, accelerating degradation and regulating crop physiology and rhizosphere microbial community, all of which will subsequently improve soil health. It is highly likely that nano-enabled strategies will become a critical and sustainable tool to improve crop resilience to climate change-caused stresses. Moreover, future investigation on the use of novel NMs (e.g. nanocomposites, pH or enzyme-responsive NMs) in precision agriculture are highly encouraged, although potential/unknown risks to ecosystems and human health should always be considered.

ANALYTICAL CHEMISTRY



DR. CHRISTIAN DIMKPA gave a presentation on "Approaches for increasing phosphorus use efficiency: A case for chitosan and tripolyphosphate" as a Keynote Speaker at the 11th African Materials Research Society Conference. The meeting was held at the Université Cheikh Anta Diop (The Cheikh Anta Diop University) in Dakar, Senegal (December 12-15). During the meeting **DR. DIMKPA** also moderated a session on Materials for Agriculture. The AMRS meeting was attended by over 500 participants from several African universities, the US (NSF, UPenn, Rensselaer Polytechnic Institute, Worcester College, among several others), Europe, Israel and India.

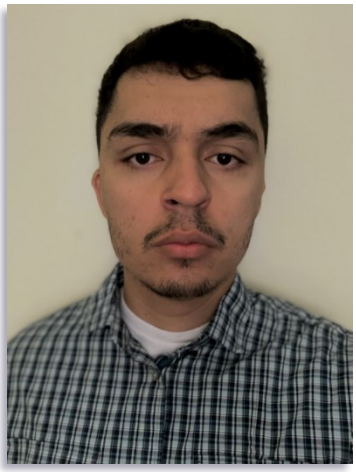
GRANTS AWARDED

1. **DR. NUBIA ZUVERZA-MENA** and **DR. JASON WHITE** were granted USDA awards to fund two projects in which they participate as Co-PI and key personnel: "Manganese and iron based nano-enabled agrochemicals for food security" and "Crop exposure to micro-nanoplastics and potential impact on human nutrition and health," each for ~$750,000 total.

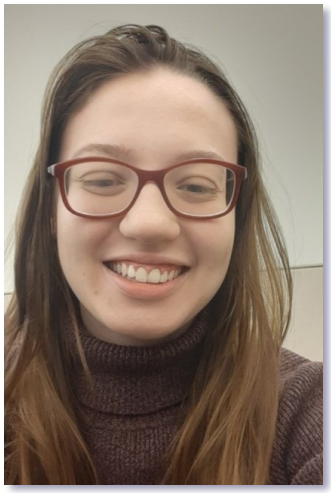
DR. ZUVERZA-MENA along with **DR. JASON WHITE, DR. SARA NASON**, and **DR. SARA THOMAS**, participated in the monthly meeting with collaborators from Yale and the University of Minnesota (December 7) on a NIH NIEHS funded phytoremediation studies; met with **DR. JASON WHITE**, **DR. CHRIS DIMKPA** and **DR. TRUNG HUU BUI** regarding locking PFAS in soil with modified-biochar (December 9); attended the group meeting with **DR. SARA NASON** and **DR. PEIYING WANG** on the USDA wastewater reuse project (December 12); and along with **DR. RAJA MUTHURAMA-LINGAM** interviewed Ms. Sophia Al-Meshrefawi from Southern Connecticut State University for a potential internship during the spring of 2023 (December 15); and along with **DR. SARA NASON**, virtually attended the EPA regional meeting on PFAS and biosolids where The CAES's work on the topic was highlighted (December 14).

DR. SARA THOMAS attended and gave an oral presentation on the topic "Nanoparticle enhanced phytoremediation of PFAS" at the 35th SRP annual meeting organized by the National Institute of Environmental Health Sciences (NIEHS) held in Raleigh, North Carolina in (December 14-16).

NEW STUDENTS, STAFF, AND VOLUNTEERS



MR. BRIAN CINTRA CARDOSO has joined the Department of Analytical Chemistry as a visiting intern. He is an undergraduate student at the University of São Paulo (USP), Brazil. His work at the Center for Nuclear Energy in Agriculture (CENA/USP) focuses on the analysis of the impacts of application of a nanoformulation of metribuzin on soil non-target organisms. Brian will stay at CAES for four months to conduct research to track a metribuzin nanoformulation with fluorescent markers in plants.



MS. CAMILA DE WERK PINÁCIO joined the Analytical Chemistry Department in December 2022 and will stay for four months during which time she will be studying the uptake and distribution of nanoformulations in target plants in different soil systems. Camila is an Agronomic Engineering undergraduate student (University of São Paulo - Esalq/USP). Her research focuses on the behavior of herbicides in the environment under the auspices of the Center for Nuclear Energy in Agriculture - CENA/USP).

DR. JINGYI ZHOU joined the Station as a Postdoctoral Research Scientist in December 2022. Dr. Zhou obtained a Ph.D. degree in Human Nutrition from the University of Alabama in 2022. Her Ph.D. research focused on understanding the structure-function relationships in food carbohydrates by using various microscopic, spectroscopic, and crystallographic techniques to develop food materials of unique structures and properties for improving food quality and nutritional benefits, with specialties in nanoencapsulation and flavor modulation. She employed gas chromatography-mass spectrometry (GC-MS) to determine the stability and release profiles of aromas and flavors, taste masking, and flavor scavenging effect of formed nanoscale inclusion complexes. Dr. Zhou completed her Master of Science and Bachelor of Science studies from the Department of Food Science, University of Massachusetts Amherst, in 2019 and 2017, respectively, with an expertise in protein extraction and characterization. At CAES, Dr. Zhou is working with **Dr. Christian O. Dimkpa** and **Dr. Jason C. White** in the Department of Analytical Chemistry. Her study focuses on nanotechnology applications and implications on food safety and security.

ENTOMOLOGY

DR. GOUDARZ MOLAEI attended the 2022 annual meeting of the Northeastern Mosquito Control Association and presented an update of the Northeast Regional Center for Excellence in Vector-Borne Diseases programs (December 5).

DR. DOUGLAS BRACKNEY presented a poster titled, "Microbiome presence and composition alter mosquito susceptibility to arboviruses: an axenic model", at the 71st annual meeting of the American Society of Tropical Medicine and Hygiene in Seattle, WA (Nov 1). Poster contributors were **MR. DUNCAN COZENS, DR. ZANNATUL FERDOUS, MS. JACQUELYN LAREAU**, and **DR. BLAIRE STEVEN.**

MS. ANGELA BRANSFIELD participated via Zoom in Yale's Biosafety Committee meeting (December 15); and participated in a CAES Health and Safety Committee meeting (December 20).

MS. JAMIE CANTONI joined **DR. MEGAN LINSKE**, and **DR. SCOTT WILLIAMS** (Department of Environmental Science and Forestry) in a Zoom call with collaborators from Dartmouth College to discuss updates pertaining to a study concerning tick abundance and pathogen prevalence using collective data from across the northeastern U.S. (December 12).

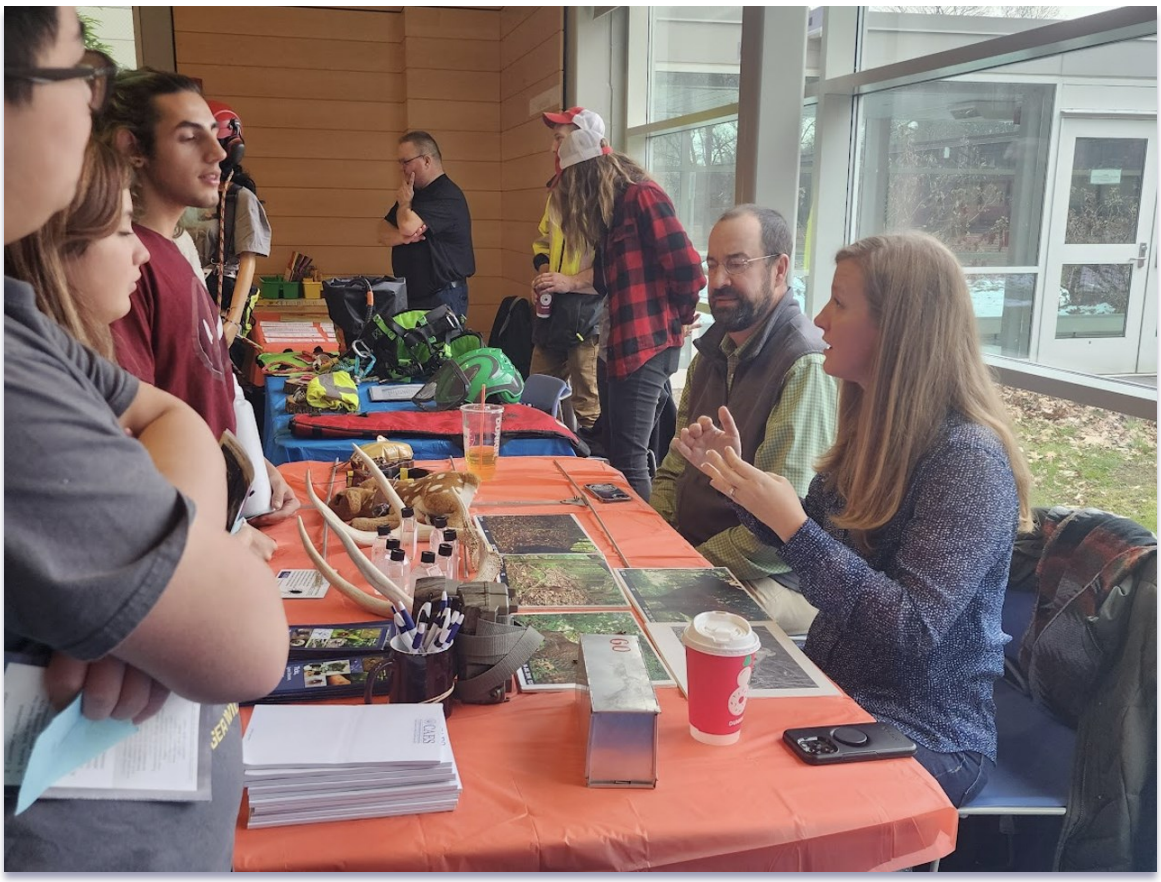
DR. MEGAN LINSKE participated in a collaborative meeting with Genesis Laboratories, Inc. and White Buffalo, Inc. about a future Centers for Disease Control and Prevention (CDC) funding opportunity (December 8); participated in a Wildlife Society Leadership Institute virtual meeting to discuss the 2023 Leadership Institute application and selection criteria for candidates (December 8); participated in regional active tick surveillance meeting hosted by Dr. Lucas Price and Dr. Jonathan Winter (Dartmouth University) to discuss recent findings on tick distribution and infection in the Northeast and how they can be utilized in predictive analytics (December 10); participated in a Zoom call with colleagues from the Northeast Regional Center of Excellence in Vector Borne Diseases on a collaborative strategy to apply for a CDC funding opportunity for vector control training and evaluation (December 13); hosted Dr. Allison Snow (University of Massachusetts) and discussed host-targeted acaricidal-treatment strategies used on primary host species, as well as host capture techniques (December 14); participated in a career fair for Lyman Hall High School students in Wallingford (December 15); participated in a Zoom call with colleagues from Cornell University and Columbia University on a collaborative strategy to apply for a CDC funding opportunity for vector control training and evaluation (December 20, 23).

MS. TANYA PETRUFF gave a talk titled "Range Expansion of *Aedes albopictus*, *Anopheles crucians* and *Culex erraticus* through Connecticut: A Cause for Concern?" at the 2022 annual meeting of the Northeastern Mosquito Control Association in Hyannis, MA (December 5-7).

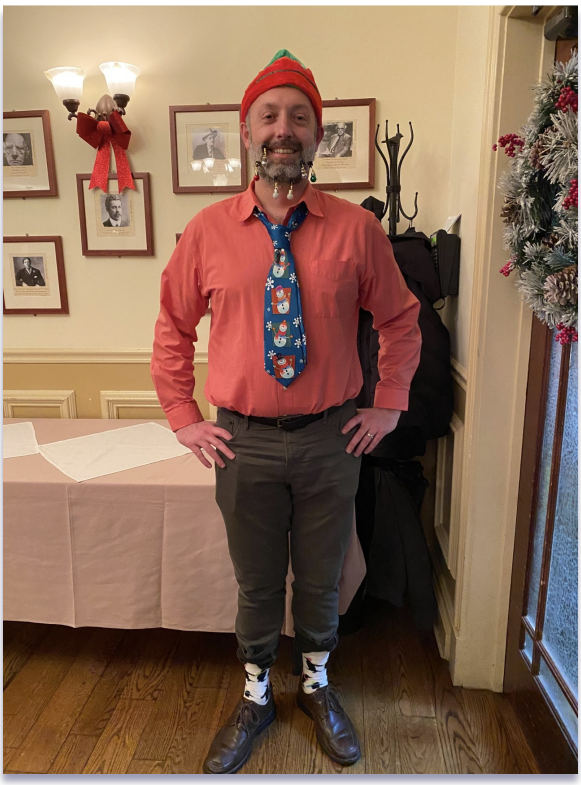
DR. CLAIRE RUTLEDGE presented a lecture titled, "New insects in Connecticut" livestreaming as an Advanced Master Gardeners class (December 2); presented the talk "New insects in Connecticut" to the MAD Gardeners in Litchfield, CT (December 4); was interviewed by the Norwalk Bulletin in a segment titled "Long Term Hope for Control of the

Emerald Ash Borer" https://thelastgreenvalley.org/long-term-hope-for-control-of-the-emerald-ash-borer/ (December 13); helped to administer the oral portion of the Connecticut Arborist Licensing Exam. New Haven (December 14); and gave a livestreamed talk, "Trapping methodologies for Bonze Birch Borer (*Agrilus anxius*) and Emerald Ash Borer (*Agrilus plainpennis*)" as part of a symposium presented by The Swedish Board of Agriculture on Survey, Diagnosis and Outbreaks, Actions for *Agrilus anxius* and *Agrilus planipennis* (December 19).

MR. JOHN SHEPARD participated in an Executive Board Meeting and presented the invited talk "Arbovirus Activity in Connecticut, 2022"; was elected to the position of 2nd Vice President at the 68th Annual Meeting of the Northeastern Mosquito Control Association in Hyannis, MA (December 4-7); and along with **MS. TANYA PETRUFF**, met via Zoom with Dr. Addie Williams, Dr. Paola Carolina Valenzuela Leon, and Karina Sewell from NIH/NIAID to discuss the establishment of a mosquito colony for their research program (December 16).



Dr. Megan Linske and **Dr. Scott Williams** participating in the Lyman Hall High School Career Fair to discuss career paths involving wildlife biology, ecology, and public health. December 15, 2022.



Dr. Doug Brackney, winner of the 2022 Holiday Costume Party!

PUBLICATIONS

1. Pavlicevic, M., Abdelraheem, W., **Zuverza-Mena, N.**, O'Keefe, T., Mukhtar, S., **Ridge, G.**, **Ranciato, J.**, Haynes, C., **Elmer, W.**, **Pignatello, J.**, Pagano, L., Caldara, M., Marmiroli, M., Maestri, E., Marmiroli, N., and **White, J. C.** (2022). Engineering Nanoparticles, Natural Nanoclay and Biochar, as Carriers of Plant-Growth Promoting Bacteria. *Nanomaterials*, *12*. DOI: 10.3390/nano12244474

Abstract: The potential of biochar and nanoparticles to serve as effective delivery agents for beneficial bacteria to crops was investigated. Application of nanoparticles and biochar as carriers for beneficial bacteria improved not only the amount of nitrogen-fixing and phosphorus-solubilizing bacteria in soil, but also improved chlorophyll content (1.2–1.3 times), cell viability (1.1–1.5 times), and antioxidative properties (1.1–1.4 times) compared to control plants. Treatments also improved content of phosphorus (P) (1.1–1.6 times) and nitrogen (N) (1.1–1.4 times higher) in both tomato and watermelon plants. However, the effect of biochars and nanoparticles were species-specific. For example, chitosan-coated mesoporous silica nanoparticles with adsorbed bacteria increased the phosphorus content in tomato by 1.2 times compared to a 1.1-fold increase when nanoclay with adsorbed bacteria was applied. In watermelon, the situation was reversed: 1.1-fold increase in the case of chitosan-coated mesoporous silica nanoparticles and 1.2 times in case of nanoclay with adsorbed bacteria. Our findings demonstrate that use of nanoparticles and biochar as carriers for beneficial bacteria significantly improved plant growth and health. These findings are useful for design and synthesis of novel and sustainable biofertilizer formulations.

ENVIRONMENTAL SCIENCE AND FORESTRY

GRANTS AWARDED

1. DR. BLAIRE STEVEN and colleagues from the University of Connecticut and DEEP were selected for a Long Island Sound Sea Grant. The title of the successful proposal is "Testing the Effects of Vegetation on Saltmarsh Ecology, Services, and Restoration Success: From Microbial Ecology and Biogeochemistry to Wildlife Conservation." Total funding $909,478 with $94,486 to CAES, 2 years.

Abstract: Salt marshes are among the most productive ecosystems globally but are undergoing rapid change as sea-levels rise, with anticipated loss of diverse services, from habitat for declining species to carbon sequestration and nitrogen removal. By raising elevation, sediment addition has garnered interest from many conservation practitioners given its potential to protect services and improve coastal resilience. The saltmarsh sparrow has received much attention due to rapid declines and its conservation has become central to much saltmarsh management in the eastern US, yet we do not understand how restoration affects saltmarsh sparrows or the consequences for other functions and services of managing for this one species. Large-scale sediment additions in particular raise concerns because they inevitably make marshes less suitable for saltmarsh birds in the short-term. Adding sediment in meso-scale patches (hummocks a few 100 m^2 in size), potentially mitigates this risk, while requiring far less sediment than uniform applications, creating considerable micro-topography, limiting the area of disturbance, and maintaining interspersed sources for revegetation that complement planting. Where rare species occur, hummocks also allow customized sediment placement to avoid impacts on remaining fragments of high-quality habitat and potentially lessen adverse effects on the target species. By combining hummock creation with a revegetation planting experiment at Great Meadows Marsh, Stratford, we have created a unique system for testing the effects of sediment additions. By simultaneously studying responses of vegetation, greenhouse gas fluxes, the soil microbial community, and declining saltmarsh birds, and making comparison to reference marshes, our interdisciplinary team will evaluate the trade-offs among sediment placement outcomes and inform future restoration goals. By partnering with local, state, and regional practitioners, we will develop practical guidelines for adaptive management, identify best management practices for similar projects, and disseminate our results widely.

PUBLICATIONS

1. Wang, Z., Alinezhad, A., **Nason, S.**, Xiao, F., and **Pignatello, J. J.** (2023). Enhancement of Per-and Polyfluoroalkyl Substances Removal from Water by Pyrogenic Carbons: Tailoring Carbon Surface Chemistry and Pore Properties. *Water Research, 229*. DOI: 10.1016/j.watres.2022.119467

Abstract: Several countries, including the United States, plan to set an enforceable maximum contaminant level for certain per- and polyfluoroalkyl substances (PFAS) in drinking water. Among the available treatment options, sorption by pyrogenic carbonaceous sorbents (PCS) is a practical and effective approach to remove PFAS from water in pilot-

and full-scale applications. The two most important properties of PCS, surface chemistry and pore structure, were tailored in this study to understand their importance in the sorption of various anionic shorter-chain and longer-chain PFAS. Brief thermal oxidation (post-pyrolysis air oxidation, PPAO) of PCS, including biochars, at a moderate temperature (400 °C) was used to increase specific surface area and nanoporosity. The sorption distribution ratio, KD, of individual PFAS after PPAO treatment increased by as much as three orders of magnitude compared to the unmodified PCS—more effectively so for longer-chain than shorter-chain compounds. Pore reaming plays a major role in the sorption enhancement and an ion-pair (PFAS-counterions) sorption mechanism is proposed. In addition, irreversible sorption of a quaternary ammonium cationic polymer, poly(dimethyldiallylammonium) chloride (pDADMAC), was employed to reverse the surface charge of biochar. Coating with pDADMAC increased PFAS sorption by a factor of 10–3000 predominantly by an anion-exchange mechanism. Sorption enhancement was more effective for the sulfonate than the carboxylate with the same perfluoro chain length. The results of this study are expected to inform the design of carbons with greater ability to remove PFAS from water, which are urgently needed for water facilities to comply with state and federal regulations.

2. Qaseem, M. F., Wang, K., Yang, H., Zhao, S., Li, H., and Wu, A.-M. (2023). Transcriptomic evidence reveals low gelatinous layer biosynthesis in *Neolamarckia cadamba* after gravistimulation. *International Journal of Molecular Sciences*, *24*, 268. DOI: 10.3390/ijms24010268

Abstract: Trees can control their shape and resist gravity by producing tension wood (TW), which is a special wood that results from trees being put under stress. TW is characterized by the presence of a gelatinous layer (G layer) and the differential distribution of cell wall polymers. In this study, we investigated whether or not gravistimulation in *N. cadamba* resulted in TW with an obvious G layer. The results revealed an absence of an obvious G layer in samples of the upper side of a leaning stem (UW), as well as an accumulation of cellulose and a decrease in lignin content. A negligible change in the content of these polymers was recorded and compared to untreated plant (NW) samples, revealing the presence of a G layer either in much lower concentrations or in a lignified form. A transcriptomic investigation demonstrated a higher expression of cell wall esterase- and hydrolase-related genes in the UW, suggesting an accumulation of noncellulosic sugars in the UW, similar to the spectroscopy results. Furthermore, several G-layer-specific genes were also downregulated, including fasciclin-like arabinogalactan proteins (FLA), beta-galactosidase (BGAL) and chitinase-like proteins (CTL). The gene coexpression network revealed a strong correlation between cell-wall-synthesis-related genes and G-layer-synthesis-specific genes, suggesting their probable antagonistic role during G layer formation. In brief, the G layer in *N. cadamba* was either synthesized in a very low amount or was lignified during an early stage of growth; further experimental validation is required to understand the exact mechanism and stage of G layer formation in *N. cadamba* during gravistimulation.

DEPARTMENTAL RESEARCH UPDATES

DR. SCOTT WILLIAMS hosted a candidate for the open forest ecologist position in the ESF Department (December 6-7); held a collaborative meeting between Genesis Laboratories, Inc. and White Buffalo, Inc. for a future Centers for Disease Control and Prevention (CDC) funding opportunity (December 8); participated in a Zoom meeting with Dr. Andrea Swei, Associate Professor in the Department of Biology at San Francisco State University, advising on host-targeted strategies for tick management (December 8); met virtually with regional active tick surveillance partners to discuss recent findings on tick distribution and infection in the Northeast headed by Dartmouth University postdoctoral fellow Dr. Lucas Price and Professor Dr. Jonathan Winter (December 10); participated in a Zoom call with colleagues from Cornell University and Columbia University on a collaborative strategy to apply to a CDC funding opportunity for vector control training (December 13); hosted University of Massachusetts Research Professor Dr. Allison Snow and demonstrated host-targeted acaricidal-treatment strategies as well as white-tailed deer capture techniques (December 14); participated in a career fair for the sophomore class at Lyman Hall High School in Wallingford (December 15); hosted a candidate for the open forest ecologist position in the ESF Department (December 19-20); was job shadowed by an East Haddam High School student as a part of her senior capstone project (December 20); participated in a Zoom call with colleagues from Cornell University and Columbia University on a collaborative strategy to apply to a CDC funding opportunity for vector control training (December 20, 23).

MR. JOSEPH P. BARSKY attended a virtual meeting with staff from the Connecticut Natural Resources Conservation Service to discuss future soil sampling and characterization efforts (December 6); served as an invited panelist in an online webinar titled “Dogs on Land Trust Properties” hosted by Flanders Nature Center, Woodbury, CT (10 attendees) (December 7); participated in the quarterly meeting of the New England Society of American Foresters Executive Committee (December 14); met with Connor Hogan, Director of McLean Game Refuge to discuss collaborative research on the use of slash walls to limit herbivory impacts to native regeneration by white-tailed deer (December 21).

MR. GREGORY BUGBEE chaired a virtual meeting of the Northeast Aquatic Plant Management Society Scholarship Committee (December 8); gave a virtual lecture titled “Grass Carp in Connecticut Lakes – Somethings Fishy Going on Here” as part of the Connecticut Federation of Lakes Fall Seminar Series (75 attendees) (December 12); with **MS. SUMMER STEBBINS** participated in a virtual meeting of the United States Army Corps of Engineers Connecticut River Hydrilla Task Force (December 21).

DR. SUSANNA KEIRÖ administered the Tree Protection Examination (December 12); served in a meeting of the Yale University Biosafety Committee (December 15); attended an executive council meeting of the Connecticut Urban Forest Council (December 21).

DR. SARA NASON attended virtual meetings for the Benchmarking and Publications for Non-Targeted Analysis working group (December 1, 6, 15); met virtually with PFAS researchers from the University of Connecticut and Yale University as part of the CT PFAS testing Laboratory Capacity and Capability discussion group (December 2); attended the

Connecticut Interagency PFAS Task Force Action Plan Three Year Review Meeting in Hartford (December 8); attended the EPA Region 1 States PFAS in Biosolids Roundtable (December 14).

DR. ITAMAR SHABTAI attended a virtual meeting with Connecticut Natural Resources Conservation Service staff to discuss future soil sampling and characterization efforts (December 6); gave an oral presentation at the American Geophysical Union meeting in Chicago on "A Spectromicroscopy Study of the Organo-mineral Interactions in the Rhizosphere" (100 attendees) (December 12).

MS. SUMMER STEBBINS with **DR. QUAN ZENG, MS. KAROL ALVES BARROSO, MS. MEGHAN CAHILL, DR. ITAMAR SHABTAI,** and **DR. LEIGH WHITTINGHILL** hosted two students from Wilbur Cross High School as part of the Women in STEM mentorship program and provided them a tour of the laboratory facilities at The CAES's New Haven campus.

DR. JEFFREY WARD participated in a (FEMC) Forest Ecosystem Monitoring Cooperative State Coordinators meeting (December 8); participated in a Connecticut Forest and Park Association (CFPA) Governance Committee meeting (December 13).

DR. LEIGH WHITTINGHILL participated in a NIFA grant review panel (December 2); hosted a lab visit with the Girls in STEM program with two juniors from Wilbur Cross High School (December 6); met with the CAES Postdoctoral Scholar Association board for the first time as Co-mentor (December 12); participated in the Connecticut Council on Soil and Water Conservation quarterly meeting (December 15).

PLANT PATHOLOGY AND ECOLOGY

DR. WASHINGTON DA SILVA taught a discipline "Plant Molecular Virology Lab" to postgraduate students in the department of agronomy at the Universidade Federal Rural do Semiarido (UFERSA), Mossoro, Brazil (15 students) (December 5-16); participated in a USA Federal Grant Panel via Zoom as a grant reviewer (21 attendees) (December 12-16); gave a seminar titled "The Role of Nanotechnology in Plant Viral Disease Management: A Perspectives Talk" to students and faculty members of the department of Biology at Universidade Federal do Rio Grande do Norte (UFRN) (55 attendees) (December 19).

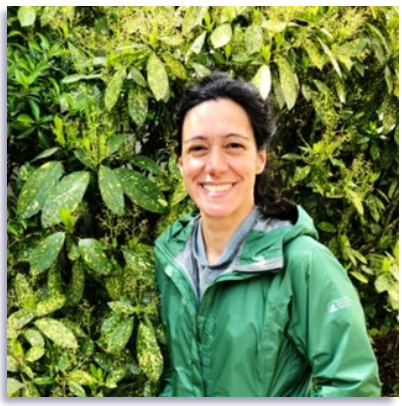
Ms. Karol Barroso from the **da Silva Lab** successfully passed her qualification exam (B exam) via Google Meetings (6 attendees) (December 28). Kudos to Karol Barroso, now a Ph.D. candidate!

DR. WADE ELMER attended the Atlantic Basin Conference on Chemistry's Annual meeting in Marrakech, Morocco, December 13-16, and presented "Use of nano Cu for crop disease management" (December 15) (13 adults).

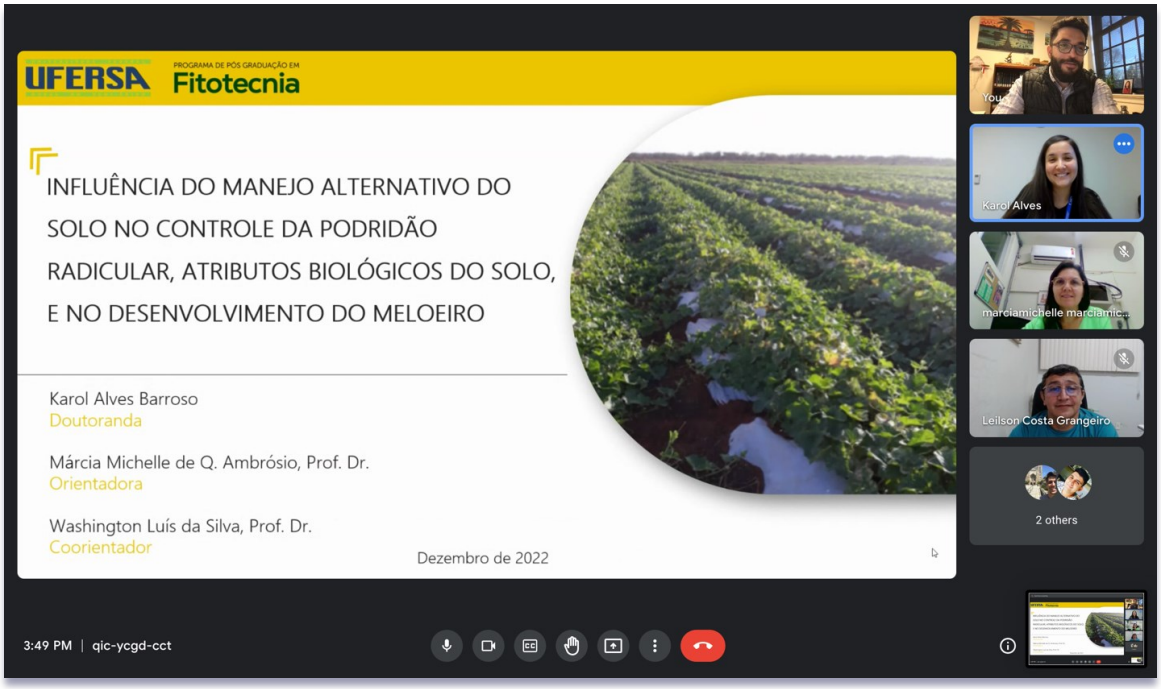
DR. NEIL SCHULTES gave three lectures on "Genetically Modified Plants in Agriculture" in the Yale University course Sci030 (November 18, December 2 9).

DR. YONGHAO LI instructed "Phytophthora bleeding canker" in the Review Night of the Connecticut Tree protective Association Arboriculture 101 Course in New Haven (24 adults) (December 8); attended the Plant Diagnostic Network Northeast Reginal monthly meeting via Zoom (December 15).

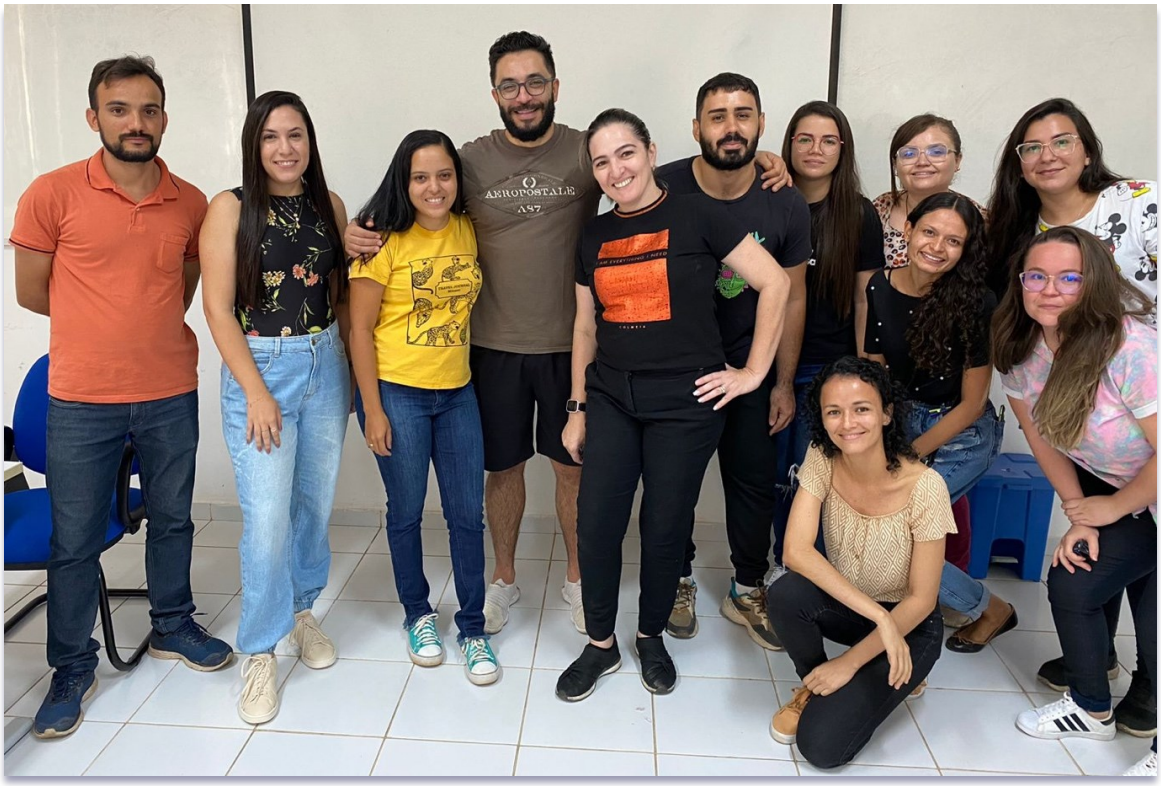
NEW STUDENTS, STAFF, AND VOLUNTEERS



Felicia Millett joins the Plant Disease Information Office (PDIO) as a Plant Diagnostician. She received her master's degree in Plant Science in December 2022 from the University of Connecticut, working with **Dr. Quan Zeng** as her major advisor. Her research focused on trichomes as colonization sites and host entry points of the fire blight pathogen on apple leaves. She will assist **Dr. Yonghao Li** in serving Connecticut's growers and gardeners by handling and performing diagnostic tests on samples received, conducting seed germination tests and contributing to public outreach programs. Felicia enjoys mountain biking and hiking throughout Connecticut's many trail systems.



Ph.D. student (now candidate), Karol Barroso, presenting her thesis project during her qualification exam.



Dr. Washington da Silva with students from his Plant Molecular Virology class at UFERSA.

VALLEY LABORATORY

DR. RICHARD COWLES presented "Soil dwelling insect pests of strawberries" for the New England Vegetable and Berry Growers Conference, Manchester, NH (80 participants) (December 13).

MS. ROSE HISKES with **DR. YONGHAO LI** assisted The Connecticut Tree Protective Association with their hands-on review night for students of the Arboriculture 101 course. (24 attendees) (December 8).

PUBLICATIONS

1. Zhang, M.-Y., **Li, D.-W.** Yin, Z. M., Li, H., and Zhu, L.-H. (2022). Red foliage blight of × *Taxodiomeria peizhongii* caused by *Neopestalotiopsis clavispora* newly reported in China. *Plant Disease*, *106*(11), 2988. https://doi.org/10.1094/PDIS-02-22-0444-PDN

Abstract: × Taxodiomeria peizhongii Z.J. Ye, J.J. Zhang & S.H. Pan is a hybrid of Taxodium mucronatum and Cryptomeria fortunei. It can adapt to various site conditions and has a good saline-alkali tolerance, making it a unique tree species in eastern China (Ling et al. 2006; Zhang et al. 2003). In August 2020, a red foliage blight with an incidence of 70% (105/150 plants) was found on leaves of × T. peizhongii in a nursery in Shanghai, China (31°41′56″N, 121°21′12″E). It developed from apical leaves of branches downward. Infected leaves became reddish brown and withered. Fresh specimens were collected from three infected trees. Small samples (3 to 4 mm2) from lesion margins were sterilized (Zhang et al. 2021), plated on potato dextrose agar (PDA), and incubated at 25°C. Nine isolates of the same fungus were obtained. Three representative isolates (DFS1-3, DFS1-8, and DFS1-9) were used for morphological and molecular studies and deposited in China's Forestry Culture Collection Center (cfcc57401 to cfcc57403). The colonies of three isolates on PDA grew fast, covering the entire plate with white cottony mycelia in 7 days. Acervuli of DFS1-3 were 618 to 996 × 586 to 945 µm (n = 50). Conidiogenous cells were 4.4 to 9.8 µm (n = 50) long. Conidia were five-celled, clavate to fusiform, smooth, 19 to 24 × 6.4 to 8.8 µm (n = 50). The three median cells were dark brown to olivaceous, the central cell was darker than the other two cells, and the basal and apical cells were hyaline. All conidia developed one filiform basal appendage (3.4 to 8 µm long; n = 50), and two to three apical appendages (15 to 30 µm long; n = 50). The morphological characters of DFS1-8 and DFS1-9 were almost identical to DFS1-3. Based on morphological studies, the isolates were Neopestalotiopsis sp. (Maharachchikumbura et al. 2014). The DNA of three isolates was extracted. The internal transcribed spacer region (ITS), β-tubulin 2 (TUB2), and translation elongation factor 1-alpha (TEF1-α) loci were amplified using the primer pairs ITS1/ITS4, T1/Bt-2b, and EF1-728F/EF-2 (Maharachchikumbura et al. 2014). BLAST results showed that ITS of the three isolates were identical to Pestalotiopsis sp. at a high level (>99%), and TUB2 and TEF1-α were highly similar to Neopestalotiopsis sp. (>99%). The sequences were deposited in GenBank (accession nos. OM188301 and OM222696 to OM222697 for DFS1-3; OM188303 and OM222698 to OM222699 for DFS1-8; OM188302 and OM222700 to OM222701 for DFS1-9). Maximum likelihood and Bayesian posterior probability analyses using IQtree v. 1.6.8 and Mr. Bayes v. 3.2.6 with the concatenated sequences (ITS, TUB2, and TEF1-α) clustered three isolates together with N. clavispora, including the type isolate

(MFLUCC 12-0281). Based on the morphology and phylogeny, the fungus was N. clavispora (Maharachchikumbura et al. 2014). To confirm pathogenicity, nine healthy 2-year-old seedlings, and 10 leaves per seedling, were wounded with a sterile needle and inoculated with conidial suspension (106 conidia/ml). Three control plants were sprayed with sterile water. Seedlings were covered with plastic bags after inoculation and kept in a greenhouse at 25 ± 2°C and 80% relative humidity. Seven days after inoculation, all inoculated leaves were reddish brown and withered like those observed in the field, but the control plants remained symptomless. N. clavispora was successfully reisolated from the infected tissues. This pathogen has been reported to cause leaf blight on many other hosts, such as Ligustrum lucidum (Chen et al. 2019) and macadamia (Santos et al. 2019), but recently the disease has also been reported on flowers, such as Anthurium (Daengsuwan et al. 2021). It has not been reported on Taxodium or Cryptomeria. This is the first report of N. clavispora infecting × T. peizhongii in the world. These data will help select appropriate fungicides for managing this newly emerging disease.

2. Liao, Y.-C.-Z., Zhang, M.-Y., Chen, Y., **Li, D.-W.**, Sun, H., and Zhu, L.-H. (2022). First report of *Erysiphe magnoliicola* causing powdery mildew of *Magnolia* × *soulangeana* in China. *Plant Disease*, *106*(12), 3212. DOI: 10.1094/PDIS-01-22-0020-PDN

Abstract: Magnolia × soulangeana Soul.-Bod., the saucer magnolia, is a woody ornamental plant cultivated widely in China, the United Kingdom, and the United States (POWO 2022; Wang 2001). In August 2021, symptoms and signs of powdery mildew appeared on leaves of M. × soulangeana on the Nanjing Forestry University (NJFU) campus. The powdery mildew mainly infected young seedlings, with an incidence of 96.8% (436/450 seedlings), but some adult trees were infected (5/30 trees). The mycelium was amphigenous, thinly effused or conspicuous, forming circular to irregular white patches. Noticeable brown lesions and necrosis occurred in the later stage of infection. Chasmothecia started to develop in October 2021 and fully matured in early November 2021. Ten fresh specimens were collected and examined to identify the pathogen. Photos were taken with a ZEISS Axio Imager A2m microscope, a Zeiss stereo microscope (SteRo Discovery v20), and a scanning electronic microscope (JSM-7600F). Conidiophores arose from the upper part of mother cells, 78.5 ± 11.2 × 10.9 ± 1.7 µm (n = 30). Foot cells in conidiophores were straight and cylindrical with a constricted basal septum near the hyphal mother cell, 33.6 ± 4.3 × 10.3 ± 1.2 µm (n = 30). Conidia were hyaline, ellipsoid to oval, solitary or in chains of two to three, 38.5 ± 3.3 × 18.4 ± 1.0 µm (n = 30). Chasmothecia were amphigenous, scattered or aggregated, blackish brown, oblate, 101.1 ± 11.4 µm in diam. (n = 30), with 6 to 10 appendages. Appendages were aseptate, rarely one-septate, four to five times frequently dichotomously branched; tips were noticeably recurved, brown at the base, 105.1 ± 10.7 × 8.5 ± 1.4 µm (n = 30). Asci were six to eight per chasmothecium (n = 30), ellipsoid to obovoid or saccate with a short stalk or sessile, 64.2 ± 6.5 × 46.1 ± 5.7 µm (n = 30), four to six spored. Ascospores were oblong-ovoid, 26.2 ± 1.4 × 13.8 ± 0.7 µm (n = 30). Based on the morphological characteristics, the fungus was identified as Erysiphe magnoliicola S.E. Cho, S. Takam. & H.D. Shin (Cho et al. 2014). To confirm the identity, a representative voucher specimen collected and deposited in the NJFU herbarium (NF50000008) was used for phylogenetic analysis. Mycelia and conidia were collected from diseased leaves and genomic DNA of the pathogen was extracted. The internal transcribed spacer region (ITS) and large subunit (LSU) loci were amplified with primers ITS1/ITS4 and LR0R/LR05 (White et al. 1990). The sequences were deposited

in GenBank (ITS: OL454094; LSU: OM758416). BLAST results showed that the ITS sequence was highly similar to a sequence of E. magnoliicola (type) (KJ567072, identities = 614/619 [99.2%]), while the LSU sequence was highly similar to E. magnoliicola (KJ567068, 889/891 [99.8%]) and E. magnoliae (JX235969, 903/909 [99.3%]). Phylogenetic analyses using ITS or LSU sequences with maximum likelihood and Bayesian posterior probability using IQ-TREE v. 1.6.8 and MrBayes v. 3.2.6 placed the fungus in the E. magnoliicola clade. Based on the morphology and phylogeny, the fungus was identified as E. magnoliicola. Pathogenicity was tested on six potted M. × soulangeana. Three seedlings were inoculated by gently pressing naturally infected leaves onto healthy leaves. Healthy leaves from three other seedlings served as controls. Inoculated and control seedlings were placed in separate growth chambers at 23 ± 2°C/16 ± 2°C, 70% relative humidity, with a 16 h/8 h light/dark period. Symptoms developed 10 days postinoculation. The powdery mildew on the inoculated seedlings was examined, sequenced, and confirmed as E. magnoliicola. Control leaves did not develop powdery mildew. Magnolia × soulangeana is a hybrid of Magnolia denudata × Magnolia liliiflora. Both species, as well as M. sieboldii, are known hosts of E. magnoliicola (Cho et al. 2014). This is the first report of powdery mildew caused by E. magnoliicola on M. × soulangeana. This provides crucial information for developing strategies to monitor and manage this disease.

3. He, J., Sun, M.-L., **Li, D.-W.**, Zhu, L.-H., Ye, J.-R., and Huang, L. (2022). A real-time PCR for detection of pathogens of anthracnose on Chinese fir using TaqMan probe targeting ApMat gene. *Pest Management Science*. DOI: 10.1002/ps.7260

Abstract: Anthracnose is one of the most widespread and destructive diseases on Chinese fir. Colletotrichum cangyuanense, Colletotrichum fructicola, Colletotrichum gloeosporioides, and Colletotrichum siamense are the causal agents of anthracnose on Chinese fir. A rapid and accurate diagnosis of different pathogens is critical for the disease management.

4. Wan, Y., Jin, G.-Q., **Li**, **D.-W.**, Wu, S., and Zhu, L.-H. (2022). First report of *Colletotrichum fructicola* causing leaf spots of *Liriodendron chinense* × *tulipifera* in China. *Forest Pathology*, *52*. DOI: 10.1111/efp.12779

Abstract: *Liriodendron chinense* × *tulipifera* is widely planted in China as an ornamental plant. In July 2018, a foliar disease, with an incidence of ~23% trees and ~45% leaves per individual tree infected, occurred on *L. chinense* × *tulipifera* on the campus of Nanjing Forestry University, Jiangsu Province, China. Symptoms were small brown to dark spots surrounded by a yellow halo initially, which enlarged and coalesced into regular or irregular brown necrotic lesions up to 8.5 ± 1.3 mm across. Fungi were isolated from the margins of the lesions. Three representative isolates (E3-2, E3-3 and E3-4) were selected for phylogenetic analyses. One representative isolate E3-2 was used for pathogenicity tests and morphological identification. The pathogenicity of isolate E3-2 to *L. chinense* × *tulipifera* was confirmed on 1-year-old seedlings with lesions after 5 days. The phenotypic characteristics of the isolates were similar to those of *Colletotrichum* sp. (Glomerellaceae). Phylogenetic analyses using concatenated sequences of ITS, *ACT*, *CHS*, *GADPH*, *CAL*, *SOD2* and *TUB2* placed E3-2, E3-3 and E3-4 in the clade of *C. fructicola*. Based on the morphological and phylogenetic studies, the isolates were identified as *C. fructicola*. This is the first report of *C. fructicola* causing *L. chinense* × *tulipifera* leaf spots in China.

JOURNAL ARTICLES APPROVED DECEMBER 2022

Cheah, C. Collaborations in Connecticut to protect eastern hemlocks. *The Habitat*.

Chen, S., Pan, Z., Zhao, C., Zhou, Y., Rui, Y., Jiang, C., Wang, Y., **White, J. C.**, and Zhao, L. Engineering climate-smart rice using a nanobiostimulant-based "stress training" strategy. *Nature*.

Cowles, R. S. Christmas tree economics. *The Real Tree Line*.

Dimkpa, C., Adzawla, W., Pandey, R., and Bindraban, P. Fertilizers for food and nutrition security: an overview of soil health implications for Sub-Saharan Africa. *Frontiers in Soil Science*.

Khalil, N., **Shepard, J. J.**, Foss, K., and **Molaei*, G.** Evidence of *Uranotaenia sapphirina* (Diptera: Culicidae) feeding on annelid worms in the Northeastern U.S. *Journal of Medical Entomology*.

Li, H., Liao, Y.-C.-Z., **Li, D.-W.**, and Zhu, L.-H. Beneficial impacts of foliar applied ZnO quantum dots on endophytic and rhizosphere microbial communities of pumpkin (*Cucurbita moschata* Duch.). *Environmental Science and Technology*.

Li, H., Liao, Y.-C.-Z., **Li, D.-W.**, and Zhu, L.-H. First report of *Colletotrichum gloeosporioides* causing leaf tip blight of *Jasminum mesnyi* in China. *Plant Disease*.

Li, H., Liao, Y.-C.-Z., **Li, D.-W.**, and Zhu, L.-H. First report of *Erysiphe alphitoides* causing powdery mildew of *Cocculus orbiculatus* in China. *Plant Disease*.

McMillan, J. R., Chaves, L. F., and **Armstrong, P. M.** Ecological predictors of mosquito population and arbovirus transmission synchrony estimates. *Journal of Applied Ecology*.

Soghigian, J., Sither, C., Andrade Justi, S., Morinaga, G., Cassel, B. K., Vitek, C. J., Livdah, T., Xia, S., **Gloria-Soria, A.**, Powell, J. R., Zavortink, T., Hardy, C., Burkett-Cadena, N. D., Reeves, L. E., Dunn, R. R., Yeates, D. K., Sallum, M. A., Byrd, B., Trautwein, M. D., Linton, Y., Reiskind, M. H., and Wiegmann, B. M. An enduring enemy: Phylogenomics reveals the history of host use in mosquitoes. *Science*.

Triplett, L. R., **Taerum, S.**, Patel, R., and **Steven, B.** Not just bacteria and fungi: toward harnessing the protist "dark matter" of the phytobiome. *ABiotech*.

Wang, Z., Chen, X., Lia, J., Wang, C., Yue, L., **Elmer, W., White, J. C.,** Cao, X., and Xing, B. Lanthanum silicate nanomaterials enhanced disease resistance in rice: Mechanisms of action and soil health evaluation. *Environmental Science and Technology*.

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The Connecticut Agricultural Experiment Station

Main Laboratories
123 Huntington Street
New Haven, CT 06511-2016
Phone: 203-974-8500

Lockwood Farm
890 Evergreen Avenue
Hamden, CT 06518-2361
Phone: 203-974-8618

Griswold Research Center
190 Sheldon Road
Griswold, CT 06351-3627
Phone: 860-376-0365

Valley Laboratory
153 Cook Hill Road
Windsor, CT 06095-0248
Phone: 860-683-4977

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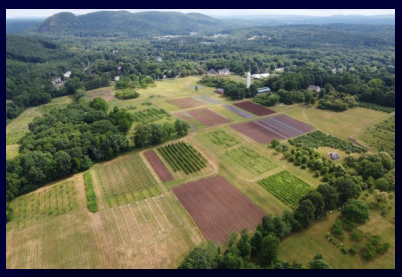

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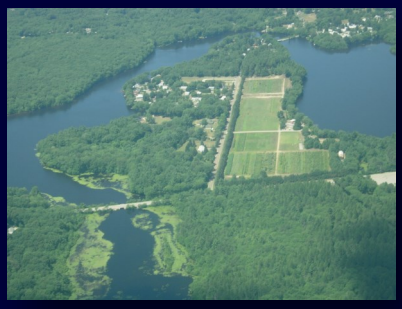
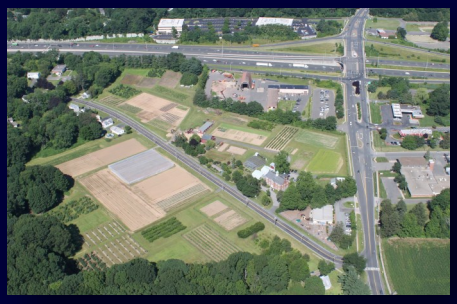


Griswold Research Center, Griswold



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Station News was prepared and edited by Dr. Jason White, Ms. Vickie Bomba-Lewandoski, and Ms. Kelly Fairbrother.

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