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

JASON C. WHITE, PH.D. along with **SARA NASON, PH.D., NUBIA ZUVERZA-MENA, PH.D.,** and **Trung Bui, Ph.D.,** participated in a Zoom meeting with collaborators at Yale University and the University of Minnesota for a joint NIEHS grant (April 2); along with **CHRISTIAN DIMKPA, PH.D.**, hosted a Zoom call with collaborators at Johns Hopkins University and Stonybrook University to discuss progress on a joint USDA nanoscale phosphorus project (April 2 & 16); participated in the weekly NSF Center for Sustainable Nanotechnology (CSN) all hands call (April 3, 10, & 17); met by Teams with Convergent Bio scientists to discuss collaborative research (April 3 & 17); spoke by Zoom with collaborators at the University of Minnesota to discuss grant opportunities (April 3); along with **CHRISTIAN DIMKPA, PH.D.**, and **staff of the Department of Analytical Chemistry** hosted the CT Department of Consumer Protection (DCP) Commissioner Bryan T. Cafferelli and staff for a tour of the adult use cannabis testing laboratory and a discussion of mutual interest in the program (April 4); participated in the USDA Closer-to-Zero meeting and gave an update on CAES programs (April 4); participated in the quarterly University of Connecticut CAHNR Deans Advisory Council meeting at the Storrs campus (April 4); hosted the monthly CAES J-Visa recipient meeting (April 5); hosted US Senator Richard Blumenthal for a press conference focused on ticks and tickborne diseases (April 6); hosted the CSN monthly Nanochem-Plant call (April 9); hosted the quarterly CAES Safety Committee meeting (April 10); gave a lecture titled "Nano-enabled agriculture: A path to global food security in a changing climate" by Zoom to the University of New Haven graduate course Introduction to Nanobiotechnology (April 10); travelled to Calgary, Alberta Canada to participate in the closing meeting of the Thrive Accelerator course and gave a presentation on nano-enabled agriculture (April 11-12); spoke by Teams with a UConn student to discuss CAES and nano-enabled agriculture research (April 15); participated in a Board meeting of the International Phytotechnology Society (April 16); spoke by Zoom with UConn extension staff and a hemp farmer about having a hemp demonstration plot on a CAES farm (April 16); participated in an "All Commissioners" Teams call (April 18); along with **SARA NASON, PH.D.,** and **NUBIA ZUVERZA-MENA, PH.D.,** participated in a Teams call with CT DEEP staff to discuss soil sampling for PFAS analysis (April 19); participated in the monthly CSN Faculty call (April 19); gave a presentation by Zoom titled "Nanobiotechnology-based Strategies for Enhanced Crop Resilience" at the NanoFlorida 2024 International Conference (April 20); visited the Institute of Materials Science at the University of Connecticut to give a presentation titled "Nano-enabled agriculture: A path to global food security in a changing climate" and met with faculty and graduate students to facilitate new research collaborations (April 26); along with **NUBIA ZUVERZA-MENA, PH.D.,** and **Mandeep Kaur, Ph.D.,** met with collaborators at Rutgers University and NJIT to discuss project on a joint USDA grant (April 29); along with **CHRISTIAN DIMKPA, PH.D., NUBIA ZUVERZA-MENA, PH.D.,** and **Mila Pavlicevic, Ph.D.,** met with collaborators at the University of Texas El Paso and the University of Rhode Island to discuss progress on a collaborative USDA grant (April 30); along with **CHRISTIAN DIMKPA, PH.D., NUBIA ZUVERZA-MENA, PH.D.,** and **Mila Pavlicevic, Ph.D.,** met with representatives of Mosaic, Inc. to discuss a research project (April 30); and along with **Chaoyi Deng, Ph.D.,** and **Hina Ashraf, Ph.D.,** attended the semi-annual CSN All Hands meeting at Johns Hopkins University in Baltimore MD (April 30-May 1).

PUBLICATIONS:

1. O'Keefe, T. L., Deng, C., Wang, Y., Mohamud, S., Torres-Gomes, A., Tuga, B., Huang, C.-H., Alvarez-Reyes, W., **White, J. C.**, and Haynes, C. L. (2024). Chitosan-coated mesoporous silica nanoparticles for suppression of *Fusarium virguliforme* in soybeans (*Glycine max*). *ACS Sust. Chem. Eng.* DOI: 10.1021/acsagscitech.4c00025.

Abstract: There is a need to develop new and sustainable agricultural technologies to help provide global food security, and nanoscale materials are showing promising results in this area. In this study, mesoporous silica nanoparticles (MSNs) and chitosan-coated mesoporous silica nanoparticles (CTS-MSNs) were synthesized and applied to soybeans (*Glycine max*) by two different strategies in greenhouse and field studies to study the role of dissolved silicic acid and chitosan in enhancing plant growth and suppressing disease damage caused by *Fusarium virguliforme*. Plant growth and health were assessed by measuring soybean biomass and chlorophyll content in both healthy and *Fusarium*-infected plants at harvest. In the greenhouse study, foliar and seed applications with 250 mg/L nanoparticle treatments were compared. A single seed treatment of MSNs reduced disease severity by 30% and increased chlorophyll content in both healthy and infected plants by 12%. Based on greenhouse results, seed application was used in the follow-up field study, and MSNs and CTS-MSNs reduced disease progression by 12% and 15%, respectively. A significant 32% increase was observed for chlorophyll content for plants treated with CTS-MSNs. Perhaps most important, nanoscale silica seed treatment significantly increased (23-68%) the micronutrient (Zn, Mn, Mg, K, B) content of soybean pods, suggesting a potential sustainable strategy for nano-enabled biofortification to address nutrition insecurity. Overall, these findings indicate that MSN and CTS-MSN seed treatments in soybeans can enable disease suppression and increased plant health as part of a nano-enabled strategy for sustainable agriculture.

2. Chen, L., Fang, L., Yang, X., Luo, X., Qiu, T., Zeng, Y., Huang, F., Dong, F., **White, J. C.**, Bolan, N., and Rinklebe, J. (2024). Sources and human health risks associated with potentially toxic elements (PTEs) in urban dust: A global perspective. *Environ. Int.* 108708.

Abstract: Long-term exposure to urban dust containing potential toxic elements (PTEs) poses detrimental impacts on human health. However, studies estimating human health risks in urban dusts from a global perspective are scarce. We evaluated data for twelve PTEs in urban dusts across 59 countries from 463 published articles, including their concentrations, input sources, and probabilistic risks to human health. We found that 34.1 and 60.3% of those investigated urban dusts have been heavily contaminated with As and Cd, respectively. Traffic emissions and industrial activities were identified as two major sources of PTEs in those urban dusts. The input of PTEs was significantly correlated with economic structure but not population size of the cities. The mean hazard index values that are lower than the safe thresholds could still cause non-negligible health risks to human. Arsenic and Cr were the major PTEs threatening human health, and relatively high risk levels were observed in cities in China, Korea, Chile, Malaysia, and Australia. Importantly, our analysis suggested that PTEs threaten the health of approximately 92 million adults and 280 million children worldwide. Overall, our findings provide important foundational knowledge for policy decision-making to protect human from exposure to PTEs in urban dusts.

3. Dimkpa, C. O., Haynes, C. L., and **White, J. C. (**2024). Reducing greenhouse gas emissions with nanofertilizers. *Nature Sustain*. DOI: 10.1038/s41893-024-01335-5.

Abstract: A growing population, climate change, and the environmental impacts of conventional agricultural practices are worsening food insecurity. New research shows that use of nanofertilizers can increase food production while simultaneously decreasing the negative environmental effects of agriculture.

4. Wang, Y., Deng, C., Zhao, L., **Elmer, W. H.**, **Dimkpa, C. O.**, Sharma, S., **Wang, Z.**, Parkash Dhankher, O., Xing, B., and **White, J. C.** (2024). Time-dependent and coating specific modulation of tomato (*Solanum lycopersicum* L.) molecular response to nanoscale sulfur: An orthogonal mechanistic investigation. *ACS Nano* DOI: 10.1021/acsnano.4c00512.

Abstract: Nano-enabled strategies have recently attracted attention as a sustainable platform for agricultural applications. Here, we present a mechanistic understanding of nanobio -interaction through an orthogonal investigation. Pristine (nS) and stearic acid-surface modified (cS) sulfur nanoparticles (NPs) as a multi-functional nanofertilizer were applied to tomato (Solanum lycopersicum L.) through soil. Both nS and cS increased root mass by 73% and 81%, and increased shoot weight by 35% and 50%, respectively, compared to the untreated controls. Bulk sulfur (bS) and ionic sulfate (iS) had no such stimulatory effect. Notably, surface modification of S NPs had a positive impact, as cS yielded 38% and 51% greater shoot weight compared to nS at 100 and 200 mg/L, respectively. Moreover, nS and cS significantly improved leaf photosynthesis by promoting the linear electron flow, quantum yield of photosystem II, and relative chlorophyll content. The time-dependent gene expression related to two S bioassimilation and signaling pathways showed a specific role of NPs surface physicochemical properties. Additionally, a time-dependent Global Test and machine learning strategy applied to understand the NP surface modification domain metabolomic profiling showed that cS increased the contents of IA, tryptophan, tomatidine, and scopoletin in plant leaves, as compared to the other treatments. These findings provide critical mechanistic insights into the use of nanoscale sulfur as a multifunctional soil amendment to enhance plant performance as part of nano-enabled agriculture.

5. Karim, A., Yadav, A., Sweety, U. H., Kumar, J., Delgado, S., Hernandez, J. A., **White, J. C.**, Vukovic, L., and Narayan, M. (2024). Interfacial interactions between engineered nanoplastics and biological systems: Towards an atomic and molecular understanding of plastics-driven cellular dyshomeostasis. *ACS Appl. Mat. Inter.* DOI: 10.1021/acsami.4c03008.

Abstract: Micro- and Nano-Plastics (MPs and NPs) have been found in human milk, blood, tissues and organs. They are associated with a host of aberrant health outcomes including inflammation, genotoxicity, developmental disorders, onset of chronic diseases and autoimmune disorders (in adults, children, neonates and fetuses). Yet, the interfacial interactions between engineered nanomaterials and biomolecular systems remains an underexplored domain. Here, we have examined experimentally, in vitro, in vivo and by computation the impact of Polystyrene (PS) NPs on a host of biomolecular systems and assemblies. Our results reveal that PS NPs essentially abolished the helix-content of the milk protein β-lactoglobulin (BLG) in a dose-dependent manner and reduced both the binding affinity and the on-rate constant of its ligand (retinol), thereby compromising its physiological role in

milk. Furthermore, PS NPs drove the near stoichiometric formation of β-sheet elements from α-helices in BLG and adversely impacted the soluble-to-toxic transformation of Hen Egg-White Lysozyme (HEWL), suggesting a role in the promotion of amyloidogenesis. Exposure of PS NPs to C. elegans resulted in a density-dependent decrease in the fluorescence of GFP-tagged dopaminergic neurons, a finding that co-related with the locomotory compromise in the nematode. Finally, in silico studies indicated that the most favorable PS:BLG docking score and binding energies corresponded to a pose near the hydrophobic ligand binding pocket (calyx) of the protein where the NP fragment was found to make non-polar contacts with a number of side-chain residues via the hydrophobic effect and through van der Waals forces. Binding energetics reveal that PS:BLG interactions destabilize the binding of retinol to the protein and can potentially displace retinol from the calyx region of BLG thereby impairing its biological function. Taken together, the experimental, in vitro, in vivo and in silico data provide insight into the mechanism(s) by which PS NPs disrupt biomolecular structure and function, induce amyloidosis, onset neuronal injury and drive aberrant behavioral outcomes.

6. Vaidya, S., **Deng, C.**, **Wang, Y.**, **Zuverza-Mena, N.**, **Dimkpa, C. O.**, and **White, J. C.** (2024). Nanotechnology in agriculture: A solution to global food insecurity in a changing climate? *NanoImpact*, *34*, 100502.

Abstract: Although the Green Revolution dramatically increased food production, it led to non- sustainable conventional agricultural practices, with productivity in general declining over the last few decades. Maintaining food security with a world population exceeding 9 billion in 2050, a changing climate, and declining arable land will be exceptionally challenging. In fact, nothing short of a revolution in how we grow, distribute, store, and consume food is needed. In the last ten years, the field of nanotoxicology in plant systems has largely transitioned to one of sustainable nano-enabled applications, with recent discoveries on the use of this advanced technology in agriculture showing tremendous promise. The range of applications is quite extensive, including direct application of nanoscale nutrients for improved plant health, nutrient biofortification, increased photosynthetic output, and greater rates of nitrogen fixation. Other applications include nano-facilitated delivery of both fertilizers and pesticides, nano-enabled delivery of genetic material for gene silencing against viral pathogens and insect pests, and nanoscale sensors to support precision agriculture. Recent efforts have demonstrated that nanoscale strategies increase tolerance to both abiotic and biotic stressors, offering realistic potential to generate climate resilient crops. Considering the efficiency of nanoscale materials, there is a need to make their production more economical, alongside efficient use of incumbent resources such as water and energy. The hallmark of many of these approaches involves much greater impact with far less input of material. However, demonstrations of efficacy at field scale are still insufficient in the literature, and a thorough understanding of mechanisms of action is both necessary and often not evident. Although nanotechnology holds great promise for combating global food insecurity, there are far more ways to do this poorly than safely and effectively. This review summarizes recent work in this space, calling out existing knowledge gaps and suggesting strategies to alleviate those concerns to advance the field of sustainable nano-enabled agriculture.

7. Cahill, M., **Arsenault, T.**, **Bui, T.**, **Zuverza-Mena, N.**, **Bharadwaj, A.**, **Prapayotin-Riveros, K.**, **White, J. C.**, and **Dimkpa, C.** (2024). Copper stimulation of tetrahydrocannabinol (THC) and cannabidiol (CBD) production in hemp (*Cannabis sativa* L.) is copper-type, dose, and cultivar-dependent. *J. Agric. Food Chem*. *72*(13), 6921–6930

Abstract: Copper (Cu) is an element widely used as pesticide for the control of plant diseases. Cu is also known to influence a range of plant secondary metabolisms. However, nothing is known as to whether Cu influences the levels of the major metabolites in hemp (Cannabis sativa L.), tetrahydrocannabinol (THC) and cannabidiol (CBD). This study investigated the impact of Cu on the levels of these cannabinoids in two hemp cultivars, Wife and Merlot, under field conditions, as a function of harvest time (August-September), Cu-type (nano, bulk, or ionic), and dose (50, 100, and 500 ppm). In Wife, Cu caused significant temporal increases in THC and CBD production during plant growth, reaching increases of 33 and 31 % for THC, and 51 and 16.5 % for CBD, by harvest 3 and 4, respectively. CuO nanoparticles at 50 and 100 ppm significantly increased THC and CBD levels, compared to the control: respectively, by 18 and 27 % for THC, and by 19.9 and 33.6 % for CBD. These nano-specific increases coincided with significantly more Cu in the inflorescences (buds) than in the control and bulk CuO treatments. Contrarily, no temporal induction of the cannabinoids by Cu was noticed in Merlot, suggesting a cultivar-specific response to Cu. However, overall, in Merlot, Cu ions, but not particulate Cu, induced THC and CBD levels by 27 and 36 %, respectively, compared to the control. Collectively, our findings provide information with contrasting implications in the production of these cannabinoids, where dependent on the cultivar, metabolite levels may rise above the 0.3% regulatory threshold for THC, but to a more profitable level for CBD. Further investigations with a wider range of hemp cultivars, CuO NPs doses, and harvest times would clarify the significance and broader implications of the findings.

8. Sun, X., Yang, R., Ji, J., Zhu, Z., **White, J. C.**, and Shen, Y. (2024). An evaluation of microplastic contamination in the marine waters and species in the coastal region of the South Yellow Sea, China. *J. Haz. Mat*. *469*, 134018.

Abstract: Microplastics (MPs) contamination of marine environments poses a significant ecological risk, although impacts on species' realized niche spaces remain unclear. The current study investigates MPs distribution across pelagic habitats, benthic sediments, and key biota in the South Yellow Sea, China. Samples were collected via trawling across estuarine transects, and tissues were digested to extract MPs. Density gradient separations and vacuum-filtrations prepared particle extracts for ATR-FTIR and Micro-Raman spectroscopic characterization. Sampling along industrialized river transects reveals ubiquitous plastic particle presence, with concentrations ranging from 0 to 51.68 item/L seawater. Contamination levels reach their peak at station estuaries before dispersing offshore, indicating significant waste stream inputs. Importantly, MPs detected in demersal and pelagic fish species, as well as in bivalves, confirm exposure across trophic niches. Gastrointestinal tract and gill concentrations reached 0.6 items/g fresh tissue, reflecting significant biological uptake and in vivo retention. The greatest population of organisms occurred adjacent to polluted areas. Overall, distribution of MPs from polluted rivers to coastal food webs was evident, suggesting potential negative impacts on key ecological functions in this system. These findings underscore the need to develop upstream mitigation efforts so as to minimize MPs contamination in areas where nearshore and offshore niches intersect.

9. Hafeez, R., Guo, J., Ahmed T., Razab, M., Jiang, H., Shahid, M, Ibrahim, E., Yang, Y., Wang, J., Yand, C., An, Q., **White, J. C.**, and Li, B. (2024). Bio-formulated chitosan nanoparticles enhance disease resistance against rice blast by physiomorphic, transcriptional, and microbiome modulation of rice (*Oryza sativa* L.). *Carbo. Polym. 334,* 122023

Abstract: Rice blast disease (RBD) caused by Magnaporthe oryzae, threaten food security by cutting agricultural output. Nano agrochemicals are now perceived as sustainable, cost-effective alternatives to traditional pesticides. This study investigated bioformulation of moringa chitosan nanoparticles (M-CsNPs) and their mechanisms for suppressing RBD while minimizing toxic effects on the microenvironment. M-CsNPs, sized 46 nm with semi-spherical morphology, significantly suppressed pathogen growth, integrity, and colonization at 200 mg L-1 in vitro. Greenhouse tests with foliar exposure to the same concentration resulted in a substantial 77.7% reduction in RBD, enhancing antioxidant enzyme activity and plant health. Furthermore, M-CsNPs improved photosynthesis, gas exchange, and the nutritional profile of diseased rice plants. RNA-seq analysis highlighted upregulated defense-related genes in treated rice plants. Metagenomic study showcased reshaping of the rice microbiome, reducing Magnaporthe abundance by 93.5%. Both healthy and diseased rice plants showed increased microbial diversity, particularly favoring specific beneficial species Thiobacillus, Nitrospira, Nocardioides, and Sphingomicrobium in the rhizosphere and Azonexus, Agarivorans, and Bradyrhizobium in the phyllosphere. This comprehensive study unravels the diverse mechanisms by which M-CsNPs interact with plants and pathogens, curbing M. oryzae damage, promoting plant growth, and modulating the rice microbiome. It underscores the significant potential for effective plant disease management.

10. Dai, Y., Yuan, H., Cao, X., Liu, Y., Xu, Z., Jiang, Z., **White, J. C.**, **Zhao, J.**, Wang, Z., and Xing, B. **(**2024). La_2O_3 Nanoparticles can cause cracking of tomato fruit through genetic reconstruction. *ACS Nano*, *18*(10), 7379–7390.

Abstract: In this study, cracking mechanisms of tomato (Solanum lycopersicum) fruit skin in response to La_2O_3 nanoparticles (NPs) were investigated. Tomato plants were exposed to La_2O_3 NPs at 0-9 mg/L for 90 days under field conditions. Higher concentrations of La_2O_3 NPs (3 and 9 mg/L) increased obvious cracking of the fruit skin by 17.9% and 25.0%, respectively. After exposure to 3 mg/L La_2O_3 NPs, decreased thickness of cuticle and cell wall, and lower wax crystallization patterns of tomato fruit skin were observed. Biomechanical properties (e.g., firmness and stiffness) of fruit skin were decreased by 34.7% and 25.9%, respectively. RNA-sequencing revealed that cuticle biosynthesis related genes were significantly down-regulated, which contributed to the lower thickness of cuticle, and genes regulating pectin remodeling were responsible for the thinner cell wall. Additionally, genes related to water and abscisic acid homeostasis were significantly upregulated, causing the increases of water and soluble solid content of fruit by 0.8% and 40.46%, respectively, and an enhancement of fruit inner pressure. Therefore, the thinner fruit cuticle and cell wall combined with the higher inner pressure caused the fruit cracking. The findings of this study increase our understanding of the impacts of nanomaterials on important agricultural crops, including the structural reconstruction of fruit skin contributing to NPs-induced cracking at the molecular level.

MICHAEL LAST, THEODORE ANDREADIS, PH.D., and **JASON C. WHITE, PH.D.**, at the portrait unveiling for Theodore Andreadis, the 9th CAES Director.

Connecticut Department of Consumer Protection staff touring the adult use cannabis testing laboratory at CAES.

JASON WHITE, PH.D., and **GOUDARZ MOLAEI, PH.D.**, speaking at a press conference on ticks and tick-borne diseases with Senator Blumenthal.

ANALYTICAL CHEMISTRY

CHRISTIAN DIMKPA, PH.D. was a keynote Speaker at the Annual Conference of the Phytopathology Society of Nigeria (PSN) during April 21-24, 2024. During the event, he organized a workshop on "Nanotechnology Applications to Address Plant Disease and Increase Yield," followed by a presentation on "Nano-Enabled Applications for Plant Disease Control," and made a book presentation to the PSN. The book is titled Mineral Nutrition and Plant Disease, the Chapter 11 of which was co-authored by **CHRISTIAN DIMKPA** and **WADE ELMER.**

RAJA MUTHURAMALINGAM delivered a virtual guest lecture on the topic of "Nanoparticle-assisted drug delivery" to 36 graduate students in the MS-Biomedical Engineering program at the University of New Haven (March 20).

MILICA PAVLICEVIC participated, together with **JASON WHITE, PH.D.**, **CHRISTIAN DIMKPA, PH.D.**, and **NUBIA ZUVERZA-MENA, PH.D.**, in Zoom meetings with the Center for Sustainable Nanotechnology (April 15), collaborators from University of El Paso (April 30), and Mosaic Group (April 30). Report for experiments done on behalf of Mosaic group was also submitted (on April 21).

NEW STUDENTS, STAFF, AND VOLUNTEERS:

Hina Ashraf recently joined the Department of Analytical Chemistry on April 15, 2024, as a CSN Postdoctoral Researcher. Originally from Pakistan, Hina holds a Ph.D. in Agricultural Sciences with a specialization in Plant Pathology from the Department of Plant Pathology, Faculty of Agricultural Sciences, University of the Punjab, Lahore, Pakistan. During her Ph.D. project, Hina conducted research on the inhibition mechanism of green-synthesized metal/metal oxide nanoparticles towards *Fusarium oxysporum*, which is the causal agent of tomato wilt. She studied the impact of these nanoparticles on boosting growth and defense responses in tomatoes. At CAES, Hina plans to investigate the potential benefits of modified nanocellulose for pesticide and nutrient delivery to different plant systems such as tomato, soybean, and watermelon. Her focus will be on modified phytoglycogen, which can be applied through foliar and soil applications.

ILENIA IOSA joined the Department of Analytical Chemistry on April 5, 2024. Originally from Italy, Ilenia is a biotechnologist currently completing her Ph.D. program at the University of Parma. Her research focuses on developing tools for sustainable agriculture. During the first two years of her Ph.D. project, Ilenia developed a Real-Time PCR based method to trace and quantify microorganisms within a microbial consortium added as biostimulant to agricultural soils. This method allows the traceability of these microorganisms overtime, providing insights into their survival time in the field, their optimal growth conditions, and the efficiency of their delivery systems. Ilenia will be staying for a period of three months, during which time she plans to work on biostimulants and to study how they can impact health of tomato plants and soil biodiversity under non-stressed and stressed growth conditions.

PUBLICATIONS:

1. Dimkpa, C. O., Haynes, C. L., and **White, J. C.** (2024). Reducing greenhouse gas emissions with nanofertilizers. *Nature Sustainability*. DOI: 10.1038/s41893-024-01335-5.

Abstract: A growing population, climate change and the environmental impacts of conventional agricultural practices are worsening food insecurity. New research shows that use of nanofertilizers can increase food production while simultaneously decreasing the negative environmental effects of agriculture.

2. Mehrotra, S., Goyal, V., Chhokar, V., and **Dimkpa, C.O.** (2024). Green synthesis and characterization of ginger-derived silver nanoparticles and evaluation of their antioxidant and antibacterial activities. *Plants MDPI*, *13*(9), 1255. DOI: 10.3390/plants13091255.

Abstract: The efficacy, targeting ability, and biocompatibility of plant-based nanoparticles can be exploited in fields such as agriculture and medicine. This study highlights the use of plant-based ginger nanoparticles as an effective and promising strategy against cancer and for the treatment and prevention of bacterial infections and related disorders. Ginger is a well-known spice with significant medicinal value due to its phytochemical constituents including gingerols, shogaols, zingerones, and paradols. The silver nanoparticles (AgNPs) derived from ginger extracts could be an important non-toxic and eco-friendly nanomaterial for widespread use in medicine. In this study, AgNPs were biosynthesized using an ethanolic extract of ginger rhizome and their phytochemical, antioxidant, antibacterial, and cytotoxic properties were evaluated. UV–visible spectral analysis confirmed the formation of spherical AgNPs. FTIR analysis revealed that the NPs were associated with various functional biomolecules that were associated with the NPs during stabilization. The particle size and SEM analyses revealed that the AgNPs were in the size range of 80–100 nm, with a polydispersity index (PDI) of 0.510, and a zeta potential of −17.1 mV. The purity and crystalline nature of the AgNPs were confirmed by X-ray diffraction analysis. The simple and repeatable phyto-fabrication method reported here may be used for scaling up for large-scale production of ginger-derived NPs. A

phytochemical analysis of the ginger extract revealed the presence of alkaloids, glycosides, flavonoids, phenolics, tannins, saponins, and terpenoids, which can serve as active biocatalysts and natural stabilizers of metallic NPs. The ginger extracts at low concentrations demonstrated promising cytotoxicity against Vero cell lines with a 50% reduction in cell viability at 0.6–6 µg/mL. When evaluated for biological activity, the AgNPs exhibited significant antioxidant and antibacterial activity on several Gram-positive and Gram-negative bacterial species, including Escherichia coli, Bacillus subtilis, Pseudomonas aeruginosa, and Staphylococcus aureus. This suggests that the AgNPs may be used against multi-drug-resistant bacteria. Ginger-derived AgNPs have a considerable potential for use in the development of broad-spectrum antimicrobial and anticancer medications, and an optimistic perspective for their use in medicine and pharmaceutical industry.

3. Wang, Y., **Deng, C.**, Zhao, L., **Dimkpa, C.O.**, **Elmer, W. H.**, Sharma, S., **Wang, Z.**, Dhankher, O. P., Xing, B., and **White, J. C.** (2024). Time-dependent and coating specific modulation of tomato (*Solanum lycopersicum* L.) molecular response to nanoscale sulfur: An orthogonal mechanistic investigation. *ACS Nano*, *18*(18), 11813–27. DOI: 10.1021/acsnano.4c00512

Abstract: Nanoenabled strategies have recently attracted attention as a sustainable platform for agricultural applications. Here, we present a mechanistic understanding of nanobiointeraction through an orthogonal investigation. Pristine (nS) and stearic acid surface-modified (cS) sulfur nanoparticles (NPs) as a multifunctional nanofertilizer were applied to tomato (*Solanum lycopersicum*L.) through soil. Both nS and cS increased root mass by 73% and 81% and increased shoot weight by 35% and 50%, respectively, compared to the untreated controls. Bulk sulfur (bS) and ionic sulfate (iS) had no such stimulatory effect. Notably, surface modification of S NPs had a positive impact, as cS yielded 38% and 51% greater shoot weight compared to nS at 100 and 200 mg/L, respectively. Moreover, nS and cS significantly improved leaf photosynthesis by promoting the linear electron flow, quantum yield of photosystem II, and relative chlorophyll content. The time-dependent gene expression related to two S bioassimilation and signaling pathways showed a specific role of NP surface physicochemical properties. Additionally, a time-dependent Global Test and machine learning strategy applied to understand the NP surface modification domain metabolomic profiling showed that cS increased the contents of IA, tryptophan, tomatidine, and scopoletin in plant leaves compared to the other treatments. These findings provide critical mechanistic insights into the use of nanoscale sulfur as a multifunctional soil amendment to enhance plant performance as part of nanoenabled agriculture.

ENTOMOLOGY

TIA M. BLEVINS attended the 49th annual meeting of the Horticultural Inspection Society - Eastern Chapter in Burlington, VT. Ms. Blevins, the chapter's Archivist, participated in discussions on box tree moth, spotted lantern fly, elm zigzag sawfly, export issues, rose mosaic virus, and the regulation of pest and diseases of concern to the agricultural industry of Connecticut. (April 1-5).

ANGELA BRANSFIELD participated via Zoom in Yale University's Biosafety Committee meeting (April 18).

ANDREA GLORIA-SORIA, PH.D., participated as a poster judge at the 13th Sigma Xi Student Research Conference that took place at Quinnipiac University (70 attendees) (April 24).

KELSEY E. FISHER, PH.D., presented "Conservation and restoration recommendations that align with monarch butterfly behavior and biological needs" for Wallingford Garden Club (30 attendees) (April 9); presented about bumblebees for third graders at Seth G. Haley School for Mayor Borer's Earth Day event (~100 attendees) (April 22); presented "Understanding insect movement and dispersal behavior helps protect pollinators and biodiversity" for the Experiment Station Associates (April 24).

NOELLE KHALIL presented an invited lecture with **MEGAN LINSKE, PH.D.**, titled "Tick Biology, Ecology, and Behavior" at Southern Connecticut State University (8 attendees) (April 4).

MEGAN LINSKE, PH.D., participated in a meeting with collaborators from BanfieldBio, Inc. and North Carolina State University to discuss blacklegged tick repellency trials and the upcoming field season (April 2, 16, & 30); presented an invited lecture titled "Tick Biology, Ecology, and Behavior" at Southern Connecticut State University (8 attendees) (April 4); participated in the Wildlife Society (TWS) Leadership Institute Committee meeting as an alumnus and Committee Co-Chair (April 11); was interviewed by Nicole Nalepa and Scot Haney for WFSB News to discuss "Staying Safe from Tick Bites" for families (April 15); participated in a podcast titled "Ticked Off Over Ticks" hosted by Nicole Nalepa (WFSB News) (April 15); participated in a call with staff from the Centers for Disease Control and Prevention's Division of Vector-Borne Diseases on progress made on a funded integrated tick management and seasonal spray projects (April 17); participated in the Northeast Section of TWS Executive Committee meeting as Past President and Workshop Chairperson in Hyannis, MA (April 21); participated in the Northeast Regional Center for Excellence in Vector-Borne Diseases Training and Evaluation Center Leadership Meeting to discuss the Academic Training Program (April 24).

GOUDARZ MOLAEI, PH.D., was interviewed on ticks and tick-borne disease activity by the following media outlets: WTIC (April 1), WTNH Channel 8 (April 2), WSHU, NBC, and News 12 (April 8), NBC CT (April 23), WCBS 880 and WTNH Channel 8 (April 24), and CT Insider (April 25); discussed with the CT DPH authorities the recent increases in American dog tick, *Dermacentor variabilis*, populations and the relatively higher incidence of Rocky Mountain Spotted Fever Disease in CT residents since 2016 (April 3); attended the monthly meeting of the longhorned tick, *Haemaphysalis longicornis*, and discussed activity of this tick species in Connecticut (April 8); was interviewed with a University of Connecti-

cut student to prepare a podcast on the impact of warming temperatures on vector-borne diseases (April 8); presented a seminar at the Southern Connecticut State University on ticks and tick-borne diseases (April 11); presented a talk, "Range Expansion of Native and Invasive Ticks and Ensuing Public Health Challenges" to the Flanders Nature Center in Woodbury, CT (April 18); attended the leadership meeting of the Northeastern Center of Excellence in Vector-Borne Diseases and Training and Evaluation Center (TEC) to discuss student internships and medical professionals' trainings on vector-borne diseases (April 24); presented a seminar at the Southern Connecticut State University on ticks and tick-borne diseases surveillance (April 25); attended the Yale MPH students' presentation on "Barriers to Engagement in Passive Tick and Tick-Borne Disease Surveillance Program in Connecticut" (April 30).

JACOB RICKER attended the Eastern Plant Board's 98th Annual Meeting in Burlington, VT, which held discussions, presentations, and a meeting for the Eastern Horticultural Inspection Society (April 1-4).

GALE RIDGE, PH.D., was live interviewed about ticks and Lyme disease on the Chaz and AJ WPKN morning radio show followed by an interview on the lone star, Gulf coast, and black legged ticks found in Connecticut by Channel 8 TV (April 2); Springer Nature published the 356-page book edited by Gale Ridge with collaboration from 20 other authors titled "The Physician's Guide to Delusional Infestation" (April 6); delivered a talk about jumping worms to the KNOX farmer training program in Hartford (15 attendees) (April 11); interviewed by Kayla Blanton, freelance journalist on how to manage multicolored Asian lady beetles that enter buildings (April 19); and celebrated the Woodbridge Town Earth Day festivities with a Station table display (April 27).

CLAIRE RUTLEDGE, PH.D., presented a talk titled 'Spotted Lanternfly in Connecticut' to the Master Gardener's class Norwich, CT (50 attendees) (April 9); attended the on-line symposium 'Spotted Lantern Fly Field Ops Meeting' & presented a talk titled 'Spotted Lanternfly research in Connecticut' (102 attendees) (April 17-18); met with Elizabeth Kolbert, the Pulitzer Prize winning author of 'The Sixth Extinction', at a field site in Kent, CT to discuss the biological control program for emerald ash borer in Connecticut (April 19).

JOHN SHEPARD presented "Jamestown Virus Comes into View: Understanding the Threat from an Underrecognized Arbovirus" as part of the CAES Seminar Series (April 3); was interviewed about the challenges and experiences faced in a mosquito/mosquito-borne disease surveillance program by Johanna Ravenhurst, a Ph.D. candidate from the University of Massachusetts, Amherst (April 11).

VICTORIA L. SMITH, PH.D., participated in the 98th annual meeting of the Eastern Plant Board, held at the Hilton Burlington Lake Champlain in Burlington, VT (April 1-4); was awarded the Distinguished Service Award by the Eastern Chapter of the Horticultural Inspection Society (April 4); was interviewed by Brooke Griffin of Fox 61 News, concerning spotted lanternfly (April 23).

KIRBY C. STAFFORD III, PH.D., **(Emeritus)** participated in a meeting of the Pollinator Advisory Committee (April 17) and participated in a meeting of the NEVBD-Training Evaluation Center as an Advisory Board member (April 24).

GRANTS AWARDED:

1. ANDREA GLORIA-SORIA, PH.D., (Co-Investigator) and Seth Reymond, Ph.D., (PI - Yale YSPH) received seed money from The Ambrose Monell Vector Borne and Zoonotic Diseases Grant Program, Yale School of Public Health, to develop "A low-cost amplicon sequencing panel for *Aedes aegypti* genomics." $49, 237.

PUBLICATIONS:

1. Anderson, J. F., **Molaei, G.**, Fish, D., **Armstrong, P. M.**, **Khalil, N.**, Brudner, S., **Misencik, M. J.**, **Bransfield, A.**, **Olson, M.**, and **Andreadis, T. G.** (2024). Host-Feeding Behavior of Mosquitoes in the Florida Everglades. *Vector Borne Zoonotic Dis.* DOI: 10.1089/vbz.2023.0072.

Abstract: West Nile virus (WNV), Everglades virus (EVEV), and five species of *Orthobunyavirus* were isolated from mosquitoes collected in the Everglades in 2016-2017. Prior studies of blood meals of mosquitoes in southern Florida have related findings to acquisition and transmission of EVEV, St. Louis encephalitis virus, and WNV, but not the *Orthobunyavirus* viruses associated with the subgenus *Melanoconion* of the genus *Culex*. Our study contributes to a better understanding of the host and viral associations of mosquito species in southwestern Florida.

2. Johnson, R. M., Stopard, I. J., Byrne, H. M., **Armstrong, P. M.**, **Brackney, D. E.**, and Lambert, B. (2024). Investigating the dose-dependency of the midgut escape barrier using a mechanistic model of within-mosquito dengue virus population dynamics. *PLoS Pathog*. *20*(4). DOI: 10.1371/journal.ppat.1011975

Abstract: Arboviruses can emerge rapidly and cause explosive epidemics of severe disease. Some of the most epidemiologically important arboviruses, including dengue virus (DENV), Zika virus (ZIKV), Chikungunya (CHIKV) and yellow fever virus (YFV), are transmitted by *Aedes* mosquitoes, most notably *Aedes aegypti* and *Aedes albopictus*. After a mosquito blood feeds on an infected host, virus enters the midgut and infects the midgut epithelium. The virus must then overcome a series of barriers before reaching the mosquito saliva and being transmitted to a new host. The virus must escape from the midgut (known as the midgut escape barrier; MEB), which is thought to be mediated by transient changes in the permeability of the midgut-surrounding basal lamina layer (BL) following blood feeding. Here, we present a mathematical model of the within-mosquito population dynamics of DENV (as a model system for mosquito-borne viruses more generally) that includes the interaction of the midgut and BL which can account for the MEB. Our results indicate a dose-dependency of midgut establishment of infection as well as rate of escape from the midgut: collectively, these suggest that the extrinsic incubation period (EIP)-the time taken for DENV virus to be transmissible after infection-is shortened when mosquitoes imbibe more virus. Additionally, our experimental data indicate that multiple blood feeding events, which more closely mimic mosquito-feeding behavior in the wild, can hasten the course of infections, and our model predicts that this effect is sensitive to the amount of virus imbibed. Our model indicates that mutations to the virus which impact its replication rate in the midgut could lead to even shorter EIPs when double-feeding occurs. Mechanistic models of within-vector viral infection dynamics provide a quantitative understanding of infection dynamics and could be used to evaluate novel interventions that target the mosquito stages of the infection.

3. Johnson, **R. M.**, Stopard, I. J., Byrne, H. M., **Armstrong, P. M.**, and **Brackney**, **D. E.,** and Lambert, B. Investigating the dose-dependency of the midgut escape barrier using a mechanistic model of within-mosquito dengue virus population dynamics. *PLOS Pathogens*. DOI: 10.1371/journal.ppat.1011975

Abstract: Arboviruses can emerge rapidly and cause explosive epidemics of severe disease. Some of the most epidemiologically important arboviruses, including dengue virus (DENV), Zika virus (ZIKV), Chikungunya (CHIKV) and yellow fever virus (YFV), are transmitted by *Aedes* mosquitoes, most notably *Aedes aegypti* and *Aedes albopictus*. After a mosquito blood feeds on an infected host, virus enters the midgut and infects the midgut epithelium. The virus must then overcome a series of barriers before reaching the mosquito saliva and being transmitted to a new host. The virus must escape from the midgut (known as the midgut escape barrier; MEB), which is thought to be mediated by transient changes in the permeability of the midgut-surrounding basal lamina layer (BL) following blood feeding. Here, we present a mathematical model of the within-mosquito population dynamics of DENV (as a model system for mosquito-borne viruses more generally) that includes the interaction of the midgut and BL which can account for the MEB. Our results indicate a dose-dependency of midgut establishment of infection as well as rate of escape from the midgut: collectively, these suggest that the extrinsic incubation period (EIP)—the time taken for DENV virus to be transmissible after infection—is shortened when mosquitoes imbibe more virus. Additionally, our experimental data indicate that multiple blood feeding events, which more closely mimic mosquito-feeding behavior in the wild, can hasten the course of infections, and our model predicts that this effect is sensitive to the amount of virus imbibed. Our model indicates that mutations to the virus which impact its replication rate in the midgut could lead to even shorter EIPs when double-feeding occurs. Mechanistic models of within-vector viral infection dynamics provide a quantitative understanding of infection dynamics and could be used to evaluate novel interventions that target the mosquito stages of the infection.

ENVIRONMENTAL SCIENCE AND FORESTRY

SCOTT WILLIAMS, PH.D., participated in a collaborative Zoom call with members of the Banfield Biologic NIH SBIR-funded tick repellent fabric team (April 2); participated in a Zoom call with staff from CDC Division of Vector-Borne Diseases, University of Massachusetts, University of Rhode Island, Penn State University, State of Massachusetts, MaineHealth, Michigan State University, Texas A&M University, Tufts University, and Genesis Laboratories about tick management strategies involving white-tailed deer (April 3); participated in a collaborative Zoom call with members of the Banfield Biologic NIH SBIR-funded tick repellent fabric team (April 14); participated in a Zoom call with staff from the CDC Division of Vector-Borne Diseases on progress made on a funded integrated tick management project (April 17); as Executive Treasurer, participated in the annual meeting of the Executive Committee of the Northeast Section of The Wildlife Society, Hyannis, MA (April 21); participated in a Zoom meeting for the Centers for Disease Control and Prevention-funded Teaching & Evaluation Center leadership members (April 24); participated in a collaborative Zoom call with members of the Banfield Biologic NIH SBIR-funded tick repellent fabric team (April 30).

JOSEPH P. BARSKY presented a talk on forest research during ENV 674 -Yale School of the Environment field trip to the Naugatuck State Forest along with **ROBERT MARRA, PH.D.**, and **JEFFREY S. WARD, PH.D.**, (18 attendees) (April 19); organized and hosted a virtual meeting for the 2025 New England Society of American Foresters Winter Meeting Planning Committee (April 23); participated in the Society of American Foresters House of Society Delegates Meeting (April 24).

GREGORY BUGBEE presented invited talk "Invasive Aquatic Plants and Their Management" to the Essex Land Trust at Essex Town Hall (30 attendees) (April 3); spoke on "Soil Testing" to a soils class from Southern Connecticut State University (20 attendees) (April 11); gave a talk titled "Container Gardening Indoors and Out" to the North Haven Garden Club at the North Haven Congregational Church. (40 attendees) (April 11); gave a tour of the OAIS greenhouse and short talk to a 6th grade class from St. Thomas Day School (20 attendees) (April 23); with **JEREMIAH FOLEY, PH.D.**, **SUMMER STEBBINS**, and **RILEY DOHERTY** met with the United States Army Corps of Engineers to discuss the CT River Hydrilla Project (April 3, 10, 17, & 24); presented an invited talk on "Invasive Aquatic Plants and Their Management" at a CT DEEP training program at the American Jobs Center in Waterbury (20 attendees) (April 25); presented invited talk "Update on Invasive Aquatic Plants in Connecticut" at the Connecticut Federation of Lakes annual meeting at the Bristol Nature Center (70 attendees) (April 26); with **JEREMIAH FOLEY, PH.D.**, **SUMMER STEBBINS**, and **RILEY DOHERTY** gave an update on OAIS efforts to address hydrilla in the CT River at the quarterly CT DEEP Hydrilla Task Force meeting (April 29); with **JEREMIAH FOLEY, PH.D.**, **SUMMER STEBBINS**, and **RILEY DOHERTY** gave an update on OAIS efforts to address hydrilla in the CT River at the quarterly CT River Conservancy DEEP Hydrilla Task Force meeting (April 29).

RILEY DOHERTY presented on the new web mapping application for statewide invasive aquatic species data for the Essex Land Trust in the talk "The Spread of Aquatic Invasive Species in Connecticut" (30 attendees) (April 3); met with speaker Breanne Kisselstein, Ph.D., to discuss issues facing people with disabilities in stem with other members of the CAES DEI

Committee (April 9); with **SUMMER STEBBINS**, trained the Farmington River Watershed Association staff members in aquatic plant identification (5 attendees) (April 17); attended the Connecticut Federation of Lakes board meeting (April 17); gave two greenhouse tours to educate elementary school students on invasive aquatic plants as part of the St. Thomas Day School STEAM Festival (38 attendees) (April 25); presented on the new web mapping application for statewide invasive aquatic species data at the Connecticut Federation of Lakes Annual Meeting (70 attendees) (April 27); was voted in as a board member of the Connecticut Federation of Lakes at the Annual Meeting (April 27).

JEREMIAH FOLEY, IV, PH.D., was awarded the Experiment Station Associates Early Career Scientist Award 2024 (April 1); gave an update on Connecticut River hydrilla to the Essex Land Trust at the Essex Town Hall (30 attendees) (April 3); gave two greenhouse tours to educate elementary school students (kindergarten and 1st grade) on invasive aquatic plants as part of the St. Thomas Day School STEAM Festival (April 15); with **Summer Stebbins** met with the Northeastern University Hydrilla Hunters to test out their autonomous vessel (April 18); presented a terrestrial invasive pest workshop as part of a CT DEEP training program at the American Jobs Center in Waterbury (20 attendees) (April 24); gave an update on Connecticut River hydrilla to the Connecticut Confederate of Lakes (70 attendees) (April 27).

SUSANNA KERIÖ, D.SC., met with representatives of Connecticut tree planting programs and municipal staff to locate trees for a study testing the impact of mycorrhizal inoculation on urban tree health in Hamden (April 2), Milford (April 11), Bloomfield (April 15), and Bridgeport (April 16); attended a meeting to plan the CT Urban Forest Council elections and gathering in New Haven (April 19); gave an invited talk on "Urban tree pathology" at Wesleyan University (30 attendees) (April 26).

SARA NASON, PH.D. participated in meetings for the Best Practices for Non-Targeted Analysis working group (April 1, 16, & 23); met with Meghan Lally, Raymond Frigon (CT DEEP Remediation Division), Jasmine Jones, **CHRISTIAN DIMKPA, PH.D.,** and **JASON WHITE, PH.D.**, to discuss sampling plans for monitoring PFAS in CT farm soils (April 19).

ITAMAR SHABTAI, PH.D., met with Eric Slessarev, Ph.D., (Yale) to discuss future collaborations (April 3); met with **BLAIRE STEVEN, PH.D., NUBIA ZUVERZA-MENA, PH.D.,** and Cyren Rico, Ph.D., (University of Missouri) to discuss a grant proposal to NASA (April 5); and discussed a grant proposal to NASA with **BLAIRE STEVEN, PH.D.,** and Gabriella Weiss, Ph.D., (University of Maryland, Baltimore) (April 25).

SUMMER STEBBINS gave an aquatic plant identification workshop to the Essex Land Trust at the Essex Town Hall (30 attendees) (April 3); presented on invasive aquatic plant management to the Farmington River Watershed Association at CAES (5 attendees) (April 17); with **JEREMIAH FOLEY, PHD.**, met with the Northeastern University Hydrilla Hunters and tested out their autonomous vessel on the Connecticut River (April 18); gave an aquatic plant identification workshop as part of a CT DEEP training program at the American Jobs Center in Waterbury (20 attendees) (April 24); gave two greenhouse tours to educate elementary school students on invasive aquatic plants as part of the St. Thomas Day School STEAM Festival (24 attendees) (April 25).

ELISABETH WARD, PH.D., presented an invited talk in the seminar “Discussions in Leadership with Forestry Professionals” led by Gary Dunning (Executive Director, The Forests Dialogue) and Terry Baker (CEO, Society of American Foresters) at The Yale School of the En-

vironment (15 attendees) (April 2); met with **Ph.D.s: CLAIRE RUTLEDGE, CAROLE CHEAH, VICTORIA SMITH, ROBERT MARRA**, **TIA BLEVINS**, and **FELICIA MILLETT** to discuss current forest health monitoring efforts in Connecticut (April 4-17); participated as a proposal reviewer for the Forest Ecosystem Monitoring Cooperative Ecosystem Monitoring Fund (April 11); met with Nate Siegert, Ph.D., (USDA Forest Service), Alana Russell (Rhode Island Department of Environmental Management), and David Orwig, Ph. D. (Harvard Forest) to discuss collaborations for monitoring forest ecosystem responses to Emerald Ash Borer invasion in southern New England (April 17); met with Chris Martin, Will Hochholzer, Nate Piche, Dan Evans, and Alex Amendola (CT DEEP Forestry Division) to design a silvicultural experiment for managing stands affected by Beech Leaf Disease for a multi-state grant proposal (April 17 & 23); organized a group discussion on research on Beech Leaf Disease in Connecticut with participants from the CAES, USDA Forest Service, and Yale School of the Environment (April 23); presented an invited talk at Wesleyan University titled "Introduction to the types of mycorrhizal fungi and their role in forest ecosystem processes" (30 attendees) (April 26).

JEFFREY WARD, PH.D., (Emeritus) participated in a Connecticut Forest and Park Association Governance Committee meeting (April 11); participated in a meeting of the Great Mountain Forest Trustees in Norfolk (April 13); spoke about impact of tree diseases on forest dynamics at Naugatuck State Forest for Yale Forest Health class (15 attendees) (April 19).

LEIGH WHITTINGHILL, PH.D., gave an invited lecture to the Longhill Garden Club in Trumbull titled "Small Plastic Pool Container Production in Urban Agriculture" (37 attendees) (April 22); met with Stephen Cremin-Endes, Director of Community Building & Organizing, Neighborhood Housing Services of New Haven, to discuss possible collaborations with urban growers (April 26).

CHARLIE (YINGXUE) YU, PH.D., presented "Transport of Biodegradable Nanoplastics in Unsaturated Porous Media" at the European Geosciences Union Annual Assembly (50 attendees) (April 15); discussed with Moran Wang Ph.D. and Ph.D. student Yang Liu from Tsinghua University about possible collaborations on modeling transport of nanoparticles in porous media with Pore Network (April 17); presented "Fate and Transport of Emerging Contaminants: Micro- and Nanoplastics" at the University of Bern, Institute of Geological Sciences, Rock-Water Interaction Group at Bern, Switzerland (15 attendees) and visited the laboratories of the Rock-Water Interaction Group (April 25–26).

NEW STUDENTS, STAFF, AND VOLUNTEERS:

Shaik Mahamad Allabakshi, PH.D. ("**Bakshi**") joined the Station as a Postdoctoral Research Scientist in April 2024. He will be working with **JOSEPH PIGNATELLO, PH.D.**, in the Department of Environmental Science and Forestry on the chemistry of removing ('scrubbing') the fumigant sulfuryl fluoride from gaseous emissions of fumigation operations. He completed his Ph.D. thesis work and dissertation in Civil & Environmental Engineering at the Indian Institute of Technology Tirupati (IIT T), India, earlier this year. His disser-

tation, titled "Development of a Nonthermal Atmospheric Pressure Photo-Plasma Reactor for the Efficient Treatment of Textile Wastewater" explored room-temperature plasma reactors like dielectric barrier discharge, plasma jets, and micro-arc discharges to degrade textile dyes, pharmaceutical compounds, or pesticides in wastewater. A side benefit is a sustainable approach to recycling treated wastewater into liquid fertilizer as a waste-to-wealth concept. Prior to his Ph.D., Bakshi earned a Master of Technology in Environmental Engineering Management from Jawaharlal Nehru Technological University Kakinada in 2018. His extracurricular activities include watching movies, cooking, traveling, and music. He can be found in the labs on the 3rd floor of the Slate Building or in his office in room 106.

PUBLICATIONS:

1. Williams, S. C. and **Linske, M. A.** (2024). Late fall synthetic acaricide application is effective at reducing host-seeking adult and nymphal *Ixodes scapularis* (Ixodida: Ixodidae) abundances the following spring. *Journal of Medical Entomology*, tjae044. DOI: 10.1093/jme/tjae044.

Abstract: Based on increases in reported cases of tick-borne illnesses, expanding ranges of native ticks, and repeated documentation of arrivals of nonnative tick species, there is a clear need for their effective management in the United States. Synthetic acaricides have proven efficacious in tick management, but real/perceived negative impacts to the environment and nontarget, beneficial insects must be addressed. We sought to determine whether late fall synthetic acaricide application, when most susceptible beneficial insects are presumably dormant or have migrated, could effectively manage host-seeking spring *Ixodes scapularis* Say abundances as compared to traditional spring application. We compared results of delivery of Demand CS (lambda cyhalothrin) via truck-mounted high-pressure spray and powered backpack blower as well as delivery of granular Demand G to experimental control (water) in peridomestic habitats in fall 2021, spring 2022, and combined fall 2021/spring 2022. High-pressure fall delivery of Demand CS and backpack delivery of Demand G significantly reduced host-seeking adult *I. scapularis* abundances within-season and the following spring combined by 100% and 94%, respectively. No host-seeking nymphal *I. scapularis* were documented in spring after fall only, spring only, or fall and spring combined delivery of Demand CS via high-pressure or powered backpack blower. No adult *I. scapularis* were documented at any time posttreatment on locations that received high-pressure delivery of Demand CS. We conclude that high-pressure delivery of Demand CS in late fall successfully eliminated multiple stages of host-seeking *I. scapularis* through the following spring while likely limiting exposure of beneficial insects to synthetic pyrethroids.

2. Yu, Y. and Flury, M. (2024). Unlocking the potentials of biodegradable plastics with proper management and evaluation at environmentally relevant concentrations. *npj Materials Sustainability*, *2*(1), 9. DOI: 10.1038/s44296-024-00012-0

Abstract: Biodegradable plastics have been proposed as an alternative to conventional plastics for many applications, such as single-use plastic bags, disposable cutleries and tablewares, and agricultural plastic mulch films. However, concerns have arisen about environmental sustainability of biodegradable plastics, especially regarding degradability, generation of biodegradable micro- and nanoplastics, and release of additives. Here, we critically evaluate literature on the degradation and ecotoxicity of biodegradable plastics with the consideration of environmentally relevant concentrations. Our evaluation suggests that, provided with proper disposal and full biodegradation, biodegradable plastics, including biodegradable micro- and nanoplas-

tics, would not accumulate substantially in the environment and would be far from reaching concentrations at which negative impacts on ecosystems can be expected. In addition, we highlight existing regulatory efforts to prevent adverse ecotoxicity of biodegradable plastics. To ensure timely biodegradation under various disposal conditions, we propose to calibrate the actual biodegradability in disposal environments against the intrinsic biodegradability in standards. Further, we recommend to supplement biodegradability certificates on biodegradable plastics with clear disposal instructions, to ensure proper end-of-life management. With proper testing, comprehensive labeling, and effective management, we believe that, for certain applications, biodegradable plastics are a promising substitute for conventional plastics.

3. Whittinghill, L. (2024). Determining Fertilizer Needs for Small-Scale Crop Production. *CAES Fact Sheet.*

Northeastern University mechanical engineering students demonstrated their capstone project at Keeney Cove in Rocky Hill, CT. Their project focused on constructing an autonomous aquatic rover capable of identifying submerged aquatic plants. Left to right: Alexander Pick, **JEREMIAH R. FOLEY, PH.D.**, Jessica Healey, Riya Sen, Suchi Patel, and Daniel T. Simpson.

PLANT PATHOLOGY AND ECOLOGY

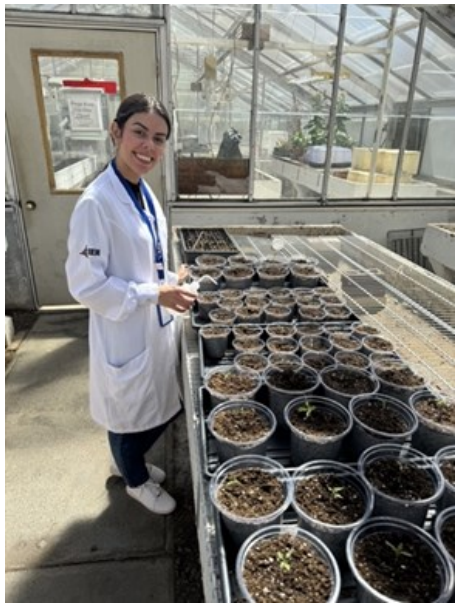
FELICIA MILLETT led a plant disease discussion at the CTPA Arboriculture 101 Review Night (36 attendees) (April 4); participated in the NPDN Professional Development Committee Meeting (9 attendees) (April 9); participated in the NEPDN monthly meeting (9 attendees) (April 11); participated in the NPDN Proficiency Committee Meeting (6 attendees) (April 16); presented "Gardening with Native Plants" to the Duck River Garden Club in Old Lyme (36 attendees) (April 24); and staffed the CAES table with **KATHERINE DUGAS** and **JAMIE CANTONI** at the Hamden Earth Day Celebration (Hamden Town Center Park) (April 27).

YONGHAO LI, PH.D., instructed "Phytophthora bleeding canker" in the Review Night of the Connecticut Tree protective Association Arboriculture 101 Course in New Haven (April 4) 36 attendees); presented "Useful Tips of Container Gardening" For Old Greenwich Garden Club and Perrot Memorial Library Educational Program in Old Greenwich via Zoom (48 attendees) (April 22); presented "Backyard Composting" to Avon Public Library via Zoom (11 attendees) (April 30); presented "Organic Plant Disease Management Class" at KNOX Hartford (10 attendees) (April 30).

QUAN ZENG, PH.D., met Breanne Kisselstein, Ph.D., during her visit to CAES and discussed mutual research interests and career development (April 9), met Vijay Choppakatla, Ph.D., from BioSafe, Inc. (April 19), Jared Jensen, Ph.D., from San Agro Inc (April 21) and discussed research collaborations.

NEW STUDENTS, STAFF, AND VOLUNTEERS:

Cleverson Freitas, **Ph.D.**, a professor at Universidade Federal do Ceara (UFC) in Brazil, will spend three months at the Rocha Lab and will work on a collaborative project between CAES and UFC to identify new targets to control plant-parasitic nematodes.



Monique Rodrigues, a Ph.D. student from the Universidade Estadual de Maringa (UEM) in Brazil, will work at the Rocha Lab for six months. Her project will focus on characterizing the behavior, development, and infectivity of root-knot nematodes in response to temperature. The Brazilian Federal Agency for Research and Education (CAPES) has granted Monique a scholarship covering her entire stay at CAES.

OTHER DEPARTMENTAL NEWS:

Members of the **DA SILVA, TRIPLETT, ZENG, MARRA,** and **ROCHA** groups in the Plant Pathology and Ecology Department co-hosted DEI committee invited speaker Brianne Kisselstein, Ph.D., who discussed her research on fungal cranberry disease.

PUBLICATIONS:

1. Almeida, B., Negreiros, A., Melo, N., Ambrósio, M., Armengol, J., **da Silva**, **W.**, and Sales Júnior, R. (2024). Evaluation of fungicides and Trichoderma spp. for controlling soil-borne fungal pathogens in melon crops. *Caatinga*, *37*, e12462. DOI: http://dx.doi.org/10.1590/1983-21252024v3712462rc.

Abstract: Soil-borne fungal pathogens pose an increasing challenge to melon cultivation globally. The demand for reduced agrochemical use in melon farming, driven by limitations on chemical residues in the fruit, underscores the need for alternative control strategies. This study assesses the effectiveness of various fungicides-difenoconazole, fluazinam, fludioxonil, and procymidone-and Trichoderma spp. strains (T. asperellum, T. harzianum, and two strains of T. longibrachiatum) in combatting Ceratobasidiumsp., Fusarium falciforme, Macrophomina phaseolina, and Monosporascus cannonballus. Fluazinam (EC50from 0.01 to 0.88 mg/L) and fludioxonil (EC50from 0.01 to 0.07 mg/L) emerged as the most effective fungicides in suppressing the mycelial growth of the pathogens in vitro, whereas procymidone (EC50from 2.31 to 9.77 mg/L) was the least effective. Fludioxonil demonstrated significant efficacy against Ceratobasidiumsp., F. falciforme, M. phaseolina, and M. cannonballus. In vitroassays revealed that all tested Trichodermaspp. strains significantly inhibited mycelial growth, with over 70% reduction for all pathogens examined. Field trials indicated that Trichodermatreatments could decrease disease incidence (28.00 to 69.33%) and severity (0.95 to 2.25) in melon crops. These findings illuminate the potential of various fungicides and Trichodermaspp. in managing soil-borne pathogens in melon cultivation. Such control methods might be employed independently or synergistically with other strategies like grafting onto resistant rootstocks or breeding for resistance to mitigate the threats these pathogens pose to global melon production.

2. Li, Y. Powdery Mildew of Strawberry. (2024). *CAES Fact Sheet*. https://portal.ct.gov/-/media/caes/documents/publications/fact_sheets/plant_pathology_and_ecology/powdery-mildew-of-strawberry.pdf.

3. Li, Y. Powdery Mildew of Woody Ornamentals. (2024). *CAES Fact Sheet*. https://portal.ct.gov/-/media/caes/documents/publications/fact_sheets/plant_pathology_and_ecology/powdery-mildew-of-woody-ornamentals.pdf.

Anuja Bharadwaj, Ph.D., (Analytical Chemistry), **Ph.D.s Hany Dweck, David Giesbrecht, Breahna Gillespie, Andrea Gloria-Soria, Amrita R. Mohapatra** and **Qi Xue** (Entomology), **Jeremiah R. Foley, Ph.D.**, (Environmental Science and Forestry), **Ph.D.s Cleverson Freitas**, **Ravi Patel, Raquel Rocha, Monique Rodrigues E. Silva, Neil Schultes, Stephen Taerum** and **Regan Huntley** (Plant Pathology and Ecology) served as judges in the 13th Annual Quinnipiac Sigma Xi Student Research Conference at Quinnipiac University on April 24, 2024 (75 attendees).

VALLEY LABORATORY

DEWEI LI, PH.D., participated in an international online conference 'The Genus Phytophthora - Don't Change a Winning Concept?' (April 22-26).

JATINDER S. AULAKH, PH.D., published a manuscript titled "EPSPS Gene Amplification Confers Glyphosate Resistance in Palmer Amaranth in Connecticut" in the Weed Technology Journal (online since March 18); published a manuscript titled "Ornamental Plant and Weed Response to Oxyfluorfen + Prodiamine Herbicide" in the Horticultural Technology Journal (April 10); published a factsheet titled "Chemical Control of Mugwort in Asparagus" in CAES factsheets (April 15); and gave a talk " Identification of terrestrial Invasive plants in Connecticut" in Waterbury (18 attendees) (April 24).

CAROLE CHEAH, PH.D., was interviewed by Timothy Brown, Editor of Connecticut Woodlands, for an article on HWA biological control (April 1); met with Foresters from the South Central Regional Water Authority to assess hemlock needs for HWA biological control at the Glen Reservoir and Lake Bethany (April 9); met with volunteers from the Wyndham Land Trust and Pomfret Audubon Center to assess previous HWA biological control efforts at the Bafflin Sanctuary and then met to discuss with the Director of the Pomfret Audubon Center (April 10); met with members of the Stream Committee of the Potatuck Club, Newtown to discuss hemlock conservation plans and assess needs for HWA biological control (April 19).

RICHARD COWLES, PH.D., presented "Climate change science and impacts on gardening" to the Manchester Garden Club (28 attendees) (April 8) and to the Mansfield Garden Club (25 attendees) (April 18).

ROSE HISKES gave a talk on "Exotic Insects and Jumping Worms" to the Tolland Garden Paths Club at the Tolland Agricultural Center (17 attendees) (March 2); participated in a virtual Connecticut Invasive Plant Working Group (CIPWG) Symposium Planning Committee meeting (March 14); led a meeting of the Connecticut Invasive Plant Outdoor Educators on Zoom (March 26). She participated in the Connecticut Tree Protective Association Arboriculture 101 Review Night (36 attendees) (April 4); participated in a virtual Connecticut Invasive Plant Working Group (CIPWG) Symposium Planning Committee meeting (April 17); organized the CIPWG display for the West Hartford Earth Day (April 20) and Hamden Earth Day (April 27); gave a talk on "Invasive Plants: The Silent Invaders" at the Stafford Library in Stafford (19 attendees) (April 22) as well as at the Gardeners of Simsbury meeting at the Simsbury Library (30 attendees) (April 23); led a meeting of the Connecticut Invasive Plant Outdoor Educators on Zoom (April 23).

PUBLICATIONS

1. Aulakh, J. S., Kumar, V., Brunharo, C. A. C. G., Veron, A., and Price, A.J. (2024). EPSPS gene amplification confers glyphosate resistance in Palmer amaranth in Connecticut. *Weed Technol. 38*(31), 1–7. DOI: 10.1017/wet.2024.17

Abstract: A Palmer amaranth biotype (CT-Res) with resistance to glyphosate was recently confirmed in a pumpkin field in Connecticut. However, the underlying mechanisms conferring glyphosate resistance in this biotype is not known. The main objectives of this research were 1) to determine the effect of plant height (10, 20, and 30 cm) on glyphosate

resistance levels in CT-Res Palmer amaranth biotype, and 2) to investigate whether the target site–based mechanisms confer glyphosate resistance. To achieve these objectives, progeny seeds of the CT-Res biotype after two generations of recurrent selection with glyphosate (6,720 g ae ha−1) were used. Similarly, known glyphosate-susceptible Palmer amaranth biotypes from Kansas (KS-Sus) and Alabama (AL-Sus) were included. Results from greenhouse dose-response studies revealed that CT-Res Palmer amaranth biotype had 69-, 64-, and 54-fold resistance to glyphosate as compared with the KS-Sus biotype when treated at heights of 10, 20, and 30 cm, respectively. Sequence analysis of the EPSPS gene revealed no point mutations at the Pro106 and Thr102 residues in the CT-Res Palmer amaranth biotype. Quantitative polymerase chain reaction analysis revealed that the CT-Res biotype had 33 to 111 relative copies of the EPSPS gene compared with the AL-Sus biotype. All these results suggest that the EPSPS gene amplification endows a high level of glyphosate resistance in the GR Palmer amaranth biotype from Connecticut. Because of the lack of control with glyphosate, growers should adopt the use of effective alternative preemergence and postemergence herbicides in conjunction with other cultural and mechanical tactics to mitigate the further spread of GR Palmer amaranth in Connecticut.

Aulakh, J. S., Witcher, A., and Kumar, V. (2024). Ornamental Plant and Weed Response to Oxyfluorfen Plus Prodiamine. *Hort Technol. 34*(3), 227-233. DOI: 10.21273/HORTTECH05372-23

Abstract: Ornamental plant and weed response to oxyfluorfen + prodiamine herbicide was evaluated in Connecticut and Tennessee, USA, in 2017 and 2018. Preemergence application of oxyfluorfen + prodiamine was made at 0 lb/acre, 2 + 0.75 lb/acre, 4 + 1.5 lb/acre, and 8 + 3 lb/acre to container-grown ornamental plants on an outdoor gravel pad and weeds in greenhouse experiments. Ornamental plants were treated first within a week after transplanting and again 6 weeks after the first treatment. Asiatic jasmine (*Trachelospermum asi*aticum), candlestick plant (*Senna alata*), and English ivy (*Hedera helix*) in Tennessee, USA; and 'Blue Flag' iris (*Iris* sp.), 'Firecracker' gladiolus (*Gladiolus* sp.), and 'Green Carpet' Japanese pachysandra (*Pachysandra terminalis*) in Connecticut, USA, were not injured with oxyfluorfen + prodiamine regardless of rate applied. Lily-of-the-Nile (*Agapanthus africanus*) in Tennessee, USA, and 'Bowles' periwinkle (*Vinca minor*) in Connecticut, USA, showed minor but commercially acceptable growth reduction with oxyfluorfen + prodiamine up to 4 + 1.5 lb/acre. Shasta daisy (*Leucanthemum ×superbum*) in Connecticut, USA, was the most sensitive ornamental plant. After the first application, average necrotic injury to Shasta daisy varied from 24% with 2 + 0.75 lb/acre to 31% with 8 + 3 lb/acre of oxyfluorfen + prodiamine. After the second application, necrotic injury was ≤ 5% with all oxyfluorfen + prodiamine rates tested and was commercially acceptable (≤ 20%). Oxyfluorfen + prodiamine reduced densities of creeping woodsorrel (*Oxalis corniculata*), hairy bittercress (*Cardamine hirsuta*), giant foxtail (*Setaria faberi*), and large crabgrass (*Digitaria sanguinalis*) ≥ 80% by 4 weeks after treatment. The fresh weed biomass 6 weeks after treatment indicated an 88% to 99% reduction compared with the untreated control.

JOURNAL ARTICLES APPROVED APRIL 2024

Aulakh, J. S. Chemical Control of Mugwort in Asparagus. *CAES Factsheet*.

Aulakh, J. S. Phragmites-Distinguishing the native from the non-native. *CAES Factsheet*.

Cowles, R. S. Fatty substances make effective deer repellents. *Connecticut Gardener*.

Desiato, J., Chan, G., Palmieri, M., **Linske, M. A.**, **Brackney, D. E.**, **Cantoni, J. L.**, **Cozens, D. W.**, **Stafford, K. C. III,** and Banach, D. B. Using geospatial analysis to describe the association between active tick surveillance data and clinical cases of Anaplasmosis in Connecticut. *Journal of Medical Entomology*.

Jiang, Y., Sun, Y., Zhou, P., **White, J. C.**, Rui, Y., and Zhang, P. Incorporation of lithium iron phosphate nanomaterials in peanut and maize intercropped systems: Mechanistic evaluation of root-soil-microbe interactions and efficient phosphorus and iron utilization. *ACS Nano*.

Li, Y. Powdery Mildew of Strawberry. *CAES Fact Sheet.*

Li, Y. Powdery Mildew of Woody Ornamentals. *CAES Fact Sheet*.

Mukhtar, S., Hassani, M. A., **Zarrillo, T.**, Cui, Z., Sundin, G., and **Zeng, Q.** The role of pollinators in the assembly of the flower microbiota and the transmission of the fire blight pathogen *Erwinia amylovora*. *Environmental Microbiology*.

Nason, S. L.*, McCord, J., Feng, Y.-L., Sobus, J. R., Fisher, C. M., Marfil-Vega, R., Phillips, A.L., Johnson, G., Sloop, J., Bayen, S., Mutlu, E., Batt, A. L., and Nahan, K. Communicating with stakeholders to identify high-impact research directions for non-targeted analysis. *Analytical Chemistry*.

Noori, A., Corbelli, L., Lincoln, E., Thomas, S., **Jones, J., Nason, S. L.,** and **White, J. C.** Physiological responses of Lemna minor in a PFAS phytoremediation trial. *Frontiers in Plant Science*.

Salvas, M., **Rocha, R. O.** and **Westrick, N. M.** First Report of *Neopestalotiopsis* spp. causing leaf spot and petiole blight on strawberry in New England. *Plant Disease*.

Taerum, S. J., Patel, R. R., Micciulla, J., Stephen, B., Gage, D., and **Triplett, L. R.** Establishment and effect of a protist consortium in the maize rhizosphere. *Phytobiome*.

Wang, L., Pan, T., Li, S., Wang, Y., Cai, K., **White, J. C.**, and Xing, B. Silica nanoparticles enhance plant disease resistance by modulating the endophyte community structure in tomato (*Solanum lycopersicum* L.) roots. *Journal of Agricultural and Food Chemistry*.

Wang, P., **Zhou, J.**, **Yu, Y.**, **Zuverza-Mena, N.**, and **Nason, S. L.** Effluent variability: Challenges reusing treated wastewater for agricultural irrigation. *Agricultural Water Management*.

Yan, X., **White, J. C.**, He, E., Van Gestel, C. A. M., Peijnenburg, W. J. G. M., Cao, X., Zhao, L., Xu, X., and Qiu, H. Temporal dynamics of copper-based nanopesticide transfer and subsequent modulation of the interplay between hosts and microbiota across trophic levels. *Environmental Science and Technology*.

Zhou, J., **Wang, Y.**, **Zuverza-Mena, N.**, **Dimkpa, C.**, and **White, J. C.** Copper-based materials as an effective strategy for improving drought resistance in soybean (*Glycine max*) at the reproductive stage. *Nanoscale*.

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