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

GRANTS RECEIVED DECEMBER 2021

JASON C. WHITE (CAES) and OM PARKASH DHANKHER (UMass Amherst) (PIs): Toxic Elements in Food: Identification of Critical Knowledge Gaps to Ensure a Safe Food Supply," $50,000 conference grant funded by the USDA NIFA.

Contamination of food with metalloid arsenic (As) and heavy metals such as cadmium (Cd), mercury (Hg), chromium (Cr), among others, is widely recognized as a global health problem. There is an urgent need to understand the interactions and complexity of these toxic elements in soils in which crops are grown. Simultaneously, in order to minimize the contamination of these toxic elements in foods, there is a greater need for understanding of mechanisms in crop plants for uptake, tolerance, and accumulation in plant tissues. Additionally, approaches such as soil amendments with biochar and engineered nanomaterials as well as agronomic practices are equally important to achieve the intended outcomes to minimize the toxic elements in food crops. This conference grant will support a workshop that will focus on identifying the key knowledge gaps in soil, environmental, and plant sciences, as well as tool developments for detection and speciation of metals(loids) in soil and plant tissues. Participating experts will represent various disciplines and contribute to a conclusive report and recommendations for USDA that will highlight areas in need of significant additional research.

ADMINISTRATION

DR. JASON C. WHITE, with **DR. SARA NASON** and **DR. NUBIA ZUVERZA-MENA**, participated in a Zoom meeting with collaborators at the University of Minnesota and Yale University to discuss progress on a joint NIEHS grant (December 1); spoke by phone with Professor Parkash Dhankher of the University of Massachusetts Amherst about a joint USDA NIFA proposal (December 1); participated in the NSF Center for Sustainable Nanotechnology (CSN) weekly All-Hands call (December 1, 8, 15); participated in the annual PhD Committee meeting of Yuqing Ye of the University of Texas El Paso (December 2); participated in the monthly CT Laboratory Preparedness Teams call with the CT Department of Public Health and others (December 6); participated in a Zoom call with collaborators at the CSN and Tuskegee University to discuss a joint grant proposal (December 6); with **DR. CARLOS TAMEZ**, participated in a Zoom call with collaborators at Auburn University to discuss collaborative research on nano-enabled agriculture (December 10); participated in a Zoom call with colleagues at the University of Connecticut to discuss potential collaborative soil-related research topics (December 13); hosted a meeting in Jones Auditorium with the representatives of the Community Foundation of Greater New Haven, the New Haven Public Schools Superintendent's office and Wilbur Cross High School, along with 15 CAES staff members, to discuss establishment of a Mentoring Girls in Science Program (December 13); with **DR. LEIGH WHITTINGHILL**, participated in a Zoom call with the Commissioner of the CT Department of Agriculture and staff, as well as representatives from FEMA and USDA, to discuss a series of public webinars on urban agriculture (December 13); held a Zoom call with collaborators at Johns Hopkins University (December 13); held a Zoom call with collaborators at the University of Wisconsin to discuss collaborative research (December 14); hosted the monthly CSN Nanochemistry-Plant Zoom call (December 14); participated remotely in the NIEHS Superfund Research Program annual Meeting

(December 14-16); participated by Zoom in the mid-term review of the NRSP3 multistate project (December 14); participated by Zoom in the Northeast Experiment Station Directors monthly meeting (December 15); participated by Zoom in the monthly Farmland Preservation Advisory Board meeting (December 16); with **DR. WADE ELMER**, met with a representative of the International Festival of Arts and Ideas to discuss the potential of CAES being a tour stop at this year's event (December 16); gave an invited lecture titled, "Nanotechnology and Agriculture: Tuning Agrochemical Chemistry at the Nanoscale to Maximize Crop Production" at The International Chemical Congress of Pacific Basin Societies (Pacifichem) 2021 (December 18); with **DR. YI WANG** and **DR. WADE ELMER**, hosted a Zoom call with collaborators at the University of Massachusetts to discuss ongoing experiments as part of a joint USDA project (December 20); with **DR. CHRISTIAN DIMKPA**, participated in a Zoom call with colleagues at the Botswana University of Agriculture and Natural Resources and the Botswana Institute for Technology Research and Innovation to explore the possibility of a formalized partnership on nano-enabled agriculture (December 21); traveled to Rutgers University to meet with colleagues about a joint NSF Center Grant proposal (December 22); held a Zoom call with colleagues at the University of Parma, Italy, to discuss a joint manuscript (December 23); and with **DR. WADE ELMER** and **DR. JAYA BORGATTA**, hosted a Zoom call with collaborators at Johns Hopkins University to discuss progress on a joint USDA research project (December 23).

ANALYTICAL CHEMISTRY

DR. CHRISTINA ROBB attended the annual board meeting of the Eastern Analytical Symposium (EAS) (December 3), accepted the Executive Committee role of EAS Treasurer in 2022, and participated in the EAS Program meeting (December 10); attended the EAS Executive Committee Meetings (December 6, 13, 20, 27); participated in the American Public Health Laboratory (APHL) Food Chemistry workgroup meeting (December 8) and met with the *Journal of Liquid Chromatography* editorial staff (December 30).

DR. NUBIA ZUVERZA-MENA, with **DR. SARA NASON** and **DR. JASON C. WHITE**, participated in a virtual group meeting with collaborators from Yale University and the University of Minnesota (December 1); received recognition for five years of service to the Station (December 9); got the proposal titled, "Early Detection of Urban Maple Decline Syndrome Based on Non-Structural Carbohydrate (NSC) Levels in Association with Site and Tree Growth Metrics in Urban Environments" funded as a Co-PI, along with **DR. SUSANNA KERIÖ** and **DR. LEIGH WHITTINGHILL**, by the Louis A. Magnarelli Post-Doctoral Fellowship Program (December 9); participated in the virtual call between UConn faculty and CAES staff to identify potential soil-related collaboration projects (December 13); attended the NSF R01 grantees call (December 14); and with **DR. SARA NASON** and **DR. JASON C. WHITE**, held interviews for a post-doctoral position (December 17, 21).

ENTOMOLOGY

DR. KIRBY C. STAFFORD III was interviewed about Station history by William Hobbs (December 1); co-chaired a meeting of the Changing Dynamics of Tick Ecology, Personal Protection, and Tick Control Subcommittee of the Tick-Borne Disease Working Group (December 1, 8, 15); and participated in a meeting of the Pollinator Advisory Committee to discuss recommendations for legislation and policies to protect pollinator populations and health (December 15).

DR. CLAIRE E. RUTLEDGE helped administer the oral portion of the Arborist Licensing Exam in New Haven (5 candidates) (December 8).

DR. KIMBERLY A. STONER participated in the National Bee Monitoring Workshop by Zoom with bee researchers from across the US and Canada (December 2); and convened the Pollinator Advisory Committee to discuss recommendations for legislation and policies to protect pollinator populations and health (December 15). The Pollinator Advisory Committee consists of **KIMBERLY STONER**, **KIRBY STAFFORD**, **RICHARD COWLES**, **MARK CREIGHTON**, and **TRACY ZARRILLO** of CAES, and Laura Saucier of CT DEEP.

MS. TRACY ZARRILLO hosted a visit from Mr. James Dorey and Ms. Maisha Lucas, post graduate associates at Yale University, provided a tour of the pollinator lab, and discussed plans for collaborating on a future regional New England data publication (December 9).

ENVIRONMENTAL SCIENCES

DR. JOSEPH PIGNATELLO met with co-investigators from the University of Maryland and GeoSyntec Corp. on a SERDP grant (December 8); and met virtually with several CAES scientific staff and faculty from UConn to discuss potential collaborations on nutrient and PFAS fate (December 13).

DR. PHILIP ARMSTRONG gave a talk titled, “Synchrony of Mosquito and Arbovirus Collections in Connecticut, USA” at the virtual Annual Northeastern Mosquito Control Association Meeting (100 attendees) (December 7); and gave a talk titled, “Vector Competence of Three Human-Biting Tick Species for Powassan Virus” at the virtual Northeastern Center of Excellence in Vector-Borne Diseases meeting (50 attendees) (December 9).

MS. ANGELA BRANSFIELD participated in a BioRAFT’s EHS Community Connection webinar titled, “Safety Culture: A JEDI approach via org-culture?” (December 2); participated in a CAES Health and Safety Committee meeting (December 10); and attended the first CAES DEI Committee meeting (December 17).

MR. GREGORY BUGBEE, as a member of the Northeast Aquatic Nuisance Species Panel, spoke in two virtual meetings on “Hydrilla in the Connecticut River” (December 3, 8); and as a member of the Connecticut River Hydrilla Task Force, gave a virtual update on hydrilla in the Connecticut River (December 13).

DR. SARA NASON participated in virtual meetings for the Benchmarking and Publications for Non-Targeted Analysis working group (December 9, 22).

FORESTRY AND HORTICULTURE

DR. JEFFREY S. WARD participated in a Forest Ecosystem Monitoring Cooperative State Coordinators virtual meeting (December 2); participated in an Oak Resiliency Project Update conference call (December 2); administered practical and oral examinations to arborist candidates for the Connecticut Tree Protection Examining Board (December 8); was elected to the Connecticut Forest and Park Executive Board (December 15); gave a talk titled, "Multiyear Defoliations in Southern New England Increases Oak Mortality" at the 2021 Forest Ecosystem Monitoring Cooperative Virtual Conference (December 16); and participated in the Yankee SAF meeting planning committee (December 21).

DR. SUSANNA KERIÖ participated on the Connecticut Urban Forestry Council's grant committee (December 6); assisted in administering the arborist exam (December 8); was awarded the Magnarelli postdoctoral fellowship award (December 9); served on the Connecticut Urban Forestry Council's grant committee (December 14); and served on the Yale Biosafety Committee (December 16).

DR. LEIGH WHITTINGHILL held a virtual meeting with Eliza Caldwell (Community Garden manager) and Jonathan Savage (Farm manager) with Gather New Haven to discuss their farms and gardens, issues they were having, Dr. Whittinghill's research, and possible future collaborations (December 1); had a virtual meeting with Abbie Winer with the Andover Community Garden to discuss their garden, Dr. Whittinghill's research, and possible future collaborations (December 1); had a virtual meeting with Micro2Life to discuss their farm, Dr. Whittinghill's research, and possible future collaborations (December 2); spoke with Diann Litwin at Common Ground to discuss their participation in farm monitoring research (December 2); had a virtual meeting between UConn and CAES members to discuss possible collaborations for a project on soil monitoring (December 13); met virtually with the Department of Agriculture and other stakeholders on a CT Urban Agricultural webinar series (10 attendees) (December 13); gave a CAES Seminar titled, "The Influence of Production Practices on Urban Agriculture Outcomes" in Jones Auditorium (70 attendees) (December 15); and attended the CT Soil and Water Conservation Council quarterly meeting as the CAES representative (December 16).

DR. SCOTT C. WILLIAMS participated in a Zoom call with Drs. Danielle Smith, Jean Tsao, and Susan Paskewitz of the Midwest Center for Excellence in Vector Borne Diseases on the acaricidal treatment of deer for tick control (December 13).

MR. JOSEPH P. BARSKY participated in a virtual quarterly meeting of the New England Society of American Foresters Executive Committee (December 15).

PLANT PATHOLOGY AND ECOLOGY

DR. WADE ELMER attended via Zoom a NIFA reporting webinar (81 attendees) (December 9, 16); attended via Zoom the Nano Plant Group for the Center for Sustainable Nanotechnology meeting (12 attendees) (December 14); presented "Nanoscale Copper for Plant Disease Management" via Zoom to the Jubilee lecture series of the Indian Phytopathological Society's Annual Meeting (55 attendees) (December 14); attended, via Teams, the CT Management Advisory Council Meeting (84 attendees) (December 15); participated in the monthly APS

Foundation Committee meeting (9 attendees) (December 15); presided over the CAES Diversity Equity and Inclusion Committee in Jones Auditorium (19 attendees) (December 17); participated via Zoom in a monthly APS Press Update conference with authors of the *Compendium of Citrus Diseases* (5 attendees) (December 17); with **DR. JASON WHITE**, **DR. YI WANG**, and colleagues from the University of Massachusetts, met via Zoom for a NIFA grant project on nano S (7 attendees) (December 20); with **DRS. JASON WHITE**, **CHRISTIAN DIMKPA**, **JAYA BORGATTA**, **ISHAQ ADISA**, and colleagues from Johns Hopkins University, met via Zoom for a NIFA grant project on nano P (7 attendees) (December 21).

DR. M. AMINE HASSANI presented a lecture titled, "*Dickeya dadantii* Pectinolytic Phytopathogens" to students in the Bacterial Plant Pathogens and Diseases course in the Department of Plant Science and Landscape Architecture at the University of Connecticut (20 attendees) (December 1).

MS. ROSE HISKES confirmed via USDA APHIS PPQ a first detection of *Paracorsia repandalis* in Connecticut: https://bugguide.net/node/view/2048795#3388896 (December 1); with Connecticut Invasive Plant Working Group (CIPWG) Symposium Planning Committee members Anne Rowlands and Lisa Brodlie, met at the Oakdale Theater in Wallingford to select a venue for CIPWG's 2022 Symposium (December 13, 14); and participated in a Zoom meeting conducted with Ms. Lorraine Muha, LiveNation, and CIPWG about possibly holding its 2022 fall symposium at the Oakdale Theater in Wallingford (December 17, 29).

DR. YONGHAO LI presented a lecture titled, "Phytophthora Bleeding Canker of Beech" in the Review Night of the Connecticut Tree Protective Association Arboriculture 101 Course held in Jones Auditorium (24 adults) (December 1); and participated in the National Plant Diagnostic Network Online Communication & Web Portal Committee meeting via Zoom (8 adults) (December 8).

DR. ROBERT E. MARRA administered oral examinations to arborist candidates for the Connecticut Tree Protection Examining Board (December 8); and presented a talk on Beech Leaf Disease and Oak Wilt to the annual meeting of the CT Environmental Council at the Oakdale Theater in Wallingford (300 participants) (December 14).

DR. QUAN ZENG participated in Zoom planning sessions for the New England and New York Fruit Consortium webinar (December 17).

VALLEY LABORATORY

DR. JAMES LAMONDIA participated in the Boxwood Blight SCRI Annual Meeting (virtual) (December 6); and conducted oral exams for candidates for the Connecticut arborist license and participated in the quarterly meeting of the Connecticut Tree Protection Examining Board in New Haven (December 8).

DR. DEWEI LI participated in the virtual 64th Annual Forest Pest Management Forum (December 7-9).

DEPARTMENTAL RESEARCH UPDATES DECEMBER 2021

ADMINISTRATION

1. Wang, Yi, **Christian Dimkpa**, C. Deng, **Wade H. Elmer**, J. Gardea-Torresdey, and **Jason C. White**. (2022). Impact of engineered nanomaterials on rice (*Oryza sativa* L.): A critical review of current knowledge. *Environmental Pollution, 297*. DOI: 10.1016/j.envpol.2021.118738.

Abstract: After use, a large number of engineered materials (ENMs) are directly or indirectly released into the environment. This may threaten the agricultural ecosystem, especially with crops under high demand for irrigation water, such as rice (*Oryza sativa* L.), a crop that feeds nearly half of the world's population. However, consistent and detailed information on the effects of nanoparticles in rice is limited. This review is a systematic exploration of the effects of ENMs on rice, with a critical evaluation of the mechanisms reported in the literature by which different nanomaterials cause toxicity in rice. The physiological and biochemical effects engendered by the nanoparticles are highlighted, focusing on rice growth and development, ENMs uptake and translocation, gene expression changes, enzyme activity modifications, and secondary metabolite alterations.

2. Mendez, O. E., C. E. Astete, R. Cueto, **Brian Eitzer**, E. A. Hanna, F. Salinas, **Carlos Tamez**, **Yi Wang**, **Jason C. White,** and C. M. Sabliov. (2022). Lignin nanoparticles as delivery systems to facilitate translocation of methoxyfenozide in soybean (*Glycine max*). *Journal of Agriculture and Food Research, 7*. DOI: 10.1016/j.jafr.2021.100259.

Abstract: Nanoscale delivery systems have the potential to improve the effectiveness of agrochemicals while reducing their negative environmental impacts. Herein, we explore the use of lignin nanoparticles (LNPs) to enhance the translocation of methoxyfenozide (MFZ), a non-systemic pesticide, in soybean plants under hydroponic conditions. LNPs (113.8 ± 3.5 nm and zeta potential – 53.3 ± 6.9 mV) were synthesized by emulsion evaporation from lignin-graft-poly(lactic-co-glycolic) acid and MFZ was incorporated into the LNPs (2.7% w/w). Twenty eight day old soybeans were grown hydroponically and were treated with 0.01, 0.1 or 1 mg/ml of LNPs. Plants were harvested after 6, 12, and 24 h of continuous hydroponic exposure to the roots and the concentration of MFZ was quantified in root, stem, and leaf tissues. The results suggest effective and time dependent transfer of MFZ from the hydroponic suspension to the roots, and translocation from the roots to the leaves. MFZ concentrations in the 1 mg/ml treated-plants at 24 h were 519.30, 3.72 and 1.72 μg/g in the roots, stem, and leaves, at 24 h, respectively, as compared to only 28.52, 0.58, 0.39 μg/g in the plants under neat MFZ exposure. The translocation efficiency (TE) of nanodelivered MFZ ranged from 0.06 to 0.08 at 0.01 mg/ml TE, 0.01–0.05 at 0.1 mg/ml, and 0.01–0.006 at 1 mg/ml over 24 h. Even though TE was higher for free MFZ, the concentration and total amount of analyte translocated to the shoots by LNPs were higher than those of free MFZ. In conclusion, LNPs were able to significantly enhance the translocation of non-systemic MFZ from the roots to the soybean aerial tissues in 24 h. This work provides a new platform to enhance the accuracy and precision of pesticide delivery and will be a valuable tool in sustainable nano-enabled agriculture.

3. Xu, X., C. Zhao, K. Qian, M. Sun, Y. Hao, L. Han, C. Wang, C. Ma, **Jason C. White**, and B. Xing. (2022). Physiological responses of pumpkin to zinc oxide quantum dots and nanoparticles. *Environmental Pollution*, *296*. DOI: 10.1016/j.envpol.2021.118723.

Abstract: The present study investigated that the potential of soil or foliar applied zinc oxide quantum dots (ZnO QD, 11.7 nm) to enhance pumpkin (Cucurbita pepo) growth and biomass in comparison with the equivalent concentrations of other sizes of ZnO particles, ZnO nanoparticles (ZnO NPs, 43.3 nm) and ZnO bulk particles (ZnO BPs, 496.7 nm). For foliar exposure, ZnO QD increased dry mass by 56% relative to the controls and values were 23-35% greater than that of the other ZnO particles. The cumulative water loss in the ZnO QD treatment was 10% greater than with ZnO NPs, suggesting that QD could better enhance pumpkin growth. For the root exposure, biomass and accumulative water loss equivalent across all Zn treatments. No adverse effects in terms of pigment (chlorophyll and anthocyanin) contents were evident. Foliar exposure to ZnO QD caused 40% increases in shoot Zn content as compared to the control; the highest Zn content was evident in the Zn2+ ionic treatment, although this did not lead to growth enhancement. In addition, the shoot and root content of other macro- and micro-nutrients were largely equivalent across all the treatments. The contents of other nutritional compounds, including amino acids, total protein and sugar, were also significantly increased by foliar exposure of ZnO QD. The total protein in the ZnO QD was 53% higher than the ZnO particle treatments in the root exposure group. Taken together, our findings suggest that ZnO QDs have significant potential as a novel and sustainable nano-enabled agrichemical and strategies should be developed to optimize benefit conferred to amended crops.

4. Deng, C., **Yi Wang**, G. Navarro, Y. Sun, K. Cota-Ruiz, J. A. Hernandez-Viezcas, G. Niu, C. Li, **Jason C. White**, and J. Gardea-Torresdey. (2022). Copper oxide (CuO) nanoparticles affect yield, nutritional quality, and auxin associated gene expression in weedy and cultivated rice (*Oryza sativa* L.) grains. *Sci. Tot. Environ.*, *810*. DOI: 10.1016/j.scitotenv.2021.152260.

Abstract: Weedy rice grows competitively with cultivated rice, and significantly diminishes rice grain production worldwide. Grain was weedy and cultivated rice grown for four months in field soil amended with nanoscale CuO (nCuO), bulk CuO (bCuO), and copper sulfate ($CuSO_4$) at 0, 75, 150, 300, and 600 mg Cu/kg soil. Cu translocation, essential element accumulation, yield, sugar, starch, protein content, and the expression plant growth-associated genes in grains were determined. The distribution of Cu-based compounds in harvested grain was determined by two-photon microscopy. The grains of weedy and cultivated rice were differentially impacted by CuO-based compounds. Treatment at 600 mg/kg significantly decreased grain yield as compared with control was in the order: bCuO (by 88.7%) > $CuSO_4$ (by 47.2%) ~ nCuO (by 38.3%); the Cu grain content was: nCuO ~ $CuSO_4$ > bCuO. In grains, K, Mg, Zn, and Ca contents were decreased by nCuO in weedy rice by up to 47.4%, 34.3%, 37.6%, and 60.0%, but no such decreases were noted in cultivated rice. In rice spikes, nCuO increased Mg, Ca, Fe, and Zn levels by up to 118.1%, 202.6%, 133.8%, and 103.9%, respectively. Nanoscale CuO upregulated the transcription of auxin by 5.22- and 1.38-fold, respectively, in grains of weedy and cultivated rice. These findings demonstrate a cultivar-specific and concentration-dependent response of rice to nCuO, including differential impacts in the grain. Understanding the impact of nanoscale CuO

at the physiological and molecular level provides valuable information for the future use of Cu based nanomaterials in sustainable agriculture.

5. Wu, T., X. Liao, Y. Zou, Y. Liu, K. Yang, **Jason C. White**, and D. Lin. (2022). Fe-based nanomaterial transformation to amorphous Fe: Enhanced alfalfa rhizoremediation of PCBs-contaminated soil. *Journal of Hazardous Materials*, *425*. DOI: 10.1016/j.jhazmat.2021.127973.

Abstract: Nano-enabled phytoremediation is an emerging remediation strategy for soils that are moderated contaminated with persistent organic contaminants, and there is a significant need for increased mechanistic understanding and for case studies. Herein, we evaluated the remediation the PCB28-contaminated soil using combined alfalfa and Fe-based materials, including zero-valent iron at 20 nm, 100 nm, and 5 mm, and also iron oxide including a-Fe_2O_3, g-Fe_2O_3, and Fe_3O_4 around 20-30 nm. Compared with alfalfa remediation alone (63.2%), Fe-based nanomaterials increased PCB28 removal values to 72.4-93.5% in planted soil, with a-Fe_2O_3 treatment promoting the most effective pollutant removal. Mechanistically, the crystalline Fe-based nanoparticles were transformed into amorphous forms in the plant rhizosphere, resulting in greater availability and enhanced iron nutrition. This nutritional shift induced root metabolic reprogramming of amino acid and carbohydrate cycling, and related functional bacterial enrichment of *Ramlibacter*, *Dyella*, *Bacillus*, and *Paraburkholderia*. A significant positive correlation between amorphous iron, root metabolites, and associated microbes with PCB28 removal was evident, implying that iron supplementation selected for rhizospheric microorganisms that favor PCBs degradation. Overall, this rhizoremediation promotion strategy of Fe species-metabolites-microbes highlights the potential for the hybrid application of nano-phytotechnology in the remediation of soils contaminated with persistent organic xenobiotics.

6. Shidore, T., **Nubia Zuverza-Mena**, **Jason C. White**, and **Washington da Silva**. (2021). Nanoenabled delivery of RNA molecules for prolonged antiviral protection in crop plants: A review. *ACS Applied Nano Materials*, *4* (12), 12891-12904. DOI: 10.1021/acsanm.1c03512.

Abstract: Exogenous application of RNA molecules, such as siRNA or dsRNA, for RNAi induction to control plant virus infections has the potential to be an effective and sustainable alternative to transgenic plants. High throughput sequencing analysis can help to maximize the outcome of this technique by guiding the identification of genomic regions that could be ideal as dsRNA/hpRNA/siRNA templates for foliar application. Unfortunately, the instability of topically applied RNA molecules provides only short-term protection against virus infection (~5 days). Innovative approaches such as the use of nanomaterials as carriers of RNA molecules could not only help overcome this shortcoming, but also allow a more sustained and targeted release of the molecules. However, limited knowledge is available on the use of nanomaterials for exogenous application of RNA molecules to achieve prolonged anti-viral protection. This review discusses the technique of exogenous application of viral dsRNA for virus control and the potential use of high throughput sequencing technology for designing optimally active RNA molecules. Furthermore, a comprehensive overview of potential nanomaterials that could be ideal for RNAi mediated virus control is provided, with emphasis on the need to develop smart and responsive engineered nanomaterials for the same purpose.

ENTOMOLOGY

1. Linske, Megan A., **Scott C. Williams**, **Kirby C. Stafford III**, and Andrew Y. Li. (2021). Integrated tick management in Guilford, CT: Fipronil-based rodent-targeted bait box deployment configuration and *Peromyscus leucopus* (Rodentia: Cricetidae) abundance drive reduction in tick burdens. *Journal of Medical Entomology*. DOI: 10.1093/jme/tjab200.

Abstract: Integrated tick management (ITM) is a comprehensive strategy used to reduce presence of ticks and their associated pathogens. Such strategies typically employ a combination of host and non-host targeted treatments which often include fipronil-based, rodent-targeted bait boxes. Bait boxes target small-bodied rodents, specifically white-footed mice (*Peromyscus leucopus* Rafinesque) that not only play a crucial role in the blacklegged tick (*Ixodes scapularis* Say (Ixodida: Ixodidae)) life cycle, but also in the transmission of numerous pathogens, primarily *Borrelia burgdorferi* Johnson, Schmid, Hyde, Steigerwalt & Brenner (Spirochaetales: Spirochaetaceae), the causal agent of Lyme disease. This study aimed to determine the effect of bait box deployment configuration on tick burden reduction while also further exploring bait consumption and *P. leucopus* abundances as measures of bait box usage and effectiveness. Boxes were deployed on nine properties within each of six neighborhoods (n = 54) in two different configurations: grid and perimeter. Multiple factors were analyzed as potential predictors for reduction in tick burdens using a backward stepwise selection procedure. Results confirmed the perimeter configuration was a more effective deployment strategy. In addition, overall *P. leucopus* abundance was a significant predictor of tick burden reduction while bait consumption was not. These findings not only further support the recommended perimeter deployment configuration but provide insight into effective utilization in areas of high *P. leucopus* abundance. The identification of this significant relationship, in addition to configuration, can be utilized by vector control professionals and homeowners to make informed decisions on bait box placement to make sustained impacts on the *I. scapularis* vector and associated pathogens within an ITM framework.

ENVIRONMENTAL SCIENCES

1. Khalil, Noelle, E. A. H. Little, K. I. Akaratovic, J. P. Kiser, C. F. Abadam, K. J. Yuan, **Michael J. Misencik**, **Philip M. Armstrong**, and **Goudarz Molaei**. (2021). Host associations of *Culex pipiens*: A two-year analysis of bloodmeal sources and implications for arboviral transmission in southeastern Virginia. *Vector-Borne and Zoonotic Diseases*, *21*(12), 961-972. DOI: 10.1089/vbz.2021.0069.

Abstract: Understanding vector-host interactions is crucial for evaluating the role of mosquito species in enzootic cycling and epidemic/epizootic transmission of arboviruses, as well as assessing vertebrate host contributions to maintenance and amplification in different virus foci. To investigate blood-feeding pattern of *Culex pipiens*, engorged mosquitoes were collected on a weekly basis at 50 sites throughout Suffolk, Virginia, using Centers for Disease Control and Prevention miniature light traps, BG-Sentinel traps, and modified Reiter gravid traps. Vertebrate hosts of mosquitoes were identified by amplifying and sequencing portions of the mitochondrial cytochrome b gene. Of 281 *Cx. pipiens* bloodmeals successfully identified to species, 255 (90.7%) contained solely avian blood, 13 (4.6%) mammalian, 1 (0.4%) reptilian, and 12 (4.3%) both avian and mammalian blood. Nineteen avian species were identified as hosts for *Cx. pipiens* with American

robin (n = 141, 55.3% of avian hosts) and northern cardinal (n = 57, 22.4%) as the most common hosts. More American robin feedings took place in areas of higher development. Three mammalian species were also identified as hosts for *Cx. pipiens* with Virginia opossum and domestic cat as the most common hosts in this class (each n = 6, 46.2% of mammalian hosts). There was no significant seasonal difference in the proportion of bloodmeals obtained from avian hosts, but there was a decrease in the proportion of bloodmeals from mammalian hosts from spring to fall. One engorged specimen of *Cx. pipiens* with Virginia opossum-derived bloodmeal tested positive for West Nile virus (WNV), and another with black-and-white warbler-derived bloodmeal tested positive for eastern equine encephalitis virus. Our findings, in conjunction with the results of vector competence studies and virus isolation from field-collected mosquitoes, lend additional support that *Cx. pipiens* serves as the principal enzootic vector and potential epizootic/epidemic vector of WNV in southeastern Virginia.

2. Nason, Sara, Elizabeth Lin, Krystal J. Godri Pollitt, and Jordan Peccia. (2022). Changes in sewage sludge chemical signatures during a COVID-19 community lockdown, part 2: Nontargeted analysis of sludge and evaluation with COVID-19 metrics. *Environmental Toxicology and Chemistry*. DOI: 10.1002/etc.5226.

Abstract: Sewage sludge and wastewater include urine and feces from an entire community, and it is highly likely that this mixture contains chemicals whose presence is dependent on levels of SARS-CoV-2 in the community. We analyzed primary sewage sludge samples collected in New Haven, Connecticut, USA, during the initial wave of the COVID-19 pandemic using liquid chromatography coupled with high-resolution mass spectrometry and performed an exploratory investigation of correlations between chemical features and COVID-19 metrics including concentrations of severe acute respiratory syndrome–coronavirus 2 (SARS-CoV-2) RNA in the sludge and local COVID-19 case numbers and hospital admissions. Inclusion of all chemical features in this analysis is key for discovering potential indicator compounds for COVID-19, whose structures may not be known. We found correlations with COVID-19 metrics for several identified chemicals as well as many unidentified features in the data, including three potential indicator molecules that are recommended for prioritization in future studies on COVID-19 in wastewater and sludge. These features have molecular weights of 108.0935, 318.1214, and 331.1374. While it is not possible to achieve prediction of COVID-19 epidemiological metrics from the one data set used in the present study, advances in this research area are important to share as scientists worldwide work on discovering efficient methods for tracking SARS-CoV-2 in wastewater and the environment.

3. Place, B. J., E. M. Ulrich, J. K. Challis, A. Chao, B. Du, K. Favela, Y.-L. Feng, C. M. Fisher, P. Gardinali, A. Hood, A. M. Knolhoff, A. D. McEachran, **Sara L. Nason**, S. R. Newton, et al. (2021). An introduction to the Benchmarking and Publications for Non-Targeted Analysis Working Group. *Analytical Chemistry*, *93*(49), 16289-16296. DOI: 10.1021/acs.analchem.1c02660.

Abstract: Non-targeted analysis (NTA) encompasses a rapidly evolving set of mass spectrometry techniques aimed at characterizing the chemical composition of complex samples, identifying unknown compounds, and/or classifying samples, without prior knowledge regarding the chemical content of the samples. Recent advances in NTA are the result of improved and more accessible instru-

mentation for data generation and analysis tools for data evaluation and interpretation. As researchers continue to develop NTA approaches in various scientific fields, there is a growing need to identify, disseminate, and adopt community-wide method reporting guidelines. In 2018, NTA researchers formed the Benchmarking and Publications for Non-Targeted Analysis Working Group (BP4NTA) to address this need. Consisting of participants from around the world and representing fields ranging from environmental science and food chemistry to 'omics and toxicology, BP4NTA provides resources addressing a variety of challenges associated with NTA. Thus far, BP4NTA group members have aimed to establish a consensus on NTA-related terms and concepts and to create consistency in reporting practices by providing resources on a public Web site, including consensus definitions, reference content, and lists of available tools. Moving forward, BP4NTA will provide a setting for NTA researchers to continue discussing emerging challenges and contribute to additional harmonization efforts.

PLANT PATHOLOGY AND ECOLOGY

1. Cui, Z., **Regan B. Huntley**, **Neil P. Schultes**, K. U. Kakar, C.-H. Yang, and **Quan Zeng**. (2021). Expression of the type III secretion system genes in epiphytic *Erwinia amylovora* cells on apple stigmas benefits endophytic infection at the hypanthium. *Mol. Plant-Microbe Interact.*, *34*(10), 1119-1127. DOI: 10.1094/MPMI-06-21-0152-R.

Abstract: *Erwinia amylovora* causes fire blight on rosaceous plants. One of the major entry points of *E. amylovora* into hosts is flowers, where *E. amylovora* proliferates epiphytically on stigmatic and hypanthium surfaces and, subsequently, causes endophytic infection at the hypanthium. The type III secretion system (T3SS) is an important virulence factor in *E. amylovora*. Although the role of T3SS during endophytic infection is well characterized, its expression during epiphytic colonization and role in the subsequent infection is less understood. Here, we investigated T3SS gene expression in epiphytic *E. amylovora* on stigma and hypanthium of apple flowers under different relative humidities (RH). On stigma surfaces, T3SS was expressed in a high percentage of *E. amylovora* cells, and its expression promoted epiphytic growth. On hypanthium surfaces, however, T3SS was expressed in fewer *E. amylovora* cells than on the stigma, and displayed no correlation with epiphytic growth, even though T3SS expression is essential for infection. *E. amylovora* cells grown on stigmatic surfaces and then flushed down to the hypanthium displayed a higher level of T3SS expression than cells grown on the hypanthium surface alone. Furthermore, *E. amylovora* cells precultured on stigma had a higher potential to infect flowers than *E. amylovora* cells precultured in a T3SS- repressive medium. This suggests that T3SS induction during the stigmatic epiphytic colonization may be beneficial for subsequent infection. Finally, epiphytic expression of T3SS was influenced by RH. Higher percentage of stigmatic *E. amylovora* cells expressed T3SS under high RH than under low RH.

2. Taerum, Stephen J., J. Micciulla, G. Corso, **Blaire Steven**, D. J. Gage, and **Lindsay R. Triplett**. (2022). 18S rRNA gene amplicon sequencing combined with culture-based surveys of maize rhizosphere protists reveal dominant, plant-enriched and culturable community members. *Environmental Microbiology Reports*. DOI: 10.1111/1758-2229.13038.

Abstract: Protists play important roles in shaping the microbial community of the rhizosphere and defining these roles will require the study of protist isolates. However, there is still a limited understanding of how well protist isolation efforts can capture the diversity and composition of rhizosphere protistan communities. Here, we report a simultaneous isolation and 18S rRNA gene amplicon sequencing survey describing the protist diversity of maize rhizospheres in two climatically and pedologically distinct sites. We demonstrated that the maize rhizosphere exerted significant and site-dependent effects on the protistan community structure and defined a set of core and rhizosphere-enriched protists. From the same root samples, we generated a library of 103 protist isolates representing 46 18S rRNA gene sequence variants from six eukaryotic supergroups. While cultured isolates represented a small proportion of total protist diversity recovered by sequencing, they included taxa enriched in rhizosphere soils across all samples, encompassing 9% of all core sequence variants. The isolation approach also captured 17 protists not detected through 18S rRNA gene amplicon sequencing. This study demonstrated that maize roots select for distinct protistan communities, and established a diverse protist culture collection that can be used for future research linking protists to rhizosphere status and plant health.

JOURNAL ARTICLES APPROVED DECEMBER 2021

Cowles, Richard S. Spiders and other wildlife in Christmas trees. *The Real Tree Line*.

Deng, C., **Yi Wang**, J. Cantu, C. Valdez, G. Navarro, K. Cota-Ruiz, J. A. Hernandez-Viezcas, C. Li, **Jason C. White**, and J. Gardea-Torresdey. Soil and foliar exposure of CuO nanoparticles to soybean (*Glycine max*): Coating and particle size-dependent Cu accumulation. *NanoImpact*.

Huang, G., **Nubia Zuverza-Mena**, **Jason C. White**, H. Hu, B. Xing, and O. Parkash Dhankher. Sulfur nanoparticles alleviate CuO nanoparticle toxicity to wheat (*Triticum aestivum* L.) by limiting Cu accumulation and by modulating the antioxidant defense system. *Science of the Total Environment*.

Kodati, Srikanth, **Richard Cowles**, and **James LaMondia**. Survival of conidia of the boxwood blight pathogen *Calonectria pseudonaviculata* under different relative humidity conditions. *Plant Health Progress*.

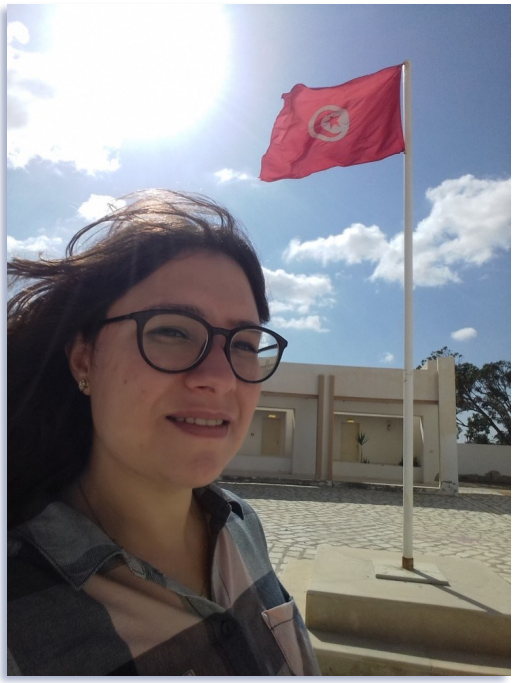
Li, Yonghao. Viral diseases (TSWV/INSV) of bedding plants. *CAES Fact Sheet*.

Yan, X., Z. Pan, S. Chen, N. Shi, T. Bai, L. Dong, D. Zhou, **Jason C. White**, and L. Zhao. Rice exposure to silver nanoparticles in a life cycle study: Dose dependent positive impacts on grain metabolomic profile, yield, and soil bacteria. *Environmental Science & Technology*.

NEW STUDENTS, STAFF, AND VOLUNTEERS DECEMBER 2021

DR. SHITAL R. VAIDYA joined the Station as a Postdoctoral Research Scientist in December 2021; she previously served as an Affiliate at CAES scientific between May and December 2021. Dr. Vaidya obtained a Ph.D. degree in Nanotechnology from the University of Trieste, Italy, in 2015. Her Ph.D. research focused on understanding the magnetic properties of metallic and metal oxide thin films using Auger Photoelectron Coincidence Spectroscopy. She also has extensive experience of teaching Physics at different levels for more than four years. With a Physics major, Dr. Vaidya completed her Master of Science program from the University of Pune, India, in 2008, and the Bachelor of Science studies from A.W. College, Otur, University of Pune, India, in 2006. As a junior research fellow at the University of Pune, Dr. Vaidya chemically synthesized copper and zinc oxide nanoparticles and analyzed their optical, magnetic, and structural properties. Her research showed room-temperature ferromagnetism in copper nanoparticles. At The CAES, as an Affiliate Dr. Vaidya worked with **Dr. Nubia Zuverza-Mena** in the Department of Analytical Chemistry (DAC) and helped a graduate student in DAC to characterize the green-synthesized nanoparticles by UV-Visible, dynamic light scattering (DLS), scanning electron microscope (SEM) and transmission electron microscope (TEM). She prepared nanoparticles, treated root and leaf samples using fixation, dehydration and resin embedding processes. As a Postdoctoral Fellow she is involved in both research on nanotechnology applications and implication and the LFFM grant on human and animal food safety and defense. Dr. Vaidya can be reached via her email at Shital.Vaidya@ct.gov.

MR. KEN I. JOHNSON is a Ph.D. candidate in chemistry from Stony Brook University under Dr. Benjamin S. Hsiao. He is currently a visiting researcher in the Department of Analytical Chemistry since December 14, 2021. Ken is researching chemical and engineering processes to upcycle lignocellulosic biomass into functional nanomaterials for water purification. Cellulose, the most abundant natural polymer, is biodegradable, contains modifiable hydroxyl groups, and can yield nano-sized fibers via defibrillation using a top-down approach. By extension, Ken is collaborating with **Dr. Christian Dimkpa** to test bio-nano-fertilizers as slow release and inducer type fertilizers.



DR. INÈS KARMOUS is a visiting scientist on a Fulbright Scholarship. She is from the University of Gabes, Higher Institute of Applied Biology of Medenine (ISBAM), Tunisia, where she is an Assistant Professor. Dr. Karmous is also a researcher at the University of Carthage, Faculty of Sciences of Bizerte, Tunisia. She will collaborate with **Dr. Wade Elmer** using green synthesis of nanoparticles for disease management.

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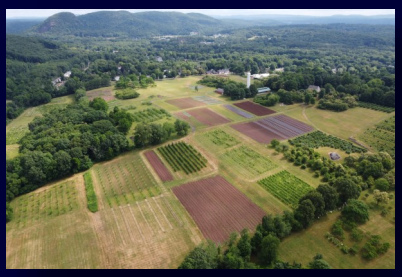

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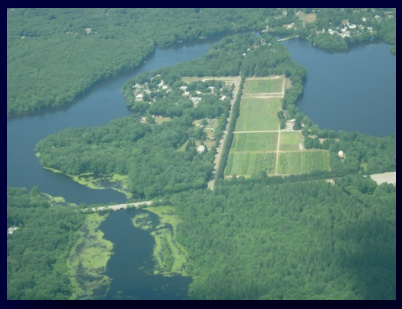

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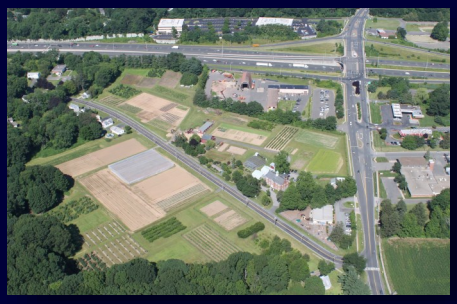

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Station News was prepared and edited by Dr. Jason White, Ms. Vickie Bomba-Lewandoski, Ms. Sandra Carney, and Ms. Kelly Fairbrother.

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