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

GRANTS RECEIVED JANUARY 2022

1. Scott C. Williams and **Megan A. Linske**. "Field trial of fipronil laced bait to control *Ixodes scapularis* immatures on rodents," Centers for Disease Control and Prevention subaward in collaboration with Genesis Laboratories, Inc.; $95,953; January 2022 to August 2024.

We have received this subaward to determine the impacts of oral systemic acaricide treatment of the major pathogen reservoir (white-footed mice) on tick-borne pathogen infection, abundance of parasitizing juvenile blacklegged ticks (*Ixodes scapularis*), and host-seeking blacklegged ticks. Field work will be conducted in summer 2022 and 2023 at 45 cooperating homes in southern Guilford, CT. We will feed mice an ultra-low-dose fipronil-laced bait (0.005% fipronil) and determine consumption rates and impacts on tick abundances and pathogen infection over the two field seasons.

2. Washington da Silva (CAES), Nubia Zuverza-Mena (CAES), Teja Shidore (CAES), Tania Maria Guardado Alvarez (TGA Scientific Consulting), and Christy L. Haynes (University of Minnesota). "Tunable release of dsRNA molecules into plants from sustainable nanocarriers: A novel management tool for viral pathogens," $636,000 research grant funded by the USDA NIFA.

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 (January 5); participated in the NSF Center for Sustainable Nanotechnology (CSN) weekly All-Hands call (January 5, 12, 26); hosted a Zoom meeting with Dr. Soledad Peresin and Dr. Celeste Iglesias of Auburn University to discuss a collaborative research proposal (January 10); participated in the PhD Proposal B Exam of Jesus Cantu of the University of Texas El Paso (Dr. White is on his PhD Committee) (January 10); with **DR. WADE ELMER, DR. CHRISTIAN DIMKPA** and **DR. JAYA BORGATTA**, hosted a Zoom call with collaborators at Johns Hopkins University to discuss progress on a joint USDA research project (January 10, 11); hosted the monthly CSN Nanochemistry-Plant Zoom call (January 11); with **DR. JAYA BORGATTA**, participated in a Zoom call with Prof. Naglaa Yousef of Sohag University (Egypt) to discuss collaborative work (January 11); with **DR. WADE ELMER** and **MS. CALANTHE CAVADINI**, testified in front of the Commission on Human Rights and Opportunity (CHRO) and discussed the agency Affirmative Action Plan (January 12); participated in the monthly CSN All Faculty meeting and gave a research highlight presentation titled "Nanomaterial Chemistry and Plant Interactions" (January 13); hosted the monthly CAES J-1 Visa recipient meeting (January 14); with **DR. WADE ELMER, DR. CHRISTIAN DIMKPA,** and **DR. CHAOYI DENG**, hosted a Zoom meeting with Professor Laurene Tetard and Professor Swadesh Santra to discuss collaborative research (January 14); hosted the quarterly CAES Board of Control meeting (January 18); with **DR. WADE ELMER, DR. CHRISTIAN DIMKPA,** and **DR. CHAOYI DENG,** hosted a Zoom meeting with Mr. Christopher Castillo and Professor Juan Pablo Giraldo of the University of California Riverside to discuss collaborative research (January 18); participated in the oral preliminary exam of Ms. Cheng-Hsin Huang of the University of Minnesota (Dr. White is on her PhD committee) (January 19); participated in the PhD proposal defense of Chunyang Li

from the University of Massachusetts (Dr. White is on her PhD committee) (January 19); with **DR. LEIGH WHITTINGHILL**, participated in a USDA, FEMA, CT DoAg, UConn, and CAES sponsored public webinar on urban agriculture (January 19); participated by Zoom in the monthly Farmland Preservation Advisory Board meeting (January 20); with **MR. GREGORY BUGBEE**, participated in a Zoom meeting with Representative Christine Palm to discuss hydrilla and other invasive aquatic plant species (January 20); 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 (January 21); hosted a Teams meeting with Mr. Troy Ruff of the Department of Consumer Protection Division of Drug Control to discuss adult use cannabis sample collection for analytical method validation (January 24); met by Zoom with Dr. Christy Haynes of the University of Minnesota and Dr. Vasilis Vasiliou of Yale University to discuss a Freedom of Information Act request (January 25); participated in the bimonthly Experiment Station Associates meeting and gave a Director's report (January 26); with **DR. NUBIA ZUVERZA-MENA, DR. SARA NASON**, and **DR. LEIGH WHITTINGHILL,** met by Zoom with Jane Philbrick and colleagues to discuss a phytoremediation project in Bridgeport (January 28); and participated in an FDA -sponsored Zoom call to discuss sampling for human and animal food projects (January 28).

ANALYTICAL CHEMISTRY

DR. CHRISTINA ROBB attended executive committee meetings of the Eastern Analytical Symposium (EAS) (January 3, 10, 17, 24, 31); worked with the *Journal of Liquid Chromatography* (January 19); met with FDA collaborator (January 21).

ENTOMOLOGY

DR. KIRBY C. STAFFORD III co-chaired a meeting of the Changing Dynamics of Tick Ecology, Personal Protection, and Tick Control Subcommittee of the Tick-Borne Disease Working Group (January 5, 19); presented a talk on Connecticut's Forests, Trees, and CAES: A History of People, Pests & Diseases as part of their 100th anniversary review to the virtual annual meeting of the Connecticut Tree Protective Association and, with **DR. CLAIRE RUTLEDGE**, presented a brief update on research at CAES relevant to arborists (January 20); participated in a meeting of the Pollinator Advisory Committee to discuss recommendations for legislation and policies to protect pollinator populations and health (January 14, 21, 24); participated in the Centers for Disease Control and Prevention's "Vector Week" and presented a talk on tick surveillance at the CDC's virtual Vector Week conference (434 attendees) (January 25-27).

MR. MARK H. CREIGHTON spoke at the annual Connecticut Beekeepers Association bee school on "Basic Honey Bee Health," which had a primary focus on Varroa destructor and the proper use of acaricides. Special focus was placed on the proper use of oxalic acid as was requested by the Pesticide Management Program at the Connecticut Department of Energy and Environmental Protection (84 new beekeepers) (January 29).

DR. MEGAN LINSKE participated in a call with USDA collaborators on manuscript preparation for our 5-year integrated tick management study (January 13), par-

ticipated in a call with collaborators from Columbia University and Maine Medical Center Research Institute (MMCRI) about a CDC integrated tick management grant proposal (January 14); participated in a call with the Wildlife Society's (TWS) Diversity, Equity, and Inclusivity meeting to discuss program development and application (January 18), participated in a call with members of the Annual Northeast Fish and Wildlife Agencies Conference 2022 planning committee as President and Workshop Chairperson of the Northeast Section of TWS (January 20), participated in a call with members of TWS Leadership Institute to prepare for the class of 2022 call for applications (January 20), participated in a call with collaborators from Columbia University, MMCRI, and a research contact from the CDC about an integrated tick management grant proposal (January 20); and participated in the Centers for Disease Control and Prevention's "Vector Week" for CDC grantees (January 25-27).

DR. GOUDARZ MOLAEI directed the CAES Tick Testing Laboratory; of the 187 submissions, blood-engorged adult blacklegged ticks were tested for Lyme disease, babesiosis, and anaplasmosis, and results were reported.

Two interns began working with Dr. Molaei and Ms. Khalil in the Tick Testing Laboratory. Morgan Fitch, a senior at the University of New Haven majoring in Forensic Science with a Biology concentration, started as an intern (for school credit) effective Wednesday, January 26, 2022, and Kristy Lok, a senior at the University of New Haven majoring in Forensic Science with a Biology concentration, started as an intern (for school credit) effective Wednesday, February 9, 2022.

DR. GALE E. RIDGE presented a talk titled "Introduction to Delusional Infestation (DI). It Takes a Village to Care for DI Sufferers. Definition, History, and Understanding" to an international audience and presenters hosted by the University of New Hampshire (125 attendees) (January 18); and participated in a webinar led by Nancy Hinkle (University of Georgia) and hosted by the City of New Orleans, Mosquito, Termite and Rodent Control Board on the subject of delusional infestation (January 25).

DR. CLAIRE E. RUTLEDGE participated in the Annual Meeting of the Connecticut Tree Protective Association via live-streaming. She was re-elected as Vice-President of the Association and, with DR. KIRBY STAFFORD, presented a brief update on research at the Station relevant to arborists (200 adults) (January 20).

DR. VICTORIA L. SMITH presented a talk via Zoom for the UMass Wine and Small Fruit Growers on spotted lanternfly (approx. 160 participants) (January 11); participated in the virtual meeting of the Connecticut Tree Protective Association (January 20); and presented a talk via Zoom on spotted lanternfly and box tree moth for the Connecticut Nursery and Landscape Association Winter Symposium (approx. 100 participants) (January 25).

DR. KIMBERLY A. STONER chaired a meeting by Zoom of the Pollinator Advisory Committee with five representatives from the Connecticut Agricultural Experiment Station and one representative from CT DEEP, to review the 2016 Connecticut law, An Act Concerning Pollinator Health (Public Act 16-17), and advised the Environment Committee of the Connecticut General Assembly on possible changes or additions to the act (January 14); chaired another meeting by Zoom of the Pollinator Advisory Committee (January 21); and chaired a meeting by Zoom of the Pollinator Advisory Committee with Diane Jorsey, Supervising Environmental Analyst of the Pesticide Management Program at CT DEEP (January 24).

MS. TRACY ZARRILLO attended a Pollinator Advisory Committee meeting to discuss recommendations for the Environment Committee of the Connecticut State Legislature on potential changes in policy or legislation to protect pollinator health (January 14).

ENVIRONMENTAL SCIENCES

DR. JOSEPH PIGNATELLO met with co-investigators from University of Maryland and GeoSyntec Corp. on a SERDP grant (January 11); met with Janet Rowley of Douglas Products and Dr. Spencer Walse of USDA-ARS, Parlier, California, to discuss patent and licensing opportunities (January 27); and met virtually with co-investigators from Villanova University, Pacific Northwest National Laboratory, and Oregon Health and Science University on a SERDP grant (January 28).

DR. SARA NASON participated in virtual meetings for the Benchmarking and Publications for Non-Targeted Analysis working group (January 13, 18); was interviewed on hemp phytoremediation of per- and polyfluoroalkyl substances by WHSU (January 21) https://www.wshu.org/connecticut-news/2022-01-27/connecticut-scientists-use-hemp-to-start-cleaning-up-pfas-on-tribal-lands-in-maine; and met with Jane Philbrick and colleagues to discuss a new phytoremediation project on brownfield sites in Bridgeport (January 28).

MS. TANYA PETRUFF gave a talk titled "Expansion of Connecticut's Mosquito Trapping and Arbovirus Surveillance Program in Response to the EEE Outbreak of 2019" at the 2021 annual meeting of the Northeastern Mosquito Control Association (approx. 150 attendees) (December 6-8).

MR. JOHN SHEPARD participated in the Executive Board Meeting (December 3), presented "Arbovirus Activity in Connecticut, 2021" (120 attendees) (December 6), and participated in the Annual Business Meeting (December 7) at the virtual 67th Annual Meeting of the Northeastern Mosquito Control Association; and met with Lindsay Baxter and Lisa Martin from Cornell University to tour the Station's mosquito rearing facilities (January 26).

DR. BLAIRE STEVEN met with Cary Chadwick and her team at the Center for Land Use Education and Research (CLEAR) to discuss opportunities for collaborative research using GIS technologies (January 19).

FORESTRY AND HORTICULTURE

DR. JEFFREY S. WARD, with **DR. SCOTT WILLIAMS**, gave a talk titled "How Deer Browse and Invasive Species Accelerate the Loss of Oak" for the Pennsylvania SAF Deer Forest Committee (28 attendees) (January 5); participated in a (FEMC) Forest Ecosystem Monitoring Cooperative State Coordinators virtual meeting (January 6); was elected as a Trustee of the Great Mountain Forest Corporation (January 8); participated in a Yankee Division - Society of American Foresters Outreach Committee virtual meeting (January 17); attended the virtual Connecticut Tree Protective Association annual meeting (January 20); participated in a Connecticut Forest and Park Association Board of Directors meeting (January 26); and participated in a Forest Ecosystem Monitoring Cooperative (FEMC) Joint Committee virtual meeting (January 27).

DR. SUSANNA KERIÖ participated on a Zoom call to plan research collaboration related to chestnut (January 6); participated in a meeting of the Yale Biosafety Committee (January 20); and participated in a virtual meeting of the Connecticut Urban Forestry Council (January 27).

DR. LEIGH WHITTINGHILL met with Ivette Ruiz of Onward Horizons Leadership Development Associates to talk about her programs, Dr. Whittinghill's research, and possible future collaborations (January 11); Dr. Whittinghill introduced herself and The CAES in a presentation during the January webinar for the State of Connecticut Support for Urban Agriculture Webinar series (69 attendees) (January 19); and met with Jane Philbrick and Christopher Bergstrom of NE Wool BX and several CAES staff to discuss two brownfield regeneration sites in Bridgeport (January 28).

DR. SCOTT C. WILLIAMS participated in a conference call with Genesis Laboratories, Inc., about research collaboration on an upcoming grant proposal (January 4); participated in a Zoom call with members of the leadership team for the Northeast Center for Excellence in Vector-Borne Diseases grant proposal to CDC (January 5); participated in a Zoom call with our USDA collaborators on manuscript preparation on data from a 5-year integrated tick management study (January 13); participated in a Zoom call with collaborators from Columbia University and Maine Medical Center Research Institute about a CDC integrated tick management grant proposal (January 14); participated in a Zoom call with our Maine Medical Center Research Institute collaborators to inform Maine Department of Inland Fisheries and Wildlife of our proposed activities (January 14); initiated a Zoom call with collaborators from Columbia University, Maine Medical Center Research Institute, and research contact from the CDC about an integrated tick management grant proposal (January 20); participated in a conference call with Genesis Laboratories, Inc., about research collaboration on an upcoming grant proposal (January 24); and participated in the Centers For Disease Control and Prevention's "Vector Week" for CDC grantees (January 25-27).

MR. JOSEPH P. BARSKY participated in the quarterly Executive Committee meeting (virtual) of the New England Society of American Foresters (January 19); and attended the virtual Connecticut Tree Protective Association annual meeting (January 20).

PLANT PATHOLOGY AND ECOLOGY

DR. WADE ELMER, with **DRS. JASON WHITE, CHRISTIAN DIMKPA, JAYA BORGATTA**, and colleagues from Johns Hopkins University, had a Zoom conference for a NIFA grant project on nano P (7 attendees) (January 11); attended via Zoom the Nano Plant Group meeting for the Center for Sustainable Nanotechnology (12 attendees) (January 11); attended via Zoom the Connecticut Commission on Human Rights and Opportunities (January 12); attended the NIFA reporting webinar (81 attendees) (January 13); with **DR. JASON WHITE** and **MR. MICHAEL LAST**, attended the CAES Board of Control Meeting in Wethersfield (10 attendees) (January 18); with **DR. YONGHAO LI**, participated in a discussion with members of the National Plant Diagnostic Network and UConn (January 19, 25); participated in the monthly APS Foundation Committee meeting (9 attendees) (January 19); met with the ad hoc committee of the CAES Diversity, Equity and Inclusion Committee in Jones Auditorium (5 attendees) (January 14, 28); presented a seminar via Zoom entitled "Nanoscale Copper for Plant Disease Manage-

ment" to the Purdue University, Department of Horticulture and Landscape Architecture (33 attendees) (January 20); participated via Zoom in a monthly APS Press Update conference with authors of the Citrus compendium (5 attendees) (January 21); with **DR. JASON WHITE, DR. CHRISTIAN DIMKPA, DR. YI WANG,** and colleagues from University of Massachusetts, had a Zoom conference for a NIFA grant project on nano S (7 attendees) (January 21).

DR. WASHINGTON DA SILVA taught a two-week long General Virology Class on Zoom to graduate students from the Universidade Federal Rural do Semiárido (UFERSA). During his lectures, he showcased the research performed at CAES with special emphasis on CAES's plant virology program (20 attendees) (December 6-17).

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 organized and conducted a Connecticut Invasive Plant Working Group Symposium planning committee meeting via Zoom (16 attendees) (January 6); participated in the Connecticut Tree Protective Association Virtual Annual Meeting (January 20); and attended the UMass Jumping Worms Virtual Conference (January 26, 27).

DR. YONGHAO LI attended the Connecticut Tree Protective Association Annual Meeting via Zoom (January 20); with **DR. WADE ELMER**, participated in the National Plant Diagnostic Network grant discussion with UConn, regional centers, and the national executive director via Zoom (8 adults) (January 19) and (4 adults) (January 25); attended the Connecticut Nursery and Landscape Association Winter Symposium and presented "Principles of Disease Management" (77 adults) and "Use of Fungicides in Nursery and Landscape Settings" (73 adults) via Zoom (January 25, 26); attended the National Plant Diagnostic Network IT Meeting via Zoom (January 26, 27); and presented "2021 Plant Disease Update – CAES" at the Northeast Plant Diagnostic Network meeting via Zoom (18 adults) (January 31).

DR. ROBERT E. MARRA presented a talk on Beech Leaf Disease and Oak Wilt for the Valley Green Winter Seminar Series, at the Villa Bianca in Seymour (80 participants) (January 12).

DR. STEPHEN J. TAERUM presented "Exploring the Protists in the Phytobiome" at the virtual Plant & Animal Genomes XXIX meeting (28 participants) (January 12).

VALLEY LABORATORY

DR. RICHARD COWLES presented "Application of Kaolin to Pumpkins to Improve Flower Bud Formation" to the Climate Adaptation Fellowship Program, University of Maine (40 attendees) (January 5); and spoke about "Neonicotinoid Alternatives" to Valley Green's pesticide training for turf professionals, Marlborough, MA, remotely (50 attendees) (January 13).

DEPARTMENTAL RESEARCH UPDATES JANUARY 2022

ADMINISTRATION

1. Pagano, L., Marmiroli, M., Villani, M., Magnani, J., Rossi, R., Zappettini, A., **White, J. C.**, Marmiroli, N. (2022). Engineered nanomaterial exposure affects organelle genetic material replication in *Arabidopsis thaliana*. *ACS Nano*. DOI: 10.1021/acsnano.1c08367

Abstract: Mitochondria and chloroplast are not only the cellular energy sources but also have important regulatory and developmental roles in cell function. CeO_2, FeOx ENMs, ZnS, CdS QDs and relative metal salts were utilized in Murashige-Skoog (MS) synthetic growth medium at different concentrations (80-500 mg L^{-1}) and times of exposures (0-20 days). Analysis of physiological and molecular response of A. thaliana chloroplast and mitochondrion demonstrates that ENMs increase or decrease functionality and organelle genome replication. Exposure to nanoscale CeO_2 and FeOx cause a 81-105% increase in biomass, whereas ZnS and CdS QDs yielded neutral or 59% decrease in growth, respectively. Differential effects between ENMs and their corresponding metal salts highlight nanoscale-specific response pathways, which include energy production and oxidative stress response. Differences may be ascribed to ENM and metal salt dissolution rate, toxicity of the metal ion, which suggests eventual biotransformation processes occurring within the plant. With regard to specific effects on plastid (pt) and mitochondrial (mt) DNA, CdS QD exposure triggered potential variations at sub-stoichiometric level in the two organellar genomes, while nanoscale FeOx and ZnS QDs caused a 1- to 3-fold increase in ptDNA and mtDNA copy number. Nanoparticle CeO_2 exposure did not affect ptDNA and mtDNA stoichiometry. These findings suggest that modification in stoichiometry as potential morpho-functional adaptive response to ENMs exposure, triggered by modifications of bioenergetic redox balance which leads to reduce the photosynthesis or cellular respiration rate.

2. Imperiale, D., Lencioni, G., Marmiroli, M., Zappettini, A., **White, J. C.**, Marmiroli, N. (2022). Interaction of hyperaccumulating plants with Zn and Cd nanoparticles. *Sci. Total Environ.*, *817*. DOI: 10.1016/j.scitotenv.2021.152741

Abstract: Plants, metal hyperaccumulator are an interesting example of natural selection and environmental adaptation but they may also be useful to developing new technologies of environmental monitoring and remediation. *Noccaea caerulescens* and *Arabidopsis halleri* are both Brassicaceae and are known metal hyperaccumulators. This study evaluated tolerance, uptake and translocation of zinc sulfide quantum dots by *N. cearulescens* and cadmium sulfide quantum dots by *A. halleri* in direct comparison with the non-hyperaccumulator, genetically similar *T. perfoliatum* and *A. thaliana*. Growth media were supplied with two different concentrations of metal in either salt ($ZnSO_4$ and $CdSO_4$) or nanoscale form (ZnS QDs and CdS QDs). After 30 days of exposure, the concentration of metals in the soil, roots and leaves was determined. Uptake and localization of the metal in both nanoscale and non-nanoscale form inside plant tissues was investigated by Environmental Scanning Electron Microscopy (ESEM) equipped with an X-ray probe. Specifically, the hyperaccumulators in comparison with the non hyperaccumulators accumulate salt and nanoscale Zn and Cd in the aerial parts with a BCF ratio of 45.9 for Zn salt, 49.6 for nanoscale Zn, 2.64 for Cd salt and 2.54 for nanoscale Cd. Results obtained with a differential extraction analytical

procedure also showed that a significant fraction of nanoscale metals remained inside the plants in a form compatible with the retention of at least a partial initial structure. The molecular consequences of the hyperaccumulation of nanoscale materials are discussed considering data obtained with hyperaccumulation of ionic metal. The analysis with TEM-EDX of dried tissues after the exposure, showed that a significant amounts of Zn and Cd remained in a non soluble form, which on the contrary was put down when centrifuged at high speed. This is the first report for these plants of hyperaccumulation of engineered nanomaterials (ENMs).

ANALYTICAL CHEMISTRY

1. Dimkpa, C. O., Campos, M. G. N., Fugice, J., Glass, K., Ozcan, A., Huang, Z., Singh, U., Santra, S. (2022). Synthesis and characterization of novel dual-capped Zn-urea nanofertilizers and application in nutrient delivery in wheat. *Environmental Science: Advances*. DOI: 10.1039/D1VA00016K

Abstract: Nanoscale nutrients are promising for improving crop performance. However, size-induced potential for drifting, segregation, or transformation warrants strategies to streamline fertilization regimes. Herein, we developed three nanofertilizers by coating urea granules with Zn nanoparticles capped with binary capping agents: *N*-acetyl cysteine (NAC) and sodium salicylate (SAL); NAC and urea; or SAL and urea. Coating was accomplished at 80–100% efficiencies. When evaluated in sorghum through soil application at 6.4 (rate-1) and 2.1 (rate-2) mg Zn per kg soil, the nanofertilizers influenced sorghum performance, plant accumulation, and soil retention of Zn, N, and P comparably with the control (Zn-sulfate). However, SAL–urea–Zn, NAC–SAL–Zn, and NAC–urea–Zn nanofertilizers evoked rate-dependent significant ($P < 0.05$) effects compared to Zn-sulfate. Early SPAD (chlorophyll) counts were significant with SAL–urea–Zn rate-1, compared to Zn-sulfate. NAC–SAL–Zn and SAL–urea–Zn rate-1 significantly increased shoot biomass, compared to Zn-sulfate. Notably, NAC–urea–Zn rate-2 strongly promoted grain or total above-ground Zn or N accumulation compared to SAL–urea–Zn rate-1, NAC–SAL–Zn rate-1, or NAC–urea–Zn rate-1, indicating that a lower rate of Zn can be used for NAC–urea–Zn to facilitate Zn and N delivery. Residual soil Zn was significantly higher with NAC–SAL–Zn rate-1, compared to Zn-sulfate. However, residual ammonium was significantly higher in Zn-sulfate, compared to other treatments, except for NAC–urea–Zn rate-2. Contrarily, residual P was significantly higher with SAL–urea–Zn rate-1 than with Zn-sulfate. These findings indicate that coating of urea with Zn nanoparticles can facilitate the application of nanoscale nutrients in agriculture, without any penalty on plant performance or nutrient delivery.

ENTOMOLOGY

1. Little, E. A. H., Hutchinson, M. L., Price, K. J., Marini, A., **Shepard, J. J.**, **Molaei, G.** (2022). Spatiotemporal distribution, abundance, and host interactions of two invasive vectors of arboviruses, *Aedes albopictus* and *Aedes japonicus*, in Pennsylvania, USA. *Parasites & Vectors*, *15*. DOI: 10.1186/s13071-022-05151-8

Abstract: *Aedes albopictus* and *Aedes japonicus*, two invasive mosquito species in the United States, are implicated in the transmission of arboviruses. Studies have shown interactions of these two mosquito species with a variety of vertebrate hosts; however, regional differences exist and may influence their contri-

bution to arbovirus transmission. We investigated the distribution, abundance, host interactions, and West Nile virus infection prevalence of *Ae. albopictus* and *Ae. japonicus* by examining Pennsylvania mosquito and arbovirus surveillance data for the period between 2010 and 2018. Mosquitoes were primarily collected using gravid traps and BG-Sentinel traps, and sources of blood meals were determined by analyzing mitochondrial cytochrome b gene sequences amplified in PCR assays.

2. Cheng, C., **Ridge, G.**, Koo, J., Brownstone, N. (2021). Improving care for delusional infestation patients: What can dermatologists learn from an entomologist? *Derm. Online J.*, *27*(11), 1-6. DOI: 10.5070/D3271156087

Abstract: Delusional Infestation (DI) represents one of the most difficult patient encounters that dermatology practitioners may experience. It is common for DI patients to doctor shop. Thus, dermatologists are one of several disciplines that may encounter DI patients in their practices. Others include veterinarians, epidemiologists, emergency departments, mental health practitioners, and entomologists. In this article, entomologist, Dr. Gale E. Ridge, with extensive DI experience, was interviewed to find out what an entomologist's perspective has been and what we, the dermatology providers, can learn from that. This is followed by a discussion by the dermatology experts on how the experience of entomologists compares to our experience and what we can learn from them.

3. Stafford III, K. C., **Molaei, G.**, **Williams, S. C.**, Mertins, J. W. (2022). *Rhipicephalus capensis* (Acari: Ixodidae), A geographically restricted South African tick, returning with a human traveler to the United States. *Ticks and Tick-borne Diseases*, *13*(3). DOI: 10.1016/j.ttbdis.2022.101912

Abstract: Accelerated frequency of recreational travel, globalization of business, and legal and illegal plant and animal trades have contributed to enduring introductions of exotic ticks into the United States. We herein report a new incursion of a female *Rhipicephalus capensis* on a human traveler returning to Connecticut from South Africa. Natural distribution of *R. capensis* is restricted to the Western Cape Province and southwestern portion of the Northern Cape Province of South Africa, an area called the Fynbos Biome, and adults of this species primarily parasitize large, wild ungulate hosts. Only one previous international introduction of this tick is documented on imported South African plant material into the United States in 1985. The specimen described here was identified initially by morphological means and subsequently, a partial DNA sequence for the mitochondrial ribosomal RNA gene was generated in a PCR assay, which showed 94.86% identity to an R. capensis sequence in GenBank. We also provide information on several other previously unreported or under-reported incursions by South African ticks into the United States in association with imported Fynbos floricultural materials and speckled Cape tortoises, *Chersobius signatus*. Documentation of these additional exotic tick species incursions highlights ongoing challenges of the international movement of humans, animals, and other goods carrying ticks of human and veterinary importance.

ENVIRONMENTAL SCIENCES

1. Elnour, M. A. B., **Gloria-Soria, A.**, Azrag, R. S., Alkhaibari, A. M., Powell, J. R., Salim, B. (2022). Population genetic analysis of *Aedes aegypti* mosquitoes from Sudan revealed recent independent colonization events by the two subspecies. *Frontiers in Genetics*. DOI: 10.3389/

fgene.2022.825652

Abstract: Increases in arbovirus outbreaks in Sudan are vectored by *Aedes aegypti*, raising the medical importance of this mosquito. We genotyped 12 microsatellite loci in four populations of *Ae. aegypti* from Sudan, two from the East and two from the West, and analyzed them together with a previously published database of 31 worldwide populations to infer population structure and investigate the demographic history of this species in Sudan. Our results revealed the presence of two genetically distinct subspecies of *Ae. aegypti* in Sudan. These are *Ae. aegypti aegypti* in Eastern Sudan and *Ae. aegypti formosus* in West Sudan. Clustering analysis showed that mosquitoes from East Sudan are genetically homogeneous, while we found population substructure in West Sudan. In the global context our results indicate that Eastern Sudan populations are genetically closer to Asian and American populations, while Western Sudan populations are related to East and West African populations. Approximate Bayesian Computation Analysis supports a scenario in which *Ae. aegypti* entered Sudan in at least two independent occasions nearly 70 to 80 years ago. This study provides a baseline database that can be used to determine the likely origin of new introductions for this invasive species into Sudan. The presence of the two subspecies in the country should be consider when designing interventions, since they display different behaviors regarding epidemiologically relevant parameters, such as blood feeding preferences and ability to transmit disease.

FORESTRY AND HORTICULTURE

1. Ward, J. S., Jones, C. C., **Barsky, J. P.** (2021). Multiyear defoliations in southern New England increases oak mortality. *Canadian Journal of Forest Research*, *52*(2). 10.1139/cjfr-2021-0174

Abstract: After decades of multiyear defoliation episodes in southern New England, *Lymantria dispar dispar* (previously gypsy moth) populations diminished with the appearance of the *L. dispar* fungus in 1989. Multiyear defoliations did not occur again until 2015-2018. To assess the impact of the return of multiyear defoliations, we examined 3095 oaks on 29 permanent study areas in Connecticut and Rhode Island that were established at least eleven years before the latest outbreaks. Pre-defoliation stand level oak mortality averaged 2% (three-year basis). Post-defoliation mortality did not differ between managed and unmanaged stands, but was much higher in severely defoliated stands (36%) than in stands with moderate (7%) or low-no defoliation (1%). Pre-defoliation mortality of individual trees differed among species, was lower for larger diameter trees and on unmanaged than managed stands. Post-defoliation mortality on plots with no to moderate defoliation was similar to pre-defoliation mortality levels. Following multiyear defoliations, white oak mortality was higher than for northern red and black oak. There was weak evidence that mortality was elevated on stands with higher basal area following severe defoliation. Natural resource managers should not assume that oaks that survived earlier multiyear defoliations episodes will survive future multiyear outbreaks, possibly because trees are older.

PLANT PATHOLOGY AND ECOLOGY

1. Kandel, P. P., Naumova, M., Fautt, C., **Patel, R. R.**, **Triplett, L. R.**, Hockett, K. L. (2022). Genome mining shows ubiquitous presence and extensive diversity of toxin-antitoxin systems in *Pseudomonas syringae*.

Front. Microbiol. DOI: 10.3389/fmicb.2021.815911

Bacterial toxin-antitoxin (TA) systems consist of two or more adjacent genes, encoding a toxin and an antitoxin. TA systems are implicated in evolutionary and physiological functions including genome maintenance, antibiotics persistence, phage defense, and virulence. Eight classes of TA systems have been described, based on the mechanism of toxin neutralization by the antitoxin. Although studied well in model species of clinical significance, little is known about the TA system abundance and diversity, and their potential roles in stress tolerance and virulence of plant pathogens. In this study, we screened the genomes of 339 strains representing the genetic and lifestyle diversity of the *Pseudomonas syringae* species complex for TA systems. Using bioinformatic search and prediction tools, including SLING, BLAST, HMMER, TADB2.0, and T1TAdb, we show that *P. syringae* strains encode 26 different families of TA systems targeting diverse cellular functions. TA systems in this species are almost exclusively type II. We predicted a median of 15 TA systems per genome, and we identified six type II TA families that are found in more than 80% of strains, while others are more sporadic. The majority of predicted TA genes are chromosomally encoded. Further functional characterization of the predicted TA systems could reveal how these widely prevalent gene modules potentially impact *P. syringae* ecology, virulence, and disease management practices.

VALLEY LABORATORY

1. Zhang, M.-Y., Si, Y.-Z. Ju, Y., **Li**, **D.-W.**, Zhu, L.-H. (2021). First report of leaf spot caused by *Colletotrichum siamense* on *Salix matsudana* in China. *Plant Disease*, *105*(11), 3744. DOI: 10.1094/PDIS-04-21-0776-PDN

Abstract: *Salix matsudana* Koidz. (Chinese willow) is an important landscaping tree widely grown in China (Zhang et al. 2017). In October 2019, a characteristic leaf spot disease of *S. matsudana* was found at Nanjing Forestry University. Most 25-year-old *S. matsudana* trees (13 out of 21, approximately 62%) on campus showed the leaf spot disease. On average, 70% of the leaves per individual tree were affected by this disease. Foliar symptoms began as dark brown, irregular spots with gray-white centers, gradually enlarging with time. Leaf spot symptomatic leaves were collected from three infected *S. matsudana* trees (10 leaves/tree), and small infected tissues (3 to 4 mm^2) were surface-sterilized in 75% ethanol for 30 s, 1% NaClO for 90 s, rinsed in ddH_2O, dried on sterilized filter paper, plated on potato dextrose agar (PDA), and then incubated at 25°C. Three isolates (NHY1-1, NHY1-2, and NHY1-3) of the same fungus were obtained in 85% of the samples and deposited in China's Forestry Culture Collection Center (NHY1-1: cfcc55354, NHY1-2: cfcc55355, NHY1-3: cfcc55359). The colonies of three isolates were white, but the reverse side was grayish white. The conidia of NHY1-1 were one-celled, straight, subcylindrical, hyaline, 14.4 ± 0.9 × 5.4 ± 0.4 µm (*n* = 50), with a rounded end. Conidiophores were hyaline to pale brown, septate, and branched. Appressoria were one-celled, ellipsoidal, brown or dark brown, thick-walled, and 8.0 ± 0.9 × 5.9 ± 0.5 µm (*n* = 50). The conidia and appressoria of the other two isolates were almost identical to NHY1-1. The morphological characters of the three isolates were matched with those of the *Colletotrichum gloeosporioides* complex (Weir et al. 2012). For accurate identification, the DNA of the three isolates was extracted. The internal transcribed spacer region (ITS), actin (*ACT*), calmodulin (*CAL*), chitin synthase (*CHS-1*), glyceraldehyde-3-phosphate dehydrogenase (*GAPDH*), superoxide dismutase (*SOD2*), and ß-tubulin 2 (*TUB2*) genes were amplified using the primer pairs ITS1/ITS4, ACT-512F/ACT-

783R, CL1C/CL2C, CHS-79F/CHS-345R, GDF1/GDR1, SODglo2-F/SODglo2-R, and Bt2a/Bt2b, respectively (Weir et al. 2012). The sequences were deposited in GenBank (accession nos. MW784679 and MW808959–MW808964 for NHY1-1; MW784726 and MW808965–MW808970 for NHY1-2; MW784729 and MW808971–MW808976 for NHY1-3). A BLAST search showed that ITS, *ACT*, *CAL*, *GAPDH*, *SOD2*, and *TUB2* sequences of the three isolates were identical to *C. siamense* at a high level (>99%), and *CHS-1* sequences of three isolates were consistent with *C. fructicola* at a high level (>99%). Maximum likelihood and Bayesian posterior probability analyses using IQtree v. 1.6.8 and Mr. Bayes v. 3.2.6 with the concatenated sequences (ITS, *ACT*, *CAL*, *CHS-1*, *GAPDH*, *SOD2*, and *TUB2*) placed NHY1-1, NHY1-2, and NHY1-3 in the clade of *C. siamense* with high bootstrap support values (ML/BI = 93/1). The pathogenicity of three isolates were tested on potted 2-year-old seedlings (50-cm tall) of *S. matsudana*, which were grown in a greenhouse. Healthy leaves were wounded with a sterile needle and then inoculated with 10 µl of conidial suspension (10^6 conidia ml^{-1}). Controls were treated with ddH_2O (Zhu et al. 2019). In total, 12 seedlings were inoculated including controls. Three seedlings/isolate and 10 leaves/seedling were used for each treatment. The plants were covered with plastic bags after inoculation and sterilized H_2O was sprayed into the bags twice per day to maintain humidity and kept in a greenhouse at day/night temperatures of 25 ± 2°C and 16 ± 2°C. Within 7 days, all the inoculated points showed lesions similar to those observed in field, whereas controls were asymptomatic. The infection rate of each of the three isolates was 100%. *C. siamense* was reisolated from the lesions, whereas no fungus was isolated from control leaves. The diseases caused by *C. siamense* often occur in tropical and subtropical regions of China, with a wide range of hosts, such as *Hevea brasiliensis* and *Coffea arabica*. This is the first report of *C. siamense* causing leaf spot of *S. matsudana* in China and the world. These data will help to develop effective strategies for managing this newly emerging disease.

2. Sun, X.-R., Xu, M.-Y., Kong, W.-L., Wu, F., Zhang, Y., Xie, X.-L., **Li, D.-W.**, Wu, X.-Q. (2022). Fine identification and classification of a novel beneficial *Talaromyces* fungal species from Masson pine rhizosphere soil. *Journal of Fungi*, *8*(2), 155. DOI: 10.3390/jof8020155

Abstract: Rhizosphere fungi have the beneficial functions of promoting plant growth and protecting plants from pests and pathogens. In our preliminary study, rhizosphere fungus JP-NJ4 was obtained from the soil rhizosphere of *Pinus massoniana* and selected for further analyses to confirm its functions of phosphate solubilization and plant growth promotion. In order to comprehensively investigate the function of this strain, it is necessary to ascertain its taxonomic position. With the help of genealogical concordance phylogenetic species recognition (GCPSR) using five genes/regions (ITS, *BenA*, *CaM*, *RPB1*, and *RPB2*) as well as macro-morphological and micro-morphological characters, we accurately determined the classification status of strain JP-NJ4. The concatenated phylogenies of five (or four) gene regions and single gene phylogenetic trees (ITS, *BenA*, *CaM*, *RPB1*, and *RPB2* genes) all show that strain JP-NJ4 clustered together with *Talaromyces brevis* and *Talaromyces liani*, but differ markedly in the genetic distance (in *BenA* gene) from type strain and multiple collections of *T. brevis* and *T. liani*. The morphology of JP-NJ4 largely matches the characteristics of genes *Talaromyces*, and the rich and specific morphological information provided by its colonies was different from that of *T. brevis* and *T. liani*. In addition, strain JP-NJ4 could produce reduced conidiophores consisting of solitary phialides. From molecular and phenotypic data, strain JP-NJ4 was identified as a

JOURNAL ARTICLES APPROVED JANUARY 2022

Ahmed, T., Noman, M., Jiang, H., Shahib, M., Ma, C., Wu, Z., Nazir, M. M., Alia, A., **White, J. C.**, Cheng, J., Li, B. Bioengineered chitosan-iron nanocomposite controls bacterial leaf blight disease by modulating the defense response of rice (*Oryza sativa* L.). *Nano Today*.

Aulakh, J. S. Horseweed (*Conyza canadensis*) identification and control in Christmas trees. *CAES Fact Sheet*.

Aulakh, J. S. Nonselective tank-mix partners for controlling emerged weeds at spring preemergence treatment. *The Real Tree Line*.

Azeem, A., Adeel, M., Ahmad, M. A., Shakoor, N., Zain, M., Yousef, N., Zhao, Y., Azee, K., Zhou, P., **White, J. C.**, Rui, Y. Micro and nanoplastics interactions with plant species: Trends, meta-analysis, and perspectives. *Environmental Science & Technology*.

Brueck, C. L., **Nason, S. L.**, Multra, M. G., Prasse, C. Assessing the fate of antibiotics and agrochemicals during anaerobic digestion of animal manure. *Environmental Science & Technology*.

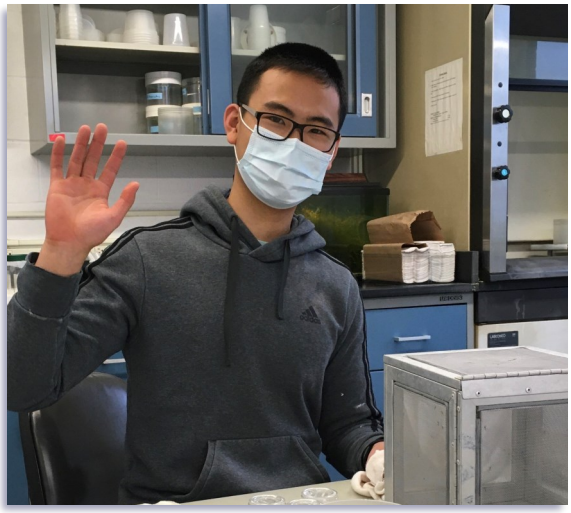
Karmous, I., Jbahi, S., Mhadhbi, M., Raouafi, A., Jarray, F., Chaoui, A., **Elmer, W. H.** Interactive effects of salinity with zinc oxide and copper oxide nanoparticles (ZnO NP and CuO NP) on *Pisum sativum* L. germination and growth. *Agronomy for Sustainable Development*.

Liao, Y.-C.-Z., Zhang, M.-Y., Chen, Y., **Li, D.-W.**, Sun, H., Zhu, L.-H. First report of *Erysiphe magnoliicola* causing powdery mildew of *Magnolia* x *soulangeana* in China. *Plant Disease*.

Nieves, J. M., **Ward, J. S.**, Royo, A. A., McDill, M. E., Kreye, J. K., Steiner, K. M. Stand and site characteristics affect the probability of stump sprouting in some eastern North American hardwoods. *Forest Ecology and Management*.

Sigmund, G., Arp, H. P. H., Aumeier, B. M., Bucheli, T. D., Chefetz, B., Chen, W., Droge, S. T. J., Endo, S., Escher, B. I., Hale, S. E., Hofmann, T., **Pignatello, J.**, Reemtsma, T., Schmidt, T. C., Schönsee, C. D., Scheringer, M. How to confront and overcome limitations in the assessment of sorption and mobility of charged organic compounds. *Water Research*.

NEW STUDENTS, STAFF, AND VOLUNTEERS JANUARY 2022



DANIEL LIU is an 11th grade student at Amity Regional High School and has been conducting experiments under the supervision of **John Shepard** in the Department of Environmental Sciences. Daniel is investigating the attraction of male and female *Aedes aegypti* to various sound frequencies for his project, "Creating and Testing a Frequency-Emitting Program to Bolster the Efficacy of Mosquito Traps and Enhance Mosquito Surveillance and Control Efforts." These experiments are being conducted in conjunction with the Amity Science Research Program. Daniel will enter his project into the Connecticut Science and Engineering Fair. Daniel is planning to study biology in college beginning in the fall of 2023. At Amity, he is captain of the cross-county team and an active member of the Debate Team.

KAROL ALVES BARROSO, a Ph.D. student in the Department of Agronomic and Forestry Sciences at the Universidade Federal Rural do Semiárido in Brazil, joined the da Silva Lab as an intern. Under the guidance of **Dr. Washington da Silva**, she will work on screening potential nanoparticles to suppress potato virus Y.

DR. ITAMAR SHABTAI joined the Station in January 2022 as an Assistant Scientist II in the Department of Environmental Sciences. He completed his PhD at the Hebrew University of Jerusalem, where he designed clay-polymer nanocomposite sorbents that remove organic contaminants from wastewater. As a post-doctoral associate at Cornell University Dr. Shabtai researched organo-mineral interactions in soil and how they affect soil organic carbon stabilization. Current projects focus on understanding how plant root exudation at different soil moisture levels impact soil cycling in the rhizosphere – the interface between soil and roots. Globally, soils contain more organic carbon than the atmosphere and terrestrial plants combined. Therefore, managing soil organic carbon stocks has hugely important agricultural and climatic implications. At The CAES, Dr. Shabtai's research will explore the impacts of agriculture on the environment, with specific focus on soil carbon and nutrient cycling.

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