Station News

The Connecticut Agricultural Experiment Station
Volume 14 Issue 2 | February 2024

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., Trung Bui, Ph.D.,** and **JASMINE JONES** participated in a Zoom meeting with collaborators at Yale University and the University of Minnesota for a joint NIEHS grant (January 2); met by Teams with staff of The Mosaic Company to discuss collaborative work (January 2); met by Teams with Department of Consumer Protection Division of Drug Control to discuss testing within the Adult Use Cannabis program (January 3); met by Zoom with a colleague at the University of Minnesota to discuss a collaboration with Land o' Lakes (January 3); along with **CHRISTIAN DIMKPA, PH.D.** and **SHITAL VAIDYA, PH.D.,** hosted a Zoom call with collaborators at Johns Hopkins University to discuss progress on a joint USDA nanoscale phosphorus project (January 4, 16, & 30); participated in the USFA NIFA Closer to Zero working group and providing a briefing on CAES activity (January 4); attended the monthly Laboratory Preparedness Advisory Committee (LPAC) meeting at the Department of Public Health (January 8); along with **NUBIA ZUVERZA-MENA, PH.D., Mandeep Kaur, Ph.D.,** and **Trung Bui, Ph.D.** participated in a monthly group meeting with collaborators at Rutgers University and the New Jersey Institute of Technology (NJIT) and discussed joint research on micro-nanoplastics in agricultural soils (January 8); along with **SARA NASON, PH.D.** and **JASMINE JONES** participated in the monthly PFAS testing Teams call (January 9); hosted the monthly CSN Nanochem-plant working group call (January 9); participated in the weekly NSF Center for Sustainable Nanotechnology (CSN) all hands call (January 10 & 31); participated by Zoom in the bi-monthly faculty call for the NSF (CSN) (January 12 & 26); along with **CHRISTIAN DIMKPA, PH.D.,** participated in the inaugural American National Standards Institute (ANSI) web meeting to develop protocols for the safety assessment of nanomaterials as fertilizers (January 16); met by Teams with a staff member from Congresswoman Rosa DeLauro's office to discuss the Closer-to-Zero program of USDA and FDA (January 16); participated in a USDA AFRI project meeting with collaborators at Columbia University and the University of California Santa Barbara (January 16); along with **MICHAEL LAST** and **LINDSAY TRIPLETT, PH.D.,** hosted the first quarter meeting of the CAES Board of Control at the CT Farm Bureau (January 17); attended the 6th International Conference on Agriculture for Sustainable Development at the National Rice Research Institute in Cuttack India and gave a presentation titled "Nanobiotechnology based strategies for enhanced crop stress resilience" (January 17-24); met with the Commissioner Bryan Hurlburt of the Department of Agriculture to discuss PFAS testing in farm soils (January 29); participated in a Teams call with staff from the National Nanotechnology Coordination Office to discuss an upcoming webinar (January 30); and hosted the CAES J-Visa Recipient meeting (January 31).

PUBLICATIONS:

1. Steven, B., Hassani, M. A., LaReau, J., Wang, Y., and White, J. C. (2024). Nanoscale sulfur alters the bacterial and eukaryotic communities of the tomato rhizosphere and their interactions with a fungal pathogen. *NanoImpact*, *33*, 100495. DOI : 10.1016/j.impact.2024.100495

Abstract: Arsenic (As) contamination in food and water has been linked to cancer and threatens human health. Rice is the daily staple food for more than half of the world's population, and the innate ability for this crop to accumulate As make it a major exposure route

via ingestion, especially inorganic As (iAs). Gaining knowledge of As transporters is essential for developing As-free rice. Here, we report that OsPIP2;6, a member of rice plasma membrane intrinsic proteins (PIPs) subfamily of aquaporins, contributes to root-to-shoot As translocation. Suppressing the expression of OsPIP2;6 by an RNAi approach leads to a significant (35-65%) decrease in As accumulation in rice seedling shoots, whereas no significant change was observed in arsenic levels in the roots. Conversely, overexpression of OsPIP2;6 results in 15-76% higher arsenic accumulation in the shoots, with no effect on root As content compared to the wild type. At maturity, RNAi suppression of OsPIP2;6 expression led to a considerable decrease (19-26%) in shoot As accumulation of RNAi lines. The As content of flag leaves and grains were 16% lower but the reduction was not statistically significant compared to the wild type plants. In mature plants, the overexpression of OsPIP2;6 increased accumulation of arsenic in the shoots and flag leaves by 31-46% and 35%, respectively, but did not cause a noticeable change in the arsenic content of the rice grain. Importantly, OsPIP2;6 is expressed in both roots and shoots, although transcript abundance is 3-fold higher in the shoots. Studies focused on the tissue-specific expression of OsPIP2;6 via GUS localization revealed that it is present in the vascular tissues of both roots and shoots. Collectively, our results show that OsPIP2;6 is involved in root-to-shoot translocation of As due to its specific localization to the vascular tissue of the roots and leaves. This knowledge will help in developing breeding programs to limit As accumulation in rice and other food crops for food safety, as well in phytoremediation strategies for As-contaminated soils and water.

2. Meselhy, A.G., Mosa, K., Kumar, K., **Musante, C., White, J. C**., and Parkash Dhankher, O. (2024). Rice plasma membrane intrinsic protein OsPIP2;6 is involved in root-to-shoot arsenic translocation in rice (*Oryza sativa* L.). *Plant Cell Rep.* DOI: 10.1007/s00299-024-03157-3

Abstract: Arsenic (As) contamination in food and water has been linked to cancer and threatens human health. Rice is the daily staple food for more than half of the world's population, and the innate ability for this crop to accumulate As make it a major exposure route via ingestion, especially inorganic As (iAs). Gaining knowledge of As transporters is essential for developing As-free rice. Here, we report that OsPIP2;6, a member of rice plasma membrane intrinsic proteins (PIPs) subfamily of aquaporins, contributes to root-to-shoot As translocation. Suppressing the expression of OsPIP2;6 by an RNAi approach leads to a significant (35-65%) decrease in As accumulation in rice seedling shoots, whereas no significant change was observed in arsenic levels in the roots. Conversely, overexpression of OsPIP2;6 results in 15-76% higher arsenic accumulation in the shoots, with no effect on root As content compared to the wild type. At maturity, RNAi suppression of OsPIP2;6 expression led to a considerable decrease (19-26%) in shoot As accumulation of RNAi lines. The As content of flag leaves and grains were 16% lower but the reduction was not statistically significant compared to the wild type plants. In mature plants, the overexpression of OsPIP2;6 increased accumulation of arsenic in the shoots and flag leaves by 31-46% and 35%, respectively, but did not cause a noticeable change in the arsenic content of the rice grain. Importantly, OsPIP2;6 is expressed in both roots and shoots, although transcript abundance is 3-fold higher in the shoots. Studies focused on the tissue-specific expression of OsPIP2;6 via GUS localization revealed that it is present in the vascular tissues of both roots and shoots. Collectively, our results show that OsPIP2;6 is involved in root-to-shoot translocation of As due to its specific localization to the vascular tissue of the roots and

leaves. This knowledge will help in developing breeding programs to limit As accumulation in rice and other food crops for food safety, as well in phytoremediation strategies for As-contaminated soils and water.

3. Li, M.; Zhang, P.; Guo, Z.; Cao, W.; Gao, L.; Li, Y.; **White, J.C.;** Rui, Y.; Lynch, I. (2024). Dynamic transformation of nano-MoS2 in soil-plant system empower its multifunctionality on soybean growth. *Environ. Sci. Technol.* DOI: https://doi.org/10.1021/acs.est.3c09004.

Abstract: Molybdenum disulfide (nano-MoS2) nanomaterials have shown great potential for biomedical and catalytic applications due to their unique enzyme-mimicking properties. However, their potential agricultural applications have been largely unexplored. A key factor prior to the application of nano-MoS2 in agriculture is understanding its behavior in a complex soil–plant system, particularly in terms of its transformation. Here, we investigate the distribution and transformation of two types of nano-MoS2 (MoS2 nanoparticles and MoS2 nanosheets) in a soil–soybean system through a combination of synchrotron radiation -based X-ray absorption near-edge spectroscopy (XANES) and single-particle inductively coupled plasma mass spectrometry (SP-ICP-MS). We found that MoS2 nanoparticles (NPs) transform dynamically in soil and plant tissues, releasing molybdenum (Mo) and sulfur (S) that can be incorporated gradually into the key enzymes involved in nitrogen metabolism and the antioxidant system, while the rest remain intact and act as nanozymes. Notably, there is 247.9 mg/kg of organic Mo in the nodule, while there is only 49.9 mg/kg of MoS2 NPs. This study demonstrates that it is the transformation that leads to the multifunctionality of MoS2, which can improve the biological nitrogen fixation (BNF) and growth. Therefore, MoS2 NPs enable a 30% increase in yield compared to the traditional molybdenum fertilizer (Na2MoO4). Excessive transformation of MoS2 nanosheets (NS) leads to the overaccumulation of Mo and sulfate in the plant, which damages the nodule function and yield. The study highlights the importance of understanding the transformation of nanomaterials for agricultural applications in future studies.

4. Bui, T. H., Zuverza-Mena, N., Dimkpa, C. O., Nason, S. L., Thomas, S., and **White, J. C**. (2024). PFAS remediation in soil: A evaluation of carbon-based materials for contaminant sequestration. *Environ. Poll*. *344*, 123335. DOI: 10.1016/j.envpol.2024.123335

Abstract: The presence of per- and poly-fluoroalkyl substances (PFAS) in soils is a global concern as these emerging contaminants are highly resistant to degradation and cause adverse effects on human and environmental health at very low concentrations. Sequestering PFAS in soils using carbon-based materials is a low-cost and effective strategy to minimize pollutant bioavailability and exposure, and may offer potential long-term remediation of PFAS in the environment. This paper provides a comprehensive evaluation of current insights on sequestration of PFAS in soil using carbon-based sorbents. Hydrophobic effects originating from fluorinated carbon (C–F) backbone “tail” and electrostatic interactions deriving from functional groups on the molecules’ “head” are the two driving forces governing PFAS sorption. Consequently, varying C–F chain lengths and polar functional groups significantly alter PFAS availability and leachability. Furthermore, matrix parameters such as soil organic matter, inorganic minerals, and pH significantly impact PFAS sequestration by sorbent amendments. Materials such as activated carbon, biochar, carbon nanotubes, and

their composites are the primary C-based materials used for PFAS adsorption. Importantly, modifying the carbon structural and surface chemistry is essential for increasing the active sorption sites and for strengthening interactions with PFAS. This review evaluates current literature, identifies knowledge gaps in current remediation technologies and addresses future strategies on the sequestration of PFAS in contaminated soil using sustainable novel C-based sorbents.

5. Nason, S., Thomas, S., Stanley, C., Silliboy, R., Blumenthal, M., Zhang, W., Liang, Y., **Jones, J., Zuverza-Mena, N., White, J. C**., Haynes, C., Vasiliou, V., and Berger, B. (2024). A comprehensive trial on PFAS remediation: Hemp phytoremediation and PFAS degradation in harvested plants. *Environ. Sci.: Advances*, *3*, 304-313. DOI: 10.1016/j.envpol.2024.123335

Abstract: Per- and polyfluoroalkyl substances (PFAS) are a class of recalcitrant, highly toxic contaminants, with limited remediation options. Phytoremediation – removal of contaminants using plants – is an inexpensive, community-friendly strategy for reducing PFAS concentrations and exposures. This project is a collaboration between the Mi'kmaq Nation, Upland Grassroots, and researchers at several institutions who conducted phytoremediation field trials using hemp to remove PFAS from soil at the former Loring Air Force base, which has now been returned to the Mi'kmaq Nation. PFAS were analyzed in paired hemp and soil samples using targeted and non-targeted analytical approaches. Additionally, we used hydrothermal liquefaction (HTL) to degrade PFAS in the harvested hemp tissue. We identified 28 PFAS in soil and found hemp uptake of 10 of these PFAS. Consistent with previous studies, hemp exhibited greater bioconcentration for carboxylic acids compared to sulfonic acids, and for shorter-chain compounds compared to longer-chain. In total, approximately 1.4 mg of PFAS was removed from the soil via uptake into hemp stems and leaves, with an approximate maximum of 2% PFAS removed from soil in the most successful area. Degradation of PFAS by HTL was nearly 100% for carboxylic acids, but a portion of sulfonic acids remained. HTL also decreased precursor PFAS and extractable organic fluorine. In conclusion, while hemp phytoremediation does not currently offer a comprehensive solution for PFAS-contaminated soil, this project has effectively reduced PFAS levels at the Loring site and underscores the importance of involving community members in research aimed at remediating their lands.

OTHER DEPARTMENTAL NEWS:

JASON C. WHITE, PH.D. at the 6th International Conference on Agriculture for Sustainable Development at the National Rice Research Institute in Cuttack India

ANALYTICAL CHEMISTRY

Mohamed Jaouahar joined the Department of Analytical Chemistry as a visiting researcher in January 2024. He is a 3rd year Ph.D. student in the Material Science, Energy, and Nanoengineering (MSN) Department at the Mohammed VI Polytechnic University (UM6P), Morocco. His expertise focuses on the study, extraction, and chemical modification of nano-biopolymers, specifically for agricultural applications. His research primarily centers on extracting cellulose microfibers from various plants and enhancing them chemically to create diverse functionalized nanocellulose for agricultural applications. Mohamed's academic history includes a MS degree in Fertilizer Sciences and Technology from ESAFE/UM6P and a M.Eng. degree in industrial engineering (ESITH, Morocco). While at CAES, Mohamed will explore the impact of nanocellulose enriched with selected micronutrients on enhancing plant (wheat) resistance to drought and salinity.

Mandeep Kaur, Ph.D. joined the Department of Analytical Chemistry in January as an Agricultural postdoctoral scientist. She holds MS, M. Phil and Ph.D. degrees in Environmental Science from Guru Nanak Dev University, India Later, she joined as a postdoc fellow in the College of Geography and Environment Science, Henan University, China for two years where she worked on toxicity of microplastics on food crops. Mandeep Kaur, Ph.D. has expertise on the detection of different environmental pollutants like microplastics, heavy metals, pesticides; and their toxicity in soil and plant (roadside plants, crops) ecosystems. Also, she possesses expertise in the estimation of geno-toxicity of EPs like heavy metals in plants as well as their fate and accumulation in different parts of plants. Additionally, she is experienced in the estimation of air pollution tolerance index of roadside plants; pollen grain study; green belt designing; soil assessment for their physiochemical parameters, nutrient status and microbial abundances. She has research experience of 8 years, and the findings of her research work have been published in referred journals. To date, she has published 27 papers including research papers/review articles/book chapters with a total of 500 citations and H-index-10. Also, she has 2 years' experience in teaching Environmental science to graduates' students at college level. Dr. Mandeep Kaur has enthusiastically participated in many International and National conferences and won various best PPT./poster awards. She has been awarded as the best Young Scientist in Environmental Sciences, 2019 in India. At CAES, Mandeep will work on "uptake and effects of micro-nanomaterials (NM) in agriculture and food crops via hydroponics".

ENTOMOLOGY

GOUDARZ MOLAEI, PH.D. met with the Dean of the College of Science and Society, the head of the Department of Biology, and faculty at the University of Bridgeport and discussed internship and research opportunities at the CAES Center for Vector Biology & Zoonotic Diseases for their students and faculty (January 5); was interviewed with the CT Examiner about tick and tick-borne diseases (January 11); participated in the Northeast Regional Center of Excellence in Vector-Borne Diseases (NEVBD) and Training and Evaluation Center (TEC) Leadership Meeting to discuss the Academic Training Program (January 16); met with four MPH students of EPH 555 project group and a faculty from the Yale School of Public Health and discussed a research project, "Barriers to Engagement in Passive Tick and Tick-borne Disease Surveillance Program in Connecticut" (January 22); and attended the quarterly meeting of the New England Center of Excellence in Vector-Borne Diseases (NEWVEC) and discussed the projects' updates and progress (January 29).

TIA M. BLEVINS attended the Connecticut Tree Protective Association's (CTPA) 102nd annual meeting held in Plantsville, CT (January 18); and attended the two-day Winter Symposium of the Connecticut Nursery & Landscape Association held in Plantsville, CT (January 24-25).

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

KELSEY E. FISHER, PH.D. met with the CAES Pollinator Advisory Committee (January 4); attended the UConn extension Vegetable and Fruit Growers conference (January 9); attended the USDA Spotted Lanternfly Research Virtual Discussion (January 18); attended the CT Entomological Society meeting (January 19); attended and presented on work related to European corn borer to subject experts at the multistate NC246: Ecology and Management of Arthropods in Corn annual working group meeting in Savannah, GA (January 22-25).

ANDREA GLORIA-SORIA, PH.D. attended the Second Annual Vector-Borne and Zoonotic Diseases Symposium at the Yale School of Public Health (January 12): gave an invited talk, "The invasion history of the yellow fever mosquito, *Aedes aegypti*" at Texas Tech Biology Department weekly seminar series (January 31)

MEGAN LINSKE, PH.D. participated in a meeting with the Deer-Targeted Tick Control Working Group (January 10); participated in the Leadership Institute Committee meeting as Co-Chair (January 11); participated in the Northeast Regional Center of Excellence in Vector -Borne Diseases (NEVBD) and Training and Evaluation Center (TEC) Leadership Meeting to discuss the Academic Training Program (January 16); participated in a call with staff from the Centers for Disease Control and Prevention (CDC) Division of Vector-Borne Diseases on progress made on a funded integrated tick management project (January 17); participated in a meeting with Genesis Lab, Inc. to discuss current and future research on host-targeted tick management strategies (January 18); participated in a meeting with Banfield Bio, Inc. and North Carolina State University to discuss updates in field and laboratory trials (January 24).

JACOB RICKER attended the CT Nursery and Landscape Association's 2024 Winter Symposium where he presented "Box Tree Moth: Scouting and Monitoring" and graduated from the CT Accredited Nursery Professional program receiving his certificate of accreditation

(January 24).

GALE RIDGE, PH.D. delivered a virtual talk on bed bugs to the Connecticut Hospital Association (January 3); presented a talk at the University of Connecticut in Storrs, to the Connecticut Entomological Society about Delusional Infestation (January 19); and presented a virtual talk about bed bugs to the Region 1 Ledge Light Health District and Senior Center Network (January 25).

CLAIRE RUTLEDGE, PH.D. presented a talk titled "Spotted Lanternfly in Connecticut" to the Small Fruit and Vegetable Conference at the University of Connecticut, in Storrs (January 7); presented a talk titled "Small trees get eaten too: Insects attacking trees" to the Greater New Haven Bonsai Society, New Haven, CT (January 7); and presented the keynote talk "Hope for Connecticut Ash Trees" at the Connecticut Tree Protective Association's Annual Meeting, Farmington, CT (January 18).

VICTORIA SMITH, PH.D. attended the National Plant Disease Diagnostic Network/ Boxwood Blight Insight Group symposium on boxwood blight (virtual) (January 17); attended the winter meeting of the Connecticut Tree Protective Association, held at the Aqua-Turf in Southington (January 18); participated in SiteOne University, with a presentation titled "Spotted Lanternfly and Box Tree Moth: BOLO", held at The Waters Edge in Darien (January 23); participated in SiteOne University, with a presentation titled "Spotted Lanternfly and Box Tree Moth: BOLO", held at Casa Mia at the Hawthorn in Berlin (January 24); participated in the Connecticut Nursery and Landscape Association Winter Symposium, with a presentation titled " CAES Update: Spotted Lanternfly and Box Tree Moth", held at the Aqua-Turf in Southington (January 25); attended the University of Connecticut Extension Bedding Plant Meeting, held in the Jones Auditorium (January 30).

TRACY ZARRILLO was visited by Ms. Casey Johnson and Ms. Emma Tondre of the University of Rhode Island to provide instruction on native bee identification (January 11); attended an online wasp identification course given by the Frost Entomological Museum, Pennsylvania State University (January 15-26); participated in a virtual meeting with Dr. Neil Cobb of the Biodiversity Outreach Network to discuss the 'Tropics to Tundra' wild bee project (January 28); and was invited by Dr. Marta Wells of Yale University to mentor an undergraduate student who is interested in doing pollinator research (January 30).

KIMBERLY STONER, PH.D. (Emeritus) spoke about the CT Environmental Rights Amendment at the Seabury Retirement Community in Bloomfield (December 2); participated in a forum on natural resource concerns led by the Coastal CT Conservation District and the Natural Resources Conservation Service at the DeKoven House in Middletown (December 5); participated in another forum on natural resource concerns at the Milford Public Library (December 6); and toured the Tantaquidgeon Museum in Uncasville and the Mashantucket Pequot Farm in Ledyard with a group from the CT Farm to School program (December 8).

NEW STUDENTS, STAFF, AND VOLUNTEERS:

AUSTIN VITELLI has joined the Inspection and Regulation Group as the Cooperative Agricultural Pest Survey State Survey Coordinator. Austin is no stranger to CAES, having worked several positions as a temporary worker or summer assistant, most recently in the CAPS program in 2023. Previously, Austin worked in the Branford School System and at Madison Earth Care.

Jacob Ricker receiving his CT Nursery Professional accreditation (January 24, 2024).

Emily Newton is a senior at the University of New Haven, studying to complete her bachelor's in forensic science with a focus in biology and the intent to get her master's in molecular biology with a minor in entomology at Rutgers University in New Jersey. She is currently writing a thesis focused on the application of mosquitoes to forensic science technology. At CAES, under the guidance of Dr. Andrea Gloria-Soria and Dr. David Giesbrecht, she is researching the use of PCR and Oxford Nanopore Technology to amplify, sequence, and develop STR profiles of the blood meals of locally sourced Culex Pipiens to be compared to a reference library for identification.

ENVIRONMENTAL SCIENCE AND FORESTRY

SCOTT WILLIAMS, PH.D. 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 (January 10); participated in a working group Zoom meeting on rodenticide use and possible negative repercussions due to effects from biomagnification in higher order predators (January 12); as the Northeast Section Representative, participated in a Zoom call for members of the Professional Certification Review Board of The Wildlife Society (January 16); participated in a Zoom meeting of the Centers for Disease Control and Prevention-funded Teaching & Evaluation Center leadership meeting (January 16); participated in an invited round table discussion on invasive species management with land managers, stewards, and practitioners from throughout Massachusetts at the Norcross Wildlife Foundation Headquarters in Wales, MA (January 17); participated in a conference call with staff from Genesis Laboratories, Inc. about progress on several collaborative research projects (January 18); participated in a collaborative Zoom call with members of the Banfield Biologic NIH SBIR-funded tick repellent fabric team (January 24).

JOSEPH P. BARSKY was elected to serve a three-year term on New England Society of American Foresters Board of Directors (January 1); participated in a QGIS training workshop at the University of Connecticut, Storrs (January 4); participated, as chair-elect, in the New England Society of American Foresters Board of Directors quarterly meeting (January 16);

attended the Connecticut Tree Protective Association Annual Winter Meeting (January 18).

GREGORY BUGBEE with **SUMMER STEBBINS** gave two Invasive Aquatic Plants Workshops at the Envirothon at Goodwin College (50 attendees) (January 13);

staffed the CAES OAIS booth at the CT Boat Show at Mohegan Sun (January 20); gave an update on “CAES OAIS and *Hydrilla* in the CT River” at a virtual meeting sponsored by the Connecticut River Conservancy (30 attendees) (January 29).

RILEY DOHERTY attended the Northeast Aquatic Plant Management Society Conference in Portsmouth, NH (January 9-11); hosted a CAES Office of Aquatic Invasive Species informational table at the Hartford Boat Show (January 19).

JEREMIAH FOLEY, IV, PH.D. presented a talk voted “most liked” at the Northeastern Aquatic Plant Management Society titled, “The Spread and Establishment of Connecticut River *Hydrilla* Outside of the Connecticut River” in Portsmouth, NH (250 attendees) (January 10); hosted a CAES informational booth at the Hartford Boat Show at Mohegan Sun representing the Office of Aquatic Invasive Species (January 19); onboarded Brian Hynes, an undergraduate from Quinnipiac University, as an intern (January 22).

SUSANNA KERIÖ, PH.D. presented a research poster titled, "Association of hardscape and site factors with street tree condition in New Haven, Connecticut" at the USDA Interagency Research Forum on Invasive Species in Annapolis, MD (January 9-12); participated in the CT Tree Protective Association's winter meeting and staffed the CAES informational booth (January 18); as Executive Secretary, attended the Executive Committee meeting of the Con-

necticut Urban Forest Council (January 25).

SARA NASON, PH.D. became vice-chair of the Best Practices for Non-Targeted Analysis working group and participated in several meetings (January 3, 4, 9, 11, 16, & 29); participated in the CT PFAS testing Laboratory Capacity and Capability discussion group meeting (January 9); met with colleagues from the CT Public Health Laboratory to discuss a new collaborative project on opioids (January 17).

ITAMAR SHABTAI, PH.D. met with collaborators at the Technical University of Munich to discuss ongoing NanoSIMS measurements and data analysis (January 9); held a Zoom meeting with colleagues from several institutions to discuss writing a collaborative perspective article (January 22); met with a colleague from the Hebrew University of Jerusalem to discuss a shared proposal for user access to the Canadian Light Source synchrotron (January 25).

ELISABETH WARD, PH.D. met with Jack Hatajik, Marlyse Duguid, Ph.D., and Sara Kuebbing, Ph.D. (The Forest School, Yale School of the Environment) to discuss a collaborative project on the effects of ash mortality from Emerald Ash Borer on understory plant composition and tree regeneration (January 24); met with Brad Oberle, Ph.D. (New York Botanical Garden) to discuss collaborative grant opportunities to analyze the benefits of urban afforestation projects using a long-term experiment (January 25).

JEFFREY WARD, PH.D. (attended a QGIS Workshop hosted by CT Society of American Foresters, CT DEEP, and UConn in Storrs (January 4); attended the Connecticut Tree Protective Association annual meeting in Plantsville (January 18); participated in a Connecticut Forest and Park Association (CFPA) Board of Directors meeting (January 24).

LEIGH WHITTINGHILL, PH.D. assisted with running the CT Vegetable and Small Fruit conference (January 9); discussed her green roof research and the upcoming 20th anniversary Green Roofs for Healthy Cities Annual Cities Alive Conference with Stephen Peck (January 10); attended the quarterly CT Council on Soil and Water Conservation meeting as the CAES representative (January 25).

YINGXUE (CHARLIE) YU, PH.D. presented a lecture titled, "Fate and transport of emerging contaminants: Micro- and nanoplastics and more" at the 2024 W4188 Multi-State Hatch Meeting at the Desert Research Institute in Las Vegas, NV (50 attendees) (January 3–5); met with collaborators from Washington State University to discuss a future grant proposal titled, "Co-transport of micro/nanoplastics and PFAS through variably saturated porous media" (January 7); presented lecture titled, "Biodegradable plastic mulch for specialty crop production" at the UConn Extension Vegetable & Small Fruit Growers' Conference at University of Connecticut (100 attendees) (January 9); met with collaborators from New Mexico State University and Washington State University to discuss a joint DOE grant proposal on transport of micro/nanoplastics and PFAS (January 29).

AWARDS, GRANTS, AND RECOGNITIONS:

BLAIRE STEVEN, PH.D. was recognized with an Extraordinary Service Award by the American Society of Microbiology (ASM). The announcement was made January 23 and acknowledged his work as an editor for the journal *Microbiology Spectrum* as well as to the local organizing committee of the Connecticut Valley branch of the ASM. As part of the award, Dr. Steven will receive a free publication in an ASM journal and a recognition at the ASM Microbe meeting in Atlanta, Georgia during the editors meeting. Established in 1899,

ASM is a scientific society of 36,000 members and ASM Journals publish 26% of all microbiology articles and contribute 44% of all microbiology citations.

ELISABETH WARD, PH.D. received $50,000 from the USDA Forest Service Forest Stewardship Program and the Department of Energy and Environmental Protection Forestry Division to use long-term data from CAES plots for a project titled "Stand level measurements for carbon sequestration." The project will analyze the effects of different forest harvesting practices on aboveground carbon storage and sequestration.

LEIGH WHITTINGHILL, PH.D. was the recipient of the Green Roofs for Healthy Cities Jeffery L. Bruce Award of Excellence in Research. This annual award recognizes excellent work in several categories of green roof design/research by established scientists, masters, and doctoral students as well as civic engagement in policy affecting the industry. Announcement of the award was made on January 6th and more information can be found here. Dr. Whittinghill received this award for her work on the use of green roof technology to produce vegetables in shallow media depths, monitoring of stormwater runoff on a working rooftop farm, and controlled examination of the effects of annual compost addition on crop yields, nutrient leaching, and green roof media properties.

SUMMER STEBBINS received a Special Recognition Award at the Northeast Aquatic Plant Management Society meeting in Portsmouth, NH for her "long-term coordination of Continuing Education Units for Society annual meetings and webinars, and her willingness to present at Society annual meetings. The Society is grateful for Summer's expertise on GIS and other mapping technologies, her willingness to share that knowledge and her work tracking Connecticut River *Hydrilla* distribution and density, and her significant contributions to Connecticut Plant Camp 2023. The Society is pleased to recognize Summer Stebbins with this Special Recognition Award for her many contributions in support of the Northeast Aquatic Plant Management Society."

PUBLICATIONS:

1.Yu, Y., Velandia, M., Hayes, D. G., De Vetter, L. W., Miles, C. A., and Flury, M. (2024). Biodegradable plastics as alternatives for polyethylene mulch films. *Adv. Agron. 183*. DOI: 10.1016/bs.agron.2023.10.003

Abstract: Plastic mulching is a critical agricultural practice for food production, which provides multiple benefits, including water conservation, weed control, and increased crop yield and quality. However, the application of conventional polyethylene mulch films has led to plastic pollution in the terrestrial environment because mulch residues in fields are difficult to remove and recycle. To address this issue, soil-biodegradable plastic mulch (BDM) films have been introduced to replace conventional polyethylene mulch films, as BDM films are designed to provide desired agronomic outcomes as well as in-situ disposal and degradation. Thus, increasing interests have been expressed toward BDM films in both research and application areas. In this review, we summarize and synthesize current knowledge about BDM films, regarding the history, definition and use, in-field degradation, agronomic performance, environmental impacts, and economic feasibility. In-field research suggests that BDMs show satisfactory agronomical performance but vary considerably in biodegradability among different products and environmental conditions, and generally do not impair soil health. However, laboratory studies indicate that BDMs may negatively impact terrestrial and aquatic ecosystems. Overall, current data indicate that BDMs are a promising alternative of conventional polyethylene

mulch films. Questions remain about in-field biodegradation, potential accumulation of BDM residues in soils, release of nonbiodegradable additives, and off-site transport of biodegradable plastic residues (including micro- and nanoplastics) to air and water. We provide recommendations to address these questions and challenges to ensure safe and sustainable use of BDM films in agriculture.

2.Welker, L., **Ward, E. B.**, Bradford, M. A., and Ferraro, K. M. (2024). Plant functional type shapes nitrogen availability in a regenerating forest. *Plant and Soil*. DOI: 10.1007/s11104-024-06483-3

Abstract: *Background and aims:* In mature forests, tree and shrub mycorrhizal associations integrate plant and fungal functional traits, making these relationships important controls on soil nitrogen availability. Whether these plant-fungal effects are observed in forests during early succession following disturbances is largely unexplored. We quantify differences in soil nitrogen availability under an ectomycorrhizal tree (*Betula lenta*) and an ericoid mycorrhizal shrub (*Kalmia latifolia*) and explore the potential for known mechanisms, such as the availability of soil carbon, to explain the patterns observed.

3. Steven, B., Hassani, M. A., LaReau, J. C., Wang, Y., and **White, J. C.** (2024). Nanoscale sulfur alters the bacterial and eukaryotic communities of the tomato rhizosphere and their interactions with a fungal pathogen. *NanoImpact*, *33*. DOI: 10.1016/j.impact.2024.100495

Abstract: Nanoformulations of sulfur have demonstrated the potential to enhance plant growth and reduce disease incidence when plants are confronted with pathogens. However, the impact of nanoscale sulfur on microbial communities in close contact with the plant root, known as the rhizosphere, remain poorly characterized. In this study, we investigate the impact of three formulations of sulfur; bulk sulfur, uncoated (pristine) sulfur nanoparticles, and stearic acid coated sulfur nanoparticles, on the rhizosphere of tomato plants. Tomato plants were additionally challenged by the pathogenic fungus *Fusarium oxysporum f. sp. Lycopersici*. Employing bacterial 16S rRNA gene sequencing, along with recently in-house designed peptide nucleic acid clamps to facilitate the recovery of microeukaryote sequences, we performed a comprehensive survey of rhizosphere microbial populations. We found the largest influence on the composition of the rhizosphere microbiome was the presence of the fungal pathogen. However, sulfur amendments also drove state changes in the rhizosphere populations; for example, enriching the relative abundance of the plant-beneficial sulfur-oxidizing bacterium *Thiobacillus*. Notably, when investigating the response of the rhizosphere community to the different sulfur amendments, there was a strong interaction between the fungal pathogen and sulfur treatments. This resulted in different bacterial and eukaryotic taxa being enriched in association with the different forms of sulfur, which was dependent on the presence of the pathogen. These data point to nano formulations of sulfur exerting unique shifts in the rhizosphere community compared to bulk sulfur, particularly in association with a plant pathogen, and have implications for the sustainable use of nanoscale strategies in sustainable agriculture.

4. Nason, S., Thomas, S., Stanley, C., Silliboy, R., Blumenthal, M., Zhang, W., Liang, Y., **Jones, J., Zuverza-Mena, N., White**, **J.,** Haynes, C., Vasiliou, V., Timko, M., and Berger, B. (2024). A comprehensive trial on PFAS remediation: hemp phytoextraction and PFAS degradation in harvested plants. *Environmental Science Advances.* DOI: 10.1039/D3VA00340J

Abstract: Per- and polyfluoroalkyl substances (PFAS) are a class of recalcitrant, highly toxic contaminants, with limited remediation options. Phytoremediation – removal of contaminants using plants – is an inexpensive, community-friendly strategy for reducing PFAS concentrations and exposures. This project is a collaboration between the Mi'kmaq Nation, Upland Grassroots, and researchers at several institutions who conducted phytoremediation field trials using hemp to remove PFAS from soil at the former Loring Air Force base, which has now been returned to the Mi'kmaq Nation. PFAS were analyzed in paired hemp and soil samples using targeted and non-targeted analytical approaches. Additionally, we used hydrothermal liquefaction (HTL) to degrade PFAS in the harvested hemp tissue. We identified 28 PFAS in soil and found hemp uptake of 10 of these PFAS. Consistent with previous studies, hemp exhibited greater bioconcentration for carboxylic acids compared to sulfonic acids, and for shorter-chain compounds compared to longer-chain. In total, approximately 1.4 mg of PFAS was removed from the soil via uptake into hemp stems and leaves, with an approximate maximum of 2% PFAS removed from soil in the most successful area. Degradation of PFAS by HTL was nearly 100% for carboxylic acids, but a portion of sulfonic acids remained. HTL also decreased precursor PFAS and extractable organic fluorine. In conclusion, while hemp phytoremediation does not currently offer a comprehensive solution for PFAS-contaminated soil, this project has effectively reduced PFAS levels at the Loring site and underscores the importance of involving community members in research aimed at remediating their lands.

5. Bui, T. H., Zuverza-Mena, N., Dimkpa, C. O., Nason, S. L., Thomas, S., and **White J. C.** (2024). PFAS remediation in soil: An evaluation of carbon-based materials for contaminant sequestration. *Environmental Pollution*, *344*(1). DOI: 10.1016/j.envpol.2024.123335

Abstract: The presence of per- and poly-fluoroalkyl substances (PFAS) in soils is a global concern as these emerging contaminants are highly resistant to degradation and cause adverse effects on human and environmental health at very low concentrations. Sequestering PFAS in soils using carbon-based materials is a low-cost and effective strategy to minimize pollutant bioavailability and exposure, and may offer potential long-term remediation of PFAS in the environment. This paper provides a comprehensive evaluation of current insights on sequestration of PFAS in soil using carbon-based sorbents. Hydrophobic effects originating from fluorinated carbon (C–F) backbone "tail" and electrostatic interactions deriving from functional groups on the molecules' "head" are the two driving forces governing PFAS sorption. Consequently, varying C–F chain lengths and polar functional groups significantly alter PFAS availability and leachability. Furthermore, matrix parameters such as soil organic matter, inorganic minerals, and pH significantly impact PFAS sequestration by sorbent amendments. Materials such as activated carbon, biochar, carbon nanotubes, and their composites are the primary C-based materials used for PFAS adsorption. Importantly, modifying the carbon structural and surface chemistry is essential for increasing the active sorption sites and for strengthening interactions with PFAS. This review evaluates current literature, identifies knowledge gaps in current remediation technologies and addresses future strategies on the sequestration of PFAS in contaminated soil using sustainable novel C-based sorbents.

PLANT PATHOLOGY AND ECOLOGY

LINDSAY TRIPLETT, PH.D. conducted Responsible Conduct of Research Training for all CAES scientific staff (95 attendees) (January 10).

WASHINGTON DA SILVA, PH.D. presented a talk titled, "The fight continues: Developing vaccine-like therapeutics to control plant pathogens" at the CT Vegetable and Small Fruit conference at UConn (127 attendees) (January 9), attended the American Phytopathological Society Virology-Mid-Year Committee Meeting on Zoom (85 attendees) (January 16).

YONGHAO LI, PH.D. presented "All About Fungi and Fungicides, What Every Gardeners Need to Know" to Burlington Garden Club members in Burlington (18 attendees) (January 11); participated in the National Plant Diagnostic Network Online Communication & Web Portal Committee meeting via Zoom (8 attendees) (January 11); participated in Attended the National Plant Diagnostic Network IT Meeting via Zoom (January 24); presented "Recap 2023, Bedding Crop Diseases to Prepare for 2024" at UConn 2024 Spring Bedding Plant Meeting in New Haven (35 attendees) (January 30).

ROBERT MARRA, PH.D. presented a talk on beech leaf disease and oak wilt to the Connecticut Tree Wardens Association (42 attendees) (January 23).

FELICIA MILLETT joined the NPDN Professional Development Committee; staffed the Station booth at the Connecticut Vegetable and Small Fruit Growers' Conference at UConn (January 9); participated in the NEPDN monthly meeting (17 attendees) (January 11); participated in the NPDN Proficiency committee Meeting (8 attendees) (January 16); participated in the NPDN Professional Development Committee Meeting (14 attendees) (January 16 & 30); staffed the Station booth at the CTPA Annual Meeting in Plantsville, CT (January 18); staffed the Station booth at the CNLA Winter Symposium in Plantsville, CT (January 24); participated in the NPDN IT/ Diagnostician Meeting (30 attendees) (January 25); and participated in the Bedding Plant Disease Workshop (35 attendees) (January 30).

RAQUEL ROCHA, PH.D. presented a talk titled "Understanding nematode parasitism to design better management strategies" at the CT Vegetable and Small Fruit conference at UConn (127 attendees) (January 9).

QUAN ZENG, PH.D. presented an invited seminar "Yeast-like fungi on apple flowers induce plant immunity and suppress fire blight infection", at the Department of Plant Pathology, Washington State University through zoom (about 40 attendees) (January 21), participated in virtual Mid-Year Meetings of APS Biocontrol Committee (14 attendees) (January 23), Phylosphere committee (16 attendees) (January 24), and Bacteriology committee (20 attendees) (January 26).

GRANTS AWARDED:

RAQUEL ROCHA, PH.D., in collaboration with Danilo Daloso, Ph.D. and Cleverson Freitas, Ph.D. from the Federal University of Ceará-Brazil (UFC) was awarded a CNPq grant for $50,000 for a joint project to study the molecular mechanisms driving tomato-root knot nematode interaction in response to temperature. The award will be used to host one postdoctoral researcher and one visiting UFC grad student at CAES.

NEW STUDENTS, STAFF, AND VOLUNTEERS:

Eric Swenson is a seasonal assistant and recent graduate in bioengineering from Northeastern University. Eric is working with **NEIL SCHULTES, PH.D.** on deciphering the nutrient requirements for virulence of the fire blight pathogen, *Erwinia amylovora*, on the apple host. He is looking forward to his time here at CAES gaining experience, building connection and preparing for his future career.

OTHER DEPARTMENTAL NEWS:

The Department of Plant Pathology and Ecology held a potluck to wish good luck to **Juliana Milagres**, who returned to Brazil after completing two years of training in the da Silva lab.

VALLEY LABORATORY

JATINDER AULAKH, PH.D. attended the Northeastern Weed Science Society Meeting in Boston MA (January 8-11); presented poster titled "Weed and Christmas Tree Response to Topramezone Herbicide" (January 9); co-authored a poster titled, "Control of Glyphosate-Resistant Common Waterhemp (Amaranthus tuberculatus) in 2,4-d/Glyphosate/Glufosinate-Resistant Soybeans" in New York (January 10); submitted a manuscript titled, "EPSPS Gene Amplification Confers Glyphosate Resistance in Palmer Amaranth in Connecticut" to the Weed Technology Journal (January 16); and submitted an article titled "Tips for Spring and Summer Weed Management in Christmas Trees" (January 22); and presented a co-authored poster titled "Impact of Spray Nozzle Types and Spray Volumes on Herbicide Efficacy for Weed Control in Enlist Soybean" at the Weed Science Society Meeting in San Antonio, TX (January 22-25).

CAROLE CHEAH, PH.D. was interviewed by Darcy Dennett, Firefly Film Works on biological control of hemlock woolly adelgid at Peoples State Forest for the 100th anniversary documentary (January 29).

RICHARD COWLES, PH.D. presented "Facts and fallacies of organics," to the Ledyard Garden Club, via Zoom, (20 attendees) (January 8). He discussed "Climate weirding, causes and effects," to the South Windsor Garden Club, (28 attendees) (January 10). He talked about "Climate change, causes and impact on turf culture," to the Massachusetts Association of Lawn Care Professionals, Marlboro, MA, (190 attendees) (January 17). He provided the CAES lunchtime seminar on "Deer repellents," (25 attendees) (January 24).

ROSE HISKES mentored Wilton High School sophomore Shriya Natajaran with her science project developing an artificial intelligence app that would analyze photos of invasive plants over time and space via Zoom (January 22).

PUBLICATIONS:

1. Robaina, Y. B., Gonzaléz Marrero, I., Nicao, M. E. L., Castañeda- Ruiz, R.F., **Li, D.-W.,** Ponce de la Cal, A., Ben Gharsa, H., Manfrino, R. G., Schuster, C., and Leclerque, A. (2024). First description of *Simplicillium lanosoniveum*, a potential antagonist of the coffee leaf rust, from Cuba. *Applied Microbiology*, *4*, 275–283. DOI: 10.3390/applmicrobiol4010018

Abstract: (1) The fungal genus Simplicillium (Cordycipitaceae: Hypocreales) has an extensive distribution and a broad spectrum of hosts and substrates. The species Simplicillium lanosoniveum is a mycoparasite with potential for biological control of coffee leaf rust, Hemileia vastatrix. Morphologically, Simplicillium closely resembles mycoparasitic and entomopathogenic Lecanicillium fungi, often resulting in misidentification. A fungal isolate was obtained from leaf-rust-infested coffee plants from Cienfuegos Province, Cuba. (2) Combined analyses of morphology and molecular markers (ITS, LSU, EF-1alpha) were used for fungal identification. (3) In the NJ, ML, and BI phylogenies which were reconstructed, the isolate LBSim-01 was located in the Simplicillium lanosoniveum clade. This species-level identification was supported by morphological features. (4) The isolate LBSim-01 was assigned to the species Simplicillium lanosoniveum. This is the first description of a Simplicillium fungus associated with coffee leaf rust in Cuba. The presented results hold implications for the biological control of this economically relevant plant disease.

JOURNAL ARTICLES APPROVED JANUARY 2024

Aulakh, J. S., Kumar, V., Brunharo, C., Veron, A., and Price, A. J. EPSPS gene amplification confers glyphosate resistance in palmer amaranth from Connecticut. *Weed Technology*.

Castillo, C., Hoang, K. N. L., Alford, C., Svendahl, E., **Deng, C.**, **Wang, Y.**, Wang, Y., Hernandez, R., **White, J. C.**, Wheeler, K. E., Murphy, C. J., and Giraldo, J. P. In vivo transformations of positively charged nanoparticles alter the formation and function of RuBisCO photosynthetic protein corona. *Nature Nanotechnology*.

Channab, B.-E., El Idissiab, A., **White, J. C.**, and Zahouily, M. MOF ZIF-8, carboxymethylcellulose and polyvinyl alcohol bio-nanocomposite controlled-release phosphorus fertilizer: Improved P management and tomato growth. *Composites part B: Engineering*.

Hao, Y., Ma, C., Cai, Z., **White, J. C.**, Liang, A., Xu, X., Li, H., Jia, W., Cao, Y., Han, L., Tan, Q., Chen, G., Xiao, J., Zheng, W., Pagano, L., Maestri, E., Marmiroli, M., Marmiroli, N., Zhao, J., and Xing, B. Safe production of rice (*Oryza sativa*) in As (III, V)-contaminated soil: An advanced remedial strategy using micro/nanoscale bone biochar. *Nature Food*.

Kandhol, N., Singh, V. P. Sharma, S., **White, J. C.**, Rinklebe, J., Corpas, F. J., Chen, Z.-H., and Tripathi, D. K. Nanoscale materials and NO-ROS homeostasis: Understanding trilateral dynamics for plant health and sustainable agriculture. *Trends in Plant Science*.

Li, Y., **Dugas, K.** and **Millett, F**. Seed Germination and Purity Analysis 2022. *CAES Technical Bulletin*.

Muthuramalingam, R. and **da Silva, W**. Innovative stain-free technique for high-resolution imaging of virus particles via standard transmission electron microscopy. *Heliyon- Cell Publication.*

Noman, M., Ahmed, T., Wang, J., and **White, J. C**. Micronutrient-microbiome interplay: A critical regulator of soil-plant health. *Trends in Microbiology*.

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. Chitosan-coated mesoporous silica nanoparticles for suppression of *Fusarium virguliforme* in soybeans (*Glycine max*). *ACS Sustainable Chemistry and Engineering*.

Qaseem, M. F., Yang, S., Bednarz, L., DiMauro, A., Jiang, E., Allen-Cantu, J., and **Keriö, S**. Chinese chestnut growth, physiology and cell death in response to drought, mycorrhizal inoculation, and *Cryphonectria parasitica* inoculation. *Tree Physiology*.

Qin, L., Yu, L., Wang, M., Sun, X., Wang, J., Liu, J., **White, J. C.**, **Wang, Y.**, and Chen, S. The environmental risk threshold (HC5) for Cd remediation in Chinese agricultural soils. *Journal of Cleaner Production*.

Robaina, Y. B.*, Marrero, I. G., Lorenzo, M. E., Castañeda-Ruiz, R., **Li, D.-W.**, Ponce de la Cal, A., Gharsa, H. B., Manfrino, R. G., Schuster, C., and Leclerque, A. First description of *Simplicillium lanosoniveum*, a potential antagonist of the coffee leaf rust from Cuba. *Journal of Fungi*.

Shang, H., Li, C., Cai, Z., Hao, Y., Cao, Y., Xu, X., **White, J. C.**, Ma, C., and Xing, B. Na-

noscale selenium-mediated detoxification of cadmium in rice (*Oryza sativa* L.) through simultaneous regulation of gene expression and microbial community structure. *Science Advances*.

Sun, X., Yang, R., Ji, J., Zhu, Z., **White, J. C.**, and Shen, Y. An evaluation of microplastic contamination in the marine waters and species in the coastal region of the South Yellow Sea, China. *Science of the Total Environment*.

Yu, Y. and Flury, M. Biodegradable plastics as promising substitutes for conventional plastics. *NPJ Materials Sustainability*.

Zeng, Q., Slack, S., and **Hassani, A**. Pathogen spotlight on *Erwinia amylovora* - Recent advances in genomics, resistance breeding, and disease management. *Phytopathology*.

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

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

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

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

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

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