Station News

The Connecticut Agricultural Experiment Station
Volume 10 Issue 8 August 2020

The mission of The Connecticut Agricultural Experiment Station is to develop, advance, and disseminate scientific knowledge, improve agricultural productivity and environmental quality, protect plants, and enhance human health and well-being through research for the benefit of Connecticut residents and the nation. Seeking solutions across a variety of disciplines for the benefit of urban, suburban, and rural communities, Station scientists remain committed to "Putting Science to Work for Society", a motto as relevant today as it was at our founding in 1875.

CAES
The Connecticut Agricultural Experiment Station
Putting Science to Work for Society since 1875

This Issue

GRANTS RECEIVED JULY 2020

"Nanoscale sulfur for plant nutrition, disease suppression and food safety." **White, J.C.**; Parkash-Dhanker, O.; Elmer, W.; Xing, B. Awarded from USDA NIFA AFRI in September 2020 for 3 years; $499,323 (CAES $250,020)

PROJECT SUMMARY

With a projected global population of 9.7 billion by 2050, agricultural production will need to increase by up to 70%, making achieving global food security among the most significant challenges we face. Further confounding this effort is that the growth in food production will have to occur in the face of a changing climate and on decreasing arable land. Ideally, strategies driving this effort will need to be sustainable, efficiently using water and energy while minimizing negative environmental impacts. One major shortcoming of current agricultural practices is the high inefficiency of agrochemical delivery and utilization, with losses averaging 10-90%. As such, there has been rapidly growing interest in using nanotechnology to address these inefficiencies. Current approaches have focused on nano-enabled conventional agrichemicals, nanosensors, and waste treatment strategies. Nano-enabled agricultural strategies will be incredibly complex and will certainly not be a single "silver" bullet. However, it is clear that efficient, multi-functional strategies to promote food production are needed.

In the literature, it is clear that although bulk/chelated sulfur has been used in agriculture for some time, little is known about the potential of nanoscale sulfur as an agricultural amendment. Sulfur is known to be pivotal in disease resistance through activation of defense barrier production and by its role in the glutathione pathway of stress response. However, the use of sulfur at the nanoscale remains largely unexplored. The goal of this project is to use nanoscale sulfur as a novel multifunctional agricultural amendment. Based on preliminary data, our central hypothesis is that nanoscale sulfur can be used to strategically enhance yield, suppress disease, and improve food safety by reducing heavy metal uptake. Our three objectives are:

Obj.1- Demonstrate the efficacy of nanoscale sulfur as a novel fertilizer for promoting crop growth and yield.
Obj.2- Demonstrate the potential of nanoscale sulfur for crop disease suppression.
Obj.3- Demonstrate the use of nanoscale sulfur for preventing heavy metal uptake in crops.

We will use commercial and in-house synthesized nanosulfur of different sizes and coatings in greenhouse and field trials as a novel fertilizer for rice, wheat, soybean, tomato, lettuce, and carrot. Greenhouse trials will include hydroponic designs relevant to increased interest in urban agriculture. The efficacy of nanoscale sulfur for suppressing crop disease and promoting health through defense activation will be evaluated in three disease systems; soybean with *Fusarium* and tomato with either bacterial spot (*Xanthomonas*) or *Fusarium*. Last, nanosulfur will be investigated as an amendment to minimize As and Cd uptake by rice and wheat, respectively. Although NP use in agriculture is increasing, the stresses from an increasing population and changing climate require novel strategies for sustainably enhancing food production. Novel multifunctional approaches such as that of nanoscale sulfur to promote growth, suppress disease, and minimize metal contamination have great potential to maximize agricultural output. The multidisciplinary team of investigators will establish a Center of Excellence that will deploy a unique combination of educational and dissemination strategies to engage a range of stakeholders in this project.

DR. QUAN ZENG received an industry grant of $20,000 to investigate the mechanism and efficacy of a new anti-microbial product developed by T3 Bio Science Inc.

ADMINISTRATION

DR. JASON C. WHITE participated in the weekly Center for Sustainable Nanotechnology (CSN) center-wide ZOOM call (July 1, 15, 22, 29); participated in the annual meeting of the CAES Research Foundation (July 2); participated in a USDA NIFA AFRI grant review panel by ZOOM (July 6-10); participated in Plant Science Day planning meetings (July 10, 15); hosted the CAES J-1 Visa recipients monthly ZOOM call (July 17); spoke by phone with Ms. Jan Spiegel of CT Mirror regarding current CAES programs and research (July 13); hosted the monthly CSN Nanochem-plant ZOOM call (July 14); spoke by phone with Prof. Jorge Gardea-Torresdey of the University of Texas El Paso regarding an upcoming special issue of *Environmental Science & Technology* focused on the "Environmental Implications of Nanofertilizers" that we are co-editing (July 15); participated in a Teams meeting with CSN faculty and Dr. Amarjit Basra of OCP North America to discuss nanofertilizers (July 16, 17); participated in a ZOOM call with Professor Howard Fairbrother of Johns Hopkins University to discuss collaborative research (July 17, 31); participated in a ZOOM call with Prof. Jorge Gardea-Torresdey of UTEP and Prof. Phil Demokritou of Harvard University regarding a collaborative grant proposal (July 21); participated in a USDA NIFA/Research, Education, and Economics Resources (REE) National Virtual Partnership Webinar Update (July 22); participated in a ZOOM call with collaborators at Louisiana State University, Auckland University, and the University of Agricultural Sciences and Veterinary Medicine in Romania regarding collaborative research (July 23); participated in a CSN Summer Undergraduate Research Experience (SURE) webinar (July 28); traveled to Fish and Kent Farm in Suffield, CT, along with the Commissioner of Agriculture Mr. Bryan Hurlburt, **DR. JAMES LAMONDIA,** and **MS. KITTY PRAPAYOTIN-RIVEROS**, to present the 2020 Century Farm Award on behalf of the CT Agricultural Information Council (July 29); and traveled to Copps Island Oysters by Norm and Son, LLC in Norwalk, CT, along with **DR. JAMES LAMONDIA** and **MS. KITTY PRAPAYOTIN-RIVEROS**, to present the 2020 Outstanding Young Farmer award on behalf of the CT Agricultural Information Council (July 31).

The 2020 Century Farm Award presentation to Fish and Kent Farm in Suffield, CT. Present from left to right are Mr. Bryan Hurlburt (Commissioner, CT Department of Agriculture), Mr. Andy Fish, Dr. Jason C. White, Dr. James LaMondia, and Ms. Jamie Smith (CT DoAg).

The 2020 Outstanding Young Farmer award presentation to Jimmy Bloom of Copps Island Oysters by Norm and Son, LLC in Norwalk, CT. Present from left to right are Ms. Kristin DeRosia-Banick (CT DoAg), Dr. Jason C. White, Mr. Jimmy Bloom and children, and Mr. Norm Bloom.

ANALYTICAL CHEMISTRY

DR. BRIAN EITZER spoke with Michael Dong of LC/GC magazine about collaborating on a paper about multi-residue analysis (July 6); participated in an FDA FERN cCAP conference call (July 9); an ASTM D37.03 Laboratory Subcommittee meeting (July 13); an APHL Cannabis Community of Practice call (July 23); an FDA Food Defense Planning Call (July 28); and a PI call for the SCRI Ornamental Pollinator grant (July 28).

DR. CHRISTINA ROBB participated in an FDA FERN cCap conference call (July 9) and a board meeting of the Eastern Analytical Symposium (EAS) (July 10).

DR. CHRISTIAN DIMKPA assumed the position of Department Head of Analytical Chemistry on August 3. He came to the Station from the International Fertilizer Development Center based in Muscle Shoals, Alabama, where he was a Senior Scientist and worked on balanced -nutrient fertilizer development and evaluation under a variety of agro-environmental conditions, such as drought. He coordinated research partnerships on USDA and USAID-funded projects in the broad area of enhancing nutrient (nanoscale and conventional) use efficiency in different crop systems. Christian obtained his PhD in Bioenvironmental Science in 2009 from the University of Jena in Germany, under the auspices of the International Max Planck Research School of the Max Planck Institute for Chemical Ecology Jena.

MS. KITTY PRAPAYOTIN-RIVEROS participated in a Sample Analysis Data Exchange - IT Implementation Phase Meeting on WebEx to discuss the NFSDX (National Food Safety Data Exchange) phase II Sample Data Elements Mapping File (July 7, 21); participated in a CT Weekly Office Hours for Teams with Microsoft Customer Success Manager (July 6, 13, 20, 27); documented and recorded the award presentation with Dr. Jason White for the 2020 Connecticut Century Farm Award to Mr. Andy Fish at Fish and Kent Farm in Suffield, CT https://youtu.be/0FHa4VVWwUg (July 29); documented and recorded the award presentation with Dr. Jason White for the 2020 Connecticut Young Farmer Award to Mr. Jimmy Bloom at Copps Island Oysters by Norm and Son, LLC in Norwalk, CT https://youtu.be/BGO1KoabR7Y (July 30).

Dr. Christian Dimkpa

ENTOMOLOGY

DR. KIRBY C. STAFFORD III participated in a press conference at CAES for Senator Richard Blumenthal (July 9); with Dr. Ben Beard (CDC), presented a webinar on ticks and tick management for the U.S. Environmental Protection Agency Region 1 (July 9); presented a webinar entitled "Ticks in Connecticut: It's More Than Just Lyme Disease" for White Memorial Conservation Center (July 15); was interviewed about ticks and Virtual Plant Science Day by Guy and Janelle Beardsley on the WPKN's Organic Farmstand Radio Show (July 16); was interviewed about ticks and tick-borne disease risks in Connecticut by Jan Ellen Spiegel, CT Mirror (July 21); and was interviewed about the seeds being received from China by Sean McCabe, News 12 (July 29).

DR. GALE E. RIDGE was interviewed about summer insects and a grasshopper named Lady Lubber by Robert Miller of the Danbury News-Times (July 27); and was interviewed about native Cicada killer/hunters solitary wasps being mistaken for giant Asian murder hornets by Jan Spiegel of the CT Mirror (July 30).

DR. VICTORIA L. SMITH participated in a meeting of the Yale Biosafety committee via ZOOM (20 attendees) (July 16); was interviewed about the recent shipment of unsolicited seeds from China by NBC30, WFSB, and WTNH (July 28); and was interviewed about gypsy moth and general forest health conditions by Jan Spiegel of the CT Mirror (July 29).

DR. KIMBERLY A. STONER participated in a ZOOM meeting with Jamie Fischer, Research Director of the White Memorial Foundation, and Carly Borken of the Taft School about pollinator research projects the students can do as part of distance learning from anywhere in the world (July 6); and participated in a telephone meeting with Jim Randazzon of the Metropolitan District Commission, Kelly Kennedy, a concerned local citizen, and Louise Washer of the Pollinator Pathway and Norwalk River Watershed Association about managing lands of the MDC for water quality and benefits to pollinators and other wildlife (July 9).

ENVIRONMENTAL SCIENCES

DR. JOSEPH PIGNATELLO attended a virtual Board meeting of the CAES Research Foundation; participated in a virtual grant review panel for the USDA-NIFA-AFRI - Bioenergy, Natural Resources, and Environment (BNRE) Foundational and Applied Science Program, Soil Health Program (July 7-9); participated in a virtual conference with collaborators from the University of Maryland and GeoSyntec on a collaborative project (July 29).

DR. PHILIP ARMSTRONG was interviewed about EEE virus and the expansion of the statewide surveillance program by the Associated Press (July 1); spoke at a press event and met with Senator Richard Blumenthal on the threat posed by ticks and mosquitoes (July 9); was interviewed about climate change and its impact on mosquito populations by the CT Mirror (July 16), and was interviewed about the risk of EEE virus by Patch Media (July 23).

MS. ANGELA BRANSFIELD participated in the Federal Select Agent Program's webinars eFSAP updates (July 7) and APHIS/CDC Forms 2, 3 and 4 Updates and Issues (July 15); and participated in the American Biological Safety Association's Select Agent webinar Personnel Suitability (July 22).

MR. GREGORY BUGBEE gave a virtual talk via ZOOM entitled "Lawn Care During Drought" at the New Canaan Public Library (approx. 50 attendees) (July 10).

DR. ANDREA GLORIA-SORIA attended the virtual 13th Annual Arthropod Genomics Symposium (July 21-23).

DR. GOUDARZ MOLAEI was interviewed about tick testing procedures at the CAES-TTL and tick activity in Connecticut by the New Haven Register (July 21); was interviewed about tick activity and repellents for humans and dogs by the New York Magazine (July 23); and was interviewed about tick activity and factors influencing tick availability and abundance by the CT Mirror (July 30).

DR. SARA NASON participated in a conference call for the Benchmarks and Publications for Non-targeted Analysis working group (July 29) and a call with collaborators from Yale, Agilent, and the University of Florida discussing progress on collaborative work (July 31).

MS. SUMMER STEBBINS gave a talk entitled "Invasive Aquatic Plants in Connecticut: How Can They Impact Your Lake?" to the Lantern Hill Valley Association at the Long Pond boat launch in North Stonington (20 attendees) (July 18).

FORESTRY AND HORTICULTURE

DR. JEFFREY S. WARD participated in a conference call with state and private foresters to discuss forest management and carbon storage/sequestration (July 13); met with Jaymie Frederick (Inland Wetlands, Town of Branford) and citizens to discuss running bamboo containment (4 attendees) (July 16).

DR. SUSANNA KERIÖ participated in a ZOOM meeting with collaborators (The American Chestnut Foundation, University of Georgia) to discuss projects related to somatic embryogenesis in American chestnut (July 7).

DR. ABIGAIL A. MAYNARD participated in the G3 Governor's Council on Climate Change, Agriculture/Soils Working Group ZOOM meetings (July 8).

PLANT PATHOLOGY AND ECOLOGY

DR. WADE ELMER attended an APS Press Quarterly meeting via ZOOM (8 adults) (July 7); attended a CAES Research Foundation Annual Meeting via ZOOM (10 adults) (July 15); attended a USDA NIFA plan of work briefing; and presented a Plantopia Podcast Interview with David Gadoury for APS on "Earthworms and Soil Health" (July 28).

DR. YONGHAO LI participated in the National Plant Diagnostic Network Online Communications and Web Portal Committee ZOOM meeting (8 adults) (July 8).

DR. ROBERT E. MARRA met with Gary Haines of Aquarion on Centennial Watershed property in Easton to site a long-term Beech Leaf Disease monitoring plot (July 9); met with Dr. Mark Ashton of Yale Forestry to site a long-term Beech Leaf Disease monitoring plot at Yale Myers Forest in Ashford (July 10); met with Phil Royer of MDC to site a long-term Beech Leaf Disease monitoring plot on MDC property in East Hartford (July 14); was interviewed about beech leaf disease and oak wilt by Jan Ellen Spiegel for the CT Mirror (July 16); met with arborist David Barvenik in Branford to inspect, and collect samples from, a possible oak wilt infection (July 16); met with Kris Lambert and Gregory Decker of the Friends of Oswegatchie Hills Preserve to site a long-term Beech Leaf Disease monitoring plot in Oswegatchie Hills Preserve in East Lyme; met with DEEP Forester Nate Piche to site a long-term Beech Leaf Disease monitoring plot in Nathan Hale State Forest (July 22); and presented, via ZOOM, a webinar entitled "Ecology of Forest Fungi" to the Daytime Gardeners Club of North Haven (12 adults) (July 28).

VALLEY LABORATORY

DR. RICHARD COWLES presented "Targeted Insect and Mite Management" for the Great Lakes Christmas Tree Association summer meeting, as a webinar; the presentation was recorded and can be viewed online (100 attendees) (July 30).

MS. ROSE HISKES co-chaired virtual Connecticut Invasive Plant Working Group symposium planning committee meetings (July 16, 28).

DR. JAMES LAMONDIA participated in the annual meeting of the Connecticut Agricultural Experiment Station Foundation (July 2); participated in SCRI Grant project meetings (22 attendees) (July 13, 22, 27); participated in the Century Farm Award presentation to Fish and Kent Farm in Suffield (July 29); and participated in the Outstanding Young Farmer Award presentation to Jimmy Bloom in Norwalk (July 30).

DEPARTMENTAL RESEARCH UPDATES JULY 2020

An, J., P. Hu, F. Li, H. Wu, Y. Shen, **J. C. White**, X. Tian, Z. Li, and J. P. Giraldo. 2020. Molecular mechanisms of plant salinity stress tolerance improvement by seed priming with cerium oxide nanoparticles. Environ. Sci: Nano. https://doi.org/10.1039/D0EN00387E.

Abstract - Engineered nanomaterials interfaced with plant seeds can improve stress tolerance during the vulnerable seedling stage. Herein, we investigated how priming seeds with antioxidant poly (acrylic acid)-coated cerium oxide nanoparticles (PNC) impacts cotton (*Gossypium hirsutum* L.) seedling morphological, physiological, biochemical, and transcriptomic traits under salinity stress. Seeds primed with 500 mg/L PNC in water (24 h) and germinated under salinity stress (200 mM NaCl) retained nanoparticles in the seed coat inner tegmen, cotyledon, and root apical meristem. Seed priming with PNC significantly ($P < 0.05$) increased seedling root length (56%), fresh weight (41%), and dry weight (38%), modified root anatomical structure, and increased root vitality (114%) under salt stress compared with controls (water). PNC seed priming lead to a decrease in

reactive oxygen species (ROS) accumulation in seedling roots (46%) and alleviated root morphological and physiological changes induced by salinity stress. Roots from exposed seeds exhibited similar Na+ content, significantly decreased K+ (6%), greater Ca2+ (22%) and Mg2+ content (60%), as compared to controls. A total of 4,779 root transcripts were differentially expressed under normal conditions, indicating PNC seed priming alone affects cotton seedling root development. Differentially expressed genes (DEGs) associated with ROS pathways (13) and ion homeostasis (10) indicate that ROS and conserved Ca2+ plant signaling pathways likely play pivotal roles in PNC-induced improvement of salinity tolerance. These results provide potential unifying molecular mechanisms of nanoparticle-seed priming enhancement of plant salinity tolerance.

Donato, M., O. Johnson, **B. Steven,** and B. A. Lawrence. 2020. Nitrogen enrichment stimulates wetland plant responses whereas salt amendments alter sediment microbial communities and biogeochemical responses. *PLOS One*, *15*(7), e0235225; https://doi.org/10.1371/journal.pone.0235225 .

Abstract - Freshwater wetlands of the temperate north are exposed to a range of pollutants that may alter their function, including nitrogen (N)-rich agricultural and urban runoff, seawater intrusion, and road salt contamination, though it is largely unknown how these drivers of change interact with the vegetation to affect wetland carbon (C) fluxes and microbial communities. We implemented a full factorial mesocosm (378.5 L tanks) experiment investigating C-related responses to three common wetland plants of eastern North America (*Phragmites australis*, *Spartina pectinata*, *Typha latifolia*), and four water quality treatments (fresh water control, N, road salt, sea salt). During the 2017 growing season, we quantified carbon dioxide (CO_2) and methane (CH_4) fluxes, above- and below-ground biomass, root porosity, light penetration, pore water chemistry (NH_4^+, NO_3^-, SO_4^{-2}, Cl^-, DOC), soil C mineralization, as well as sediment microbial communities via 16S rRNA gene sequencing. Relative to freshwater controls, N enrichment stimulated plant biomass, which in turn increased CO_2 uptake and reduced light penetration, especially in *Spartina* stands. Root porosity was not affected by water quality, but was positively correlated with CH_4 emissions, suggesting that plants can be important conduits for CH_4 from anoxic sediment to the atmosphere. Sediment microbial composition was largely unaffected by N addition, whereas salt amendments induced structural shifts, reduced sediment community diversity, and reduced C mineralization rates, presumably due to osmotic stress. Methane emissions were suppressed by sea salt, but not road salt, providing evidence for the additional chemical control (SO_4^{-2} availability) on this microbial-mediated process. Thus, N may have stimulated plant activity while salting treatments preferentially enriched specific microbial populations. Together our findings underpin the utility of combining plant and microbial responses, and highlight the need for more integrative studies to predict the consequences of a changing environment on freshwater wetlands.

Mukome, F. N. D., M. C. Buelow, J. Shang, J. Peng, M. Rodriguez, D. M. Mackay, **Joseph J. Pignatello**, N. Sihota, T. P. Hoelen, and S. J. Parikh. Biochar amendment as a remediation strategy for surface soils impacted by crude oil. *Environmental Pollution* 265B, 115006. https://doi.org/10.1016/j.envpol.2020.115006.

Abstract - The impact of organic bulking agents on the biodegradation of petroleum hydrocarbons in crude oil impacted soils was evaluated in batch laboratory experiments. Crude oil impacted soils from three separate locations were amended with fertilizer and bulking agents consisting of biochars derived from walnut shells or ponderosa pine wood chips produced at 900°C. The batch reactors were incubated at 25°C and sampled at pre-determined intervals to measure changes in total petroleum hydrocarbons (TPH) over time. Prior to each sampling event, the sample was manually stirred and the soil moisture content was adjusted to 55–60%. Results show that the addition of fertilizer and bulking agents increased biodegradation rates of TPH. Soil samples amended with ponderosa pine wood biochar achieved the highest biodegradation rate, whereas the walnut shell biochar was inhibitory to TPH reduction. The impact of biochars on TPH biodegradation was more pronounced for a soil impacted with heavier hydrocarbons compared to a soil impacted with lighter hydrocarbons. This study demonstrates that some biochars, in combination with fertilizer, have the potential to be a low-technology and eco-friendly remediation strategy for crude oil impacted soils.

Hofmann, T.; G. Lowry, S. Ghoshal, N. Tufenkji, D. Brambilla, J. Dutcher, L. Gilbertson, J. P. Giraldo, M. Kinsella, M. del Capio Landry, W. Lovell, R. Naccache, M. Paret, J.

Pederson, J. Unrine, **J. C. White**, and K. Wilkinson. 2020. Moving forward responsibly in nanotechnology enabled plant agriculture. Nature Food 1:416–425.

Abstract - Technological innovations are needed to improve the sustainability of plant agriculture for food production. Nanotechnology offers potential solutions to the most vexing problems preventing a more sustainable agriculture including increasing nutrient utilization efficiency, improving the efficacy of pest management, combating climate change impacts, and lowering environmental impacts. Many promising nanotechnologies have been proposed and evaluated at different scales, but there are several barriers to implementation that must be addressed to promote technology adoption including (A) efficient delivery at field scale, (B) regulatory and safety concerns, and (C) consumer acceptance. Here, we rank the technology readiness and potential impacts for a wide range of opportunities for nanotechnology in agriculture, and propose a path forward to overcome these barriers and develop effective, safe, and acceptable nanotechnologies for agriculture.

Rose, N. H., M. Sylla, A. Badolo, J. Lutomiah, D. Ayala, O. B. Aribodor, N. Ibe, J. Akorli, S. Otoo, J.-P. Mutebi, A. L. Kriete, E. G. Ewing, R. Sang, **A. Gloria-Soria**, J. R. Powell, R. E. Baker, B. J. White, J. E. Crawford, and C. S. McBride. 2020. Climate and urbanization drive mosquito preference for humans. Current Biology. *Early online – July 23.* DOI:https://doi.org/10.1016/j.cub.2020.06.092

Abstract **-** The majority of mosquito-borne illness is spread by a few mosquito species that have evolved to specialize in biting humans, yet the precise causes of this behavioral shift are poorly understood. We address this gap in the arboviral vector Aedes aegypti. We first collect and characterize the behavior of mosquitoes from 27 sites scattered across the species' ancestral range in sub-Saharan Africa, revealing previously unrecognized variation in preference for human versus animal odor. We then use modeling to show that over 80% of this variation can be predicted by two ecological factors – dry season intensity and human population density. Finally we integrate this information with whole genome sequence data from 375 individual mosquitoes to identify a single underlying ancestry component linked to human preference, with genetic changes concentrated in a few chromosomal regions. Our findings suggest that human-biting in this important disease vector originally evolved as a by-product of breeding in human-stored water in areas where doing so provided the only means to survive the long, hot dry season. Our model also predicts that the rapid urbanization currently taking place in Africa will drive further mosquito evolution, causing a shift towards human-biting in many large cities by 2050.

Stoner, Kimberly A. 2020. Pollination is sufficient, even with low bee diversity, in pumpkin and winter squash fields. Agronomy. 10, 1141; doi:10.3390/agronomy10081141

Abstract **-** Pumpkins and winter squash require insect pollination to set fruit, but only three bee species are important pollinators of these crops in the Northeastern US. To determine if natural levels of pollen deposition are sufficient for full fruit production, open pollination was measured by counting pollen grains on stigmas, and open pollination was compared to supplemental hand pollination for fruit set, fruit size, and seed number. A threshold of 2300 pollen grains per stigma was sufficient for full pollination and fruit production. This threshold was met in 79 out of 80 combinations of site and sample date over four years on farms across Connecticut with a wide range of field sizes and pest management practices. Along with stigma collection, bees per flower were counted hourly on 100 flowers along a transect. Counts of bumble bees on female flowers were more closely related to the amount of pollen deposited than counts of bees on all flowers or counts of honey bees or squash bees on female flowers. There was tremendous variation in abundance of the three bee species on female flowers across farms within a year and even among years on a single farm.

Xu, T., **C. Ma**, A. Aytac, X. Hu, K. W. Ng, **J. C. White**, and P. Demokritou. 2020. Enhancing agrichemical delivery and seedling development with biodegradable, tunable, biopolymer-based nanofiber seed coatings. ACS Sus. Chem. Eng https://doi.org/10.1021/acssuschemeng.0c02696.

Abstract - One of the challenges in agriculture is the inefficiencies in agrichemical delivery and utilization. Herein, a biodegradable, tunable, biopolymer-

based nanoplatform was developed as seed coating to enhance agrichemical delivery and seedling development. The nanofibers are synthesized using electrospinning of biopolymer blends without any toxic chemicals or post-treatment and enable tunable agrichemical release by modulating the polymer composition and hydrophilicity of nanofibers. The germination and subsequent growth of different nanofiber-coated seeds (tomato and lettuce) as a function of agrichemical release kinetics were investigated in greenhouse studies, in the presence or absence of a fungal pathogen (*Fusarium* species). Results from the greenhouse studies indicate the efficacy of such nano-enabled seed coating approach due to the precise delivery of agrichemical at the right place while utilizing a miniscule amount of agrichemical. The various Cu-release nanofiber coatings appeared to promote seed germination, particularly in the diseased media conditions. This more rapid germination led to increased seedling biomass for both plants (12-29%) in the healthy media conditions. Such seed nano-coating approach might be used in pathogen infested soil conditions to increase production yields. The developed nanofiber seed coating approach brings precision to agrichemical delivery and significantly improves germination and seedling biomass for model seeds compared to conventional film coating approaches utilized by the industry, owing to its unique nanofibrous structure and controlled release kinetics.

JOURNAL ARTICLES APPROVED JULY 2020

Adeel, M., T. Farooq, **Jason C. White**, J. L. Gardea-Torresdey, and Y. Rui. COVID-19 and nanoscience in the developing world: Rapid detection and remediation in wastewater. *Nature Nano*

Aulakh, Jatinder S. Christmas tree tolerance to over-the-top application of selective grass killers. *The Real Tree Line*

Aulakh, Jatinder S. Christmas tree tolerance to over-the-top application of weed suppression treatments. *The Real Tree Line*

Aulakh, Jatinder S., and **Richard S. Cowles**. Synthetic auxin herbicides for use in Christmas tree plantations. *The Real Tree Line*

Aytac, Z., R. Huang, N. Vaze, T. Xu, **Walter J. Krol**, **Brian D. Eitzer**, **Jason C. White**, Z. Zhang, D. W. Bousfield, M. B. Chan-Park, K. K. Parker, and P. Demokritou. Biodegradable electrospun zein nanofibers for enhancing food safety and quality. *ACS Sustainable Chemistry and Engineering*

Cowles, Richard S. Biological prospecting for ecologically-based pest management in Christmas tree plantations. *The Real Tree Line*

Cui, Zhouqi, **Regan B. Huntley**, **Neil P. Schultes**, K. Kakar, and **Quan Zeng**. Expression of the type III secretion system genes in epiphytic *Erwinia amylovora* cells on apple stigmas benefits endophytic infection at the hypanthium. *Molecular Plant Microbe Interactions*

Eastwood, G., **John J. Shepard**, **Michael J. Misencik**, **Theodore G. Andreadis**, and **Philip M. Armstrong**. Local persistence of novel regional variants of La Crosse virus in the Northeast United States. *PLOS Neglected Tropical Diseases*

Gent, Martin P. N. Modeling transpiration and translocation in lettuce. I. Water, sugar, and nitrate movement in a model with root and leaf. *Life* Special Issue "Metabolism of Photosynthetic Organisms"

Gloria-Soria, Andrea, A. F. Payne, S. M. Bialosuknia, J. Stout, N. Mathias, G. Eastwood, A. T. Ciota, L. D. Kramer, and **Philip M. Armstrong**. Vector competence of *Aedes albopictus* populations from the Northeastern USA for chikungunya, dengue, and Zika viruses. *The American Journal of Tropical Medicine and Hygiene*

Li, De-Wei, **Richard S. Cowles**, and Jamie Jones. Wine cap mushroom: An intercrop in Christmas farms. *The Real Tree Line*

Li, J., Q. Li, C. E. W. Steinberg, Q. Zhao, B. Pan, **Joseph J. Pignatello**, and B. Xing. Re-

action of substituted phenols with lignin char: Dual oxidative and reductive pathways depending on substituents and conditions. *Environmental Science & Technology*

Shen, Y., J. Borgatta, **Chuanxin Ma**, **Wade H. Elmer**, R. J. Hamers, and **Jason C. White**. Copper nanomaterial morphology and composition control foliar transfer through the cuticle and mediate resistance to root fungal disease in tomato (*Solanum lycopersicum*). *Journal of Agricultural and Food Chemistry*

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The Connecticut Agricultural Experiment Station

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