Station News

The Connecticut Agricultural Experiment Station
Volume 8 Issue 9 September 2018

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

DR. THEODORE ANDREADIS was interviewed about current West Nile activity in Connecticut by Steve Pancione, NBC Connecticut (August 2); was interviewed about Plant Science Day 2018 by Ray Andrewsen, WQUN AM 1220, in Hamden (August 2); was interviewed about the early season build-up of West Nile virus in Connecticut by Kent Pierce, WTNH TV 8, New Haven (August 3); presided over a quarterly meeting of the Station's Board of Control held at Lockwood Farm (August 8); was interviewed about the extraordinarily wide distribution and levels of West Nile virus circulating in the State and risk of human infection by Fox 61 (August 22); and was interviewed about the recent occurrence of human cases of West Nile virus in the state and the continued risk for human exposure by Mackenzie Rigg, CT Mirror and WTIC Radio (August 24).

ANALYTICAL CHEMISTRY

DR. JASON C. WHITE participated in "All Hands" ZOOM weekly calls for the Center for Sustainable Nanotechnology (August 1, 15, 22, 29); hosted "Nano-agriculture" ZOOM calls for the Center for Sustainable Nanotechnology (August 6, 20); participated in a Skype call with Professor Melanie Kah of the University of Vienna and Natalie Tufenkji of McGill University regarding an invited review article for *Nature Nanotechnology* (August 9); hosted a ZOOM call with Professor Howard Fairbrother of Johns Hopkins University to discuss collaborative research on nano-enabled delivery of pesticides (August 11); met with Ms. Susan Martin of the University of Wisconsin regarding planning logistics for the upcoming "All Hands" annual meeting for the Center for Sustainable Nanotechnology, which CAES is hosting on September 21-22 (August 27); and participated by ZOOM in the Ph.D. Dissertation Proposal defense of Ms. Becky Curtis of the University of Wisconsin Milwaukee; I am an external participant on her committee (August 28).

DR. CHRISTINA ROBB attended a Mass Spectrometry and Proteomics Workshop at the University of Minnesota (August 7, 8, 9). The workshop focused on the extraction, preparation, and analysis of samples for proteomic and metabolomic analysis including database searching; participated in the FDA 50-State Conference Call/Webinar to Discuss FY2018 Microbiological Surveillance Sampling Assignments for Frozen Berries and Bagged Salad (August 15); and attended the webinar "Why Use Capillary Electrophoresis?" (August 30).

DR. NUBIA ZUVERZA-MENA attended the International Congress of Plant Pathology (ICPP) 2018: Plant Health in a Global Economy in Boston, MA and presented our work within the session "The first line of defense against plant disease in the developing world: Mineral nutrition." The oral presentation was entitled "Can

nanoparticles enhance disease resistance through mineral nutrition?" (180 attendees) (August 1).

ENTOMOLOGY

DR. KIRBY C. STAFFORD III was interviewed by Katrina Koerting, Danbury News-Times, about the new exotic longhorned tick (August 10); was interviewed by Ed Stannard, New Haven Register, about fall tick activity and the new Asian longhorned tick (August 22); was interviewed by John Burgeson, Connecticut Post, about the role of bees or wasps in a stinging incident in the news (August 24); and participated in a meeting of the IACUC Administrators Network Group at UConn Health in Farmington (26 participants); and with **DR. SCOTT WILLIAMS**, presented a webinar on tick IPM through the NEVBD (110 attendees).

MR. MARK H. CREIGHTON assisted youth from a Yale University Program for disadvantaged youth in building and painting beehives for their apiary program at Lockwood Farm, Hamden (August 4); manned a honey bee information table on Plant Science Day and spoke on beekeeping systems used in Connecticut in the demonstration tent that was attended by over 100 visitors (August 8); visited the apiary at Central Connecticut State University in New Britain and provided information on hive maintenance to the apiary managers (August 16); met with the apiary manager at The Sound School in New Haven to discuss future plans and activities at the school apiary (August 22); met with Sister Regina Cochran at the apiary for the Franciscan Sisters of Eucharist in Southington where we are developing an apiary management plan in hopes of growing the apiary for honey production (August 24); and visited Spring Glen Church in New Haven with **DR. LINDSAY TRIPLETT** and spoke about honeybees and beekeeping, including the youngsters who were very excited to view the bees in the observation hive (12 attendees) (August 26).

DR. GALE E. RIDGE collaborated with Dr. Carl Baum from the Yale School of Medicine in taking a series of photographs of insects from the CAES insect collection to be used on future American Board of Emergency Medicine, medical and toxicology certification examinations for emergency room physicians (August 21); and visited the Yale School of Nursing with Christopher Nelson, Connecticut Pest Elimination, to address a cluster of office staff who complained of being "bitten" by insects. No biting arthropods were detected, but humidity was very low (15%) and a key protagonist in the staff suffered from depression (August 22).

DR. VICTORIA L. SMITH participated in the National Meeting of the National Plant Board, held at the Hilton by the Lake in Cleveland, OH (150 participants) (August 12-16).

DR. MEGAN LINSKE participated in the Wildlife Society's Leadership Institute conference call (August 16); conducted Leadership Institute interviews with Dr. Erin McCance, consultant for Joro Consulting, and Dr. John McDonald, president of the Wildlife Society (August 20); and participated in the 2019 Northeast Fish and Wildlife Conference planning call (August 31).

DR. KIMBERLY A. STONER was interviewed by Kathy Connolly for an article on the value of goldenrod to bees and the resulting article ran in the New London Day and Zip06 newspapers, reaching 185,000 households in southeastern CT (August 9); traveled with Dr. Rob Koethe, US EPA, to Monrovia Nursery to show him how pollen is trapped from honey bee hives for research and show him the nursery operation (August 17); organized and co-led an on-farm workshop, "Pollinator Habitat at Blueberry Hill Organic Farm" with Virginia Keith (farmer) and Bill Purcell (Natural Resources Conservation Service, CT) in Danielson, CT (17 attendees, including 5 incoming Yale students) (August 20); and was interviewed by Douglas Hawes-Davis of Blue Sky Pictures, LLC for a documentary on the decline of pollinators and other flying insects worldwide (August 29).

ENVIRONMENTAL SCIENCES

DR. JOSEPH PIGNATELLO along with Dr. Yi Yang co-authored the talk, "Tailored carbons as non-conventional adsorbents and adsorbent-catalysts," (approx. 20 students out of approx. 40 attendees), and, along with Yi Yang and Jaehong Kim of Yale University, "Oxidation of Organic Contaminants by Unactivated Peroxymonosulfate: Roles of Reactive Species and Direct Oxidation" (approx. 40 students out of approx. 80 attendees), both talks in the Environmental Chemistry Division at the American Chemical Society Annual Meeting in Boston, MA (August 19-23); and was appointed Associate Editor of *Soil Science Society of America Journal* for a three-year term (August 27).

DR. PHILIP ARMSTRONG spoke to incoming students in the Epidemiology of Microbial Diseases Program at the Yale School of Public Health about research opportunities at CAES (40 attendees) (August 21); and was interviewed about the statewide mosquito surveillance program and the rise and spread of West Nile virus in Connecticut by Fox News 61 (August 1), Nutmeg TV (August 7), Coastal CT Magazine (August 9), the Connecticut Post (August 10), News Channel 8 (August 10), and WTIC (August 10).

MS. ANGELA BRANSFIELD participated in the American Biological Safety Association's Select Agent Community webinar *Entity Experiences Preparing for Select Agent Inspections* (August 6).

MR. GREGORY BUGBEE was interviewed by the Danbury News-Times on the extent of the invasive water chestnut problem in Connecticut (August 1).

DR. GOUDARZ MOLAEI organized an exhibit on tick-borne pathogens and tick bite prevention and safety at the Stafford Middle School "Safe Day" event in Stafford Springs (approx. 180 students out of approx. 207 attendees) (August 31).

FORESTRY AND HORTICULTURE

DR. JEFFREY S. WARD along with **MR. JOSEPH P. BARSKY**, attended the Forested Wetland Soils Workshop in Storrs (August 15); met with Alex Amendola, South Central Connecticut Regional Water Authority, to discuss forest regeneration and invasive control in Bethany (August 17); was interviewed about risks of dead and dying trees along Connecticut's roadsides by Gregory Hladky of the Hartford Courant (August 20); met

with Hallie Metzger, Rebekah's Hill Flora and Fauna Preservation Society and Weantinoge Heritage Land Trust staff to discuss forest management in Goshen (August 22); was interviewed about risks of dead and dying trees along Connecticut's roadsides by Toni Terzi, Fox 61 news (August 22); and was interviewed about using herbicides to control invasives by Ken Dixon, Connecticut Post (August 30).

DR. ABIGAIL A. MAYNARD assisted with a composting operation at the Wesleyan University's Long Lane Farm in Middletown (6 students) (August 1, 22, 29) and discussed the New Crops Program with growers at the Hamden Farmer's Market (5 farmers) (August 23).

DR. SCOTT C. WILLIAMS met with a Wesleyan graduate student about potential research collaboration using deer exclosures (August 6); gave an invited lecture entitled "Less-toxic integrated control and host reservoir dilution of Ixodes scapularis in residential settings" at the Integrated Management of Ticks and Mosquitoes, New York State Integrated Pest Management Conference, White Plains, NY (100 attendees) (August 7); with **DR. KIRBY STAFFORD**, gave a Northeast Regional Center for Excellence in Vector-Borne Diseases-sponsored webinar entitled "Integrated Tick Management" (150 attendees) (August 30); and participated in a Northeast Fish and Wildlife Conference planning conference call (August 31).

PLANT PATHOLOGY AND ECOLOGY

DR. DONALD AYLOR presented an invited talk entitled "Atmospheric Dispersal of Plant Pathogens Over Multiple Spatial and Temporal Scales" at the International Conference on Plant Pathology in Boston (ICPP 2018) (100 attendees) (August 3).

DR. WADE ELMER was interviewed by Mr. John Burgeson, Connecticut Post, about how nanoparticles of micronutrients can suppress plant disease (August 8).

DR. YONGHAO LI participated in the Sentinel Plant Network Workshop planning conference call (7 participants) (August 6); co-sponsored The Sentinel Plant Network Workshop held at the Connecticut College Arboretum in New London and instructed the Diagnostics 102 labs (44 attendees) (August 16-17).

DR. ROBERT MARRA met with Ms. Amy Taylor, Director of Sponsored Programs and Research at Southern Connecticut State University (SCSU), to finalize terms for Dr. Marra's Principal Investigator (PI) status at SCSU. Also in attendance were Dr. Rebecca Silady (SCSU Department of Biology) and Ms. Julianne Fowler, Ms. Taylor's assistant (August 29).

DR. NEIL SCHULTES presented a poster entitled "Nucleobase transport in *Erwinia amylovora*" at the International Congress of Plant Pathology held in Boston, MA (over 250 attendees at the poster sessions) (July 29-August 3).

DR. LINDSAY TRIPLETT organized the 2018 Plant Health Fellows program "wrapped

up" the Plant Science Day presentation of their field plot, Nanoparticle Effects on Chrysanthemum Wilt (assisted by Dr. Lindsay Triplett, 25 visitors) (August 8), and co-organized the noon-time seminar presentations of their mentored laboratory projects (40 attendees) (August 9).

DR. QUAN ZENG gave an oral presentation "Fire blight: history, management, and new challenges" on Plant Science Day at Lockwood Farm, Hamden (200 attendees) (August 8); and was interviewed by Mr. John Burgeson, Connecticut Post, about recent research updates on fire blight (August 8).

VALLEY LABORATORY

DR. JATINDER S AULAKH participated in the CT Invasive Plant Workgroup meeting held at the Valley Laboratory (August 23).

MS. ROSE HISKES participated in the CT Invasive Plant Workgroup meeting held at the Valley Laboratory (August 23).

DR. JAMES LAMONDIA and **DR. DEWEI LI** conducted a tour of Valley Laboratory research plots and a broadleaf tobacco farm for Xueliang Ren, visiting scholar from Guizhou Acadamy of Tobacco Institute, China (August 17).

DR. ELISHA ALLEN-PERKINS and her husband Todd welcomed their son, William Richard, on August 18. He was 7 lbs., 14.8 oz. and measured 19.5 inches. Everyone is doing great.

DEPARTMENTAL RESEARCH UPDATES AUGUST 2018

Dimkpa, C.O.; Singh, U.; Bindraban, P.E.; **Elmer, W.E.**; Gardea-Torresdey, J.; **White, J.C**. 2018. Exposure to weathered and fresh nanoparticle and ionic Zn in soil promotes grain yield and modulates nutrient acquisition in winter wheat (*Triticum aestivum*). *J.Agric. Food Chem*. DOI: 10.1021/acs.jafc.8b03840.

Abstract- Zinc is an essential element that can be supplied to humans via agronomic fortification of food crops. Here, we show that residual (previously cropped soil) and fresh (uncropped soil) ZnO nanoparticles (NP) or Zn salt (6 mg Zn/kg soil) promote grain yield and alter nutrient content in wheat. Residual Zn increased grain yield by 15%, while fresh Zn increased grain yield by 29%; each case was irrespective of Zn type. Decreased post-harvest soil pH indicated that ZnO NP were transformed to Zn ions; however, other transformation products cannot be ruled out. Relative to the respective controls (no added Zn) and each residual Zn type, fresh ZnO NP significantly increased grain N content by 12%, while fresh Zn salt had no effect. Compared to the controls, Zn was significantly bioaccumulated in the plant from both Zn types. However, root-to-shoot bioaccumulation efficiency was low: 24 and 20% for residual ZnO NP and Zn salt, respectively, and 48 and 30%, for fresh ZnO NP and Zn salt, respectively. Grain Zn content was increased 186% and 229% by residual ZnO nanoparticles and Zn salt, respec-

tively, and 229% and 300% by fresh ZnO nanoparticles and Zn salt, respectively. Therefore, shoot-to-grain Zn translocation efficiency was high: 167 and 177% for residual ZnO nanoparticles and Zn salt, respectively, and 209 and 155% for fresh ZnO nanoparticles and Zn salt, respectively. Thus, ZnO nanoparticles were more efficient than Zn salt for shoot Zn accumulation, while grain efficiency of Zn translocation contrasted between Zn types, dependent on nutrient aging in soil. Importantly, a Zn ion-specific assay indicated the grain Zn do not exist in the ionic state. Our findings demonstrate that ZnO NP and Zn salt promote wheat productivity similarly, but varied in their effects on nutrient acquisition, dependent on nutrient aging. These findings have relevance for biofortification efforts of Zn in grains for human nutrition.

Dimkpa, C.O.; Adisa, I.O.; Elmer, W.E.; Gardea-Torresdey, J.L.; **White, J.C**. 2018. Size-specific effects of nanoparticle Mn exposure on nutrient acquisition and distribution in wheat. *Agronomy* 8(9), 158; doi.org/10.3390/agronomy8090158.

Abstract- Manganese (Mn) is an essential nutrient required by plants in trace amounts. However, due to heightened reactivity resulting from nano-scale properties, Mn nanoparticles can be toxic even at low doses. Here, we demonstrate that nano Mn was not toxic to wheat in a near-neutral soil, under a low soil or foliar exposure, 6 mg/kg/plant. Rather, wheat grain yield was increased, 16%, or 22%, when exposed via soil or foliar, but the increase was insignficant. The yield effect of nano Mn exposed via soil was comparable to that caused by bulk or ionic Mn. In contrast to yield, all Mn types significantly reduced shoot N content, compared to the control. However, nano Mn exhibited other subtle, yet significant effects on nutrient acquisition that were not similarly duplicated by ionic or bulk Mn: reduction (25%) in shoot Mn accumulation; stronger reduction (33%) in shoot P content; reduction (7%) in shoot K content; and increase (30%) in soil residual nitrate-N. Despite lowering shoot Mn, nano Mn increased grain Mn translocation efficiency to between 10 and 38%, compared to the control and other Mn types. Compared to treating soil, foliar exposure to nano Mn exhibited significant differences: 37% and 12% more shoot and grain Mn contents, respectively; 40% less soil nitrate-N; and 17% and 43% more soil and shoot P, respectively. Collectively, our findings indicate that nano-scale Mn in soil could affect plants in delicate ways that are different than bulk or ionic Mn. Limited change in soil pH may be contributing to the degree of plant response to different Mn types. However, applying nano Mn as a foliar treatment could modulate nano Mn effects in plants.

Elmer, W.H.; Ma, C.; White, J.C. 2018. Nanoparticles for plant disease management. *Curr. Op. Environ. Sci. Health* doi.org/10.1016/j.coesh.2018.08.002.

Abstract- Engineered nanoparticles (NPs) (1-100 nm) that have demonstrated activity in suppressing plant diseases are metalloids, metallic oxides, nonmetals, and carbon nanomaterials. NPs have been integrated into disease management strategies as bactericides/fungicides and as nanofertilizers to enhance health. As demand for food production increases against a warming climate, nanoparticles will play a role in mitigating the new challenges in disease management resulting in a reduction in active metals and other chemical inputs.

Elmer, W.H., Ma, C. and **White, J.C.**, 2018. Nanoparticles for Plant Disease Management. Current Opinion in Environmental Science & Health 6:66-70.

Abstract- Engineered nanoparticles (NPs) (1–100 nm) that have demonstrated activity in suppressing plant diseases are metalloids, metallic oxides, nonmetals, and carbon nanomaterials. NPs have been integrated into disease management strategies

as bactericides/fungicides and as nanofertilizers to enhance plant health. Although there are reports of over 18 different NPs of single element and carbon nanomaterials affecting disease and/or plant pathogens, only Ag, Cu, and Zn have received much attention thus far. Some NPs act directly as antimicrobial agents while others function more in altering the nutritional status of the host and thus activate defense mechanisms. For example, NPs of Ag and Cu can be directly toxic to microorganisms. Other NPs of B, Cu, Mn, Si, and Zn appear to function in host defense as fertilizers. As demand for food production increases against a warming climate, nanoparticles will play a role in mitigating the new challenges in disease management resulting in a reduction in active metals and other chemical inputs

Guo, H.; **White, J.C.**; Wang, Z.; Xing, B. 2018. Nano-enabled fertilizers to control the release and use efficiency of nutrients. *Curr. Op. Environ. Sci. Health* doi.org/10.1016/j.coesh.2018.07.009.

Abstract- The productivity of current agricultural practices relies heavily on fertilizer use. A major limitation of conventional fertilizers is their low crop nutrient use efficiency (NUE) and high loss into water bodies, which not only compromises crop production and food security but also limits the development of sustainable agriculture. One important approach to address this issue is to engineer nano-enabled fertilizers to deliver nutrients to crops in a controlled release (CR) manner. Herein, we concentrate on the strategies for design and use of nano -enabled fertilizers that can control nutrient release and enhance NUE. We identified six types of nanostructured materials as nutrient carriers: nanoclays, hydroxyapatite nanoparticles, mesoporous silica nanoparticles, carbon-based nanomaterials, polymeric nanoparticles, and other nanomaterials. This review discusses recent progress on the design and use of nanomaterials as carrier vehicles for the controlled fertilizer release, and offers new perspectives and directions for future studies. This forward thinking approach includes: the development of standardized and comprehensive evaluation systems for new nano-formulations by incorporating core criteria release models, NUE, crop productivity, energy and material budget analysis, and environmental impact; design of multifunctional nanomaterials; and the construction of stimuli-responsive nanocarriers.

Medina-Velo; I.A.; **Zuverza-Mena, N.**; Tamez; C.; Ye, Y.; Hernandez-Viezcas, J.A.; **White, J.C.**; Peralta-Videa, J.R.; Gardea-Torresdey, J.L. 2018. Minimal transgenerational effect of ZnO nanomaterials on the physiology and nutrient profile of *Phaseolus vulagaris. ACS Sustain. Chem. Eng*. 6:7924-7930.

Abstract- Seeds of second generation (S2) bean plants (Phaseolus vulgaris) that cultivated in nanoparticle (nano)-free soil were analyzed to determine the residual effects of previous parental generation exposure to uncoated nano-ZnO (Z-COTE), coated nano-ZnO (Z-COTE-HP1), bulk ZnO, or ionic Zn (ZnCl2). Antioxidant enzymatic activity was determined in immature seeds, while the yield and nutritional composition of the seeds were measured at the end of the growth cycle. None of treatments affected pod production, maturation time, Zn accumulation, or the content of sugar, starch or protein in S2 as compared with controls. The accumulation of K, P, S, Mg, Fe, Mn, B, Mo, and Cu in S2 seeds also remained unaffected. However, Z-COTE at 500 mg kg-1 and Z-COTE HP1 at 125 and 500 mg kg-1 reduced Ni in S2 seeds by 60%, 41%, and 74%, respectively, compared with the control. The Zn nanomaterials (NMs) did not impact the activity of ascorbate peroxidase, catalase, and superoxide dismutase (SOD). However, ZnCl2 at 500 mg kg-1 increased SOD in S2 seeds. The data suggest that ZnO NMs have low residual transgenerational effects on seed composition, which could be beneficial in agricultural production.

Ni J. and **Pignatello J.J.***, Charge-Assisted Hydrogen Bonding as a Cohesive Force in Soil Organic Matter: Water Solubility Enhancement by Addition of Simple Carboxylic Acids, Environmental Sciences: Processes & Impacts; DOI:10.1039/c8em00255j (online August 3).

Abstract- Weak bonds between molecular segments and between separate molecules of natural organic matter (OM) govern its solubility, adsorption, supramolecular association in solution, and complexation with metal ions and oxides. We tested the hypothesis that especially strong hydrogen bonds, known as (negative) charge-assisted hydrogen bonds, (-)CAHB, contribute significantly to OM cohesion and increase water solubility of solid-phase OM. The (-)CAHB, exemplified by structures such as (-CO2×××H×××O2C-)- and (-CO2×××H×××O-)-, may form between weak acids with similar proton affinity, and is shorter, more covalent, and much stronger than ordinary hydrogen bonds. Using a high-organic reference soil, we show that (-)CAHBs within the solid OM phase (intra-OM) are disrupted by solutions of aliphatic and aromatic acids, resulting in enhanced solubility of OM. The aromatic acids included naturally occurring plant exudate compounds. At constant pH and ionic strength, OM solubility increased with added organic acid concentration and molecular weight. Polar compounds incapable of forming (-)CAHBs, such as alkanols, acetonitrile, and dimethyl sulfoxide, were ineffective. Solubility enhancement showed behavior consistent with (-)CAHB theory and published observations—namely, i) that formate is more effective than acetate due to its tendency to form stronger (-)CAHBs; ii) that solubility enhancement peaks at pH ~5-6, where the product of interacting carboxylate ion concentrations reaches a maximum; and iii) that elution of acetate or formate through soil columns releases hydroxide ion, consistent with formation of (-) CAHBs between added acid and free weak acid groups on the solid OM. The results support the hypothesis that the (-)CAHB contributes to the cohesion of OM in the solid state.

Soghigian, J., Andreadis, T.G., and **Molaei***, G., Population Genomics of Culiseta melanura, the Principal Vector of Eastern Equine Encephalitis Virus in the United States. PLoS Neglected Tropical Diseases, https://doi.org/10.1371/journal.pntd.0006698; Published: August 17, 2018.

Abstract- Eastern Equine Encephalitis (EEE) (Togaviridae, Alphavirus) is a highly pathogenic mosquito-borne arbovirus that circulates in an enzootic cycle involving Culiseta melanura mosquitoes and wild Passeriformes birds in freshwater swamp habitats. Recently, the northeastern United States has experienced an intensification of virus activity with increased human involvement and northward expansion into new regions. In addition to its principal role in enzootic transmission of EEE virus among avian hosts, recent studies on the blood-feeding behavior of Cs. melanura throughout its geographic range suggest that this mosquito may also be involved in epizootic / epidemic transmission to equines and humans in certain locales. Variations in blood feeding behavior may be a function of host availability, environmental factors, and/or underlying genetic differences among regional populations. Despite the importance of Cs. melanura in transmission and maintenance of EEE virus, the genetics of this species remains largely unexplored. To investigate the occurrence of genetic variation in Cs. melanura, the genome of this mosquito vector was sequenced resulting in a draft genome assembly of 1.28 gigabases with a contig N50 of 93.36 kilobases. Populations of Cs. melanura from 10 EEE virus foci in the eastern North America were genotyped with double-digest RAD-seq. Following alignment of reads to the reference genome, variant calling, and filtering, 40,384 SNPs were retained for downstream analyses. Subsequent analyses revealed genetic differentiation between northern and southern populations of this mosquito species. Moreover, limited fine-scale population structure was detected throughout north-

eastern North America, suggesting local differentiation of populations but also a history of ancestral polymorphism or contemporary gene flow. Additionally, a genetically distinct cluster was identified predominantly at two northern sites. This study elucidates the first evidence of fine-scale population structure in Cs. melanura throughout its eastern range and detects evidence of gene flow between populations in northeastern North America. This investigation provides the groundwork for examining the consequences of genetic variations in the populations of this mosquito species that could influence vector-host interactions and the risk of human and equine infection with EEE virus.

Stoffer-Bittner, A.J., **Dingman, D.W.**, Mourad, G.S., **Schultes, N.P.** (2018) Functional characterization of the uracil transporter from Honeybee pathogen *Paenibacillus larvae* Microbiol. Path. 124: 305-310.

Abstract- The genome of the Honeybee bacterial pathogen, *Paenibacillus larvae*, encodes for protein a with substantial amino acid sequence similarity to the canonical *Escherichia coli* uracil transporter UraA. *P. larvae* expresses the uracil permease (*PlUP*) locus, and is sensitive to the presence of the toxic uracil analog 5-fluorouracil under vegetative growth conditions. The solute transport and binding profile of PlUP was determined by radiolabeled uptake experiments via heterologous expression in nucleobase transporter-deficient *Saccharomyces cerevisiae* strains. PlUP is specific for the transport of uracil and competitively binds xanthine and uric acid. Further biochemical characterization reveals that PlUP has a strong affinity for uracil, Km 0.09 μM, however has a low affinity for uric acid, Ki 336 μM. Uracil transport is diminished in the presence of the proton disruptor carbonyl cyanide m-chlorophenylhydrazone, but not by the sodium gradient disruptor Ouabain.

White, J.C.; Gardea-Torresdey, J. 2018. Nanotechnology and agriculture: The path to food security may be through the very small. *Nature Nano*. 13:627:629.

Abstract-Nanotechnology could make agriculture more efficient and more sustainable, but more systematic understating of the mechanisms involved is necessary to prove the potential of nano-enabled agrochemicals. With a projected global population of 9.7 billion by 2050, agricultural production will need to increase by up to 60%, making achieving and sustaining global food security among the most significant 'grand challenges' we face. Further confounding this effort is the fact that this growth in food production will have to occur in the face of a changing climate and on decreasing acreage of arable land. Ideally, the strategies driving this effort will also need to be sustainable, efficiently using water and energy resources, while minimizing negative environmental impacts. One of the major shortcomings of current agricultural practices is the high inefficiency of agrochemical delivery and utilization, with losses averaging 10–75% presenting a prime target for improvement. As such, there has been significant interest over the past decade in using nanotechnology to address these inefficiencies. From areas of research such as materials synthesis, nanomedicine, and electronics, it is known that substances at the nanoscale behave differently, including being more reactive and mobile, and potentially biocompatible. It is, thus, clear that many of the novel properties afforded to materials at the nanoscale may be of direct benefit for reducing the inefficiencies currently plaguing agricultural production.

Zhang, L.; Lei, C.; Yang, K.; **White, J.C.**; Lin, D. 2018. Cellular response of *Chlorella pyrenoidosa* to oxidized multi-walled carbon nanotubes. *Environ. Sci.: Nano*. DOI: 10.1039/C8EN00703A.

Abstract- Although a number of reports have demonstrated potentially significant toxicity upon exposure to carbon nanotubes (CNTs), the interaction of

these materials with microalgae and the resulting physiological responses are largely unknown. This study investigated the interaction between oxidized multi-walled CNTs (o-MWCNTs) and algal cells (Chlorella pyrenoidosa), with a focus on assessing CNTs cellular internalization, as well as physiological and molecular response to exposure. The results show that o-MWCNTs exhibited greater algal toxicity than pristine MWCNTs and that toxicity was positively correlated with increasing oxidation level of the o-MWCNTs. This enhanced toxicity was closely related to the greater agglomeration of o-MWCNTs with algal cells. CNTs attachment to cell surface facilitated internalization by both direct penetration and by endocytosis. Algal cells did experience increased antioxidant defense upon CNT exposure/stress. Additional cellular responses included regulation of cell membrane fluidity and osmotic pressure, forming polyphosphate bodies, accumulating neutral lipids, and stimulation of cell division and the pentose phosphate pathway. When the protective responses were exhausted, toxicity in the form of membrane and organelle damage, denaturation of macromolecules, and metabolic disturbance occurred, resulting in compromised cell integrity and eventual death. The findings of this work provide new insight useful for understanding the fate and toxicity of CNTs in aquatic environments.

Zuverza-Mena, N.; **White, J.C**. 2018. Engineered nanomaterials in terrestrial systems: Interactions with co-existing contaminants and trophic transfer. *Curr. Op. Environ. Sci. Health* 6:60–65.

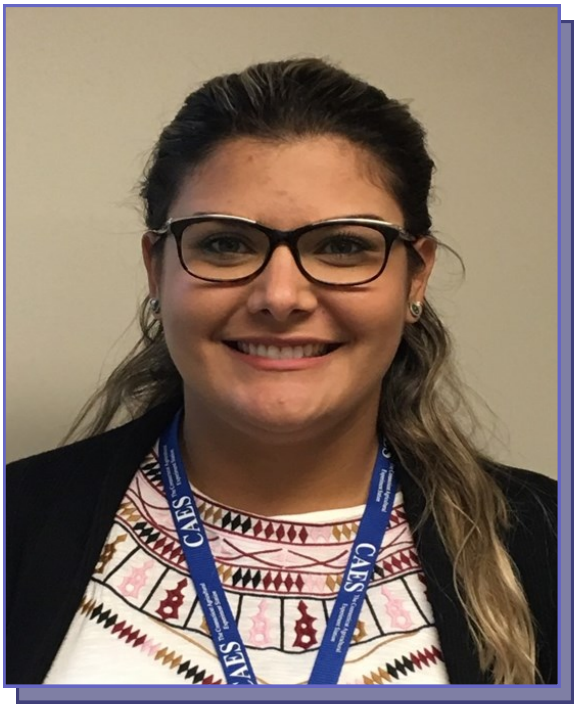
Abstract- Engineered nanomaterials (ENMs) are being introduced to soils and can interact with co-existing contaminants. The impacts of ENMs/co-contaminant exposure on plants are highly variable. Interactions of carbon- or metal-based ENMs with pollutants often result in a decreased co-contaminant toxicity, but are species- and exposure-scenario dependent. Moreover, current research suggests that it is possible for ENMs to be transferred through the food chain. This work presents an overview of the current efforts that have been made to understand the role of ENMs in the fate of other chemicals in terrestrial environments and the impacts on higher trophic levels.

JOURNAL ARTICLES APPROVED AUGUST 2018

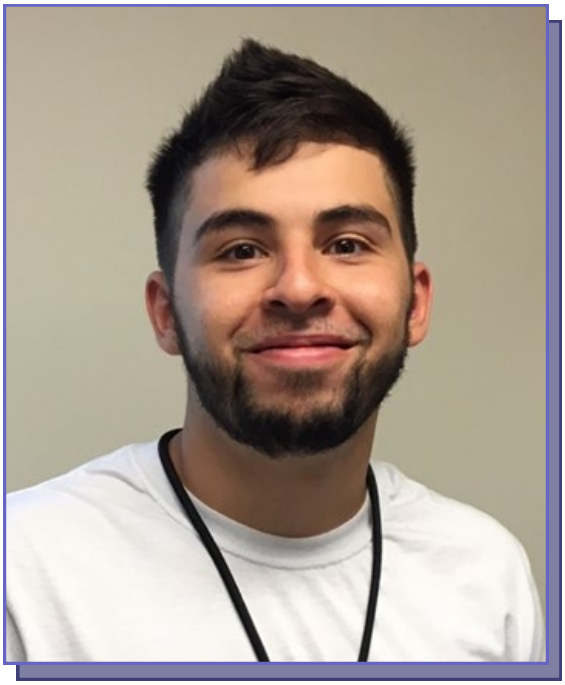
Adisa, I., V. L. R. Pullagurala, J. R. Peralta-Videa, C. O. Dimkpa, **Chuanxin Ma**, **Wade H. Elmer**, J. L. Gardea-Torresdey, and **Jason C. White**. Engineered nanomaterials as plant fertilizers and pesticides: Emerging opportunities with lower environmental impacts. *Environmental Science: Nano*

Zhao, L., Z. Zhang, J. Wang…**Jason C. White**, et al. $C_{60}(OH)_{24}$ nanoparticle exposure to cucumber (*Cucumis sativus*): Cell membrane compositional changes and altered metabolite and protein profiles. *ACS Nano*

NEW STAFF, STUDENTS, AND VOLUNTEERS AUGUST 2018



Ms. Júlia Marques Oliveira joined Dr. Elmer's laboratory as to perform part of her Ph.D thesis research. Júlia is from Brazil and is enrolled as a Ph.D candidate at Universidade Federal de Lavras (UFLA) in Lavras, Brazil. She has been awarded funding through the Doctoral Sandwich Program Abroad. She will continue the investigation of the role of nanoparticles on soybean sudden death syndrome.



Mr. Isaac Diaz has joined Dr. Wade Elmer's Laboratory as student intern. Isaac is a rising senior at Central Connecticut State University and is interested in abiotic stress resistance of crops. Along with assisting in ongoing studies, Isaac will work on the role of nanoparticles on plant stress caused by drought and disease.

CAES

The Connecticut Agricultural Experiment Station

Putting Science to Work for Society since 1875

The Connecticut Agricultural Experiment Station

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