**W-4045 Technical Committee Annual Report 2022**

**Agrochemical Impacts on Human and Environmental Health: Mechanisms and Mitigation**

Chair: Susanne Brander, Ph.D., Oregon State University

Past Chair: Kevin Armbrust, Ph.D., Louisiana State University

Secretary: Daniel Snow, Ph.D., University of Nebraska, Lincoln

**2022 Annual Meeting Summary: Monday June 6th – Wednesday 8th 2022**

The 2022 Annual Meeting was held at the University of Nebraska, Lincoln Innovation Campus. On Monday evening after a casual introductory dinner at the Scarlett Hotel, review teams met to review W-4045 project reports. The review teams evaluated the reports with a focus on and high regard for clarity, scientific merit/quality, impact, and collaboration with other W-4045 members.

**Participant List**

Daniel Snow (meeting host) Professor, W-4045 Secretary, Meeting Host, Nebraska Agricultural Experiment Station, University of Nebraska, Lincoln

Bisoondat Macoon Program Leader, Nebraska Agricultural Experiment Station, University of Nebraska, Lincoln

Hector Santiago Assistant Dean, Agricultural Research Division, Assistant Director, Nebraska Agricultural Experiment Station, University of Nebraska, Lincoln

Chris Pritsos Director Nevada Agricultural Experiment Station, Associate Dean of Research, University of Nevada Reno

Kevin Armbrust Professor, Past W-4045 Project Lead, Louisiana State University

Jeff Jenkins Professor, Oregon State University

Qing Li Professor, University of Hawaii

Daniel Schlenk Professor, University of California Riverside

Rafael Muñoz-Capana University of Florida

Susanne Brander Associate Professor, New W-4045 Project Lead, Oregon State University

Laura Basirico Research Associate, Lousiania State University

Arindam Malakar Assistant Professor, University of Nebraska Lincoln

Kiranmavi Mangalgiri Assistant Professor, Oklahoma State University

Tiffany Messer Assistant Professor, University of Kentucky

Frederik Michel Professor, Ohio State University

Danesha Seth Carley Associate Professor, North Carolina State University

**Meeting Summary**

The meeting began at 8:30 AM with introductory remarks from the hosts, Dan Snow, Chris Pritsos, and Chair, Kevin Armbrust. At 8:45 AM we heard comments from NIFA National Program Leader, Institute of Food Production and Sustainability, Division of Plant Systems – Production; Bisoondat Macoon. We then were graciously welcomed at 9:15 AM by Hector Santiago, Assistant Dean, Agricultural Research Division and Assistant Director, Nebraska Agricultural Experiment Station.

Project Reviews began about 9:45 AM and continued in the afternoon following the schedule in the attached meeting agenda. Reviews consist of a brief overview (no slides) by the project report author followed by a review summary by the lead reviewer for the team, other team input, and open discussion. Participant reviews were punctuated by 10 minute presentations (with slides), with 5 minutes for questions, for new member candidates: Daniel Schlenk (UC Riverside), Rafael Muñoz-Capana (Florida), Arindam Malakar (Nebraska), and Kiranmayi Mangalgiri (Oklahoma). We were excited to welcome them all, introductions and report reviews as well as ensuing discussions all went well.

Following the new member presentation there was a vote by W-4045 members present to accept all presenters into W-4045.

At 9:00 AM on Tuesday the W-4045 business meeting was convened by Chris Pritsos. The 2021 meeting minutes were approved.

Chris Pritsos and Kevin Armbrust led a discussion on application for a regional award, due in early 2023. Susanne Brander offered to help lead the application. Others who volunteered included Kevin Armbrust and Dan Snow.

Kevin Armbrust officially stepped down as Chair and the group thanked him profusely for his years of service. Susanne Brander who had assumed the role of Secretary for 2022 will now become Chair for the next two years, and Dan Snow will begin two year period as Secretary. It was voted that the 2022 meeting will be hosted by the University of Nebraska. The meeting date was tentatively scheduled for June 6-8, 2022.

The group thanked Dan Snow for the meeting at UNL, which was incredibly well run, everyone thoroughly enjoyed their time in Lincoln, Nebraska. Qing Li tentatively agreed to host the 2023 meeting in Hawaii, and will look into arrangements. He plans to update Brander and other W4045 members in late summer. The group also is making plans to apply for the regional award and possibly a national level award as well. The meeting was adjourned at 11:30 AM on June 8th, 2022.

**Report review summaries 2022**

Report review summaries below represent work from each W-4045 member present at the annual meeting, as well as their colleagues and collaborators.

Frederick C. Michel - Ohio State University

*Title:*Survey of Composts for Herbicide Phytotoxicity and Development of a Novel Bioassay for Persistence Herbicides in Composts

Accomplishments

Persistent herbicides (PH) pose an existential threat to commercial, municipal and community composting, and to the emerging circular economy. PH have been found in composts in many states and have cost compost producers millions of dollars. Common garden plants including tomato and bean are sensitive to these compounds at concentrations below 10 ppb. Chemical analysis is inconsistent and requires expensive liquid chromatography and mass spectrometry equipment, as well as highly trained analytical chemists, to detect in composts at these concentrations. Various different bioassays have been developed for the detection of these compounds. Methods differ in plant species used, watering methods, mix ratios, and rating systems. In this project, a tomato bioassay was used to survey compost samples from 2021 for herbicide toxicity and plant growth. Chemical and physical properties, stability and other properties for 72 composts were also measured. Aspects of previous bioassay methods were used to create an easy-to-use bioassay for producers. It uses peat moss and compost mixes with soil blocks in planting trays to allow large numbers of samples to be assayed at once with reduced effort for watering and lighting. Soil blocks proved to be effective at measuring PH at ppb levels. This approach is being developed as a fair and measured approach that can be used by compost producers to screen ready to sell compost for potential PH contamination.

Impact Statement

• \_Composting facilities, and gardeners using composts, have reported phytotoxity symptoms such as poor growth, leaf cupping and loss of apical dominance consistent with herbicide contamination.

• \_These have been attributed to a class of herbicides known as Persistent Herbicides (PH) that includes clopyralid, picloram, aminopyralid, quinclorac and aminocyclopyrachlor present at very low concentrations (<10 ppb).

• \_The rates of decomposition and the effects of composting temperatures on the transformation of these compounds during composting are not well known.

• \_Reported here are a survey of growth response of composts collected in 2021 from the US and Canada and the development of a simplified bioassay for PH that can be used to measure the phytotoxicity of multiple compost samples.

• \_By combining information about the rates of transformation, initial concentrations in crops to which these compounds are applied, feedstocks upon which they are found, and low-cost bioassays for their detection in composts, strategies to minimize their impacts on crops grown using composts can be developed.

Kevin Armbrust – Louisiana State University

*Title:*Refinement of the State of California’s Pesticide Evaluation Protocol to better characterize

concentrations and biological effects of current use pesticides in the State’s Irrigated Lands

Regulatory monitoring program

Accomplishments

The Central Valley Regional Water Quality Control Board (Regional Board) uses a permitting

process to regulate municipalities, businesses, and industries whose discharge practices could

impact the quality of surface and ground waters in the Central Valley. Discharges from irrigated

agricultural lands are permitted under the Regional Board’s Irrigated Lands Regulatory Program

(ILRP), a program designed to ensure that agricultural operations do not impair water quality.

Growers are required to work either individually or through local water-quality coalitions to

comply with discharge permit requirements, including preventing sediment, fertilizer, pesticides,

manure and other materials used or mobilized by agricultural activities from leaving the field via

spray drift, irrigation runoff, stormwater runoff or other processes. In 2012, the Regional Board

adopted a Waste Discharge Requirements General Order that implemented the ILRP within the

Eastern San Joaquin River Watershed (ESJ) region. The 2012 General Order requires the

approximately 3,300 growers represented by the ESJ Water Quality Coalition (the Coalition) to

administer a water-quality monitoring program known as the ESJ Surface Water Monitoring

Program (the Program). The Program, which is ongoing, assesses water quality using chemistry

and toxicity testing through the range of agricultural conditions spanning a year; the overarching

goal is to detect agricultural chemicals that exceed water quality objectives, document changes in

condition over time, implement practices that address water quality impairment, and measure the

effectiveness of management actions to improve water quality. Following adoption of the General Order for the ESJ region in 2012, members of the environmental community filed petitions with the State Water Resources Control Board (State Board) challenging the adequacy of numerous aspects of the General Order, including the Program’s design and reporting requirements. The petitioners contended that the Program’s monitoring and reporting requirements do not support the feedback mechanism necessary for the Regional Board to determine if required management practices have a high likelihood of achieving receiving water-quality objectives. In response, the Coalition submitted an evaluation contending the Program is adequate and appropriate for protecting water quality. The State Board reviewed the matter and, in 2018, issued a General Order directing the Regional Board to establish a public external expert review process for assessing the competing Program evaluations. In response, the Regional Board asked the Southern California Coastal Water Research Project Authority (SCCWRP), a public agency serving the water-quality management community, to convene and facilitate this panel review process. The Panel’s overarching charge was to evaluate the Program’s existing monitoring and assessment framework and make recommendations for improvements and/or corrections as needed.

Impact Statement

This work contains findings and recommendations of an expert panel, of which the

Project leader was a participant, to refine the State of California’s Pesticide Evaluation Protocol

to better characterize concentrations and biological effects of current use pesticides in the State’s

Irrigated Lands Regulatory monitoring program. The recommendations are planned to be

incorporated into future monitoring designs. Analytical chemistry recommendations for method

validation supporting use of non-standard methods have already been adopted and in use by State

Water Boards for imidacloprid.

Publications

1. Hutton, S.J. , S. St. Romain, E. Pedersen, S. Siddiqui, P. Chappell, J. White, K. Armbrust and S.Brander. (2021). Salinity Alters Toxicity of Commonly Used Pesticides in a Model Euryhaline Fish Species (Menidia beryllina). Toxics. 9(5):114
2. Smith, P.N., K. Armbrust, R. Brain, W. Chen, N. Galic, L. Ghebremichael, J. Giddings, M. Hanson, J. Maul, G. Van Der Kraak, and K. Soloman. (2021). Assessment of Risks to Listed Species from the Use of Atrazine in the USA. Journal of Toxicology and Environmental Health, Part B: Critical Reviews. (July:1). <https://doi.org/10.1080/10937404.10932021.11902890> LOUISIANA - Armbrust p. 7
3. Xu, W. E. Vebrosky, K. Armbrust. (2020). Potential Toxic Effects of 4-OH-Chlorothalonil Degradation Product on Human Skin Health. Journal of Hazardous Materials. 394:122575. https://doi.org/10.1016/j.jhazmat.2020.122575

Qing Li – University of Hawaii

*Title:* Pesticide research and development: General discussion and spinosad case.

Accomplishments

On average, it has taken approximately 10 years and $250 million to discover and develop one pesticide out of approximately 100,000 compounds. A successful pesticide researcher nowadays should be knowledgeable and skillful in multiple scientific disciplines. Due to the high costs and unique requirements, only a handful of companies in the world can afford to continue discovering new molecules as pest control agents for this $70 billion pesticide market. Pesticide research and development (R/D) is a high-risk and yet high-reward business. In this perspective, general pesticide R/D is briefly discussed and a case study is used to illustrate how spinosad was discovered to beat the odds and became a successful product despite the many challenges facing pesticide R/D.

Impact Statement

Safe and effective pesticides are essential for agriculture. Fermentation pesticide R/D reports are few. Sipnosad discovery is used as a case study to illustrate how dereplication in fermentation pesticide R/D was carried out. Dereplication is a strategy to recognize and eliminate the active substances already studied in the early stage of the screening process. This perspective hopefully can rekindle the enthusiasm in pesticide discovery through fermentation.

Publications

1. Chen, M.; Liu, S.; Yuan, X.; Li, Q.X.; Wang, F.; Xin, F.; Wen, B. 2021. Methane production and characteristics of the microbial community in the co-digestion of potato pulp waste and dairy manure amended with biochar. *Renewable Energy* 163: 357-367. DOI: 10.1016/j.renene.2020.09.006

2. Wang, X.; Murison, J.; Wang, J.; Leong, G.; Wu, Z.; Li, Q.X. 2021 Dermal exposure assessment to trinexapac-ethyl: a case study of workers in golf course in Hawaii, USA. *Environmental Science and Pollution Research 28*(1):1072-1076. DOI: 10.1007/s11356-020-10566-w. PMID: 32829436

3. Fang, L.; Xu, Y.; Xu, L.; Shi, T.; Ma, X.; Wu, X.; Li, Q.X.; Hua, R. 2021. Enhanced biodegradation of insecticides in industrial wastewater via immobilized *Cupriavidus nantongensis* X1T. *Science of the Total Environment 755*: 142505. DOI: 10.1016/j.scitotenv.2020.142505

4. Tan, X.; Liang, Z.; Zhi; Y.; Lang Yi; Bai, S.; Forest, K.H.; Nichols, R.A.; Dong, Y.; Li, Q.X. 2021. Isoorientin, a GSK-3\_β \_i\_n\_h\_i\_b\_i\_t\_o\_r\_,\_ \_r\_e\_s\_c\_u\_e\_s\_ \_s\_y\_n\_a\_p\_t\_i\_c\_ \_d\_y\_s\_f\_u\_n\_c\_t\_i\_o\_n\_,\_ \_spatial memory deficits and attenuates pathological progression in APP/PS1 model mice. *Behavioural Brain Research 398*: 112968. PMID: 33069740. DOI: 10.1016/j.bbr.2020.112968

5. Yuan, M.; Zhao, H.; Huang, Q.; Liu, X.; Zhou, Y.; Diao, X.; Li, Q.X. 2021. Comparison of three palm tree peroxidases expressed by *Escherichia coli*: uniqueness of African oil palm peroxidase. *Protein Expression and Purification 179*: 105806. PMID: 33301885. DOI: 10.1016/j.pep.2020.105806

6. Huang, B.; Jiao, Y.; Zhu, Y.; Ning, Z.; Ye, Z.; Li, Q.X.; Hu, C.Y.; Wang, C. 2021. Mdfi promotes C2C12 cell differentiation and positively modulates fast-to-slow-twitch muscle fibers transformation. *Frontiers in Cell and Developmental Biology, section Signaling 9*: 605875. DOI: 10.3389/fcell.2021.605875

7. Cao, J.; Wang, W.; Zhao, Z.; Liu, X.; Li, Q.X. 2021. Genome, metabolic pathways and characteristics of cometabolism of dibenzothiophene and the biodiesel byproduct glycerol in

*Paraburkholderia* sp. C3. *Bioresource Technology 326*: 124699. PMID: 33535150. DOI: 10.1016/j.biortech.2021.124699

8. Wu, S.; Ma, F.; He, J.; Li, Q.X.; Hammock, B.D.; Tian, J.; Xu, T. 2021. Fusion expression of nanobodies specific for the insecticide fipronil on magnetosomes in *Magnetospirillum gryphiswaldense* MSR-1. *Journal of Nanobiotechnology* 19(1): 1-9. DOI: 10.1186/s12951-021-00773-z

9. Nzila, A.; Musa, M.M.; Sankara, S.; Al-Momani, M.; Xiang, L.; Q.X. Li. 2021. Degradation of benzo[a]pyrene by halophilic bacterial strain *Staphylococcus haemoliticus* strain 10SBZ1A. PLoS ONE 0247723. DOI: 10.1371/journal.pone.0247723

10. Cho, I.K.; Lee, S.E.;·Chang, C.L.; Li, Q.X. 2021. Dietary vitamin B3 deficiency suppresses the formation of ocular depression and up-regulation of optomotor-related blind gene-1 in Mediterranean fruit fly larvae. *Analytical Science Advances* 2: 416–426. DOI: 10.1002/ansa.202100017

11. Fang, L.; Xu, L.; Zhang, N.; Shi, Q.; Shi, T.; Ma, X.; Wu, X.; Li, Q.X.; Hua, R. 2021. Enantioselective degradation of the organophosphorus insecticide isocarbophos in *Cupriavidus nantongensis* X1T: characteristics, enantioselective regulation, degradation pathways, and toxicity assessment. *Journal of Hazardous Materials 417*: 126024. PMID: 33992014.

12. Qu, R.-Y.; He, B.; Yang, J.-F.; Lin, H.-Y.; Yang, W.-C.; Wu, Q.-Y.; Li , Q.X.; Yang, G.-F. 2021. Where are the new herbicides? *Pest Management Science 77*(6): 2620-2625. DOI: 10.1002/ps.6285

13. Wang, X.; Li, Q.X.; Heidel, M.; Wu, Z.; Yoshimoto, A.; Leong, G.; Pan, D.; Ako, H. 2021 Comparative evaluation of industrial hemp varieties: field experiments and phytoremediation in Hawaii. *Industrial Crops and Products 170*: 113683. DOI: 10.1016/j.indcrop.2021.113683

14. Zhu, M.; Ou, X.; Tang, J.; Shi, T.; Ma, X.; Wang, Y.; Wu, X.; Li, Q.X.; Hua, R. 2021. Uptake, distribution and translocation of imidacloprid-loaded fluorescence double hollow shell mesoporous silica nanoparticles and metabolism of its released imidacloprid in pakchoi. *Science of the Total Environment 787*: 14578. DOI: 10.1016/j.scitotenv.2021.147578

15. Baek, S.J.; Hammock, B.; Hwang, I.K.; Li, Q.X.; Moustaid-Moussa, N.; Park, Y.; Safe, S.; Suh, N.; Yi, S.S.; Zeldin, D.C.; Zhong, Q.; Bradbury, J.A.; Edin, M.L.; Graves, J.P.; Jung, H.Y.; Jung, Y.H.; Kim, M.-B.; Kim, W.; Lee, J.; Li, H.; Moon, J.S.; Yoo, I.D.; Yue, Y.; Lee, J.-Y.; Han, H.J. 2021. Natural products in the prevention of metabolic diseases: Lessons learned from the 20th frontier scientists workshop. *Nutrients 13*(6): 1881. DOI: 10.3390/nu13061881

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18. Yu, P.-F.; Li, Y.-W.; Zou, L.-J.; Liu, B.-L.; Xiang, L.; Zhao, H.-M.; Li, H.; Cai, Q.-Y.; Hou, X.-W.; Mo, C.-H.; Wong, M.H.; Li, Q.X. 2021. Variety-selective rhizospheric activation, uptake, and subcellular distribution of perfluorooctanesulfonate (PFOS) in lettuce (*Lactuca sativa* L.). *Environmental Science and Technology* 55, 13, 8730–8741. PMID: 34169723. DOI: 10.1021/acs.est.1c01175

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20. Wang, W.; Gao, D.; Zheng, Q.; Zhao, X.; Na, R.; Wan, X.; Li, Q.X. 2021. Interactions of isoorientin and its semi-synthetic analogs with human serum albumin. *Bioorganic Chemistry 116*: 105319. DOI: 10.1016/j.bioorg.2021.105319

21. Huang, B.; Jiao, Y.; Zhu, Y.; Ning, Z.; Ye, Z.; Li, Q.X.; Hu, C.Y.; Wang, C. 2021. Putative microRNA-mRNA networks upon Mdfi overexpression in C2C12 cell differentiation and muscle fiber type transformation. *Frontiers in Cell and Developmental Biology, section Protein and RNA Networks 8*: 675993. DOI: 10.3389/fcell.2021.605875

22. Zhang, Z.; Wang, Z.; Li, Q.X.; Hua, R.; Wu, X. 2021. Enantioselective metabolism of phenylpyrazole insecticides by rat liver microsomal CYP3A1, CYP2E1 and CYP2D2. *Pesticide Biochemisry and Physiology 176*: 104861. DOI: 10.1016/j.pestbp.2021.104861

Brian Richards – Cornell University

Title: Glyphosate runoff from hydrologically-active fields: field-scale monitoring, and the role of washoff from surface plant biomass

Accomplishments

High-frequency edge-of-field monitoring sampling of outflow from a switchgrass (*Panicum virgatum* L.) field site has shown losses of dissolved glyphosate ((N-(phosphonomethyl)glycine) herbicide ranging from 0.15 to 8.5 percent of applied active ingredient. Losses are greatest when a mobilizing rain event occurs within several days of spraying. We are continuing to monitor these field scale sites and are working to concurrently determine the potential role of washoff of spray from plant canopies and/or plant residues in this observed mobilization.

Impact Statement

We are measuring the events and field conditions that contribute to dissolved glyphosate loss in runoff from croplands, with a view toward designing practices to reduce these losses from farm fields.

Publications

Brindt, Naaran, Steven Pacenka, Brian K Richards, Srabani Das, Anna L. Schatz, Cathelijne R. Stoof, Abeyou W. Worqlul, Fasikaw A. Zamale, Zain Azzaino, Tammo S. Steenhuis. 2022. Self-Organizing Hydrological Processes in Runoff Source Areas. *Catena DOI: 10.1016/j.catena.2021.105955*

Jeff Jenkins – Oregon State University

*Title:* Using *Daphnia Magna* to Assess Chlorpyrifos Risk to Aquatic Receptors at the Landscape Scale

Accomplishments

Pesticides are subject to atmospheric and hydrologic transport from sites of application to aquatic ecosystems. Across the landscape, concentrations in surface water can vary spatially and temporally according to ecohydrology and seasonal use practices. While bioassays can provide a screening-level understanding of toxicity, impact on aquatic receptors should consider exposure pulse magnitude, duration, and frequency. Characterizing risks to non-target aquatic organisms related to pesticide exposure requires complex spatial and temporal information on life history and ecology, as well as pesticide use patterns and environmental fate. Probabilistic methods can be used to characterize realistic pesticide use practices while hydrologic models can simulate transport from the application sites to aquatic ecosystems allowing for spatial and temporal estimation of exposure, and a biologically based effects assessment can simulate aquatic receptor response and recovery to an estimated exposure scenario. For this study, use practices of the organophosphate insecticide chlorpyrifos (CPF) were characterized in the Zollner Creek watershed in the Willamette Valley, OR between 2010 and 2011. The Soil and Water Assessment Tool (SWAT) was used to simulate the fate and transport of CPF and estimate daily aqueous exposure concentrations at the watershed outflow. Two-year continuous Daphnia magna CPF body burden was estimated based on modeled environmental concentrations and CPF uptake and depuration rates. Daily, 48h time-weighted average (TWA), and 21d TWA of D. magna internal doses were compared to lethal dose values (LDx) from the corresponding dose-response curves to estimate mortality.

Impact Statement

* 1. \* Pesticide surface water monitoring beginning in the 1970’s has resulted in pesticide detections throughout Oregon's agricultural production regions.
	2. \* Surface water monitoring programs should be integrated with modeling in selecting mitigation strategies to reduce pesticide surface water loading.
	3. \* Past reports have focused on the application of the Soil and Water Assessment Tool (SWAT) to rapidly evaluate mitigation measures at the watershed scale.
	4. \* Reported here is a 2-yr probabilistic application of SWAT to estimate a likely range of chlorpyrifos daily surface water concentrations that in turn allow daily estimates of D. magna internal dose for comparison to corresponding dose-response curves to estimate mortality, an indicator of potential population level impacts.
	5. \* By combining institutional and local knowledge and expertise, this application of SWAT serves as an integrative technology in facilitating stakeholder implementation of alternative pest management practices and BMPs that meet both production and environmental protection goals.

Publications

1. Maggio, S.A. and J.J. Jenkins. 2022. Multi- and trans-generational effects of chlorpyrifos exposures to Daphnia magna. Environ. Toxicol. Chem.Vol 41, p. 1054-1065, https://doi.org/10.1002/etc.5283.
2. Janney, P. K., J. J. Jenkins. 2022. Passive sampling and ecohydrologic modeling to investigate pesticide surface water loading in the Zollner Creek watershed, Oregon, USA. Science of the Total Environment. Vol 819, 1 May 2022, 152955.

Laura Basirico – Louisiana State University

*Title:* Identification and characterization of non-petroleum oils in support of emergency response

and ecosystem assessment

Accomplishments

With the advent of containerized trade and global supply chains, oceans have become

increasingly important transport routes for cargo ships. The volume of seaborne trade has nearly

doubled over the past 20 years, reaching 11 billion tons loaded in 2019. The upward trend

continues with an estimated 80 percent of goods transported by ship in 2021 [1]. In addition to

conventional fuels like crude oils and distillate fuels, there is an increase in the global production

and export of non-petroleum oils for use in alternate energy applications. Palm oil production

and export has increased with 48.9 million tons of the product transported in 2016. Asia is

responsible for two-thirds of global palm oil consumption with the EU and the United States

accounting for about 15%, largely for biofuels production [2]. Even as non-petroleum oils are a

growing component of global bulk transport, there are minimal data on the chemical and

physical properties of these oils. The increase in global transport as well as recent spill incidents

involving non-petroleum products highlight the need for advancements in extraction methods

and analytical identification of biogenic and non-petroleum oils. The current research attempts to

supplement existing literature with chemical profiles for high priority non-petroleum oils and

build a reference library of non-petroleum oils to aid in source identification of spilled

substances.

Impact Statement

The results of this work are currently implemented by the Emergency Response Division (ERD)

of the National Oceanic and Atmospheric Administration (NOAA), to support emergency

response decision making (including identifying responsible parties and the fate and effect of

spilled materials) in the event of spill incidences of non-petroleum oils.

Publications

1. Vebrosky, E. N., Basirico, L. M., Armbrust, K. L. (2019). Degradation of Dicloran in irradiated water-sediment systems. Journal of Agricultural and Food Chemistry 67(27), 7609-7615.
2. Warr, L. N., Scluter, M., Schauer, F., Olson, G.M., Basirico, L.M., Portier, R.J. (2018). Nontronite-enhanced biodegradation of Deepwater Horizon crude oil by Alcanivorax

borkumensis. Applied Clay Science 158, 11-20.

Laura McConnell – Bayer, Inc.

*Title*: Regulatory Scientific Affairs and Environmental Safety Teams at Bayer Crop Science

Accomplishments

**OpenLabs** – Inside a Bayer residue study performed under Good Laboratory Practice (GLP) - https://openlabs.cropscience.bayer.com/ OpenLabs invites you to observe a real-life regulatory study in Bayer Crop Science laboratory through a 360o digital platform. I would love to get your feedback on this project.

**Transparency: Product Safety Study Results**

Beginning in 2017, Bayer was the first in the industry to begin making crop protection product safety study summaries available on-line. These summaries are the same as those submitted to the European Food Safety Authority. Full study reports are available upon request, or if you have further questions, you can submit a contact form.

We have now made available our genetically modified crop seeds and traits safety study documents. In addition, we have made available the scientific approach we use to assess risks to operators (users, applicators).

**Glyphosate Renewal Group Website** - https://www.glyphosate.eu/

Glyphosate is currently under review for renewal in Europe. In June 2020 a dossier was submitted to European Food Safety Authority. The companies involved with the registration of glyphosate in Europe (including Bayer) have made public all the regulatory documents and scientific publications that are required for renewal, including study reports and summaries of 100 new safety studies. It also includes information from a review of 12,000 scientific public literature articles

Impact Statement

Over the last year, I have been involved with several internal projects to improve coordination of Bayer scientists participating in scientific societies. I have also been working to develop strategic initiatives to improve the quality of external engagement. For example, we developed a custom website for use at SETAC Europe (https://express.adobe.com/page/WC8FXNHGstaPm/) that allowed attendees to see the list and links to the more than 25 papers being presented by Bayer scientists. I have continued strong collaboration with NC State Center of Excellence for Regulatory Science in Agriculture (CERSA), and Bayer is collaborating with the new NC State Plant Sciences Initiative. I am also currently working on a digital resource for universities to find the right Bayer speaker for their seminar series or other event.

Publications

Not applicable

Tiffany Messer – University of Kentucky

*Title:* Pesticide Occurrence, Distribution, and Loading in Rivers with Varying Land Uses and Precipitation Regimes

Accomplishments

Neonicotinoids have become the most widely used insecticide group in the United States (U.S.), yet the overall contribution to water resources remains largely unknown. The objectives of this study were to: 1) quantify grab pesticide concentrations and annual load of selected insecticides and fungicides (e.g., acetamiprid, azoxystrobin, clothianidin, dimethoate, dinotefuran, imidacloprid, metalaxyl, picoxystrobin, pyraclostrobin, thiacloprid, thiamethoxam, and trifloxystrobin) and associated neonicotinoid degradation byproducts in two watersheds and 2) compare pesticides and associated potential byproduct occurrence, distribution, and loading rates with respect to seasonality and weather (e.g., flood and no flood year). The drainage area weighting method was utilized to determine pesticide mass loading in two distinct watersheds in the Southeastern and Midwestern U.S. In total, twelve sampling campaigns were conducted in the agriculturally dominated Elkhorn River watershed in northeast Nebraska at two sampling locations from 2019 to 2020, while three sampling campaigns were conducted in the urban/forested Neuse River watershed at three sampling locations in 2019. Polar organic chemical integrative samplers (POCIS) were deployed at each sampling sites for a period of 30 days, and grab water samples were collected at each time of POCIS collection. Pesticide load, occurrence, and distributions were statistically different between sampling method, sampling location, and sampling season. This study has direct implications on how pesticide fate and mass transport is predicted in river systems that have the potential to increase ecotoxicity risks and further deteriorate water quality for downstream users.

Impact Statement

Fate and transport mechanisms of pesticides in soil-water environments and their impact on water quality in urban and agricultural watersheds is an important component in water resource

management. Therefore, we are: 1) quantifying the annual load of selected insecticides and fungicides and associated degradation byproducts in two watersheds and 2) comparing pesticides and associated potential byproduct occurrence, distribution, and loading rates with respect to seasonality and weather (e.g., flood and no flood year). Pesticide load, occurrence, and distributions were statistically different between sampling method, sampling location, and sampling season. Findings from this study have direct implications on how pesticide fate and mass transport is predicted in river systems and provides guidance on the formation and fate and transport of toxic degradation products that have the potential to increase ecotoxicity risks and further deteriorate water quality for downstream users.

Publications

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Dan Snow – University of Nebraska, Lincoln (Co-I Arindam Malakar)

*Title:* Impact of geogenic trace contaminants present in soil and irrigation water on agricultural produce and their effective mitigation.

Accomplishments

Over 56 million acres of cropland are irrigated in the US. A large proportion is concentrated in areas with high natural but hazardous trace elements such as arsenic, selenium, and uranium in groundwater and soils. Crops grown in these soils are vulnerable to contamination, by uptake of these trace contaminants, which can be public health hazard. This project pursued to ensure food quality in irrigated crops by identifying nanoscale migration of trace contaminants at the rhizosphere and control contaminant mobility using a synthetic nanomineral soil amendment. Naturally occurring nanominerals of iron play a critical role in the bioavailability of contaminants and nutrients in irrigated unsaturated soils. Ubiquitous natural nanomineral of iron such as ferrihydrite in unsaturated irrigated soils was found to play critical role in controlling the uptake of trace contaminants. In this project, we identified the role of natural nanominerals of iron at the rhizosphere through a series of field experiments at two sites located in central and western Nebraska, with varied soil and climatic conditions. We identified the temporal nanomineral migration during growing seasons under different management practices. Controlled greenhouse experiments proved that natural nanominerals, when synthetically produced can be beneficial to crop production and limit trace contaminant uptake under both unsaturated and saturated conditions. The outcomes advanced understanding of the role of natural nanominerals in irrigated unsaturated soils and support synthetic 2-line ferrihydrite nanomineral soil amendment for reducing contaminant bioavailability and improving nutrient availability, water holding capacity, and promote healthy plant growth.

Impact Statement

Rapidly increasing population and living standard has resulted in a significant pressure to increase agricultural production from limited resources while at the same time make food safer for consumption. Soil and irrigation water used for crop production in many areas contains elevated levels of geogenic contaminants such as arsenic, cadmium, chromium, and uranium. Edible plants and crops are known to accumulate these trace elements leading to toxic exposure. This four-year study looked closely at mobilization and transfer of natural arsenic, uranium and selenium from soil or irrigation water to food and feed crops, which to date have not been well studied. Knowledge gained has greatly improve our understanding of the processes controlling geogenic contaminants and potential impacts to the health of humans and animals. Our team has developed a novel remediation approach based on natural iron nanomineral (ferrihydrite) which may be used as a cost-effective soil amendment. Integrating field & greenhouse experiments with chemical equilibrium modeling helped identify relevant geochemical reactions occurring at the root zone-soil-pore water interface controlling mobilization and bioavailability of uranium, selenium and arsenic. Results show contaminant uptake was reduced in different stages of plant development irrigated with water containing elevated concentrations of these elements, while at the same time improving nutrient stability in soil. Recent work has been focused on development of a commercial soil amendment for this purpose.

Publications

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3. P. Singh, P. Devi, **A. Malakar** and **D. D. Snow**, eds., *Selenium Contamination in Water*. Wiley, United Kingdom. **(2021)** DOI:10.1002/9781119693567
4. **A. Malakar**, S. R. Kanel, C. Ray, D. D. Snow and M.N. Nadagouda, Nanomaterials in the environment, human exposure pathway, and health effects: A review. *Science of The Total Environment*, 759, 143470. **(2021)**
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7. **A. Malakar**, D. D. Snow and C. Ray, Irrigation water quality – a contemporary perspective, *Water,* 11(7), 1482. **(2019)**

Susanne Brander – Oregon State University

*Title:* Comparative behavioral toxicology using the larval euryhaline fish, *Menidia beryllina*: An assessment of six pyrethroids at three salinities relevant to brackish water

Accomplishments

Pyrethroids, a class of commonly used insecticides, are frequently detected in aquatic environments, including estuaries. The influence salinity has on organism physiology and the physiochemical properties of hydrophobic chemicals, such as pyrethroids, has driven interest in how toxicity changes in saltwater compared to fresh. Early life exposures in fish to pyrethroids cause toxicity at environmentally relevant concentrations, which can alter behavior. Behavior is a highly sensitive endpoint that influences overall organism fitness and can be used to detect toxicity of environmentally relevant concentrations of aquatic pollutants. Inland Silversides, *Menidia beryllina*, a commonly used euryhaline model fish species were exposed from 5 days post fertilization (~1-day pre-hatch) for 96 hours to six pyrethroids: bifenthrin, cyfluthrin, cyhalothrin, cypermethrin, esfenvalerate and permethrin. Exposures were conducted at three salinities relevant to brackish, estuarine habitat (0.5, 2, and 6 PSU) and across 3 concentrations, either 0.1, 1, 10, and/or 100 ng/L, plus a control. After exposure, *M. beryllina* underwent a behavioral assay in which larval fish were subjected to a dark and light cycle stimuli to determine behavioral toxicity. Assessment of total distanced moved and thigmotaxis (wall hugging), used to measure hyper/hypoactivity and anxiety like behavior respectively, demonstrate that even at the lowest concentration of 0.1ng/L pyrethroids can induce behavioral changes at all salinities. We found that the pattern of toxicity differed across the three salinities. Additionally, we found evidence to suggest that log KOW influences the direction of thigmotaxis behavior at different salinities. Overall, this assessment of the six pyrethroids at three salinities demonstrates the largest assessment of pyrethroid toxicity under different abiotic conditions to date.

Impact Statement

Exposure to agrochemicals such as pesticides had been linked to endocrine disruption and developmental toxicity in fish, and the interaction of aquatic organisms with microplastics that can arise from agricultural activities (e.g. from mulch, biosolids) may cause adverse effects. We are continuing the evaluation of effects of pesticides, fungicides, and herbicides across a salinity gradient in the model fish *Menidia beryllina* (funded by the EPA and Delta Science)*,* and the occurrence and effects of micro and nanoplastics in fish and invertebrates, also across salinities. We are completing an evaluation of the occurrence of microplastics in wild-caught Oregon seafood sold at coastal markets and grocery stores (Oregon Sea Grant), some of which is likely introduced by agricultural activities, given the level of agricultural activity in the state. Over 90% of the particles found in seafood fillets analyzed in this study are microfibers. Previous work from my research group has documented adverse effects of agrochemicals on early life stages of fishes that can propagate throughout multiple generations, and also indicates that the toxicity of exposures to agrochemicals and microplastics can differ depending on environmental conditions (e.g. salinity, temperature). Current investigations involve the development of new *in vivo* and *in vitro* assays to measure sublethal toxicity of biocides and plastics in estuarine model species (silversides and an invertebrate – mysid shrimp), as well as further evaluation of the latent effects of pesticide exposure in early life, with a focus on pyrethroids. One of this past year’s primary accomplishments was the completion of a cross comparison between 6 different pyrethroids to evaluate behavioral toxicity, a multi-generational study on pyrethroids in fish, as well as work now being submitted for publication on microfibers, one of the primary microplastic pollutants found in biosolids applied to agricultural lands. We have also obtained new funding to further investigate the fate and effects of microplastics in biosolids, with a focus on treatment level, deposition in soil and terrestrial invertebrates such as earthworms, in addition to our more typical investigations into effects on aquatic organisms, and plan to apply for NIFA funding in September to expand upon this work.

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Danesha Seth Carley – North Carolina State University

***title***: A New Center for Excellence in Regulatory Science in Agriculture

Accomplishments

Though many systems currently exist for communication among sectors of the agricultural enterprise, here is the need for a more transparent forum that brings together stakeholders from multiple sectors including federal and state regulatory bodies, scientists, growers and producers, commodity groups, and non-governmental organizations (NGOs) to more effectively engage on issues of regulatory science in agriculture. Therefore, NC State University recently formed a multi-sector consortium to address the regulatory challenges and adoption barriers to innovation in agriculture. The Center of Excellence in Regulatory Science in Agriculture (CERSA), co-led

by NC State and Louisiana State University, provides undergraduate, graduate and continuing education training in regulatory science and provides a forum for the advancement of

regulatory science in agriculture.

Impact Statement

Our work directly impacts improved understanding by our stakeholders (including general public) of the risk assessment process and risks and benefits of agricultural technology. Through our enhanced communication and collaboration, stakeholders better understand regulatory policy that will help to advance modern concepts in risk assessment and management in agriculture.

Publications

1. Seth Carley, D. and K. Armbrust. 2021. Making the Case for Regulatory Science in Agriculture. ACS Agricultural Science & Technology. Manuscript ID: as-2021-00011y*.*