2019

Kentucky Water Resources Research Institute, University of Kentucky: Annual Technical Report 2018

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Kentucky Water Resources Research Institute
University of Kentucky

Annual Technical Report
2018

General Information

Products

2016KY254B:
Ji, Y., & Wang, Y.T. (2019). “Selenium Reduction by a Defined co-culture of Shigella fergusonii Strain TB42616 and Pantoea vagans Strain EWB32213-2.” Accepted for Publication in Bioprocess and Biosystems Engineering.

Ji, Y., Lin, L. & Wang, Y.T. (2019). “Selenium Removal by Activated Alumina in Batch and Continuous-Flow Reactors.” Accepted for Publication in Water Environment Research.

Ji, Y., & Wang, Y.T. (2019). “Kinetic Modeling of Selenium Reduction by a Defined Co-culture in Batch Reactors.” Accepted for publication in Process Biochemistry.

Ji, Y., & Wang, Y.T. (2018, June). “Selenium Reduction by a Defined Co-culture.” Presented at the 2018 ASCE EWRI Conference, Minneapolis, MN.

Ji, Y., Lin, L., & Wang, Y.T. (2018, October). “Selenium Removal with Adsorption by Activated Alumina Packed Continuous-Flow Reactor.” Presented at the 2018 WEFTEC Annual Conference, New Orleans, Louisiana.

Ji, Y., & Wang, Y.T. (2019, April). Selenium Removal using an alum-impregnated activated alumina packed bioreactor cultured with Shigella fergusonii strain TB42616. In Proceedings of the 4th World Congress on Civil, Structural, and Environmental Engineering (CSEE’19). Rome, Italy.

2017KY266B:
Zhang, X., Wendroth, O., Matocha, C., Zhu, J., and J. Reyes. (2019). Assessing field-scale variability of soil hydraulic conductivity at and near saturation. CATENA. (in revision)

Zhang, X., Zhu, J., Wendroth, O., Matocha, C., and Edwards, D. (2019). Effect of macroporosity on pedotransfer function estimates at the field scale. Vadose Zone Journal, 18: 180151. doi:10.2136/vzj2018.08.0151

2017KY267B:
Agouridis, C., S. Austen, B. Ford, and C. Barton. (2019, July). Using Stream Restoration to Improve Hydrology and Water Quality in an Urban Watershed: A Case Study. 2019 ASABE International Meeting, Boston, MA.

2018KY275B:
Atena, A. & Brion, G.M. (2019, August). The Impact of WWTP on MRSA Prevalence in Creek Sediments. Poster Presentation at the 2019 KY/TN Water Professionals Conference, Louisville, KY.

Atena, A., & Brion, G.M. (2019, March). Assessment of MRSA Presence in Suburban WWTPs Effluent and Receiving Streams in Lexington, Kentucky. Poster presented at the 2019 Kentucky Water Resources Annual Symposium, Kentucky Water Resources Research Institute, Lexington, KY. Retrieved from https://uknowledge.uky.edu/kwrri_proceedings/2019/.

2018KY279B:
Baughn, C. (2019, March). Evaluating Potential Health Threats from Untreated Karst Springs as Community Drinking Water Sources, Monroe County, Kentucky. In Proceedings of the 2019 Kentucky Water Resources Annual Symposium, Kentucky Water Resources Research Institute, Lexington, KY, p. 33. Retrieved from https://uknowledge.uky.edu/kwrri_proceedings/2019/.

2018KY281B:
Kaiser, R. (2019). An Urban Karst Aquifer Resource Evaluation and Monitoring Toolbox. Master’s Thesis, Western Kentucky University, Department of Geography and Geology.

Kaiser, R., J. Polk, M. Parise, L. North, M. Powell, & Shelley, J. (2019, August). Developing an Urban Karst

Groundwater Evaluation and Monitoring Toolbox. Poster Presentation at the 2019 KY/TN Water Professionals Conference, Louisville, KY.

Kaiser, R., Polk, J., Powell, M., & Agga, G. (2019, June). Monitoring BMPs and Emerging Threats to Stormwater Management. Kentucky Stormwater Association Annual Conference, Berea, KY.

Kaiser, R. (2019, March). Developing an Urban Karst Groundwater Evaluation and Monitoring Toolbox. In Proceedings of the 2019 Kentucky Water Resources Annual Symposium, Kentucky Water Resources Research Institute, Lexington, KY, p. 31. Retrieved from https://uknowledge.uky.edu/kwrri_proceedings/2019/.

Kaiser, R., & Polk, J. (2019, January). Developing a Threat Assessment and Monitoring Framework for Urban Karst Groundwater Management. Invited presentation for the Florida Geological Survey Office, Tallahassee, FL.

Kaiser, R., J. Polk, M. Parise, L. North, M. Powell, & Shelley, J. (2018, December). Developing a Threat Assessment and Monitoring Framework for Urban Karst Groundwater Management. Oral Presentation at the National Groundwater Association Groundwater Week, Las Vegas, NV.

Kaiser, R., J. Polk, M. Parise, L. North, M. Powell, & Shelley, J. (2018, November). Developing a Threat Assessment and Monitoring Framework for Urban Karst Groundwater Management. Oral Presentation at the Geological Society of America Annual Meeting, Indianapolis, IN.

Kaiser, R., J. Polk, M. Parise, L. North, M. Powell, & Shelley, J. (2018, July). Developing a Threat Assessment and Monitoring Framework for Urban Karst Groundwater Management. Poster Presentation at the Water Professionals Conference, Nashville, TN.

2018KY282B:
Smith, K. & Matocha, C. (2019, March). The Impact of Ryegrass Root Exudates on Element Release in a Fragipan Soil. Poster presented at the 2019 Kentucky Water Resources Annual Symposium, Kentucky Water Resources Research Institute, Lexington, KY. Retrieved from https://uknowledge.uky.edu/kwrri_proceedings/2019/.

Matocha, C. (2018, October). What Breaks Down the Fragipan (laboratory discoveries). Oral presentation at Fragipan Field Day, Princeton, KY.
2018KY283B:

Lee, B. (2019, March). Canine Nutrient Contributions to the Urban Environment. In Proceedings of the 2019 Kentucky Water Resources Annual Symposium, Kentucky Water Resources Research Institute, Lexington, KY, p. 12. Retrieved from https://uknowledge.uky.edu/kwrri_proceedings/2019/.

2018KY288B:
Cagle, L. & Agouridis, C. (2019, March). Evaluating and Addressing Climate Awareness and Water in Kentucky. In Proceedings of the 2019 Kentucky Water Resources Annual Symposium, Kentucky Water Resources Research Institute, Lexington, KY, p. 27. Retrieved from https://uknowledge.uky.edu/kwrri_proceedings/2019/.

2018KY287B (Information Transfer):
Kintner, S. & S.J. Evans. (2019). Watershed Watch Nutrient Field Kit Evaluation Report. Technical Report to Watershed Watch of Kentucky. Retrieved from
https://www.research.uky.edu/sites/default/files/uploads/2019-07/WWKY%20Report%204-17-19%20FINAL.pdf

Koyagi, E. & Evans, S. (2019). Proceedings of the 2019 Kentucky Water Resources Annual Symposium, Kentucky Water Resources Research Institute, Lexington, Kentucky. Retrieved from
https://uknowledge.uky.edu/kwrri_proceedings/2019/.

McAlister, M. (2019). 2018 Kentucky River Watershed Watch: Annual Report. Kentucky Water Resources Research Institute, Lexington KY. Retrieved from http://www.krww.org/wp-content/uploads/2019/07/2018-KRWW-Basin-Annual-Report_Final.docx

Ormsbee, L., Evans, S., Hoagland, S., & Hernandez, E. (2019, August). Key Management Challenges in Operating Small Water Distribution Systems. Oral Presentation at the 2019 Water Professionals Conference, Louisville, KY.

Evans, S. (2019, April). 2018 Water Loss Data Analysis. Oral Presentation at Kentucky Drinking Water Advisory Council - Water Loss Subcommittee Meeting in Frankfort, KY.

Evans, S. (2019, April). Going with the Flow: A Water Science Career Journey. Oral Presentation at the Western Kentucky University Water Professional, Bowling Green, KY.

Curl, Douglas C. and Steven J. Evans. (2018). Kentucky Water Quality Report Cards: Interactive Mapping Tools and Grading Algorithms to Communicate Science to the General Public. Geological Society of America Abstracts with Programs, 50(6). doi: 10.1130/abs/2018AM-319377

Gilbert, L., & Evans, S. (2018). Water Organizations of Kentucky. Kentucky Water Resources Research Institute, Lexington, KY. Retrieved from https://www.research.uky.edu/sites/default/files/uploads/2019-07/WWKY%20Report%204-17-19%20FINAL.pdf

Koyagi, E., Evans, S., McAlister, M., & Ormsbee, L. (2018). Kentucky Watershed Organization Directory. Water Organizations of Kentucky. Kentucky Water Resources Research Institute, Lexington, KY. Retrieved from https://www.research.uky.edu/sites/default/files/uploads/2018-10/KY%20Watershed%20Org%20Directory%20FINAL%20102418.pdf

Information Transfer Program

In 2018, KWRRI launched a new website, https://www.research.uky.edu/kentucky-water-resources-research-institute, to better meet the needs of its stakeholders. KWRRI also established a repository for KWRRI's reports, https://uknowledge.uky.edu/kwrri/. The repository includes historical KWRRI reports, annual symposium proceedings, technical reports, and the Water Distribution System Research Database. During the reporting period, KWRRI produced two editions of its semi-annual newsletter (Spring 2018 and Winter 2019). The newsletter provides updates, facilitates information sharing, and increases communication among those in the Kentucky water community.
The 2019 Kentucky Water Resources Annual Symposium was held on March 25, 2019, in Lexington, Kentucky. The day-long symposium, attended by nearly 170 people, opened with a plenary session where panelists discussed policy and management challenges associated with drinking water and wastewater systems. This was followed by two concurrent platform sessions featuring 24 oral presentations, two poster sessions featuring 33 poster presentations, and an awards luncheon. Recipients of the FY 2018 USGS 104(b) student research enhancement grants funded through the Institute presented their results at the symposium. More information can be found on our website here: https://www.research.uky.edu/kentucky-water-resources-research-institute/2019-kwrri-annual-symposium.
On October 26, 2019, KWRRI and the Kentucky Division of Water (KDOW) co-hosted the 2018 Kentucky Watershed Forum in Lexington, Kentucky. The event brought together 69 individuals from 40 different organizations to discuss current topics related to water quality and watershed management. The forum provided a framework for networking opportunities and information exchange in a variety of formats including: river basin status reports, agency lightning round, speed dating, focus area presentations, and roundtable sessions.

Student Support

Undergraduate: 4
Masters: 7
Ph.D.: 1
Post-Doc: 0
Total: 12

Notable Achievements and Awards

2018KY281B (Polk):
• Several grants were received leveraging this funding (Cave Research Foundation, Geological Society of America,

National Speleological Society, National Ground Water Association) totaling over $10,000.
• A current proposal is in the works for USDA on the emerging pathogens and possibly NSF for a larger scale study of the UKARE applied internationally.
• Rachel Kaiser received the 2019 John D. Minton Outstanding Graduate Student Award. Her poster also won third place among student posters at the 2019 KY/TN Water Professionals Conference.

2018KY283B (Lee):
• Preliminary data from this study was used in a successful proposal to the LFUCG 2019 Stormwater Quality Incentive Grant Program Class B (Education) Projects program.

Projects

Application of Pedotransfer Functions for Estimating Soil Water Permeability at Field Scale, Western Kentucky: Calibration and Validation

Project Type: Annual Base Grant **Project ID:** 2017KY266B

Project Impact: Saturated hydraulic conductivity (Ks) is one of the pivotal parameters for assessing water transport in soil but has high spatial variability. Accurate characterization of the spatial pattern of Ks in a field is important for site-specific irrigation management. Because direct measurements of Ks are time consuming and expensive, pedo-transfer functions (PTFs) have been utilized for more than 30 years to estimate Ks indirectly. In this study seven widely used PTFs (Cosby et al. 1984; Puckett et al. 1985; Saxton et al. 1986; Vereecken et al. 1990; W?sten 1997; W?sten et al. 1999; Schaap et al. 2001) for estimating Ks were evaluated against direct measurements of Ks measured at the 48 locations on a no-till field (~30 ha) in Caldwell County, Kentucky. Apparent electrical conductivity was used in spatial interpolation by cokriging to facilitate the estimation of Ks. To apply cokriging, experimental semivariograms and cross semivariograms were fitted to exponential and Gaussian models. Both measured and Rosetta estimated data were used to characterize the spatial pattern of hydraulic conductivity in the field. All seven PTFs exhibited unsatisfactory predictions of Ks because they were derived for a larger variety of soil types, making them less sensitive to the particular soil structural conditions at the site. The co-regionalization analysis indicated that the Ks map based on PTF estimates should be evaluated carefully and handled with caution. According to the measured data, Ks showed high spatial heterogeneity, which means water management strategies should be adapted to different zones within the field.

Assessment of MRSA presence in suburban WWTPs effluent in Lexington, Kentucky

Project Type: Annual Base Grant **Project ID:** 2018KY275B

Project Impact: The incidence of infections caused by methicillin resistant Staphylococcus aureus (MRSA) in healthy individuals exposed outside of clinical settings has been increasing at alarming rates globally, but limited studies have focused on environmentally related MRSA infections, their sources, reservoirs, and transmission routes. This research study assessed the prevalence and typing of isolates of MRSA and methicillin susceptible Staphylococcus aureus (MSSA) in wastewater effluent and stream sediment in West Hickman Creek in Lexington, Kentucky. The chlorinated effluent from the West Hickman WWTP was sampled seven times over six months. Both MRSA and MSSA were negative in all samples showing effective removal from plant discharges. Stream sediment was sampled at four locations: three locations upstream of the WWTP on tributaries in suburban areas, including Veterans Park and one location downstream of the WWTP in a rural area. Both MRSA and MSSA isolates were frequently detected in all locations. MSSA and MRSA were more prevalent in sediments upstream of the WWTP. The characteristic odor of raw sewage was detected during multiple sampling events, indicating untreated sewage as the primary source of both MRSA and MSSA. Presence of MRSA at Veterans Park, irrespective of weather conditions, is suggestive that sediment may serve as a bacteria reservoir. The ratio between MRSA and MSSA populations was 7:1 regardless of location, suggesting sediment assisted survival of attached bacteria and transport downstream via stream flow. Genomic sequencing to be completed in fall 2019 will determine if the types of MRSA found upstream are the same as downstream.

Developing A Threat Assessment and Monitoring Framework for Urban Karst Groundwater Management

Project Type: Annual Base Grant **Project ID:** 2018KY281B

Project Impact: The Urban Karst Aquifer Resource Evaluation toolbox (UKARE), developed under this study, is a universal and user-friendly tool for any urban karst systems that can be utilized to determine the most 1) vulnerable, 2) threatened, and 3) suitable locations for monitoring urban karst groundwater and what should be monitored to protect groundwater quality. Preexisting indices were evaluated and developed into toolboxes for threats (24 tools), vulnerability (9 tools), and monitoring (18 tools). The UKARE was then validated using data collected weekly from 10 karst sampling sites in Bowling Green, Kentucky for almost a year. Sites (5 prioritized and 5 controls for model

validation) were chosen from 55 potential locations by applying the UKARE to a compiled karst inventory geodatabase. Monitoring validated the prioritization of UKARE scoring, with more frequent exceedances of health criteria for arsenic and lead among other parameters in higher risk drinking water source areas. Lead, antimony, selenium, iron, thallium, nitrate, and E. coli were seen throughout the entire aquifer indicating a need for management throughout the area. All sampling sites also routinely tested positive for bacteria resistant to ESBLs (serious threat), KPC (urgent threat due to resistance to nearly all antibiotics), and to generic antibiotic strengths. The bacteria resistance indicates a need to regulate the disposal of personal care products and pharmaceuticals and improve sewage infrastructure. The UKARE toolbox, along with this study, provide guidelines and a starting point for the development of urban karst groundwater management plans and collection of primary data for effective groundwater management.

Effects of Stream Restoration on Pollutant Load Reductions in an Urban Watershed

Project Type: Annual Base Grant **Project ID:** 2017KY267B

Project Impact: Urban streams present restoration challenges due to flashy hydrology and elevated concentrations of nutrients and contaminants among other factors. An unnamed tributary to South Elkhorn Creek located at a highly urbanized area in Lexington, KY was restored using regenerative stream restoration design techniques coupled with a designed filter media in 2013. This study evaluated the effectiveness of these restoration techniques on hydrology and water quality. To measure hydrology, flumes were installed at the upstream and downstream extents and equipped with continuous stage height recorders. Incoming pipes were also measured for discharge. For water quality, grab samples and in situ measurements were measured at the three locations along the stream. Data were collected for over 70 storms during a 12-month period in 2017 and 2018. Most storms had a recurrence interval of 1 year or less with a ~5-year storm as the greatest event. Storm flow volumes and peaks were found to be significantly greater upstream of the restoration than downstream. Summer months had significantly greater volume reductions as compared to winter months, and summer and fall months had significantly greater peak reductions as compared to winter months. The reason for these differences is attributed to the increased hyporheic storage and vegetative influence (e.g., evapotransipiration and roughness). Daily baseflow volumes were significantly less downstream than upstream, with summer months having the lowest baseflow volumes. For water quality, significant reductions in orthophosphate (~0.03 mg P/L), nitrate and nitrite (~0.16 mg N/L), and ammonia (~0.18 mg/L) were measured from upstream to downstream.

Evaluating and Addressing Climate Awareness and Water in Kentucky

Project Type: Annual Base Grant **Project ID:** 2018KY288B

Project Impact: In Kentucky, our future climate will have distinct effects because of industries, agricultural practices, and communities specific to the state. To increase climate awareness and to support interdisciplinary research and teaching collaborations, a consortium of Kentucky climate researchers and educators was developed (www.research.uky.edu/climate-consortium). With input from ten geographic subject matter experts, a mixed-method survey was utilized to collect data from over 500 Kentuckians throughout the state on water-oriented attitudes, values, and education (WAVE survey). Survey results show the dominate values for personal and recreational water use was water quality, for agriculture it was water accessibility and water quality, and values were more mixed for industrial settings. For personal water use, a common theme was trust and communication. Recreational users identified personal experiences and specific bodies of water. When considering industry, respondents focused on pollution and placing blame. For agricultural uses, focus was placed on lacking or broken infrastructure as well as placing blame. Responses showed word choice is important in communication. For instance, less than 10% of respondents were concerned about “aquifers” while nearly 40% were concerned about “groundwater.” “Creeks” evoked an affective response while “streams” had a lesser one. When considering whether global climate change is happening due to human activities, over 60% of respondents selected “Yes” or “Other.” Most respondents could identify isolated specific impacts of climate change; however, few could demonstrate complex, systems thinking. Analysis of the results are ongoing, but a webinar was hosted to educate water professionals about preliminary insights gained from the study.

Evaluation of Untreated Karst Groundwater as Community Water Sources, Barren and Monroe Counties, Kentucky

Project Type: Annual Base Grant **Project ID:** 2018KY279B

Project Impact: Residents of Amish, Mennonite, and Quaker communities in several southcentral Kentucky counties rely on karst springs and cave water with limited, individual treatment strategies, and in some cases, none. This study sought to assess the risks, evaluate solutions, and develop relationships to understand lifestyle choices associated with water supply sources in these communities. Four locations in Barren and Monroe counties were sampled monthly for a year, including a family of nine's two raw water sources (spring house and box) and home faucet treated by reverse osmosis and an untreated karst spring formerly used by a family of 10. Sampling included total coliforms, E. coli, turbidity, nitrate, and ammonia as well as field measurements. All untreated water was positive for total coliforms (436 to > 2,420 colonies / 100 mL) and E. coli (2 to 920 colonies/ 100 mL), indicating every sample of non-treated water was polluted and had high gastrointestinal health risk. Nitrate did not exceed MCLs in any samples. The reverse osmosis system performed well with no E. coli was detected, two single-digit total coliform samples, and one high total coliform associated with a filter overdue for changing. Similar results were found in another nearby community where several homes and a church were supplied by a karst spring and treated by in-home filter systems. Future work is expanding to an Allen County Mennonite family who does not use electricity that recently contracted Hepatitis A from an untreated spring. Creative solutions and educational approaches are continuing to be evaluated.

Modeling impacts of seasonal land cover change on fluvial sediment loads of the Upper Floyds Fork watershed, KY

Project Type: Annual Base Grant **Project ID:** 2018KY284B

Project Impact: To improve source prioritization for sedimentation, one of the leading causes of water pollution in Kentucky, continuous turbidity measurements were correlated using linear regression to suspended sediment concentration (SSC) samples collected over a range of flow conditions from the Upper Floyds Fork in Pewee Valley, Kentucky. This correlation, still being refined as data collection continues, provides an estimate of annual sediment volumes leaving the watershed. Once data collection is completed, the linear regression model will be validated and then input into an ArcSWAT GIS-model. An extensive database of surface physical characteristics (including 10-meter resolution elevation, slope and soil data) and daily hydro-meteorological variables has been compiled to support the model. To identify potential sediment sources from seasonal land cover changes, a 14-day normalized difference vegetation index (NDVI) and supervised classification procedure were applied to 30-meter resolution Landsat imagery from the USGS. Current results clearly show vegetation cover increasing in the spring season before dropping off in summer as a function of crop harvesting and drier conditions. The Kentucky Pollutant Discharge Elimination System was queried to identify construction sites as potential non-seasonal sediment point sources. Data collection will continue in the fall of 2019. The ArcSWAT will then be utilized to identify possible sites of sediment pollution due to seasonal land cover changes throughout the year. This information will help target land management practices to limit pollution from these sources in the future.

Phosphorus Contributions to Urban Runoff from Non-Anthropogenic Animal Waste

Project Type: Annual Base Grant **Project ID:** 2018KY283B

Project Impact: Phosphorus (P) is a key contributor to water quality impairments such as algal blooms, and animal waste is a significant source. In Kentucky, the dog population is approximately one-third of the size of the human population, but few studies have examined the quantity of P in domestic canine manure and potential runoff from turfgrass with manure. To quantify the nutrient content in canine manure, 1,005 dog manure samples were collected from dog parks and apartment complexes within urbanized areas of the Bluegrass physiographic region. Each sample was dried at 50 degrees C for 48 hours, ground, and analyzed for total P and total N. The percentage dry mass of these samples was found to be 3.89±0.76% (SD) total P and 3.14±1.00% total N. To quantify the runoff concentration, 24 plots were installed at the University of Kentucky Spindletop Farm to simulate rainfall according to the SERA-17 protocols. However, runoff could not be generated without exceeding the 500-year storm event rainfall. Therefore, rainfall simulator has been moved indoors were runoff simulations will be completed in 2019. Approximately 2.3 m3 of soils with low phosphorus content were collected, dried, ground and packed into shallow 1 m2 boxes. Turfgrass will be grown on top of boxes after which dog manure will be applied and rainfall simulations will commence. Total N, nitrate-N, Total P and Ortho-P will be analyzed in the runoff. This process will be repeated and compared to another soil from the Bluegrass area with a high P content.

Selenium Removal by Biological Processes in Water Supplies

Project Type: Annual Base Grant **Project ID:** 2016KY254B

Project Impact: In high levels, selenium is toxic to aquatic life and can be harmful to human health. The oxidized forms of selenium, selenate (Se (VI)) and selenite (Se (IV)), are soluble and mobile. In Eastern Kentucky, coal surface-mining operations have been identified as the major cause of selenium contamination. This study evaluated microbiological processes for potential use in selenium reduction. Testing indicated that optimal conditions for temperature, pH, and co-culture ratio of Shigella fergusonii TB42616 to Pantoea vagans EWB32213-2s were achieved at 30?, pH 8, and 1:10. Co-culture experiments significantly reduced selenium but not a pure Shigella fergusonii culture. Model simulations indicated the 1:10 co-culture was effective in facilitating Se(IV) reduction over a wide range of Se(VI) concentrations. Nitrate was found to inhibit reduction of Se(IV) in co-cultures, and to a lesser degree arsenate inhibited reduction. The activated alumina adsorption capacity of Se(IV) was found to be significantly higher than of Se(VI). Selenium removal was evaluated in continuous-flow activated alumina bioreactors with and without Shigella fergusonii. In packed-bed reactors with no cultures, the adsorption of Se(VI) reached exhaustive phase much faster than of Se(IV). Packed-bed reactors with Shigella fergusonii removed significantly more Se(VI) as compared to reactors with no microbial cells added. Selenium removal in coal wastewater from Harrodsburg, Kentucky was evaluated with the continuous-flow activated alumina bioreactor. Filtered coal slurry pond water supplemented with 10 mg/L of Se(VI) was fed to the bioreactor. An insignificant amount of Se(VI) and Se(IV) were detected in the effluent after one week.

Water and Solute Movement in a Fragipan Soil as Modified by Ryegrass

Project Type: Annual Base Grant **Project ID:** 2018KY282B

Project Impact: Fragipan horizons are cement-like layers in soils common in western Kentucky which can affect crop yields due to limitations on the vertical movement of water and nutrients. This study investigated whether a ryegrass cover crop may promote the breakdown of fragipan horizons through root exudates in combination with root drilling. Twelve fragipan soil cores were collected from Princeton, KY. Three were kept as controls, and nine were seeded with three annual ryegrass varieties. The soil water solution was extracted from ports above and below the fragipan horizon throughout the eight-week growing period and analyzed for silica, aluminum, iron (implicated in cementing the fragipan) as well as water soluble organic carbon (WSOC) extracts. Non-invasive X-ray computerized tomography (CT) scanning in combination with pseudocolored, multimasked volume renderings were used to visualize whether annual ryegrass roots breakdown the fragipan horizon. Dissolved Fe(II) concentrations in planted cores were greater during certain periods than the control cores at the top rhizon, suggesting the possible involvement of iron in dissolution. The role of silica and aluminum are still being evaluated. Liquid-chromatography mass spectra showed a peak which appeared in the planted core, which is being further investigated as a root extrudate that may assist in solubilizing fragipan material. CT renderings are being analyzed to determine if new ryegrass roots are penetrating the fragipan. Results demonstrating annual ryegrass’s success in the breakdown of the fragipan were shared with over 150 farmers during the 2018 Fragipan Field Day.