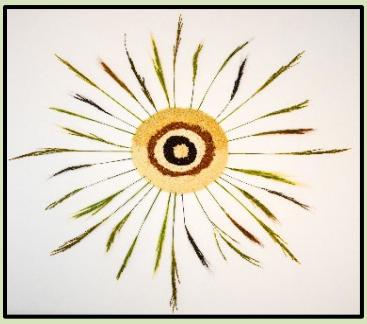
Dale Bumpers National Rice Research Center
USDA-ARS
Stuttgart, Arkansas

AUGUST 2022



MONTHLY RESEARCH HIGHLIGHTS

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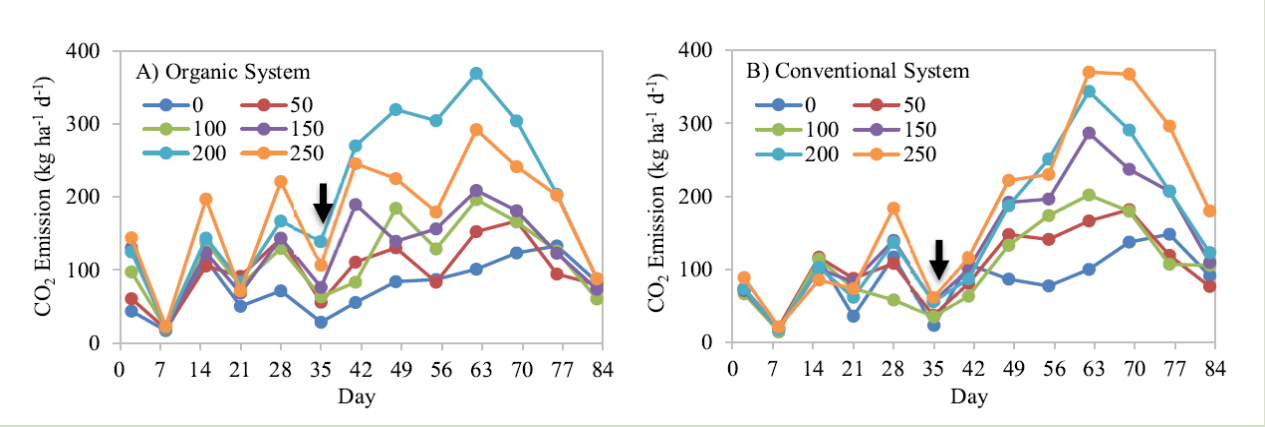
- **Recent Scientific Publications**

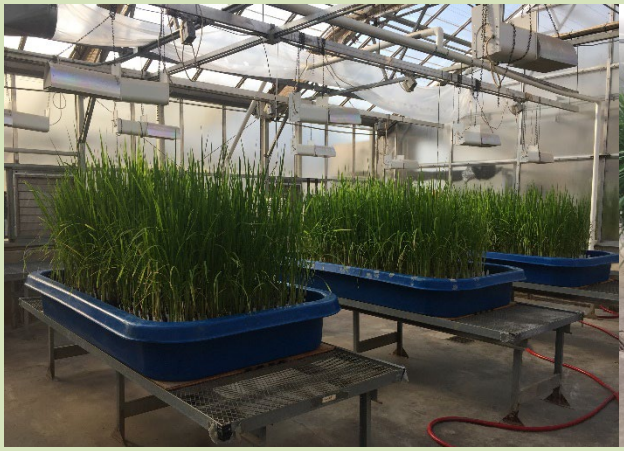
This addresses USDA-ARS Research Goal: Enhanced knowledge of crop plant interactions with abiotic and biotic environmental factors at the systems level.

Li, X., Jiang, J., Guo, J., **McClung, A.M.,** Chen, K., Velarca, M., Torbert Iii, H.A., Dou, F. 2022. Effect of nitrogen application rate under organic and conventional systems on rice (*Oryza sativa* L.) growth, grain yield, soil properties, and greenhouse gas emissions. Journal of Plant Nutrition. https://doi.org/10.1080/01904167.2022.2093746.
The market for organically produced rice continues to increase with demand outpacing production. Although nutrient availability is critical for crop productivity, organic production prohibits the use of synthetic agricultural chemicals and thus, the yield potential of organically produced rice is generally lower than in conventional systems. In addition, rice produced in flooded fields is an important source of methane emissions, a major contributor to global warming, and thus, it is important to develop an organic management system that optimizes productivity while minimizing greenhouse gas emissions (GHGE). This greenhouse study was conducted to determine the optimum fertilizer rates for rice production under organic management along with the impact on GHGE. Six rates of nitrogen (N) were applied using an organic certified soil amendment and compared with the same rates using urea. Because organic fertilizer is released slowly, the entire rate was applied prior to planting whereas the urea was applied as a three-way split. Results demonstrated that the organic fertilizer resulted in greater tiller production with increasing N rate whereas the synthetic fertilizer resulted in greater plant height. Although the timing of fertilizer application differed between the two systems, GHGE (present as CO2 equivalents) peaked during the reproductive growth phase (arrow indicates onset of flowering in graphs) for both. In addition, grain yield and total GHGE did not differ between the two management systems. This study indicates that careful management of fertilizer application can result in organic rice yields comparable to conventional production. In addition, under moderate N input levels, rice yields are optimized and GHGE are minimized.



This addresses USDA-ARS Research Goal: Identification of quantitative trait loci for tillering, root, and shoot biomass at the maximum tillering stage in rice.

Barnaby, J.Y., McClung, A.M., Edwards, J.D., Pinson, S.R.M. 2022. Identification of quantitative trait loci for tillering, root, and shoot biomass at the maximum tillering stage in rice. *Scientific Reports* 12:13304.
https://doi.org/10.1038/s41598-022-17109-y
Rice root and shoot biomass have been shown to influence soil microbiome structure influencing nutrient uptake, plant health, and methane emissions. Exploring the interrelationship of tillering, shoot biomass and root biomass is integral to understanding productivity in rice as well as the interaction of the rice plant with the environment. This study identified 11 QTLs affecting tiller number, root biomass and shoot biomass in an *indica* × tropical *japonica* mapping population at the early vegetative stage as well as at harvest maturity. Furthermore, the positive additive effects of these QTLs were associated with alleles from the *indica* parent demonstrating the importance of this gene pool as a source of genetic improvement in the predominantly tropical *japonica* germplasm that is used in the USA. In this study, a number of candidate genes that are linked with plant growth and root development were identified. This knowledge of the QTLs, associated markers, candidate genes, and germplasm resources is of value to rice cultivar improvement programs.




- **Technology Transfer**

  ✓ **Interactions with the Research Community**

  On August 17th, Drs. Yulin Jia, Shannon Pinson and Jai Rohila virtually met with Dr. Mario Ferruzzi, Professor and Chief of the Section of Developmental Nutrition in the Department of Pediatrics at the University of Arkansas for Medical Sciences, to discuss how the content nutritional and detrimental minerals, starches, and antioxidant compounds in rice grains are affected by genetics, production system, and environment.

  ✓ **Rice Germplasm Distributed**

  During the month of August, 522 rice genetic stocks were shipped to researchers in the Netherlands and the United States.

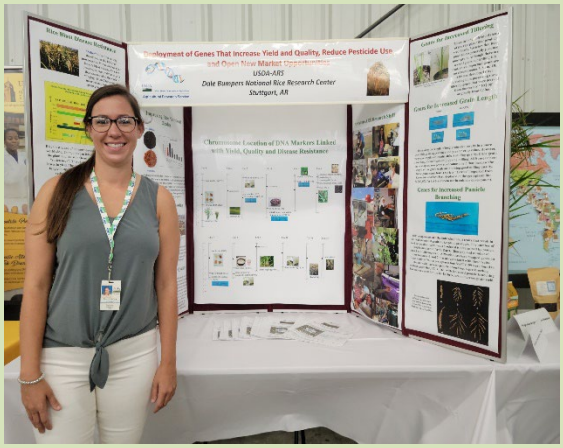
- **Stakeholder Interactions**

  On August 5, a stakeholder outreach event was held to discuss the direction for rice research at the DB NRRC and the UA RREC. The purpose of the stakeholder meeting was to solicit input regarding the following topics: rice variety development, adaptation to changing climate and production systems, new market opportunities, and new breeding technologies (genomics and bioinformatics). The meeting was attended by rice industry representatives, growers, extension agents, researchers, and rice breeders. At the meeting, Dr. Jack Okamuro presented an update on ARS rice research challenges and opportunities, and scientists from DB NRRC and UA RREC shared research updates.

- **Education and Outreach**

  On August 3rd, Drs. Anna McClung and Trevis Huggins were visited by Mr. Don Quattlebaum of historic White House Farms located in Georgetown County, South Carolina where they produce Charleston Gold rice. He was accompanied by Dr. Brian Ward, Assistant Professor with Clemson University, and they were seeking information on establishing operations in South Carolina to produce pure seed of Carolina Gold derived varieties. Although, these specialty varieties are grown on very limited acreage, they offer high value market opportunities for small independent growers.

  On August 5, DB NRRC scientists, staff and National Program leader Dr. Jack Okamuro attended the Rice Research and Extension Field Day held by the University of Arkansas Rice Research & Extension Center (UA RREC) in Stuttgart, AR. At the field day luncheon, Dr. Okamuro delivered remarks on the importance of the US rice industry and rice research. DB NRRC scientists and staff presented three posters at the field day. The posters showcased the USDA's rice collections and how DBNRRC scientists are utilizing this material to identify lines that are resistant to biotic and abiotic stress and have superior quality to share with the rice community. There was also a selection of rice products from local farms that have utilized germplasm that DBNRRC scientists selected and improved from the collections. Drs. Jeremy Edwards, Anna McClung, Georgia Eizenga, Trevis Huggins, Ms. Heather Box and Ms. Melissa Jia were available to interact with attendees and answer questions about the posters.



On August 18th, Glenn Roberts from Anson Mills, Columbia, SC visited with Drs. Anna McClung and Trevis Huggins, and Mr. Adam Rice to view seed increase operations for the USDA ARS rice collection as well as for new specialty rice varieties released from the DBNRRC research program. Pictured here is the nursery for seed increases from the *Oryza glaberrima* collection, a rice species indigenous to Africa.

On August 19th, Drs. Yulin Jia, Anna McClung, Shannon Pinson, Jai Rohila, Georgia Eizenga, and Jeremy Edwards along with Ms. Melissa Jia and Mr. Aaron Jackson virtually met with Pete Vegas and Danny Baxter with Sage V Foods to share information about the virtually cooking and processing quality needs of the US rice industry and how these qualities might be provided met through improved genetics of US rice varieties.

Adam Rice is currently a Biological Science Technician for the Germplasm group under Dr. Trevis Huggins, Adam joined the DBNRRC in 2020. Adam grew up in Ankeny, Iowa a small town about 20 minutes north of the state capital Des Moines. From an early age he developed an interest in agriculture visiting his grandfather's farm in Kentucky and watching his father, an animal scientist for Pioneer Hi-Bred, conduct research in agriculture. Adam started to develop an interest in plant genetics, especially using biotechnology to improve food crops.

Adam went to a community college in Ankeny where he earned an associate degree in biotechnology. For his associate degree, Adam interned at a molecular characterization lab at Pioneer Hi-Bred in Johnston, Iowa where he experienced hands on training in PCR and PCR plate preparation using robotics. He moved to Iowa State University where he received a B.S. degree in Genetics with a minor in agronomy. While at Iowa State he worked as a lab assistant and helped graduate students with their projects and maintained greenhouses. Adam also worked in a genetics lab where he assisted a post-doc researcher doing research in rice to identify genes that confer disease resistance to rice blast. Adam continued his education by enrolling at the University of Arkansas where he received his master's degree in crop science. He worked in the hybrid rice program in Stuttgart with Dr. Ehsan Shakiba mapping QTLs for yield traits in rice. Working in the hybrid rice program allowed Adam to gain valuable skills in growing and maintaining rice and an improved understanding of field research. In his free time, Adam enjoys fishing and being outdoors.

Jonathan Moser is currently a biological science technician at Dale Bumpers National Rice Research Center (DBNRRC) working with rice germplasm and genetics. He is primarily tasked with domestic and global seed distribution, growing, seed rejuvenation, and genomic and trait characterization of the Genetic Stocks *Oryza* (GSOR) collection of more than 38,503 rice accessions. Previously, he was a biological science technician in DBNRRC's plant physiology research lab. In this capacity he worked on often overlapping field, greenhouse, and lab projects. These rice research projects were related to, but are not limited to, heat and CO_2, soil microbes at different developmental stages (as it relates to methane emissions), root and shoot biomass assays, AWD (alternate wetting & drying) and arsenic, seasonal greenhouse (carbon dioxide and methane) gas field and greenhouse sampling (relating to global climate change), tiller-root phenotyping, mineral elements, fertilizer and AWD, yield and biomass studies, drip studies, heat stress, and seed increases. Jonathan also conducts routine onsite maintenance for both the USDA and University of Arkansas weather stations and troubleshoots hardware/software operations. On a monthly basis he downloads, compiles, reviews, and uploads weather data to an agency website for both USDA and UA stations.


Jonathan standing by *aufeis*.

Prior to accepting a position at DBNRRC, Jonathan was a part-time faculty at Kennesaw State University, where he taught (1) Science, Society, and the Environment I, and (2) Science, Society, and the Environment II. Together, these courses fulfill the general education science requirement, and both have a 200-student enrollment cap.

As a postgraduate, Jonathan was approached to fill a post-doc research associate position with Florida International University (FIU) and the National Park Service, South Florida/Caribbean Inventory & Monitoring Network (NPS SFCN). He developed, completed, and wrote two long term monitoring protocols for (1) Forest Vegetation, and (2) Mangrove-Marsh Ecotone (as it relates to rising sea levels and global climate change). The Forest Vegetation protocol includes Big Cypress National Preserve, Biscayne National Park, Buck Island Reef National Monument, Dry Tortugas National Park, Everglades National Park, Salt River Bay National Historical Park and Ecological Preserve, and Virgin Islands National Park.

Jonathan's FIU graduate thesis revolved around cold season physiology of arctic plants: (1) ecosystem respiration rates of arctic tundra at low temperatures, and (2) water uptake of arctic tundra evergreens during the Alaskan winter-spring transition. He determined the temperature response of ecosystem respiration of tundra monoliths down to temperatures as low as can be expected under snow-covered conditions (-15 °C). He used deuterium-enriched water (^2H_2O) as a tracer to evaluate water uptake of evergreen plants at snowmelt when soils are largely snow covered and frozen, finding that evergreen plants take up water under snow cover, possibly via roots but undoubtedly by foliar uptake. While a graduate research assistant at FIU, Jonathan conducted cold season ecosystem and plant physiology research at the remote Institute of Arctic Biology Toolik Field Station in Alaska.

Jonathan's first job came about while he pursued his undergraduate studies at FIU and continued after his graduation. He accepted a resource management intern position with the NPS SFCN, where he created park wide vegetation maps utilizing ArcGIS, designed an MS Access database for vegetation data collected, created a vegetation guide, and was lead author in the final written summarization report(s) for 2 vegetation mapping projects for (1) Buck Island Reef National Monument, and (2) Salt River Bay National Historical Park and Ecological Preserve, both in St. Croix, U.S. Virgin Islands. He also led the installation of weather stations at remote locations in Buck Island Reef National Monument and Salt River Bay National Historical Park and Ecological Preserve, and in Biscayne National Park, Florida.

Dr. Trevis D. Huggins, a geneticist and curator of the National Small Grains Center (NSGC) and Genetic Stocks *Oryza* (GSOR) rice germplasm at DBNRRC. Trevis was born in La Guerite village in the capital city of Basseterre on the island of St. Christopher (St. Kitts). His mother, an avid gardener out of love and necessity, was responsible for instilling a deep appreciation of the land. By her hand, the front yard was filled with rose bushes, crotons, ferns, birds of paradise and an array of tropical plants. The back yard was a bounty of vegetables such as sweet peppers, thyme, tomatoes, scallions, mint, basil, and rosemary. An abundance of trees and plants -coconut gooseberry, mango, sour orange, plum, star apple, sea grapes and pineapples - lined the property and offered shade and delicious fruit. This garden fostered Trevis' love for plants as he spent the early hours of the morning before school watering, pruning, and cutting flowers and watching his garden flourish.

At the age of 10, an unexpected gift of agricultural land was a revelation for Trevis' family. The farm was nestled between lush tropical rainforest covered mountains and a blue-grey Caribbean sea. It was about a five-minute walk north of the family house and sat next to fragrant sugar fields - a great source of refreshment after long hours of working the land. The farm had four varieties of mango trees, two coconut trees, an avocado tree, and a breadfruit tree. The family grew a variety of vegetables that included sweet peppers, tomatoes, egg plants, cabbage, spinach, collard greens, broccoli, cauliflower, carrots, parsley, thyme, scallions, sorrel, corn, pumpkin, squash, sweet potatoes, yams, and other root vegetables. The crops were an important source of food and cash for the family. Friday afternoons were harvest time with crops either sold at the local market or around the village on the weekend. Trevis stuck to this routine throughout his teenage years until he graduated tertiary college. Even after securing a job at a biomedical research foundation, he still dedicated hours each day to work on the farm.

In January 2002, Trevis left home and joined his father in Miami to pursue a college degree. He enrolled in Florida Memorial University (FMUNIV), an HBCU in Miami Gardens, Florida. Trevis was passionate about science and enrolled in the biology degree program. After three years, he graduated summa cum laude with a BS in biology. During his time at FMUNIV, Trevis gained a strong scientific foundation, but he missed the land while only able to nurture two potted plants in his

apartment. After three years as therapeutic technician at a biopharmaceutical company but still drawn to a life centered around science and plants, Trevis enrolled as a Ph.D. candidate in the Molecular and Environmental Plant Science program at Texas A&M University in College Station, Texas. His focus was plant breeding and molecular genetics of wheat. Trevis' Ph.D. focused on understanding genetic associations of heat tolerance, yield, and grain quality in wheat. As no surprise to anyone who knew Trevis, field season (March to July) was the most exciting time of year for him. He looked forward to weekly trips to research fields located throughout Texas and to Obregon, Mexico one year, where his research recombinant inbred line population was grown. These trips offered exciting opportunities to advance scientific research as well as a unique chance to see the famous Texas wildflowers that line most of the state highways. Trevis would always have his camera at hand to capture their beauty.

After four years of field experiments, greenhouse experiments and numerous road adventures he graduated Texas A&M University with his Ph.D. He continued his career in plant science as a postdoctoral research assistant with his advisor, developing wheat lines specific for tortilla production.

Trevis also served as a postdoctoral research associate at DBNNRC in molecular genetics and bioinformatics under the guidance of Dr. Jeremy Edwards before accepting the curator position at DBNRRC. Trevis curates the 19,000 rice accessions in NSGC and the 38,000 in GSOR. Currently, Trevis is developing standard operations and procedures to improve rejuvenation of accessions, characterization, and seed viability. Accessions are genotyped with 24 genetic markers for traits that are important to US rice breeders and to ensure true-to-type. He imported 36 *Oryza australiensis* accessions, which are mostly found in northern Australia from IRRI and also imported 18 NERICA (*O. sativa* x *O. glaberrima*) accessions from Africa Rice to fill genetic gaps he identified in the collection.