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

AUGUST 2023

MONTHLY RESEARCH HIGHLIGHTS

For More Information: Dr. Yulin Jia, Acting Research Leader/Center Director
yulin.jia@usda.gov

- **Recent Scientific Publications**

This addresses USDA-ARS Research Goal: Crop plants with enhanced water use efficiency and nutritional quality.

Abu-Ali, L., Maguffin, S.C., **Rohila, J.S.**, **McClung, A.M.,** Reid, M.C. 2023. Effects of alternate wetting and drying on oxyanion-forming and cationic trace elements in rice paddy soils: impacts on arsenic, cadmium, and micronutrients in rice. Environ. Geochem. Health. https://doi.org/10.1007/s10653-023-01702-9
Reduced irrigation management practices such as alternate wetting-drying (AWD) or furrow irrigation (also called row rice) have been shown to save freshwater resources, reduce methane emissions, and reduce potential arsenic concentrations in rice grains. In 2020, Dr. Rohila and Dr. McClung at DBNRRC in collaboration with Cornell University demonstrated that aerated soil conditions created by AWD leads to a decrease in soil pH and precipitation of iron oxide minerals (doi: 10.1016/j.gca.2020.02.012; highlighted in April 2020 DBNRRC Newsletter). In continuation of this collaborative research, the team was interested to test if the solubility of other trace elements in the soil pore water was impacted by irrigation management and if so, does eventually it have any impact on arsenic, cadmium, and micronutrients (e.g., zinc, manganese) in rice grain. This study included five varieties, two of which had previously been reported to be excluders for arsenic uptake and three that were accumulators of grain arsenic and was conducted in the field at Stuttgart, AR. An interesting finding from the soil pore water chemistry was that the saturated, continuously flooded soils resulted in higher solubility of all the studied trace elements (arsenic, iron, molybdenum, cadmium, manganese, copper), except zinc which was not affected by soil moisture content. However, the varieties that were arsenic excluders had relatively low levels of total grain arsenic regardless of irrigation strategy. Interestingly, the varieties that were accumulators, had higher levels under saturated field conditions, but under the AWD, the total arsenic was greatly diminished, to a level found in the excluder varieties. For cadmium, which is considered a toxic hazard for humans, there was a trend for cadmium to increase under AWD conditions, but this was statistically significant only for the varieties that were also arsenic accumulators. However, none of the varieties accumulated cadmium at levels that met the criteria for a human health concern. In contrast, for the other elements, there was no significant difference in grain content in response to flood or AWD management. Although this study was conducted using typical agricultural soils in the southern US, results may differ in areas of the world where there is heavy metal contamination of soil or water

resources. The results indicate that AWD management can be safely used without negatively impacting elements that are important in human nutrition. Arsenic and cadmium in rice, which are of concern for human health, can be effectively controlled under the AWD system. Moreover, developing rice varieties that can selectively exclude heavy metals is an approach that is effective regardless of irrigation management systems.

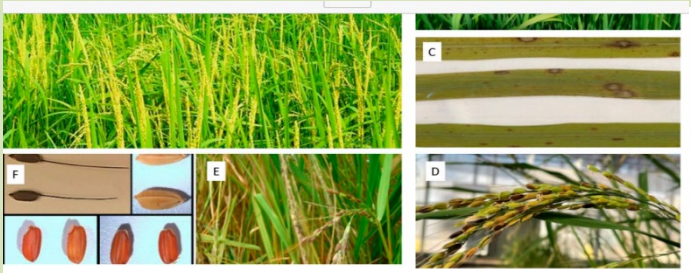
A continuously flooded rice field at Stuttgart, AR showing the setup of pore water samplers to collect soil pore water samples from the root zone throughout the field season.

This addresses USDA-ARS Research Goal: Developing crop plants with enhanced nutritional and/or product quality for consumers and producers and resistance or tolerance to diseases and pests.

Aron Osakina and **Yulin Jia**. 2023. Genetic Diversity of Weedy Rice and Its Potential Application as a Novel Source of Disease Resistance. Plants 12(15): 2850.10.3390/plants12152850

Weedy rice is one of the most troublesome agricultural issues globally because it competes for nutrients, water, sunlight, and other crucial vital resources with cultivated rice, thus posing a great threat to food security. Management and control of weedy rice continues to be an uphill task and is costly to farmers. Selective elimination of weedy rice from cultivated rice fields through application of herbicide has had limited success, since weedy and cultivated rice share morphological and physiological trait. Understanding the biology of weedy rice is essential for weed management and can also benefit crop protection. In his review, we have described that weedy rice genotypes around the world are not similar but showed genetic differentiation at whole genome level and at individual allele that control salient weedy rice traits, these alleles include *Rc* for red pericarp pigmentation, *Sh4* for seed shattering and *Hd1* for flowering and heading time. Although, weedy rice impact rice

production negatively, this review describes that some weedy rice germplasms possess unique important qualities such red pericarp pigmentation that contains important nutrient that are vital for human health, and the *Rc* allele in weedy rice can therefore be an important target for adoption in rice breeding. Also, this review focused on disease aspect where we clearly describe that some weedy rice germplasms being resistant to fungal pathogens such as *Magnaporthe oryze* and *Rhizoctonia solani*. Resistance to *M. oryzae* was attributed by genes *Ptr* and *Pi-ta*, while those that showed resistance to *R. solani* had QTLs that control plant height. In conclusion this review describes the genetic diversity in weedy rice germplasm both at allele and genome level and proposes weedy rice as a novel source for developing disease resistance in cultivated rice.



Weedy rice growth morphological trait.

Sheath blast and rice blast lesions.

Bagged weedy rice for seed collection.

- **Technology Transfer**

  ✓ **<u>Interactions with the Research Community</u>**

  Dale Bumpers National Rice Research Center 25th Anniversary of Innovative Rice Research:

  On August 2, 2023, leaders from agriculture, science, and politics convened at the DBNRRC to celebrate the 25 years of transformational rice research accomplished since the Center's opening in 1998, and how these results are positioning the rice industry to help solve world hunger, malnutrition, and the climate crisis. The open house event included tours of research laboratories and greenhouses, as well as remarks from more than a dozen key figures in attendance.

  Sanah Baig, the USDA Deputy Under Secretary for Research, Education, and Economics, highlighted three specific accomplishments that have transformed the rice industry and research community: 1) the Genetics Stocks *Oryza* (GSOR) Collection, established in 2003, which now houses approximately 38,000 accessions and has distributed over 148,000 accessions to rice breeders and researchers since its inception, 2)

The development of gene-tagging molecular markers now used to accelerate crop improvement for blast disease resistance, leaf and hull pubescence, apparent amylose content, starch pasting properties, gelatinization temperature, plant height, fragrance, and pericarp color, and 3) enhanced understanding of the genes controlling both rice plant resistance to the blast pathogen, and pathogen mechanisms for overcoming plant resistance, leading to better understanding of optimal gene deployment schemes and development of markers and pre-breeding germplasm that make multiple blast genes available to breeders in US-adapted rice germplasm. Tim Ralston, co-founder of Ralston Family Farms in Atkins, AR which grows, mills, packages, and markets rice, relayed how the success of their business was based on specialty rice varieties developed at the DBNRRC.

The outstanding progress achieved by the DBNRRC through its 25-year partnership with the University of Arkansas Rice Research and Extension Center (UARREC) was heralded in speeches by US Senator John Boozman, AR Secretary of Agriculture Wes Ward, Acting DBNRRC Director Yulin Jia, ARS Southeast Area Director Archie Tucker, ARS Deputy Administrator Nora Lapitan, ARS National Program Leader Jack Okamuro, President and CEO of USA Rice Betsy Ward, University of Arkansas System Vice President for Agriculture Deacue Fields III, Senior Associate Vice President for Agriculture-Research ad Director of the Arkansas Agricultural Experiment Station Jean-Francois Meullenet, University of Arkansas Cooperative Extension Service Associate Vice President Victor Ford, Head of Bioinformatics and Genomics at the International Rice Research Institute Kenneth McNally, and President and CEO of Riceland Food, Inc. Jason Brancel. Keith Glover, President and CEO of Producers Rice Mill, Inc., spoke 25 years ago at the DBNRRC Grand Opening, predicting then that the rice industry would come to see the DBNRRC partnership with UARREC as the source of major industry advancements. Keith declared his prediction proven true as he listed several industry advancements at the 25th Anniversary celebration.

Dr. Jan Leach, Distinguished Professor and Associate Dean for Research in the College of Agricultural Sciences, Colorado State University, celebrated past DBNRRC accomplishments. She then provided a glimpse of how future consideration of the whole phytosphere [crop plants + non-crop plants (rotation crops, weeds, etc.) + soil + microbes in and outside of the crop plant + climatic factors] can lead to fuller understanding and continued advancements for a sustainable US rice industry.
The open house tour included presentations by DBNRRC scientists and staff.
Ms. Laduska Sells gave an overview of the research studies being conducted in greenhouses. Dr. Trevis Huggins presented the importance of germplasm collections and the GSOR for preserving and disseminating genes and germplasm as breeding and research tools. Dr. Georgia Eizenga discussed the discovery of useful genes in non-domesticated (wild) rice relative species. Dr. Jeremy Edwards and his team explained how genes are molecularly tagged to allow breeders to select for genes and traits without the need for high-cost direct analysis of those traits. Dr. Yulin Jia's research team presented new knowledge on the biochemistry and genes that regulate host-plant resistance to disease-causing microbes. Dr. Jai Rohila described how his research focused on identifying the genes and mechanisms that allow rice plants to tolerate exposure to

extreme heat, drought, and salt can broaden opportunities for rice to be produced more sustainably. Dr. Shannon Pinson discussed how sales and consumption of US rice could be increased by the development of a rice variety which has a novel starch composition that resists digestion, therefore has fewer calories and a lower glycemic index, making the rice more diabetic-friendly than rice available in US grocery stores today.

The morning tour and program had 121 attendees from government and private organizations, and culminated with a group photo, cake cutting ceremony, and BBQ lunch. The afternoon program provided time for industry partners to share with DBNRRC scientists their vision of current and future needs of the US rice industry. Several DBNRRC employees received awards from the distinguished USDA administrators who were present for the celebrations. Speakers at the evening program included Rod Wing, Regents Professor and Bud Antle Endowed Chair, University of Arizona, and Mr. Jim Thompson, Consultant on Regulatory and Industry Relations at RiceTec, Inc. For more information, https://www.ars.usda.gov/news-events/news/research-news/2023/usda-research-center-in-stuttgart-commemorates-25-years-of-contributions-to-the-rice-industry/ and https://www.usarice.com/news-and-events/publications/usa-rice-daily/article/usa-rice-daily/2023/08/07/usa-rice-participates-in-usda-rice-research-celebration.

Dr. Yulin Jia Acting Research Leader DBNRRC

Sanah Baig, the USDA Deputy Under Secretary

ARS Southeast Area Director Archie Tucker

ARS National Program Leader Jack Okamuro

Abiotic Stress Tolerance in Rice
Jai Rohila and Tiffany Sookasem
Salt stress tolerance

Dale Bumpers National Rice Research Center
25th Anniversary of Innovative Rice Research

All
Orders 2,204
Accessions 147,860
Contact Dr. Trevis Huggins (Trevis.H
(Jonathan.Moser@usda.gov) with t
Center for additional information.

DALE BUMPERS
National Rice Research Center
25 Years

DALE BUMPERS
NATIONAL RICE RESEARCH CENTER

On August 3, 2023, the Arkansas Rice Field Day was attended by 350 rice industry professionals and held at the University of Arkansas Rice Research and Extension Center, Stuttgart, AR. As part of the field day, Drs. Trevis Huggins, Yulin Jia, Jeremy Edwards, Jai Rohila, Guoliang Wang (Professor and Assistant Chair of Plant Pathology, Ohio State University), Ms. Melissa H. Jia, and Mr. Adam Rice made oral presentations. Drs. Shannon Pinson and Georgia Eizenga were available to discuss the DBNRRC highlighted in two poster presentations. Dr. Huggins presented the importance of rejuvenating the USDA Rice Germplasm Collection to safeguard current genetic diversity for future rice breeding. Dr. Jia presented the development of Eclipse, a medium grain rice germplasm that will help US rice breeders incorporate into high-yielding medium grain varieties the Pita/Ptr blast resistance gene combination that has proven its long-lasting utility in long grain rice varieties. One poster highlighted the importance of identifying new genes and making them available to breeders as improved germplasm for use as breeding parents. The second poster described the US rice germplasm collection and highlighted efforts to improve the tolerance of rice to heat, drought, cold and salt; resistance to sheath blight and blast diseases; and identifying unique quality characteristics.

On August 4, 2023, Drs. Trevis Huggins and Shannon Pinson provided grain samples of approximately 115 genetically diverse rice varieties to Dr. Scott Lafontaine in the Agricultural, Food and Life Sciences Department at the University of Arkansas, Fayetteville, AR, for measuring the range of specific food processing traits contained in US and diverse rice.

On August 8, 2023, Dr. Shannon Pinson provided information on rice grain element concentrations to Dr. Anil Kumar at the Center for Plant Science Innovation at the University of Nebraska, Lincoln, NB. Dr. Kumar requested details of the field research methods and the data on grain concentrations of arsenic, copper, molybdenum, and zinc from a multi-country Rice Diversity Panel 1 study published in 2014 as Norton et al., doi:10.1371/journal.pone.0089685.

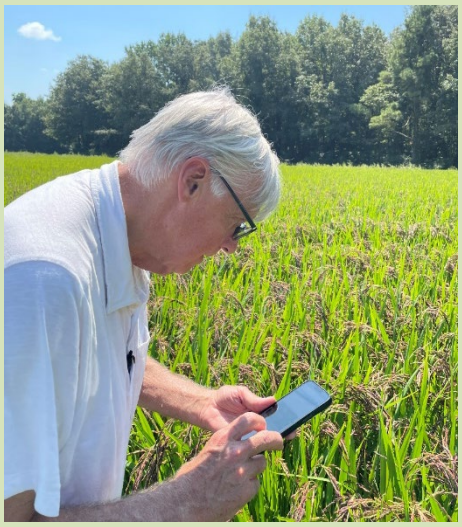
On August 8, 2023, Dr. Shannon Pinson and Ms. Laduska Sells provided rice gain and starch-chemistry information to Dr. Dmitriy Smolensky, Dr. Lester Pordesimo, Ms. Jaymi Peterson, and Ms. Kerri McConnell at the USDA-ARS Center for Grain and Animal Health Research in Manhattan, KS, to support their study on the composition of health-beneficial phenolic compounds within red- and blue-pigmented grains of several monocot crops, including rice, sorghum, and corn.

On August 9, 2023, Dr. Shannon Pinson provided information on standard US rice varieties and on the rice breeding and genetics programs in Arkansas to Dr. Zhaohua Peng in the Biochemistry and Molecular Biology Department at Mississippi State University, Starkville, MS.

On August 26, 2023, Biological Science Technician Mr. Jonathan Moser provided information to Dr. Michael Vega at Cornell University, Ithaca, NY, regarding the availability of cultivar Katy and putative Katy mutants for use in studies on microbe population, grain elements under different production systems.

- **Stakeholder Interactions**

On August 22, 2023, Drs. Trevis Huggins and Yulin Jia, and Ms. LaDuska Sells and Mr. Adam Rice visited the Shoffner farm in Newport Arkansas. They met with Ms. Hallie Shoffner and Mr. Glenn Roberts to discuss the production of seeds for farmers for ten rice varieties developed by DB NRRC. Rice fields where these varieties were planted were inspected for seed purity and disease occurrences.



- **Education and Outreach**

  On August 16, 2023, Glen Beedle presented how Program Support Assistant can efficiently support Research Leaders at Southeast ARS Research Leader training workshop, New Orleans.

See the web version of all DBNRRC research highlights at: https://www.ars.usda.gov/southeast-area/stuttgart-ar/dale-bumpers-national-rice-research-center/docs/monthly-research-highlights/