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

JANUARY 2021

MONTHLY RESEARCH HIGHLIGHTS

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- **Recent Scientific Publications**

This addresses USDA-ARS Research Goal: Development of improved plant breeding techniques that apply knowledge from genetic interaction with environment and management factors.

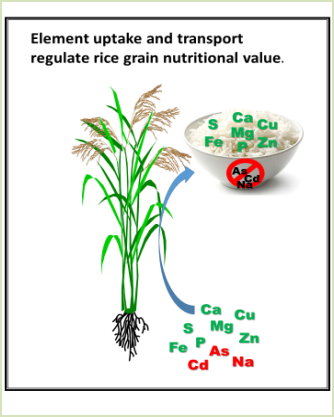
Fernandez-Baca, C.P., McClung, A.M., Edward, J.D., Codling, E.E. Reddy, V.R., and Barnaby, J.Y. * 2021. Genotype and water management impacts on mitigation of inorganic arsenic in rice. *Frontiers in Plant Sciences*. 11: 2284. https://doi.org/10.3389/fpls.2020.612054

Arsenic (As) accumulation in rice grain is a significant public health concern. Inorganic As (iAs) is of particular concern because it has increased toxicity as compared to organic As. Here, we identified seven quantitative trait loci (QTLs) associated with grain iAs and found that when the rice was grown under an alternate wetting and drying (AWD) regime for a long period of time it resulted in enhanced reduction in grain iAs concentrations. Overall, this study demonstrated that grain iAs accumulation is dependent on both irrigation management practices and genotypic differences. While severe AWD will reduce grain iAs accumulation, incorporation of selected QTLs through breeding can ensure genetic mitigation of iAs, which is particularly important under field production conditions where soil moisture conditions may vary because of management systems or weather conditions. Ultimately, coupling AWD, or other water-saving irrigation management practices, with the deployment of low iAs accumulating cultivars is key to reducing iAs exposure from rice while maintaining crop productivity.

This addresses USDA-ARS Research Goal: Enhanced knowledge of the genetic regulation of cereal grain nutritional value.

Liu, H, Long S-X, Pinson SRM, Tang Z, Guerinot ML, Salt DE, Zhao F, Huang X-Y. 2021. Univariate and multivariate QTL analyses reveal covariance among mineral elements in the rice ionome. Frontiers in Genetics, https://doi.org/10.3389/fgene.2021.638555

Rice, wheat, and corn are the three most important food crops in the world and provide many essential vitamins and minerals, but are deficient in others, and can even contain toxic levels of some compounds. To alleviate malnutrition and improve human health, there is widespread interest in developing crops that accumulate more nutritive elements (e.g., copper, iron, or zinc) in their grains while limiting the accumulation of toxic elements such as arsenic and cadmium. The identification of genes affecting accumulation of elements in grains can speed the development of crop varieties with improved nutritional value. We evaluated a rice mapping population characterized for grain and plant tissue concentrations of 16 elements in a multi-year study under both flooded and unflooded growth conditions. Flooded soils are known to make some elements less available for plant uptake (e.g., cadmium, copper, and zinc), but increase availability of others (notably arsenic). The population was analyzed using 3000 genetic markers and revealed 167 QTLs (genomic regions) affecting the concentration of individual elements in one or more tissues. More than half of the QTLs were associated with the concentration of more than one individual element. This study revealed genetic loci affecting the concentrations of specific elements and their combinations, their tissue location, and the degree of expression under flooded and unflooded growth conditions. This information will be beneficial for future breeding efforts to improve the nutritive value of not just rice, but other cereal grains as well.



- **Technology Transfer**

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

    On Jan. 5, 2021 Dr. Jai Rohila presented an overview of rice planting and strategies for efficient pre-treatment of rice seeds with beneficial fungi (endophytes) for planting in the greenhouse and in the field to four private industry researchers through a virtual meeting.

On Jan. 20th, several staff from the DBNRRC participated in the annual rice breeders meeting that was held virtually. Representatives from all public rice breeding programs attended, discussing 2020 state production statistics, pending new variety releases, and results of the 2020 Uniform Regional Rice Nursery conducted in AR, MS, TX, MO, and LA.

✓ **Rice Germplasm Distributed**

Dr. Anna McClung provided seed on Jan. 5th to Gowan USA for crop protectant studies, on Jan. 15th seed of two colored bran varieties to the ARS Southern Regional Research Center in New Orleans, on Jan. 21st seed of a short grain variety for a small business in Delaware developing a bike-peddled rice dehuller for small farmers, on Jan 26th seed of a waxy variety for an interested end-user, and on Jan. 27th seed of 5 varieties for a small farmer located on the Ohio/Indiana border.

During the month of January, 17 rice genetic stocks were shipped to researchers in the United States and Belgium from the Genetic Stocks *Oryza* (GSOR) collection.

Recent publications by the research community using germplasm provided by GSOR:

- Atighi, M.R., et al., Genome-wide DNA hypomethylation shapes nematode pattern-triggered immunity in plants. 2020. New Phytologist. 227:545-558

- Thomas, J., et al., Time-course RNA-seq analysis provides an improved understanding of gene regulation during the formation of nodule-like structures in rice. 2020. Plant Molecular Biology. 10.1007/d11103-020-00978-0

- **Stakeholder Interactions**

On Jan. 21st, Dr. Anna McClung provided information regarding production of Carolina Gold rice for a grower/miller in North Carolina.

On Jan. 27th, Dr. Anna McClung provided information regarding no-till rice production to a grower in South Carolina.

- **Education and Outreach**

On Jan. 4th, Dr. Anna McClung provided organic rice grower contacts to the Organic Farming Research Foundation that is developing a "Guidebook on Soil Health" for organic production.

Dr. Anna McClung was included in an article "Gold in these Fields- A New Relative of Carolina Gold Rice Crops Up" for the Feb./March 2021 issue of Garden and Gun magazine.

The article talks about the historical production of Carolina Gold rice in South Carolina and the development of the new variety “Santee Gold” by the DBNRRC breeding team that was derived from Carolina Gold. Pictured two parents used in the breeding cross, Carolina Gold (top left) and Presidio (top right), and, offspring, Santee Gold (bottom center).

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/