April
Highlights from the Dale Bumpers National Rice Research Center
Stuttgart, AR

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1. Recently Accepted Publications

ARS Anticipated Product: Plants with superior product quality and new uses for current crops.

Chen, M.-H., McClung, A.M., and Bergman, C.J. 2016. Concentrations of oligomers and polymers of proanthocyanidins in red and purple rice bran and their relationships to total phenolics, flavonoids, antioxidant capacity and whole grain color. Food Chemistry DOI: http://dx.doi.org/10.1016/j.foodchem.2016.04.004

Proanthocyanidins, are natural compounds found in various fruits, vegetables, and cereal grains that are proposed to have health beneficial properties for controlling some chronic diseases in humans. With the eventual goal of enhancing rice phytonutrient concentrations, we investigated the natural genetic variation of the concentrations of compounds in dark-pigmented rice brans. A 4.3-fold variation in total proanthocyanidins was found and the concentration was highly correlated with other health beneficial compounds total phenolics and total flavonoids, along with antiradical capacity, a measure of their potency. In addition differences in structures of these compounds was observed. Analysis of proanthocyanidins requires extensive laboratory methods to extract and analyze the compounds from the rice bran. For breeding purposes, it is desired to have a quick assay to select offspring that possess these desirable compounds. We found that a colorimeter could be used to determine the redness of dark pigmented brans and this was negatively and positively correlated with extractable and non-extractable proanthocyanidins, respectively. This suggests that the colorimeter would be a fast initial screening tool to select rice containing high proanthocynidins. In conclusion, we identified rice varieties with high levels of proanthocyanidins that can be used for breeding to enhance phytonutrient concentration in rice.

ARS Anticipated Product: Higher yielding crops.

Pinson, S.R.M., Y. Wang, and R.E. Tabien. 2016. Registration of TIL:383.13, TIL:625 and TIL:634, three long grain tropical *japonica* rice (*Oryza sativa* L.) germplasm lines containing novel *indica* alleles that increase tiller production and grain yield. Journal of Plant Registrations 10:171–176. doi:10.3198/jpr2014.09.0069crg; Posted online April 15, 2016 https://dl.sciencesocieties.org/publications/jpr/pdfs/10/2/171

An increase in early tiller production is desired in rice to increase yield potential, and enhance ability to shade and suppress weeds. Previous quantitative trait locus (QTL) mapping studies identified eight QTLs for improved tillering ability coming from a high-tillering cultivar from China, 'TeQing'. Three new rice germplasm lines were recently made available to breeders that possess seven of the tillering loci from TeQing, now backcrossed into an elite US rice genetic background. These germplasm lines have high tillering along with the long grain shape and intermediate amylose content and gelatinization temperature desired in U.S. rice varieties. Field trial data showed that the increased tiller production of the three germplasm lines increased panicle number and grain yield, and also caused rapid seedling-stage canopy development that would allow the plants to compete better with weeds.

ARS Anticipated Product: Plants tolerant to biotic stresses.

Jia, Y., Zhou, E., Lee, S., and Bianco, T. 2016. Co-evolutionary Dynamics of Rice Blast Resistance Gene *Pi-ta* and Magnaporthe oryzae Avirulence Gene *AVR-Pita1*. Invited monthly review for Phytopathology. http://dx.doi.org/10.1094/PHYTO-02-16-0057-RVW • posted 04/12/2016.

Rice blast disease caused by the fungus *Magnaporthe oryzae* is one of the most damaging diseases of rice in the US and worldwide. The use of major resistance genes in rice has been effective in preventing blast disease epidemics. However, the pathogen can overcome resistance by changing its avirulence gene that is essential for the plant's resistance response. In this review, we demonstrate how genomic information has accelerated our understanding of genetic variation of the major blast resistance gene *Pi-ta*, its association with rice productivity, genetic variation of the corresponding avirulence gene *AVR-Pita1* that triggers *Pi-ta*-mediated disease resistance, and the coevolution of *Pi-ta* and *AVR-Pita1* in *Oryza* species and *M. oryzae* populations, respectively. We review the genetic and molecular bases of the *Pi-ta* and *AVR-Pita* interaction, and evaluate the potential to develop long lasting broad spectrum resistance in elite rice cultivars with the aid of diagnostic DNA markers.

ARS Anticipated Product: Plants tolerant to biotic stresses.

Scheuermann, K. and Jia, Y. 2016. Identification of a *Pi9* containing rice germplasm with a newly developed robust marker. Phytopathology http://dx.doi.org/10.1094/PHYTO-02-16-0091-R • posted 04/06/2016.

Rice blast is a destructive rice disease that threatens staple rice production worldwide. There are many major blast resistance genes that provide some level of protection against the pathogen. However, deployed resistance genes can be rendered ineffective by the constantly evolving pathogen. Thus, identifying new sources of resistance that can be used by breeders to develop improved cultivars is important for food security. In the present study, we developed an effective means to incorporate a blast resistance gene *Pi9* using marker assisted selection (MAS). We first developed a DNA marker from a specific region of the *Pi9* gene. We then identified a publically available rice germplasm accessions carrying *Pi9* for breeders

to use as the *Pi9* gene donor. The genetic method we developed should accelerate the development of blast resistant rice varieties using a MAS approach.

2. New Significant Research Collaborations

International

USA

3. New Awarded Grants

4. Technology Transfer

a. Formal Events:

To Non-research stakeholders

To Research Community

b. Informal Contacts:

April 1-3, Dr. Shannon Pinson conferred with a breeder interested in using specific individuals from the TeQing-into-Lemont introgression lines (TILs) to introduce genes that enhance disease resistance, weed suppression, and yield enhancement into his international hybrid rice breeding program. Specific trait and molecular marker data were provided, with additional explanation as to their uses as breeding parents. Seed of the TILs had been previously provided by GSOR to this breeder.

April 4, Drs. Shannon Pinson, Anna McClung, Jai Rohila, and Jo Heuschele met with a local farmer interested in limiting the accumulation of arsenic in rice grains through the use of foliar chemical applications. A discussion of potential chemicals and application timings were discussed.

April 4, Drs. Yulin Jia and Anna McClung discussed with a local grower the need for development of superior quality and disease resistant medium grain for production in the south.

April 14, Dr. Shannon Pinson advised a rice geneticist in California on germplasm and methods for studying genetic variance among temperate japonica rice germplasm for concentration of arsenic in rice grains.

April 22, Dr. Ming-Hsuan Chen advised a research geneticist with the Agricultural Research Service on types of grain quality assays for screening mutants.

April 25, Drs. Anna McClung and Ming-Hsuan Chen provided information to a university professor regarding rice grain developmental stages for phytochemical study.

April 26, Dr. Yulin Jia provided information to a foreign research scientist in China through email for performing collaborative research on rice blast resistant breeding.

April 27, Dr. Yulin Jia hosted a professor and two graduate students from University of Arkansas at Pine Bluff (UA PB). Dr. Jia led a brief tour of DB NRRC and trained students on how to purify blast spores.

c. New MTAs

d. Germplasm Exchanged:

During April, 2,365 rice accessions from the Genetics Stocks *Oryza* (GSOR) collection were distributed to researchers in the US, Belgium and Japan.

5. Educational Outreach

On April 12th DBNRRC hosted parents and students participating in the Grand Prairie Home school program. Students were divided into two groups based on their age. Dr. Anna McClung gave a background on diverse rice germplasm and differences in grain types to the younger students. LaDuska Sells, Luis Coral, Tiffany Sookaserm, and Bert Ward assisted the students with a hand on milling project and Heather Box completed the tour with a rice taste test. The older students participated in a hand on project measuring photosynthesis with Dr. David Gealy, an amylose assay with Matthew Schuckmann, followed by a DNA extraction with Melissa Jia, Aaron Jackson, and Brenda Lawrence.

On April 15, Dr. Anna McClung participated in a seminar presented by Ms. Molly Tibbs at Arkansas State University, at Jonesboro. Ms. Tibbs had conducted an honors project on evaluating rice mapping parents for ascorbic acid content which has been associated with abiotic stress tolerance. Dr. Argelia Lorence, ASU, serves as the major professor for the student and Dr. McClung provided the research materials for conducting the study.

On April 28, DB NRRC hosted a total of 60 tenth graders from Watson Chapel Junior High School in Pine Bluff, Arkansas, and had hands on experience on three aspects of rice research being conducted at DB NRRC. 1). Analyzing DNA sequence for protecting rice

plants from disease with genetics with Dr. Yulin Jia, Tracy Bianco and Craig Oppel, 2) performing DNA extraction and chemical assay of rice starch with Aaron Jackson, Melissa Jia and Matthew Schuckmann, and 3) measuring leaf photosynthesis using stressed and non-stressed rice plants with Dr. Jai Rohila and Tiffany Sookaserm.

6. Awards/Honors