March 2017

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

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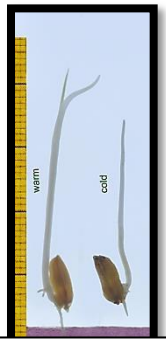
1. Recently Accepted Publications

ARS Anticipated Products: Plants tolerant to environmental changes or extremes.

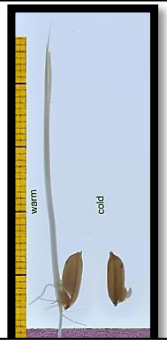
Ehsan Shakiba, Jeremy D. Edwards, Farman Jodari, Sara E. Duke, Angela M. Baldo, Pavel Korniliev, Susan R. McCouch, **Georgia C. Eizenga** (2017) Genetic architecture of cold tolerance in rice (*Oryza sativa*) determined through high resolution genome-wide analysis. PLoS ONE 12(3): e0172133. doi: 10.1371/journal.pone.0172133

Warming trends have resulted in rice growers planting much earlier. However, early spring plantings can be damaged by sudden drops in temperatures because cool temperature causes poor germination and injures the young seedlings, which results in poor stand establishment. At the reproductive stage (including booting, heading and seed set), cold or cool temperatures affect the grain development and seed quality which decreases grain yield and acceptability by the consumer. We screened a collection of over 400 diverse rice cultivars from around the world and identified 83 cultivars that had superior cold tolerance at germination. Forty-two chromosome regions were associated with cold tolerance at germination, indicating complex genetic control. Seven cultivars were found to be cold tolerant at the reproductive stage and two of these were classified as cold tolerant at germination. Twenty-nine chromosome regions were associated with reproductive cold tolerance indicating it also is controlled by many genes. This study lays the groundwork for identifying key genetic markers linked to cold tolerance at the germination and/or reproductive stage that rice breeders can use in varietal improvement programs.

Germination under warm temperature compared to cool temperature.



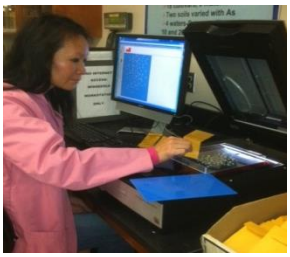
Cold tolerant at germination



No cold tolerance at germination

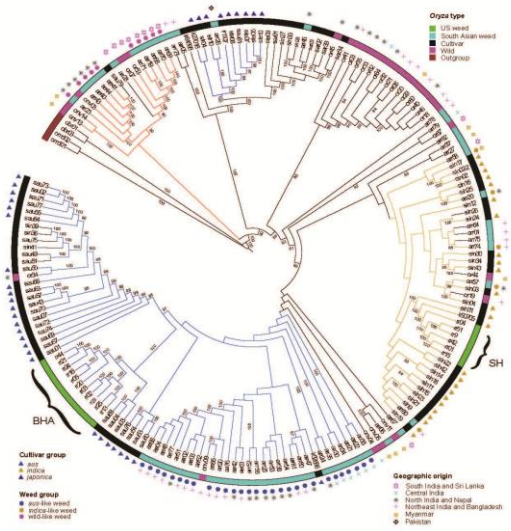
ARS Anticipated Product: Plants with superior product quality.

Haley M. Sater, **Shannon R.M. Pinson**, Karen.A.K. Moldenhauer, Terry J. Siebenmorgen, R.Esten Mason, Virginia A. Boyett, and **Jeremy D. Edwards**. 2017. Fine mapping *qFIS1-2*, a major QTL for kernel fissure resistance in rice (*Oryza sativa* L.). Crop Sci., doi:10.2135/cropsci2016.09.08213, posted online March 3, 2017.



Rice producers, millers, processers and marketers all lose income when rice kernels break during milling. The primary cause of milling breakage is development of fissures in the kernels. Three chromosome regions (QTL) associated with resistance to kernel fissuring were previously identified. This study fine-mapped the QTL with largest single effect, and broke linkage between the fissure resistance trait and a plant height gene. These molecular markers can be used to support marker-assisted breeding for improved kernel fissure resistance in new rice varieties. Candidate genes were also identified to support further research into the physiological factors and gene functions that contribute to kernel fissure resistance.

ARS Anticipated Products: Genetically and phenotypically characterized germplasm designed for elucidating gene function and/or developing superior cultivars.



Zhongyun Huang, Nelson D. Young , Michael Reagon, Katie E. Hyma, Kenneth M. Olsen, **Yulin Jia**, and Ana L. Caicedo. All roads lead to weediness: patterns of genomic divergence reveal extensive recurrent weedy rice origins from South Asian *Oryza*. Molecular Ecology Published on line on March 28. doi: 10.1111/mec.14120

Weedy red rice is one of the most important agricultural pests causing significant reduction of grain yield in cultivated rice worldwide. Understanding the genes involved in the origins, population structure, metabolic processes, and traits of weedy rice will help provide guidance in how to best control this pest. We found that weedy rice ecotypes from South Asia were more genetically variable than weedy rice from the USA however they possessed the same weedy traits like red bran, awns and shattering. When compared to cultivated rice, the weedy rice was more genetically diverse suggesting it will be more difficult to manage in agricultural production systems because of its ability to adapt.

ARS Anticipated Product: Plants with superior product quality

Jeremy D. Edwards, **Aaron K. Jackson**, and **Anna M. McClung**. 2017. Genetic architecture of grain chalk in rice and interactions with a low phytic acid locus. Field Crops Research 205, 116-123, doi.org/10.1016/j.fcr.2017.01.015

Industry and consumers desire rice that once milled produces intact and translucent kernels. The presence of grain chalk, opaque white areas in the rice grain, can reduce milling and cooking quality as well as grain appearance, thus reducing the value of the crop. The presence of grain chalk can be due to the rice variety and the environment where the rice was grown. The chalky areas of the grain are due to loosely packed starch granules and small air

spaces in the center of the grain that refract light. Environmental and crop production factors that can cause grain chalk include high temperature stress during grainfilling, low soil fertility, and pest damage. This research was conducted to identify genetic markers linked to genes which reduce rice grain chalk and which had a consistent effect across different growing environments. The study identified ten chromosome regions that accounted for 63% of the variation in chalk in a segregating rice population. The *lpa* gene which reduces phytic acid in the grain explained 25% of the variation in chalk when present. Even though the amount of chalk varied to some extent with year and planting date, the genetic markers associated with low chalk were robust across growing environments. These results will benefit breeders that use genetic markers to assist in selection and development of new varieties that have translucent grain and high economic value.

2. Technology Transfer

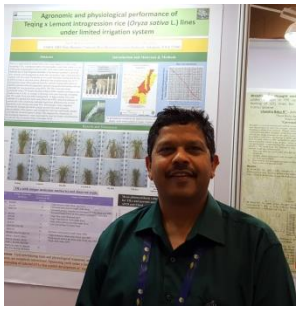
a. Formal Events:

To Non-research Stakeholders

To Research Community

On March 9, Dr. Ming-Hsuan Chen provided results of amylose and alkali spreading tests, predictors of rice cooking quality, of 500 California breeding lines to the California Rice Research Foundation, Biggs, CA.

Dr. Jai Rohila, Research Agronomist, presented research on "Agronomic and physiological performance of Teqing x Lemont introgression rice (*Oryza sativa* L.) lines under limited irrigation system" at InterDrought-V Conference February 21-25, 2017, held in Hyderabad, India. Results from this study showed that growing rice under reduced irrigation, versus in flooded soils, resulted in the plants being later to mature, having reduced height and grain weight, reduced photosynthesis, and increased number of unproductive tillers. Developing rice varieties tolerant to water stress will likely require combining genes from many physiological pathways.



On March 26-28, 2017, Research Plant Physiologist, Dr. Jinyoung Barnaby, presented research on "Using rice genetic diversity for environmental change adaptation and mitigation" at the 2nd Agriculture and Climate Change conference in Sitges, Spain. Results indicated that rice varieties differ in methane emissions when grown in flooded soils and thus choice of variety can be a means to reduce methane levels and its global warming effect. In addition, studies demonstrated that rice varieties differ in the number of genes that are up/down regulated in response to elevated CO_2 levels. These genes may be related to

physiological pathways that control protein production in the grain which impact human nutritional value of rice.

On March 31, Dr. Ming-Hsuan Chen provided results of amylose content analysis for 100 breeding lines to Dr. James Oard, Louisiana Agricultural Experiment Station, Crowley, LA.

b. Informal Contacts

On March 7, Dr. Yulin Jia provided blast resistance genes and information to a private company in the US to utilize ARS rice genetic stocks for cultivar development.

On March 28, Dr. Yulin Jia provided 1 sheath blight isolate to a researcher of a university in the US to study bacterial and fungal interaction.

On March 28, Dr. Anna McClung provided information on health beneficial compounds found in rice bran as a possible supplement to a sustainable shrimp farmer in AL.

On March 29 Dr. Anna McClung provided a comparison of growth characteristics of two rice varieties to seed company in TX.

c. Germplasm Exchanged:

During March, 98 rice accessions from the Genetics Stocks *Oryza* (GSOR) collection were distributed to researchers in the US.

3. Education and Outreach

On March 15, 2017 Dr. David Gealy gave a tour of Dale Bumpers National Rice Research Center to Bill Reed and visitors from Riceland Foods, Inc. located in Stuttgart, AR.

On March 22, 2017 Dr. Shannon Pinson responded to a set of emailed questions from 7th graders asking about methods, germplasm, and difficulties associated with breeding rice varieties to be resistant to multiple extreme weather conditions.

New Significant Research Collaborations

The collaborative project between Shannon Pinson (ARS) and Aaron Smith (Louisiana State University) titled “Improving the quality of rice by identifying targets to restrict arsenic accumulation” was awarded $500K from the Agriculture and Food Research Initiative (AFRI) competitive award program of the USDA National Institute of Food and Agriculture (NIFA) for research to be conducted over three years, April 1, 2017 to March 30, 2020.