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

**AUGUST 2024**

## MONTHLY RESEARCH HIGHLIGHTS

**For More Information: Dr. Yulin Jia, Research Leader/Center Director**
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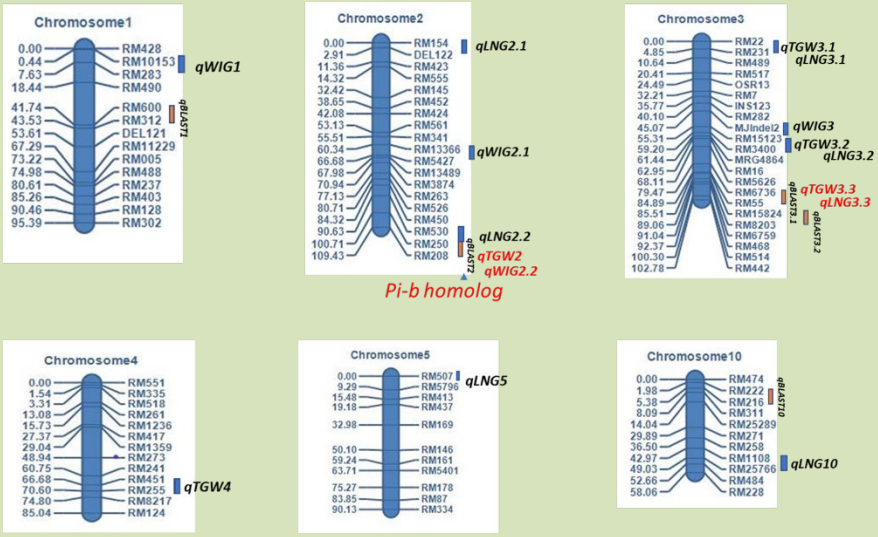
- **Recent Scientific Publications**

  *This addresses USDA-ARS Research Goal:* Crop plants with tolerance to biotic and abiotic stresses, including resilience to climate or environmental extremes.

  **Yulin Jia, Melissa H. Jia**, and **Heather Box**. Identification of Genetic Loci for Grain Traits and Disease Resistance Reveals a Potential Trade Off in Rice. Published Online:23 Aug 2024https://doi.org/10.1094/PHYTOFR-03-24-0025-R

  Plants are sessile and thus are permanently attached to their site of germination and growth. To circumvent immobility plants have evolved a sophisticated multifaceted mechanism to cope with external biotic stressors. Plants often redirect resources for growth and reproduction when under pathogen attack. This growth–defense is commonly known as the tradeoff that allows plants to alter growth and development to adapt to external biotic stressors. Understanding how plants utilize limited resources for reproductivity, and disease resistance can improve the efficiency of plant breeding. In the present study, we mapped genes for grain traits including grain length and width, and thousand grain weight. A previously constructed linkage map of a recombinant inbred line population was used, which was derived from a cross between an indica restorer rice variety Minghui63 and a temperate japonica rice variety M-202 (MHM). The MHM population was grown in replicated field plots and grain trait data were collected. Upon a 3-year field evaluation, a total of 16 loci were mapped on 9 of 12 chromosomes, including 7 for grain length, 4 for grain weight, and 5 for thousand grain weight. A thousand grain weight locus *qTGW2* a grain width locs *qWIG2.2* were mapped at known blast resistance locus *qBLAST2* on chromosome 2 that harbors a major blast resistance allele *Pi-b.* Another thousand grain weight locus *qTGW3.3* and a grain length locus *qLNG3.3* were mapped at known blast resistance locus *qBLAST3.2* on chromosome 3. These results reveal potential tradeoffs between disease resistance and productivity, which is important for breeders to develop high yielding and disease resistant rice varieties.



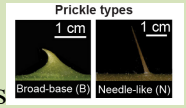

Diagrams showing genetic loci controlling grain trait and potential tradeoff loci

*This addresses USDA-ARS Research Goal:* Crop plants with traits optimized for production and harvesting efficiency, including plant architecture.

Satterlee, J.W., Alonso, D., Gramazio, P., Jenike, K.M., He, J., Arrones, A.,**Huggins, T.D., Eizenga, G.E**., … Prohens, J., Vilanova, S., Lippman, Z.B. 2024. Convergent evolution of plant prickles by repeated gene co-option over deep time. Science 385:514, eado1663 https:\\doi.org\10.1126/science.ado1663

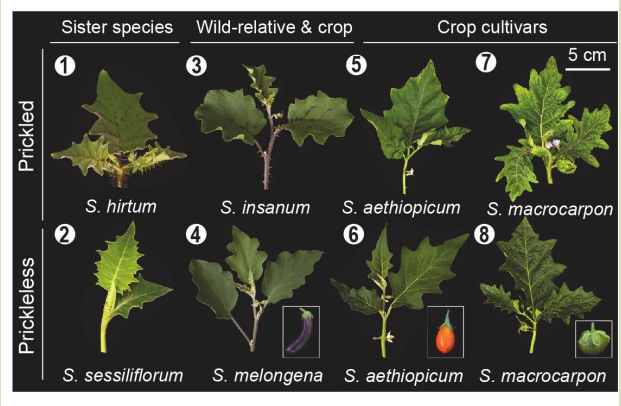
In the agriculturally important genus *Solanum*, crops like eggplants and the desert raisin (forage) have prickles which are the short, slender, sharp-pointed epidermal outgrowths and confer critical fitness advantages like defense against herbivores, improving plant competition, permitting a climbing growth habit and improving water retention. In other crops like rice and barley, prickles are referred to as “barbs” on the awns, “thorns” on roses and citrus trees, or the “stipular spines” on Chinese date and sour jujube. In rice and barley, these barbs (prickles) are undesirable because they damage harvesting equipment, causing it to wear-out faster and in the case of hand-harvesting, injure the person harvesting. Similar problems are noted in other crops, thus understanding genetic control of prickle development will aid in designing genetic studies to develop prickleless crops or crops with prickles, if so desired. There are approximately 1,500 *Solanum* species worldwide and approximately 450 species cluster into subgroups which have prickles. A survey of these three subgroups identified 30 species which did not have prickles. The DNA sequence of nine species with prickles and five prickleless species was examined and it was determined that various mutations in the *LONELY GUY* (*LOG*) gene which activates plant cell division by promoting cytokinin biosynthesis, caused decreased cytokinin production and lack of prickles which was validated in studies with transgenic plants. Across crop plants, mutations in the same *LOG* gene were associated with loss of barbs on awns in rice and barley, thornless roses, loss of stipular spines on Chinese date trees and fruit, and a prickleless desert raisin. This

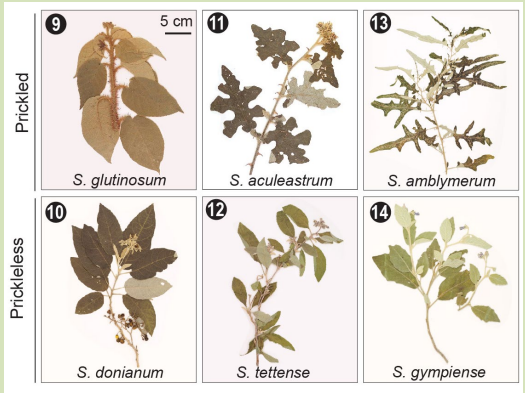
study demonstrates how genetic knowledge can be widely used to easily eliminate prickles across a broad range of row crops like rice and barley, horticultural crops like eggplant and Chinese, date and ornamental crops like roses and giant spider flowers. In the case of crop plants, prickleless varieties would reduce injury when hand harvesting and decrease “wear-and-tear” on equipment when mechanically harvesting. This serves as a model for designing studies to eliminate other undesirable traits (or incorporate desirable traits) using the extensive DNA sequence data currently available.



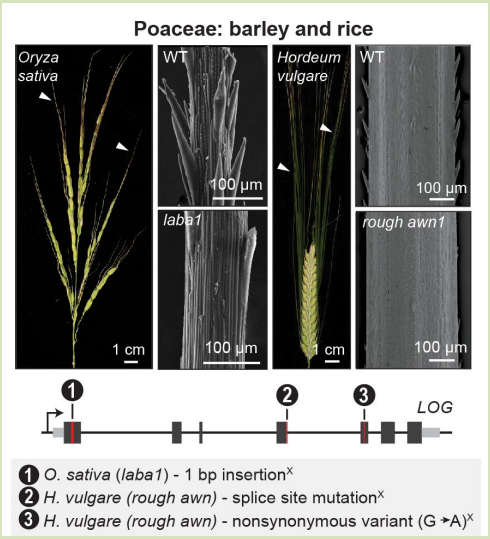

Images from living collections

Images from herbarium collections




Prickles evolved convergently across vascular plants and were lost repeatedly in the spiny *Solanum* lineage. Representative images of narrow and broad-based prickle types are shown. Images of the *Solanum* taxa that have prickles (first row) or lost prickles (second row) captured from living and herbarium collections.




Loss of convergently evolved barbs (prickles) in rice (*Oryza sativa*) and barley (*Hordeum vulgare*) are associated with mutations in the *LONELY GUY* (*LOG*) gene which activates

plant cell division. Images of rice and barley wild type inflorescences are shown with arrowheads indicating the awns. Scanning electron micrographs of the awns are shown for both the wild type and mutant genotypes (rice, *laba1*; barley, *rough awn1*). Instances of suppressing the barbs (prickles) on the awns due to mutations in the *LOG* gene are depicted in corresponding diagram of the *LOG* gene.

- **Technology Transfer**

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

  August 13-15, 2024, **Dr. Trevis Huggins** from DB NRRC attended the Plant Germplasm Operations Committee (PGOC) meeting and Curators workshop held in Davis California. Three NPGS Special Achievement awards were presented to technical staff directly associated with NPGS sites who have gone above and beyond to push the NPGS mission forward. Dr. Gayle Volk, acting National Program Leader provided an update from the Office of National Programs, an update about the National Laboratory for Genetic Resources Preservation, and Tribal relations. The PGOC subcommittees provided activity updates and progress made over the past year and discussed new ideas in the pipeline. The Genetic Observation Subcommittee and a member of the Database Management Unit (DBMU) demonstrated the use of the genetic observation tool that will be used to add molecular data into GRIN-Global. The developers for FieldBook, and Breeding Insight OnRamp provided an overview of their systems and discussed how it can fit into NPGS and GRIN-Global. As part of the curator workshop, the group visited the Tree Fruit and Nut Crops and Grapes germplasm in the field, the Tomato Genetic Resource Center and the Mars Cacao Diversity Collection.



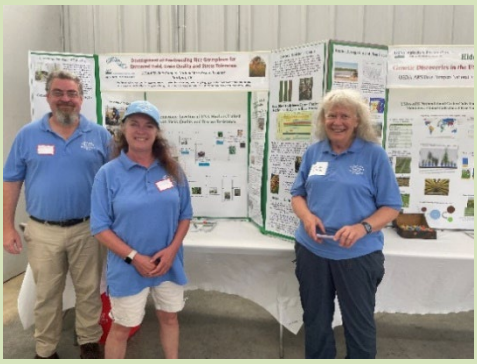
  ✓ **<u>Rice Germplasm Distributed</u>**

  During the month of August, 74 rice genetic stocks were shipped to researchers in Germany, Canada, and the United States.

  GSOR also worked/collaborated with NSGC to send an additional 235 accessions to Germany and Canada.

- **Stakeholder Interactions**

  On August 1, 2024, DB NRRC scientists and researchers presented research accomplishments at the 2024 annual Arkansas rice field day. Field stops showed ARS effort on rice germplasm characterization and enhancement, and US-Japan climate change research project and rice-fish experiment conducted by scientists of DB NRRC and Stuttgart National Aquaculture Research Center. Posters showing ARS efforts on mining rice treasures and accelerating rice breeding using genetic markers developed by ARS. The event this year has drawn over 400 stakeholders domestically and internationally.



On August 1, 2024, Dr. Yulin Jia hosted Kale Ilchena a visitor from Canada at the DBNRRC. Kale attended the 2024 Arkansas Field Day and later Dr. Jai Rohila assisted him for a tour of the facility. During this visit Kale met Dr. Shannon Pinson, Laduska Sells, and Dr. Sathish Ponniah – a UAPB faculty member – who is an awardee of the USDA 1890 Faculty Research Sabbatical in Dr. Jia lab.

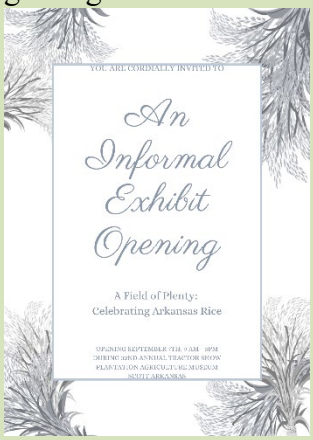

On August 6, 2024, office of technology transfer (OTT) provided in person training for all ARS scientists and supporting staff members at Stuttgart/Little Rock location. **Dr. Yulin Jia** welcomed the visitors from OTT, Brian Nakanishi, Assistant Administrator presented an overview of technology transfer at ARS, Tanaga Boozer, Technology Transfer Coordinator presented helpful hints from the SEA technology transfer office, Dennis Goodes, Deputy

Assistant Administrator presented things we should know about agreements, Ari Atkinson, Supervisory Patent Advisor presented things we should know about patents, Diana Halsey, Business Licensing Officer presented things we should know about licensing and ended with touring research conducted in both rice and fish units.


On August 20, 2024, **Drs. Yulin Jia, Jeremy Edwards** and **Trevis Huggins** along with Ms. **LaDuska Sells**, **Mr. Adam Rice** and two Postdoctoral Research Associates, **Drs. Li Wang** and **Aron Osakina** visited the Shoffner Farm in Newport Arkansas. They met with Ms. Hallie Shoffner and her staff to observe varieties developed by DB NRRC and discuss management systems. Leaf samples were collected for any observed disease and plots were inspected for purity.

At the beginning of August **Dr. Yulin Jia** was alerted that rice brown spot disease has impacted the stability of the wild rice (Zizania palustris) growing in lakes in Wisconsin. Discussion has taken place to address how ARS and University of Arkansas Rice Research and Extension Center (UA RREC) can help Tribes understand temperate and humidity that drive epidemic of the fungus, how nutrient levels and host resistance play a part in combating the fungus.

On August 26, 2024, **Heather Box** provided bundles with and without panicles for the Plantation Agricultural Museum's display. Packaged seed was also provided. The history of rice display starts Sept 7, 2024, beginning with the 32nd annual tractor show.

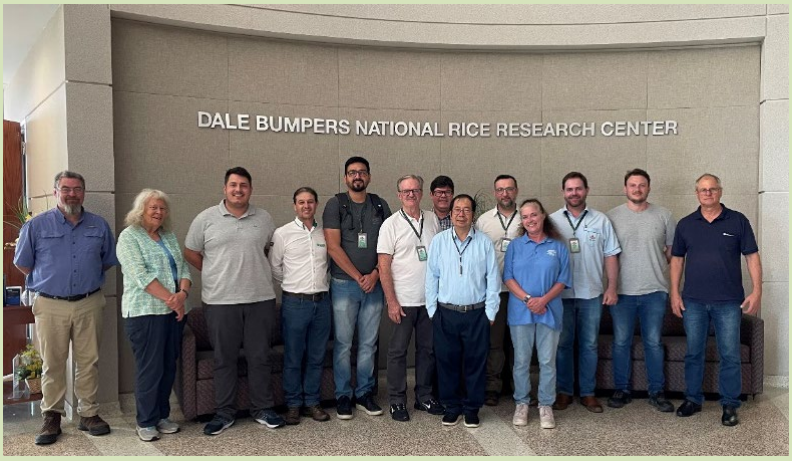



On August 30, 2024, **Dr. Yulin Jia** with Dr. Alton Johnson (Director of UA RREC) attended grand opening of Northeast Rice Research and Extension Center (NERREC). NERREC is to develop innovative, efficient rice production practices, to maximize net return for Arkansas rice producers, and to provide extension-based education/outreach to the public on the value of Arkansas rice in a sustainable ecosystem.


**International Research Collaborations**

On August 2, 2024, several scientists from the Brazilian research institute Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina (EPAGRI) and along with a few farmers and millers visited DB NRRC to exchange knowledge, experiences, and ideas about rice production systems, as well as past and future joint projects. The visit aimed to foster collaboration and innovation in agricultural practices between our institutions. **Dr. Yulin Jia** welcomed the visitors by presenting a past accomplishment of a collaborative project of DB NRRC with EPAGRI. Dr. Klaus Scheuermann from EPAGRI conducted research at DB NRRC resulting in the development of a genetic marker for *Pi-9*, a broad-spectrum blast resistance gene. Thus far, this marker has been used by rice breeders in the USA and Brazil to speed up breeding for blast resistance. **Dr. Rodrigo Pedrozo**, an ORISE Postdoctoral Research Fellow guided the Brazilian group on a tour of DB NRRC, highlighting our latest advancements in broadening genetic bases

for rice improvement. The delegation had the opportunity to observe our research labs, experimental fields, greenhouses, and seed processing facility. Further collaborative research has been discussed among scientists from both EPAGRI and DB NRRC.




On August 13, 2024, **Drs. Yulin Jia** and **Shannon Pinson** met with Dr. Mariano Durand, rice breeder in Argentina with the National Agricultural Technology Institute, commonly known as INTA. Similar to USDA in the USA, INTA is the federal agency in for the generation, adaptation and dissemination of technologies and knowledge for the agriculture, forest and agro-industrial activities in Argentina. Dr, Durand initially visited the DB NRRC on July 30, 2024, with a contingent of 42 members of the Argentina rice industry. He returned to the DB NRRC on August 13 for deeper sharing of knowledge on rice genetics and breeding. During the 8/13 meeting, Dr. Durand presented a slide overview of rice production and research in Argentina. This presentation revealed that two topics of notably high concern to the rice industries in both Argentina and the USA are resistance to rice blast disease, and meeting consumer definitions of grain quality. These topics of strong mutual interest will be the basis of further discussions on potential collaboration.


**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/**