Genomics Research Speeds Up Rice Variety Improvement

FAYETTEVILLE, ARK.

Plant breeders who develop improved rice varieties are getting new tools to speed up the process of combining genes for higher yield, disease resistance, better quality and other desirable traits in new commercial varieties.

The University of Arkansas System's Division of Agriculture is the leader of a multi-state research program called RiceCAP, or Rice Coordinated Agricultural Project, funded by a $5 million grant from the U.S. Department of Agriculture. The project began in 2005 and concludes in October 2008. RiceCAP coordinator is Jim Correll, a Division of Agriculture professor of plant pathology based on the university campus at Fayetteville.

Photos by molecular pathologist Yulin Jia show the branching pattern of mycelia that is unique to the rice sheath blight fungus, disease symptoms on a plant in the field, and soft-drink bottles that can each provide a different micro-climate for rapid screening of plants for reactions to sheath blight.

The Division of Agriculture operates one of the world's leading rice breeding programs at its Rice Research and Extension Center near Stuttgart.

New tools for rice breeders include genetic markers, which reveal the presence of genes linked to a particular genetic trait, Correll says. These markers are not "the answer" to problems that breeders are addressing, he says, but they help them make more precise selections in their crossbreeding efforts to achieve elusive combinations of genetic traits.

"Markers are currently used by our breeders. They are genomic tools, but that doesn't mean we will be developing genetically engineered rice varieties," Correll says. That point is very important, because many export customers for Arkansas rice will not accept genetically engineered rice, he says.

Plant breeding is a lengthy process. When a breeder identifies a plant with targeted traits that represent an improvement over the varieties available to growers, the breeder selects that plant as a parent in a crossbreeding program. The basic process has been used since the 19th century, but advances have been made in areas such as screening plant populations for desirable crossbreeding parents.

In the first few generations of crossbreeding, some offspring usually have a superior combination of traits and others don't. The crossbreeding goes on for several generations u-ntil a population of plants is obtained with a consistent combination of traits. O-nly at that point can the seed from a new "breeding line" be trusted to produce a consistent yield and quality of grain. The process can take seven to 10 years from the time a "parent" plant is selected for use in a breeding program.

Speeding up the process of bringing improved varieties to farmers is a major goal, Correll says.

A marker is an easily identifiable piece of genetic material, usually DNA, that scientists have determined is linked to a particular trait, Correll says. Thus, markers allow breeders to be more selective in crossbreeding and might save months or years in the development of an improved variety.

Correll says RiceCAP is developing new markers for genes associated with the fungal disease sheath blight in rice plants. Ultimately more important that providing new markers, he says, is the understanding scientists are gaining about the genetics of rice in general and sheath blight in particular.

Another RiceCAP focus is milling yield, which is a measure of the portion of whole grains milled from a lot of rough rice. Both sheath blight resistance and milling yield are difficult objectives because they are controlled by multiple genes and are greatly affected by environmental factors, Correll says.

An example of a new marker for sheath blight susceptibility is found in a project by Steven Brooks, a Division of Agriculture adjunct scientist and molecular pathologist at the USDA's Dale Bumpers National Rice Research Center near Stuttgart.

Brooks isolated a toxin produced by the sheath blight fungus and determined that plants that are sensitive to the toxin tend to be susceptible to sheath blight disease damage.

"This work provides the means to genetically map toxin sensitivity genes and eliminate susceptible genotypes when developing sheath blight-resistant cultivars," Brooks says in a paper published in the journal Phytopathology.

Yulin Jia, another molecular pathologist at the USDA Rice Research Center and a Division of Agriculture adjunct scientist, developed a "micro-chamber" screening method. It is faster and cheaper than field tests to determine if plants are susceptible or resistant to sheath blight. It is described in an article in the journal Plant Disease.

RiceCAP also has educational and outreach components. It involves graduate students in genomics research to help train the next generation of plant breeders in emerging technologies, Correll says. Scientists also have conducted workshops to help high school and junior high teachers incorporate genetics research into science courses. Δ