Texas Rice

Texas A&M University System
Agricultural Research and Extension Center
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Study to Examime the Difference in Photosynthesis Rates Among Rice Varieties and Hybrids

Hybrid rice varieties were first commercially released in the U.S. in 2000. The early hybrids exhibited tremendous growth potential but tended to lodge, the grain tended to shatter, the rice produced low whole grain and low total milling yields, and grain yields were highly variable. Hybrid rice production has come a long way over the past seven years. An increasing number of producers are now able to achieve a yield advantage and comparable milling yields to that produced by conventional inbred varieties. While lodging and shattering continue to pose problems, fertilizer management tailored to hybrid plant growth characteristics has helped. Today, an increasing number of producers are able to achieve a sufficient yield advantage with hybrids to more than offset the increased costs of purchasing hybrid seed. While the yield advantage has been attributed to the catch all term "heterosis", the morphological, physiological, and genetic attributes that collectively provide this advantage remain poorly understood.

A study was initiated in 2007 to determine the underlying physiological basis for the increased yield performance of hybrid rice and to determine whether the attributes that provide hybrids with superior yield performance can be incorporated into conventional inbred varieties.Four hybrid (XL 744, XL 723, CL XL 730, and CL XL 729) and four inbred (Banks, Cocodrie, Jefferson, and Saber) varieties are currently undergoing evaluation. This paper provides a brief summary of some of our early results.

Seven of the eight Photosynthesis chambers set up at the Texas A&M Research and Extension Center in Beaumont. Between each chamber and the control box is a 120V cord to power the blower, power and signal wire for the air velocity transducer, the temperature/humidity sensor, and 2 Bev-A-Line ® 1/8" plastic tubing for sampling CO2 levels of inlet and exhaust air.

The preliminary data that are presented in this paper were obtained using simple, but in many ways, state-of-the-art field photosynthesis chambers. Each chamber covers 4-rows x 2.5 m of a single variety (Fig. 1). Eight chambers, one for each variety, are connected via an 8-channel gas and analog multiplexer (Sable Systems International, Las Vegas, NV) to a LI-6400 photosynthesis meter (Li-Cor Inc, Lincoln, NE. During each sampling interval, photosynthesis

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From the Editor...

Hybrid Vigor!
Is it a heterosis thing,
or can inbred varieties
catch the wave?

Welcome to the August issue of Texas Rice. Our cover story compares the early season photosynthesis and growth of hybrid and inbred rice varieties. The ultimate goal of this research is to identify why hybrids have a greater yield potential than inbreds and to determine whether it is feasible to incorporate the yield enhancing traits found in many hybrids into inbred varieties.

Preliminary results from this ongoing experiment show the hybrids have about a 21% increased canopy photosynthesis rate during the pre-flowering period of crop growth, when grown in the field side-by-side with the inbreds, using the same water, fertilizer, insect, and disease management. This increased vigor ultimately results in the hybrid plants producing biomass at a faster rate and producing a greater number of tillers. If the difference in growth rates continues throughout the season, the hybrids will end up producing a higher yield as well.

The critical question, again, is whether hybrid vigor is caused by the heterosis, and if so, can the traits that control the increased vigor be incorporated into inbred varieties that are developed through conventional pedigree breeding? As a point of explanation, heterosis refers to a plant having different alleles at one or more genes for each pair of chromosomes. You can view this as being analogous to having a brown eye gene on one chromosome and a green eye gene on the matching chromosome. The conceptual difference with heterosis in rice is that we are talking about dozens, if not hundreds, of sets of alleles and, correspondingly, dozens, if not hundreds, of loci differing in terms of the traits that they control. While a large number of genes have a tremendous amount of heterosis within each and every human, the normal situation for inbred rice is uniformity, with exceedingly little variations across each loci for each pairs of chromosomes.

If the hybrid vigor is due to heterotic alleles at one or more key loci, then the answer is maybe. Under this scenario, it might be possible to incorporate the desired type of vigor into inbred varieties by stacking appropriate vigor genes. On the other hand, if hybrid vigor is due to the heterotic alleles causing the expression of additional metabolic pathways governing photosynthesis and vigor, then it will be difficult to incorporate this into inbred lines. Once this season's study is completed, we will be closer to answering this critical question.

The increased yield potential of hybrid rice is something that has been realized for some time. Dr. Yuan Longping, the co-recipient of the 2004 World Food Prize, first discovered a naturally-occurring, temperature-sensitive, sterile male mutant in 1964. Commercial hybrid rice production started in China in the early 1970s. India followed suit by initiating an aggressive hybrid rice development program in 1970, that resulted in the release of its first four hybrids in 1994. In 1979, the technology for developing hybrid rice was transferred from China to the U.S. This event is largely viewed as the first case of transfer of intellectual property from China to a western country. The first hybrid developed in the U.S. was released in 2000 by RiceTec. Today, approximately 60% of China's rice is produced using hybrids, while somewhere near 10% of India's rice is produced using hybrids.

Prior to Dr. Yuan's initial discovery and the subsequent development of what is referred to as the two-line and three-line hybrid breeding programs, the only way to produce hybrid rice, other than through the use of chemical sterilants, was to painstakingly remove all of the male pollen from individual flowers, then insert

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Farming Rice

a monthly guide for Texas growers

Providing useful and timely information to Texas rice growers, so they may increase productivity and profitability on their farms.

Susceptibility of Different Rice Varieties to the Lesser Grain Borer

Lesser Grain Borer on rice.

The lesser grain borer (LGB), *Rhyzopertha dominica* L., is an important pest of stored grains, including rough rice. Egg are laid on the exterior of the grain kernels, and the 1st instar larvae (defined as neonates) bore inside to feed on the kernels. The developing larvae can cause weight loss and damage to the germ and endosperm. Rice is generally stored as rough rice, and the rice hull or husk may offer some protection from the lesser grain borer. Variation in kernel hardness and chemical composition may also confer some level of resistance. Many new varieties of rice have been developed in recent years, but there have been few assessments of the susceptibility of various varieties to the lesser grain borer. A series of tests were conducted to evaluate selected cultivars of long-, medium- and short-grain rice to the lesser grain borer.

A total of 28 varieties of long-, medium-, and short-grain rice were received from various sources by the USDA-ARS Grain Marketing and Production Research Center (GMPRC), Manhattan, Kansas. All rice was from the 2004 crop year. Upon arrival at the GMPRC, each rice variety was placed in cold storage at about 40°F, and before being used in the test was warmed to room temperature and tempered to 14% moisture content. One thousand individual kernels were sampled from each variety to determine the percentage of intact hulls versus cracked or split hulls. Five solid hulls from each variety were cut in half and the thickness of the hulls were measured in four separate places. The developmental time of the lesser grain borer was assessed by placing ten larvae that had recently hatched from eggs (neonates) on 20g of rough rice from each variety in plastic vials. This is the larvae stage that bores inside the hull to feed on the kernel. There were four separate replicates for each variety, and the vials containing the larvae were held at 90°F, 75% relative humidity (RH) until adult emergence was determined to be completed. All emerged adults from each variety were then transferred to new vials containing 20g of the rice variety on which they were reared. Beginning two weeks after these adults were transferred, and eggs were collected each week for 4 weeks. The Dobie index of susceptibility was calculated for each variety This is determined as (log F)/ D * 100, where F is the number of progeny adults produced by the adults that emerged from the original ten neonate larvae placed in each vial and D is the median development time of those original ten larvae.

There was no difference in the percentage of solid hulls among the three rice types, but there was a wide variation within type (Table 1). The overall percentage of solid hulls ranged from 55.5 ± 2.1% in Koshihikari to 92.8 ± 1.0 % in Akita(a). Both of these were short-grain cultivars. There was also a wide range of values for adult emergence from the ten neonates exposed on each cultivar and the Dobie index values (Table1). The cultivars with the highest Dobie index values (3.7 and 3.8), indicating greater susceptibility to the lesser grain borer, were Francis, Rico, Delmati, Jefferson, and Neches. The cultivars that appeared to be tolerant to the lesser grain borer, as shown by the lower Dobie index values (1.1 to 1.6), were Wells, Jupiter, Pirogue(a), and Bengal. The same pattern followed for the development of the original ten neonate larvae exposed on the cultivars, i.e., greater survival to the adult stage on the susceptible versus the tolerant varieties. With the exception of Wells, the lesser grain borer

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generally took 2-3 days longer to develop to the adult stage on the varieties with low Dobie indices compared to the more susceptible cultivars. A higher percentage of solid hulls was correlated ($P < 0.05$) with a lower Dobie index value, lower neonate survival, and fewer progeny. Hull thickness varied among the varieties (Table 1), but was also correlated with lower Dobie index values and neonate survival ($P < 0.05$). The number of progeny produced by the original 10 neonates that survived to the adult stage (Table 1), which was reflected in the Dobie index values along with survival, was also correlated with hull thickness ($P < 0.05$). Progeny production in varieties with Dobie indices of 3.4 to 3.8 ranged from 70.5 to 138.2, with the exception of Black Japonica and Dellmati, where progeny production was comparatively low at 38.3 and 61.2. Similarly, progeny production ranged from 6.0 to 24.5 in Bengal, Jupiter, Pirogue, and Wells, which had the lowest Dobie indices (1.1 to 1.6).

The rough rice hull offers protection from insects, molds, and moisture, and any break in the hull could provide an access point for stored-product beetles. The causes of breakage or splits in the hull result from a variety of factors, including cultural practices and growing conditions; however, it is also possible that other factors unique to individual varieties affect hull breakage, which could confer different levels of tolerance to the lesser grain borer. The samples of rice varieties used in our tests came from various production sites in California, Arkansas, Texas, and Louisiana, and though all were from the 2004 crop, these varieties exhibited a wide range of susceptibility to the lesser grain borer. Further tests on cultivars from a wide range of locations, drying conditions, and crop years are necessary to define the degree of susceptibility of rough rice to the lesser grain borer and other stored-product insects.

For further information on this and other related projects, please contact Dr. Frank Arthur with the USDA-ARS Grain Marketing and Production Research Center in Manhattan, KS, (785)776-2783, frank.arthur@gmprc.ksu.edu. Recent publications can be downloaded from http://ars.usda.gov/npa/gmprc/bru/arthur. *

Article by Dr. Frank Arthur

Table 1. Percentages (means ± SEs) of solid rice hulls, adult emergence from the original ten neonate larvae placed on the rice, the Dobie index of susceptibility, the maximum thickness (in micrometers) in the thickest part of the lemma of the hull, and the number of progeny produced by the neonates that survived to the adult stage. Twenty-eight rice cultivars were evaluated for susceptibility to the lesser grain borer and some varieties were obtained from duplicate sources, as denoted by the letters a and b.

	% of Solid Hulls	Adults	Dobie Index	Thickness of lemma	Progeny
Long-grain					
Bolivar	76.6 ± 1.7	5.8 ± 1.1	2.9 ± 0.3	75.2 ± 2.1	39.5 ± 10.0
Cocodrie	88.0 ± 1.1	7.0 ± 0.6	3.4 ± 0.2	70.2 ± 1.0	100.2 ± 33.2
Dawn	62.0 ± 2.2	5.8 ± 1.4	2.8 ± 0.4	83.0 ± 4.7	32.3 ± 1.8
Dellmati	61.4 ± 1.0	8.0 ± 0.8	3.7 ± 0.3	86.6 ± 3.9	61.2 ± 16.3
Francis	81.4 ± 1.5	8.0 ± 0.8	3.8 ± 0.2	74.2 ± 5.2	95.5 ± 1.3
Jasmine	76.6 ± 1.7	7.0 ± 0.0	3.1 ± 0.1	84.8 ± 3.8	79.0 ± 30.0
Jefferson	88.0 ± 1.1	8.8 ± 0.5	3.7 ± 0.3	78.6 ± 7.9	101.8 ± 1.9
Lebonnet	89.9 ± 1.2	7.5 ± 0.6	3.5 ± 0.1	81.0 ± 6.3	138.2 ± 31.7
Neches	89.4 ± 0.8	8.2 ± 1.2	3.7 ± 0.3	80.8 ± 2.0	75.5 ± 20.7
Wells	91.2 ± 1.0	2.0 ± 0.6	1.1 ± 0.6	86.2 ± 1.4	6.5 ± 5.5
Medium-grain					
Bengal	90.5 ± 0.6	2.8 ± 0.5	1.6 ± 0.3	92.2 ± 2.5	7.5 ± 1.5
Earl	75.4 ± 2.2	7.5 ± 0.9	3.3 ± 0.2	92.2 ± 4.0	39.0 ± 14.2
Jupiter	91.6 ± 1.2	2.2 ± 0.5	1.2 ± 0.4	93.6 ± 2.4	6.0 ± 0.1
Medark	87.1 ± 1.0	7.2 ± 0.9	3.5 ± 0.2	82.6 ± 3.6	78.2 ± 22.7
Rico	76.5 ± 1.3	8.8 ± 0.9	3.8 ± 0.2	81.0 ± 3.3	132.5 ± 19.5
M-104	87.1 ± 1.0	6.0 ± 0.6	3.1 ± 0.2	78.8 ± 2.7	96.8 ± 41.8
M-202	90.8 ± 1.0	2.7 ± 0.3	2.7 ± 0.3	83.6 ± 5.3	100.0 ± 39.6
M-204	87.8 ± 1.5	6.0 ± 0.5	3.1 ± 0.1	78.8 ± 3.4	65.5 ± 10.7
M-205(a)	87.4 ± 1.5	7.8 ± 1.3	3.4 ± 0.3	86.4 ± 3.5	70.5 ± 24.3
M-205(b)	86.0 ± 1.4	5.2 ± 0.8	2.6 ± 0.2	79.6 ± 1.7	46.8 ± 12.2
M-206	86.5 ± 1.3	7.0 ± 0.9	3.6 ± 0.2	81.2 ± 3.6	89.5 ± 24.6
Short-grain					
Akita(a)	92.8 ± 1.0	4.8 ± 1.2	2.4 ± 0.5	90.4 ± 3.2	72.2 ± 24.8
Akita(b)	77.3 ± 2.5	7.2 ± 1.1	3.5 ± 0.4	89.6 ± 2.8	48.8 ± 10.6
Black Japonica	91.8 ± 1.1	6.2 ± 0.8	3.8 ± 0.8	91.0 ± 3.3	38.3 ± 12.2
Pirogue(a)	88.2 ± 1.6	7.8 ± 0.5	1.2 ± 0.4	89.4 ± 3.6	81.2 ± 20.3
Pirogue(b)	88.2 ± 1.1	2.2 ± 0.5	3.4 ± 0.1	92.4 ± 2.6	24.5 ± 11.5
Koshihikari	55.5 ± 2.1	2.9 ± 0.6	2.9 ± 0.6	72.4 ± 3.0	63.0 ± 19.2
S-102	89.7 ± 1.4	6.2 ± 0.5	3.4 ± 0.2	88.6 ± 3.4	90.2 ± 20.8

The Rice Man of Africa - Dr. Monty Jones

This is the second of a 2 - part article by Savitri Mohapatra, with the Africa Rice Center (WARDA), which is one of 15 international agricultural research centers supported by the Consultative Group on International Agriculture Research (CGIAR). Drs. Ted Wilson (TAES) and Anna McClung (USDA-ARS) toured the Center in 2001 to support collaborative efforts.

The New Rices for Africa (NERICA) are regarded an "exceptional breakthrough achievement" for their ability to thrive in the continent's poor soils, defy drought and weeds, and at the same time increase yields by up to 250%, depending on the management regime. They mature in only half the time (90 days) of traditional varieties, providing valuable food during the 'hunger' season. In addition, the protein content of NERICAs is about 25% higher than that of imported rice varieties found on the local markets in Africa.

And for this, Dr. Monty Jones became the first African in 2004 to take home the prestigious World Food Prize. "Working closely with colleagues at WARDA and the CGIAR system, through sheer personal tenacity, Monty Jones succeeded where all others before him had failed," stated the World Food Prize Committee.

In his supporting letter to the World Food Prize Committee, Sir Gordon Conway, chief scientific adviser for UK's Department for International Development, wrote, "Dr. Jones' ability to combine cutting-edge science with on-farm work has yielded significant benefits for the many poor rice farmers in Africa who were by-passed by the Green Revolution."

His NERICA breakthrough earned the West Africa Rice Center the UN Award for South-South Triangular Partnership in 2006, as well as the Consultative Group on International Agricultural Research (CGIAR) King Baudouin Award in 2000.

Dr. Monty Jones. Photo courtesy of CGIAR News, June 2004

While the research was largely undertaken in West Africa, NERICA is causing waves across sub-Saharan Africa and beyond. Latest data from WARDA and the Africa Rice Initiative indicates that Guinea, in West Africa, leads in the adoption of this rice, followed by Uganda, in East Africa. Nigeria is guzzling up virtually all the NERICA seed produced in West Africa and is looking further afield for more.

During the inaugural at the West African Rice Center last December, Dr. Jones reminisced about his childhood and his very religious upbringing in Freetown, Sierra Leone. With parents who had "white-collar jobs," he had no contact with agriculture but he dreamed of helping to produce food that would help feed the world. His mind made up, he decided to pursue his studies in agricultural science, against the wishes of his parish priests who urged him to enter the priesthood.

In the 1970s, he received a fellowship from the UN Food and Agriculture Organization allowing him to study at Birmingham University, where he received a master's degree (1979) and a doctorate in plant biology (1983). "Rice riots", catalyzed by a shortage of rice in 1985 in Sierra Leone, strengthened his resolve to become a rice researcher. In 2005, Birmingham University conferred upon him the honorary title of Doctor of Science.

Before joining WARDA in 1991, Dr. Jones worked on mangrove rice in the Rice Research Project in Rokupr in his home country. There, he first saw farmers growing African rice and he became fascinated with its hardiness, a fascination that sowed the seeds for the NERICA development.

Dr. Jones may not look like a stereotypical scientist, but perhaps he possesses some of the eccentricity that seems to go hand in hand with scientific greatness. At the WARDA ceremony, he confessed that he used to speak to his NERICA plants, praising them for their performance. Whatever he did, it worked. *

BioEnergy Alliance for Southeast Texas

Southeast Texas is an ideal choice for public and private investment into alternative energy, particularly ethanol and biodiesel production. In addition to the infrastructure to support world class refining production, the region also has a vibrant agricultural economy.

The four critical elements needed for successful production of bioenergy are:

- Agricultural Infrastructure
- Transportation Infrastructure
- Proximity to Consumers
- Research & Intellectual Capital

Southeast Texas is strategically positioned with a unique combination of MAJOR STRENGTHS in these critical areas.

On the left, sweet sorghum, a potential ethanol crop, and on the right, soybeans, a potential feedstock for the biodiesel industry. Both crops are being evaluated at the Beaumont Center.

Agricultural Infrastructure. Southeast Texas contributes \$3.5B or 19% of the state's \$13.3B in agricultural revenue. The combination of the region's agriculture-friendly climate and soil, access to water, and plentiful available land is unmatched in Texas. Rice has always been a staple crop in the region, but the ability to produce multiple high biomass crops for use as feed stock is a strong asset as well. Furthermore, this is the only region in Texas with close proximity to and expertise in the timber industry. Forest products and other cellulosic material have been studied as strong alternative feed stocks for bioenergy production.

Transportation Infrastructure. Beaumont and the surrounding region enjoy access to one of the largest and most active deepwater ports in the U.S. Southeast Texas has extensive rail and interstate infrastructure that serves the region's industrial complex. These resources are vital because ethanol is transported along a "virtual pipeline" of railcars and tank trucks from production to consumer. Another significant asset is our extensive network of pipelines in the region due to our petrochemical base. As national ethanol production ramps up over the next decade, no region in Texas is better suited to embrace pipeline transport of products than Southeast Texas.

Proximity to Consumers. Southeast Texas touts a world-class concentration of petrochemical and energy industries with their associated support services, supplying 10% of the nation's gasoline and 20% of the nation's jet fuel. This area not only continues its dominance in the energy and petrochemical industries, but this trend is accelerating with over \$10 billion in industry expansion slated over the next 5 years: Cheniere LNG - \$1 B; Golden Pass LNG - \$1 B; Sempra LNG - \$1 B; Motiva Refinery expansion - \$4.5 B; TOTAL refinery expansion \$1.8 B; Valero refinery expansion \$1 B.

Table 1. The Membership of the Bioenergy Alliance for Southeast Texas.

Members	Affiliation
Karen Bourdier	Entergy
Don Cotten	Lamar University
Bob Dickinson	Southeast Texas Regional Planning Commission
Jennifer Doornbos	Rice Producer
Jim Gillingham	Valero
Jim Rich	Greater Beaumont Chamber of Commerce
John Roby	Port of Beaumont
Keith Rogers	Expert Leadership Solutions, LLC
George Talbert	Lamar University
Lee Tarpley	Texas A&M University System
Mark Viator	Partnership Strategies, LLC
Russ Waddill	Lamar University
Mo Way	Texas A&M University System
Ted Wilson	Texas A&M University System

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Bioenergy continued...

Due to the required blending with gasoline, Southeast Texas refineries are a large and rapidly growing consumer of ethanol.

Research & Intellectual Capital. Southeast Texas has two world class higher education institutions, Texas A&M University System Agricultural Research & Extension Center and Lamar University. The Texas A&M Agricultural Research & Extension Center is one of the leading agricultural education facilities in the nation. Lamar University has a rich history of research and academic excellence meeting the needs of the private sector. The combined strengths of these premier institutions in basic and applied research, coupled with their ability to provide technical support, is particularly valuable for the emerging bioenergy industry.

Alliance

The Southeast Texas community has built an alliance of public sector organizations, government, chambers of commerce, university and research institutions, and Fortune 100 private sector expertise to leverage and provide assistance and efficient access to key resources in the community in order to encourage public and private bioenergy investment in the region (Table 1). Members of the alliance meet ca. every three weeks to discuss how to promote bioenergy research and develop a bioenergy industry. During Governor Perry's July 9 announcement of a Texas bioenergy plan, Lee Ann Woods, who was a member of the Governor's bioenergy task force, described the important role the Bioenergy Alliance for Southeast Texas has played in bringing to the attention of the governor and his bioenergy task force the importance of Southeast Texas as a major hub for bioenergy research and bioenergy industry development. Nine alliance members attended Governor Perry's announcement, an indication of the alliance's commitment to establishing a vibrant bioenergy presence in Southeast Texas.

Alliance Contact: Jim Rich, President, Greater Beaumont Chamber of Commerce (409) 838-6586, jimrich@bmtcoc.org ✻

Article by Karen Bourdier, Don Cotten, Bob Dickinson, Jennifer Doornbos, Jim Gillingham, Jim Rich, John Roby, Keith Rogers, George Talbert, Lee Tarpley, Mark Viator, Russ Waddill, Mo Way, and Ted Wilson.

Breeding Plants to Produce Industrial Oils

Plants do the most amazing things. They're a steady source of life-sustaining oxygen, food, fiber for clothing and, increasingly, renewable fuels. As if that weren't enough, scientists with the USDA Agricultural Research Service (ARS) are also eyeing these leafy dynamos as a virtual spring of never-before-seen oils that could someday rival petroleum in industrial uses and even stave off heart disease.

Plants are already tapped for a variety of useful oils, think of the shimmering liquids pressed from canola, corn and olives, but most of them are destined for the skillet or dinner plate.

However, an even greater potential for oilseed crops resides in their capacity to pump out unusual fatty acids that have valuable chemical, industrial and nutritional properties, according to John Dyer, who works at the agency's Southern Regional Research Center (SRRC) in New Orleans, La. Fish-oil-type fatty acids derived from plants, for instance, could benefit the heart, brain and eyes.

Dyer, a chemist, and Jay Shockey, a plant geneticist who also works at the SRRC, are getting inspiration from tung trees for how plants could be coaxed into churning out such impressive oils.

Tung trees, which used to be cultivated in great plantations along the U.S. Gulf Coast, produce eleostearic acid, an unusual fatty acid with applications ranging from furniture finish to computer chip production. The trees' major shortcomings are that they're slow to grow and vulnerable to hurricanes.

With traditional breeding alone, it's almost impossible to raise crops that will manufacture abundant amounts of unusual fatty acids. That's why Dyer and Shockey are looking to engineer plants that will practically gush forth unique fatty acids, such as eleostearic acid.

They recently discovered that a gene involved in the production of the important enzyme DGAT2, short for diacylglycerol acyltransferase type-2, may well be the "magic bullet" for boosting plants' oil-oozing abilities. ✻

Article by Erin Peabody, email erin.peabody@ars.usda.gov
Agricultural Research Service, USDA

Photosynthesis Study continued...

in each chamber is measured sequentially for 5 minutes. At this sampling rate, it takes 40 minutes to sample each of the eight chambers. Sampling is continuous for up to 72 hours, providing photosynthesis measurements for a range of temperatures and light intensities.

After the chambers are removed, light is measured above and below the canopy of each variety every hour from 8:30 am to 5:30 pm using an AccuPAR LP-80 PAR/LAI meter (Decagon Devices, Inc., Pullman, Washington). Leaf area index and the biomass of each structural component are also recorded for each sample, while grain yield will be estimated at main crop and ratoon crop harvest. Parameters being estimated for each hybrid and inbred include average leaf angle, leaf area index (LAI), photosynthetically active radiation (PAR) interception, canopy and average leaf area photosynthetic rates, specific leaf weight, nitrogen content and concentration, and numbers and growth rates of each structural part (leaves, stems, panicles, and roots). These data are being obtained periodically from tillering to crop maturity, and collectively will allow us to identify which plant traits are primarily responsible for the hybrid yield advantage.

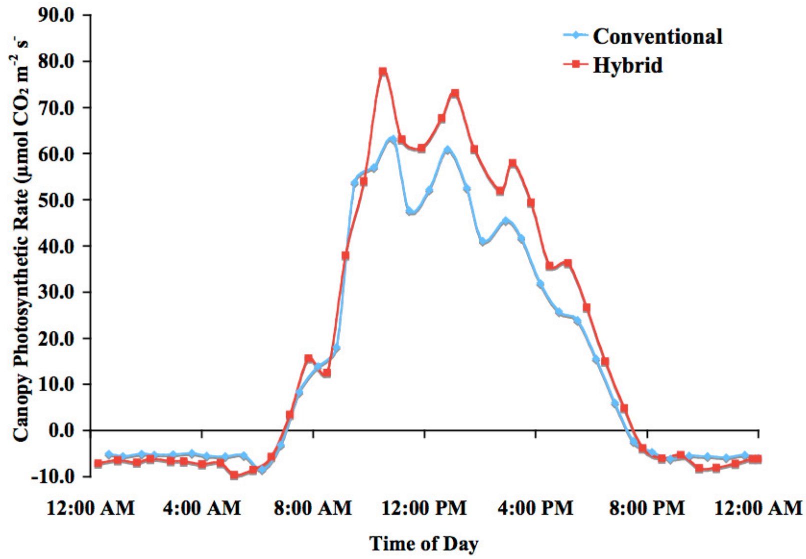

Fig. 1. Diurnal canopy photosynthetic rate contrasting the mean for hybrid and inbred varieties at 52 days after emergence at Beaumont, TX, in 2007.

Data obtained at 52 days after emergence are presented herein for several traits averaged for both the hybrid and inbred varieties. Commercial rice varieties that produce higher levels of plant biomass, in general, have a higher yield potential. Similarly, leaf and stem biomass are often related to photosynthate production, while grain yield is often related to the accumulation of nonstructural carbohydrates that is translocated from the leaves and stems to the grain after heading. Based on destructive sampling, stem mass ranged from 326 g m^{-2} to 530 g m^{-2}. Average stem mass was higher in the hybrids (466 g m^{-2}) than the inbreds (399 g m^{-2}). Leaf mass ranged from 216 g m^{-2} to 337 g m^{-2}. Average leaf mass was again higher for the hybrids (304 g m^{-2}) than the inbreds (246 g m^{-2}). Root mass ranged from 77 g m^{-2} to 112 g m^{-2}. Root mass was slightly lower for the hybrids (90 g m^{-2}) than the inbreds (94 g m^{-2}). Total plant mass ranged from 628 g m^{-2} to 961 g m^{-2}. Average total plant mass was higher for the hybrids (860 g m^{-2}) than the inbreds (740 g m^{-2}). Leaf area index


Julio Castillo and Jeanie Reeves are attaching the inlet air duct from the chamber to the centrifugal blower. Approximately 220 cubic feet per minute of air pass through each chamber.

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Photosynthesis Study continued...

Looking inside the chamber from the exhaust end. Chambers are approximately 8 x 2.5 ft, and enclose 4 rows of rice, leaving a single border row on each side of the chamber.

ranged from 4.0 m m^{-2} to 6.4 m m^{-2}. The average LAI was higher for the hybrids (5.6 m m^{-2}) than the inbreds (4.8 m m^{-2}). Number of tillers ranged from 416 tillers m^{-2} to 945 tillers m^{-2}. The average number of tillers was higher for the hybrid varieties (690 tillers m^{-2}) than the inbreds (664 tillers m^{-2}).

We have begun to unravel the physiological basis for the greater performance of the hybrids. Measurements of the diurnal pattern of photosynthesis shows the hybrids exhibit higher photosynthesis rates during most of the day. While considerable variation existed within both the hybrids and the inbreds, the hybrid varieties on average were more efficient at capturing and converting sunlight into plant biomass from ca. 10 AM to sunset. The higher LAI of hybrids explained part of the increased photosynthesis rate. The higher the amount of leaf area, in general, the higher the amount of light interception. Basically, the hybrids are able to develop a full canopy sooner than the inbreds. But the story is a bit more complicated. Without a corresponding increase in the total demand for carbohydrates and nitrogen by the developing structures, a variety that produces a greater amount of leaf area will not be able to translate increased photosynthetic capacity into increased yield.

The initial observations indicate that on average the hybrids are more vigorous than the inbreds. Surprisingly, the hybrids appear to produce less root biomass than do the inbreds. Conventional wisdom suggests that hybrids are more efficient at mining nitrogen from the soil. We will be looking at the root differences in greater detail. Other traits (e.g., yield components, and nitrogen content and concentration) are yet to be estimated and analyzed from the samples that are being obtained.

A question that remains is whether vigor and correspondingly increased photosynthesis rates for the hybrids is caused by fundamental difference in the hybrids that is caused by the heterosis, or can the associated vigor traits be selected within inbred populations? From contrasting different inbred varieties, it is very apparent that inbred genotypes contain a tremendous amount of variation in their vigor. We anticipate making major inroads into addressing this question and related questions over the next couple of years.

Research on this study is conducted by Lloyd T. Wilson, James C. Medley, and Stanley Omar PB. Samonte. For more information, please send an email to lt-wilson@aesrg.tamu.edu. *

The TSI Model 8455 Air Velocity Transducer measures the flow of air passing in the chamber. The amount of CO_2 in the air is measured at the chamber inlet and exhaust. The difference in CO_2 and the air flow rate give an estimate of canopy photosynthesis.

Update on Discovery of the Rice Panicle Mite in Texas

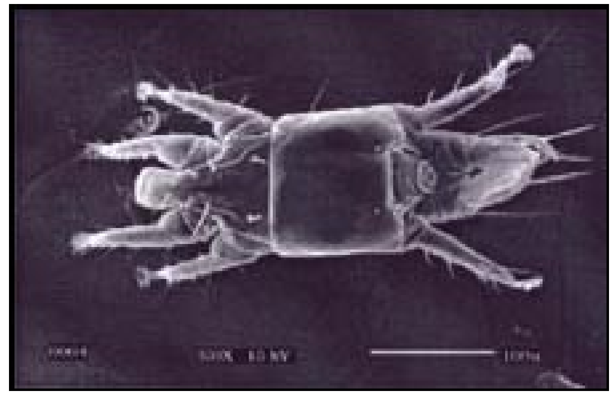
During early August, the Animal and Plant Health Inspection Service (APHIS) has been working in conjunction with RiceTec, Inc. to develop an impact analysis regarding the discovery of the Rice Panicle Mite recently discovered in Texas (See The Rice Advocate, Volume 4, Issue 35 - July 27, 2007).

The organizations issued a statement suggesting that the presence of this non-native species is likely to have little or no economic impact on the U.S. rice industry. Based on the physical characteristics of the pest, along with the local climate and production practices employed in the U.S., authorities feel that the mite can be contained and prevented from spreading to other rice producing regions.

These views were also expressed at a meeting between USDA representatives and key members of the Texas rice industry. "After talking to our contacts in the tropical rice production areas in the Western Hemisphere, I am convinced that the PRM will not become a serious issue in the rice producing areas of the United States," stated USRPA President Dwight Roberts. "This mite has caused damage in areas of continuous rice production in a true tropical setting and our climate and rice farming practices will prevent this mite from becoming an issue here on the gulf coast or in the delta."

Although the USDA scientists report finding very few specimens, sampling will continue in the other rice growing regions in accordance with their standard procedure and for precautionary measures. The full press statement reads: "Data presented at a meeting between plant health officials and private representatives of the US rice industry led to the preliminary industry conclusion that the Rice Panicle Mite (RPM) recently discovered in Texas may not be a problem in the U.S.

Normal rice management practices and typical winter weather patterns could keep any threat in check and prevent the mite from spreading to other rice growing regions. A technical working group assembled by TDA and USDA's Animal and Plant Health Inspection Service (APHIS) will analyze Texas survey data and make recommendations related to this RPM occurrence in the next few weeks. No disease has been detected despite the field sampling by APHIS. Furthermore, no



Rice panicle mite, *S. spinki* Smiley,

mites have been found in any rice seed. Dr. Ron Ochoa, Research Entomologist and mite specialist from the United States Department of Agriculture/Agricultural Research Service (USDA/ARS) presented an overview of the mite biology during the meeting, indicating that the RPM was first isolated in the U.S. from the legs of a plant hopper sampled by Louisiana State University in 1960.

The RPM (*Steneotarsonemus spinki* Smiley) had previously been seen in the U.S. on only one other occasion: on rice grown in a greenhouse in Ohio in 2004. A small number of RPM adults were discovered in a greenhouse in Brazoria County, Texas in mid July, 2007. "Early detection and reporting to APHIS and TDA was critical in the ultimate assessment of any potential damage from such mite presence "according to APHIS and TDA representatives.

Further sampling by APHIS found the mite at a rate of one per one million plants in three fields in the area. It typically takes 10 mites per plant to trigger control action in those tropical countries where it represents an economic threat. *S. spinki* has been reported to be suited to tropical climates only, and not temperate ones like the U.S. On the occasion of the Ohio detection, APHIS' New Pest Advisory Group stated that, "…spinki should not be a major problem of rice grown in the continental U.S. because economic damage has not been reported from any temperate rice growing regions of the world…and the mite is believed to be unable to over-winter in temperate rice growing regions such as in the U.S." *

Article from the Rice Advocate. For more information, please contact the USRPA office at 713-974-7423

Breeding for Higher Protein: Added Value Rice for Health Benefits

A number of high protein rice lines are under development at the LSU AgCenter at Crowley. The aim of this research is to look beyond yield and improve profit by enhancing the added value of rice. It is hoped that the success of this research could eventually open new markets and improve the value of the crop.

Currently, this research is attempting to improve two aspects of the nutritional quality of rice. The first is to improve the whole grain protein content to levels of 11% to 12.5% without changing the yield, milling quality and other grain characteristics.

The second goal is to improve the content of individual essential amino acids. Protein is composed of 20 amino acids, and 10 of them are essential in the human diet. These 10 essential amino acids cannot be produced by the human body and must be supplied through nutrition. Therefore, improving the content of these amino acids will directly increase the nutritional value of rice.

A multi-year replicated yield trial for advanced lines is being conducted and is in the second year. Among entries tested are lines FRN783, 936 and 937 (Francis derived) and WLS07 and 97 (Wells derived).

These lines have shown improved protein content to levels of 11% to 12.5%, while conventional Francis or Wells have protein levels of about 8% or 9%. Their grain and other phenotypic characteristics are similar to those displayed by the parental varieties.

In terms of amino acid content, Line WLS97, for example, has a 47% increase in the level of lysine compared with that typically found in Wells. Since lysine is the essential amino acid with the lowest percentage in the rice grain, having higher lysine content in this line means higher quality and more available protein in the grain.

Research at the Crowley also includes the quantification of B vitamins, minerals and phytochemicals among five advanced high protein lines. These compounds have known links to lipid lowering, as well as antioxidant, anti-inflammatory, glucoregulatory or anti-cancer effects. Advancement in these research areas could possibly improve the health benefits of rice. If successful, this will expand the markets for rice in areas such as the cereal industry, the bread industry, as well as the antioxidant or gluten-free products and other health enhancement industries.

Article by Dr. Ida Wenefrida
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Excerpted from the LSU AgCenter's Rice Research Station News, Vol. 4, Issue 3

Stink Bug Survey

Got stink bugs in soybeans? Jim Heitholt, Texas Agricultural Experiment Station, wants to hear from you. "Stink bugs have shown up in Mid-South crops," Heitholt says. "Just how serious are these pests from year-to-year?"

That's what a team of university researchers and Extension Specialists are trying to find out and they need to hear from as many soybean producers as possible to build a database. "You can help by responding to a survey written for the Southern soybean industry," Heitholt says. "The survey takes only about 10 minutes. By participating, you will make a big difference in our collective fight against stinkbugs. Survey results will be made available to everyone late this summer. To take the survey, go to: http://www.surveymonkey.com/s.aspx?sm=nTT_2fTEEK9v2JsuX-ihBhpvQ_3d_3d.

From http://deltafarmpress.com/news/070806-soy-survey/

House Energy Bill Boosts Alternative Energy

The House passed a new energy bill that will provide more research on alternative fuels and increase energy efficiency standards for appliances and buildings. The measure, passed by a vote of 241-172 during a Saturday session (Aug. 4), has drawn the wrath of Republicans, and a veto threat from the White House, because it does not encourage more domestic oil and gas production. The latter earned it the nickname of the "no-energy" bill from Republican House members upset that the Democratic leadership rolled back about $16 billion in tax breaks for the oil industry that the then-Republican-controlled Congress enacted in 2005.

Excerpted from an article by Forrest Laws, e-mail: flaws@farmpress.com. For full story go to http://deltafarmpress.com/topstory/070807-energy-bill/

From the Editor continued...

pollen from a donor plant. Emasculating and hand pollinating rice flowers, as this is called, is a lot harder than it sounds. Typically, a rice breeder is only able to manually emasculate and hand pollinate a couple of thousand flowers during any one year. Putting this in perspective, an 8000 lb/ac long grain rice crop matures ca. 130 million grain/ac. This means that while hand pollination is useful for developing new rice varieties it is not a practical method of producing the amount of rice required for commercial-scale production.

The male sterile gene used in producing hybrid rice works by causing pollen to become sterile if the flowers are produced in areas having warm summers. By crossing a male sterile variety with a variety having a male fertile gene, the resulting seeds that develop on the male sterile plants are all hybrids. While the steps required for a two-line and a three-line hybrid rice-breeding program are actually a bit more complicated than this implies, in essence, this is how hybrid breeding work.

The warm summer months that occur along the Texas Gulf Coast are largely the reason why the development of hybrid rice seed works well in this area. While RiceTec has attempted to expand its hybrid seed production to the cooler, more northern rice producing states, this effort has not been entirely successful. In states such as Arkansas, cool weather fronts can sporadically occur during the summer. Because the male sterile gene does not reliably express itself when rice flowers at lower temperatures, when cool fronts occur during the summer, the breeders can end up with a large percentage of plants that have breed true, or what are referred to as selfs or inbreds. When this occurs, the intended hybrid seed contains some hybrids and some inbreds. This can cause a lack of uniformity in growth characteristics and crop maturity dates, both of which are not advantageous. At least for the near future, the best place to produce new hybrid rice seed in the U.S. will be Texas.

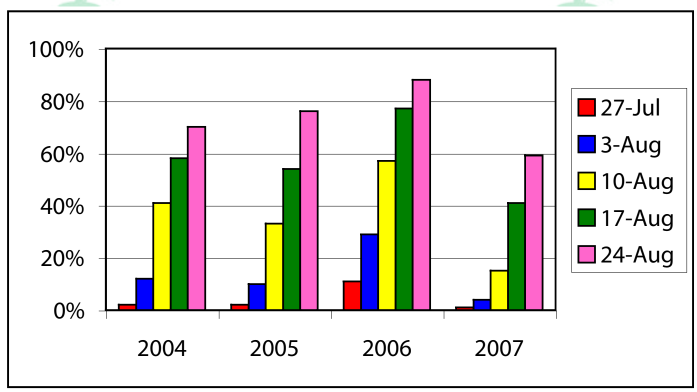
Please keep on sending us your suggestions.

Sincerely,

L.T. Wilson
Professor and Center Director
Jack B. Wendt Endowed Chair
in Rice Research

Rice Crop Update

% MC Harvested



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