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Rice Research News

Rice Research and Extension Center • University of Arkansas Division of Agriculture

INSIDE

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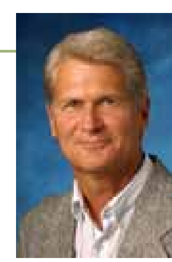
CONSTRUCTION UPDATE — Building progress for the new office, meeting and research facilities at RREC has kept pretty well on schedule. The office area is nearly complete, and the dirt work on the greenhouses is just winding up. The project is expected to be finished in mid-November. The faculty and staff are planning to complete the move to the new facility in January. On the right side of the complex is the office building, with15 offices plus conference rooms and associated facilities. It is entered from the high, arched foyer, seen in the middle of the photo, which separates the office building from the auditorium. The auditorium is a multi-function facility that can seat about 250 people. To the left of the auditorium is the "clean lab," which houses the physiology, molecular genetics and biomass energy labs. The large metal building at the top of the photo is the field lab, which will house the breeding, pathology, agronomy and entomology labs.

From the Director

Harvest time



Christopher W. Deren

Winding up a record-setting wet summer, we are getting into harvest. Fortunately, at the center we had pretty good luck getting experiments and seed production planted even with the wet spring. Our soybeans look especially good, given that they had ample moisture all season.

However, plenty of moisture can have its downside as Scott Monfort tells in his research note on black root rot in soybean. Rice diseases seemed to be particularly bad this year as well.

Farmers' concerns about diseases this year probably contributed to the very good turnout we had at our Plant Pathology tent at Field Day. There were displays of smut, blast, soybean rust and methods used at the plant disease diagnostics lab. Visitors had the opportunity to observe these displays at their leisure, and many took advantage of the chance to talk with the presenters. Given the favorable responses we heard, we'll continue presenting some of our research in this format next year.

Videos of RREC Field Day research tours are online

Research and extension presentations from the Aug. 12 field day are available for viewing online and for downloading to computers, Blackberries, iPhones and other mobile devices.

Fourteen Web videos provide a virtual field day, covering all the topics presented in four field and indoor tours. The videos can be found on the Division of Agriculture Web site: http://aaes.uark.edu/ricefielddays_videos.html.

Field day topics in the virtual tours include development of improved rice varieties; rice and soybean fertility; managing rice and soybean diseases, weeds and insect pests; rice quality; tillage and the economics of irrigation.

This year's field day included three "tent exhibits" where Division of Agriculture and USDA-ARS experts provided information on plant diseases, bio-energy, rice quality testing and family-oriented topics such as a new ATV safety training program, nutrition and 4-H activities.

Milo Shult, the U of A System's vice president for agriculture, introduced Reece Langley, USA Rice Federation vice president for government affairs, keynote speaker for the indoor part of the program following field tours. He reported on USA Rice activities to monitor and influence federal legislation and agency actions that impact rice producers.

Chris Deren, RREC director, reported on the progress of construction of new office and research facilities.

Brief updates were given by chairmen of the rice, soybean, wheat and corn/grain sorghum research and promotion boards, which are funded by farmer check-off payments, and by Dave Gealy of the USDA-ARS Dale Bumpers National Rice Research Center.

Approximately 700 field day guests enjoyed a catfish lunch to conclude the program. Oil used to fry the fish was recycled by Sammy Sadaka to make biodiesel. Sadaka is an extension engineer and leader of the Division of Agriculture biodiesel research and extension project based at RREC.

Visitors included a delegation from the Chinese National Rice Research Institute, which is one of the world's leading rice research organizations, as guests of RiceTec, Inc. They were Cheng Shihua, director general of the CNRRI; Hu Peisong, director of research and technology; and Pan Xiaofang, head of the international department.

FIELD DAY TOPICS — The "Plant Disease Tent" at the field day was popular. Among the topics were 1) black root rot and other soybean diseases, with plant pathologist Scott Monfort; 2) rice blast and sheath blight with plant pathologist Fleet Lee (pictured), research associate Guangjie Liu and Michael Lin, DB NRRC; and 3) smut with molecular geneticist Steve Brooks, DB NRRC.

Jennifer James

N-ST★R nitrogen soil test for rice

Videos of interest to rice producers

In addition to a "virtual field day" of 14 videos of RREC Field Day tours, rice producers will be interested in two other videos that can be viewed online at http://aaes.uark.edu/videos.html.

One features Jennifer James, a Jackson County farmer who is volunteer chairman of the USA Rice Federation Sustainability Task Force. James gave a presentation as keynote speaker at the Division of Agriculture's Pine Tree Research Station field day, Aug. 20.

The other video provides details about the project to develop a nitrogen soil test for rice — "N-ST*R" — in a presentation by Division of Agriculture soil scientist Rick Norman and graduate student Trenton Roberts, who recently completed his requirements for a Ph.D. degree in plant sciences at the University of Arkansas.

Black root rot, an emerging disease in soybeans

Due to a combination of cool, wet weather and recent shifts in acreage from cotton to soybeans in the last two years, black root rot is becoming an issue for soybean growers.

Traditionally, black root rot, caused by the fungus *Thielaviopsis basicola*, has been a disease primarily affecting cotton in Arkansas. It is a soil-borne fungus and is indigenous to Arkansas soils. The disease affects a plant's root system — infecting root tissue which can lead to seedling death in severe cases. Cool, wet conditions during early plant growth stages encourage the development of the disease.

In 2008, the disease was first diagnosed in soybeans in Arkansas and the southern U.S. Initial disease symptoms were similar to those found on cotton infected with black root rot. Diagnosis of black root rot in soybeans was confirmed with pathogenicity tests.

The best way to distinguish this disease is to examine the root system. The primary diagnostic characteristic of black root rot is blackened, deformed roots. The blackened roots are the result of fungus infection and colonization of cortical tissue which eventually leads to root necrosis. Confirmation of the fungus can be achieved from plating out infected roots on specialized media specific to *Thielaviopsis basicola*. A positive result will show growth of the fungus out of the infected root tissue as dark-colored round colonies on the media.

Symptoms of black root rot can also be observed above ground within the first four weeks of the growing season. Above-ground symptoms include severe stunting, stacking of the nodes and chlorotic spots that form along the veins of the leaves.

We are conducting research trials in field and greenhouse settings to understand the potential of this disease on soybeans and to generate possible control recommendations. These research trials will evaluate varieties for potential resistance as well as seed treatments for potential control. So far, greenhouse trials have shown black root rot to have a significant impact on soybean seedling survival.

Currently, very few control options are known to prevent development and spread of this disease in soybeans. Black root rot could have yield-limiting potential, however, no studies have confirmed yield loss in soybeans.

Scott Monfort
Extension Plant Pathologist

INFECTED ROOT COMPARISONS — Root system damage caused by black root rot ranges from heavy, top, with numerous blackened roots, to minimal, bottom, with just a few blackened roots.

STUNTING — Black root rot can cause severe stunting of soybean plants in a field of otherwise healthy plants.

New JES variety of aromatic rice available to seed growers

A new aromatic variety of long grain rice developed by university and U.S. Department of Agriculture plant breeders in Arkansas and Florida has been jointly released for production by seed growers.

Christopher Deren, a plant breeder and director of the University of Arkansas Division of Agriculture's Rice Research and Extension Center near Stuttgart, said the variety is named JES, for Jasmine Early Short. It joins a short list of aromatic varieties adapted to Arkansas growing conditions that have the aroma and cooking characteristics of Jasmine rice grown in the tropics of Southeast Asia.

A supply of genetically pure Foundation seed of JES was grown in 2009 at the Rice Research and Extension Center and will be available for sale to seed growers for the 2010 season, Deren said.

The new variety was developed jointly by J.N. Rutger, recently retired director of the Dale Bumpers National Rice Research Center, USDA Agricultural Research Service, Stuttgart, and Deren, when he was a plant breeder at the University of Florida. The variety is a joint release of the Florida, USDA and Arkansas research agencies.

Deren said JES was developed through induced mutation breeding. Seed of Khao Dawk Mali, which is translated as "jasmine flower rice," from Thailand were obtained from the International Rice Research Institute in the Philippines, subjected to mutagenesis at the University of Florida and grown out at the UF Everglades Research and Education Center in Belle Glade.

The focus of the breeding effort was to find variants for height and sensitivity to photoperiod or day length, Deren said. Khao Dawk Mali is a very tall variety, a trait that can cause plants to lodge or fall over under the increasing weight of developing grain. In addition, the variety is induced to flower and begin grain production by short day length. In the monsoon tropics of Southeast Asia, shorter days coincide with the decline of the monsoon season, so this trait is useful to those farmers. Grain ripening and harvest take place as the dry season commences, so harvest and drying are easier, Deren said.

In the temperate climate of Arkansas and other rice-producing states, flowering on short days is a liability, because by the time the days are short, they are also cool, and cold kills pollen, Deren said. The result is that heads are sterile, and no grain will be produced. The new variety addresses both those problems, while maintaining the desired aroma and cooking characteristics, Deren said.

In 2008, it was grown on three Arkansas farms totaling 70 acres. This extensive evaluation plus small plot tests showed that JES is moderately susceptible to lodging, is about three feet tall, heads in about 92 days, and has an average yield of about 150 bushels per acre and milling percentages of 55/69 head rice to total rice. It has moderate tolerance to blast and is moderately susceptible to sheath blight, two common fungal diseases of rice in Arkansas.

The new JES variety of aromatic rice was grown in 2009 at the Rice Research and Extension Center to supply genetically pure Foundation seed available for planting by seed growers in 2010.

Chris Deren and J.N. Rutger show a selection of the new JES aromatic rice variety, foreground, amid taller variants in a breeding plot at the Rice Research and Extension Center near Stuttgart.

Nitrogen soil test is technology breakthrough for agriculture, environment

A new soil test for nitrogen fertilization of rice may not sound like blockbuster technology, but it is, said Chuck Wilson, extension rice agronomist with the University of Arkansas Division of Agriculture.

The new technology is the first and only site-specific test of mineralizable soil nitrogen as a basis for nitrogen fertilizer recommendations in any crop. It will help farmers apply just the amount of nitrogen fertilizer needed to maximize yields with no excess to run off in surface water, Wilson said.

The new test, called "N-ST*R" (Nitrogen Soil Test for Rice), has been previewed at summer field days by Division of Agriculture soil scientist Richard Norman and his doctoral student, Trenton Roberts. A video of a field day presentation by Norman and Roberts can be viewed at http://aaes.uark.edu/NSTAR_video.html.

If validation studies in 2009 work as expected, verification studies will be implemented in fields of cooperating farmers in 2010, Wilson said.

"I'm extremely excited about it," said Marvin Hare Jr., a Jackson County farmer and a member of the Arkansas Rice Research and Promotion Board, which is funding the research along with The Rice Foundation.

"It has the potential to be one of the most important research developments (for rice farmers) in a long time," Hare said. "It will give us a tool to more accurately manage our nitrogen fertility."

Hare said following the new test recommendations could reduce or eliminate nitrogen in surface water run-off from fields.

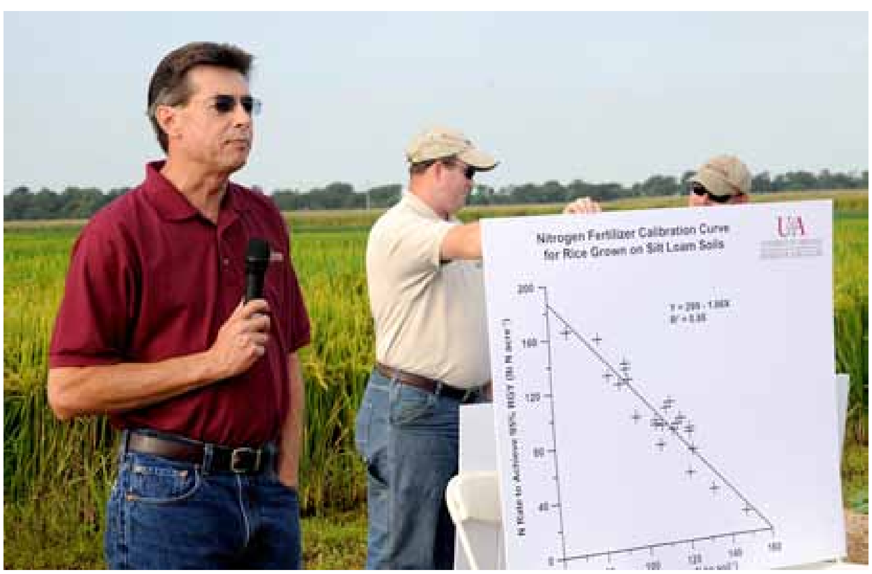
"Anything we can do to enhance sustainability is a good thing, especially when it can increase yields and reduce input costs," Hare said.

Greene County rice producer Terry Gray said the new test "has the potential to be revolutionary." He said he will run his own trials by following the test guidelines in one or more strips of rice and comparing it "to what I have been doing" in adjacent strips.

Gray said it will take time for farmers to gain confidence in the test, because their instinct is to add nitrogen if plants in a field show visual symptoms of nitrogen deficiency such as yellowing of leaves. The color and size of plants in some test plots have the appearance of a slight nitrogen deficiency during late reproductive growth, but yields have not been affected when test guidelines were followed, Norman said.

Nitrogen fertilizer is one of the biggest expenses in rice production, and its price is affected by the volatility in oil markets.

"You want to squeeze all the yield you can out of your nitrogen investment without leaving any on the table," Gray said. "We've probably been putting too much on."



BREAKTHROUGH — Richard Norman, a University of Arkansas Division of Agriculture soil scientist, and doctoral student Trenton Roberts discuss their technology breakthrough that will help rice farmers apply the amount of nitrogen fertilizer needed for optimum yields with no excess to run off in irrigation water. The presentation was during an August field day at the Rice Research and Extension Center near Stuttgart.

The N-ST*R method has been validated in field tests for the entire range of silt loam soil conditions in Arkansas, Norman said. Most Arkansas rice is grown on silt-loam soils. Research is continuing to develop a nitrogen fertilizer calibration curve for clay soils.

Currently, farmers estimate nitrogen needs based on a blanket recommendation for each soil type, previous crop and their experience with past rice crops. Validation tests have shown that the standard recommendation is usually either too little or too much, Norman said.

"Eliminating over-fertilization is just as important as being sure you apply enough," Norman said. "After the plant gets all the nitrogen it needs, the rest just feeds the fungi" that cause plant diseases such as sheath blight and blast. Too much nitrogen fertilizer can also lead to lodging and yield loss and can delay maturity and add plant residue that can slow combines as they harvest the grain, he said.

The potential savings to farmers in many

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Nitrogen soil test … *(Continued from page 5)*

cases will include lower nitrogen fertilizer bills and less fungicide to control diseases, Norman said. Fields where the standard nitrogen fertilizer rate was too little should see a yield increase.

Norman said the test predicts the amount of "mineralizable soil nitrogen," which is the form that feeds plants. Until now, there was no such test because nitrogen exists in many organic forms in a constant state of change in the soil, he said. The amount actually available to plants has been hard to pin down.

Norman has worked on the problem periodically over the last 20 years as a Division of Agriculture soil scientist. He and his colleagues finally solved the chemistry puzzle by identifying measurable soil nitrogen fractions that reliably predict the amount of mineralizable soil nitrogen available to plants.

The solution worked great in laboratory and greenhouse tests, but not in field tests until they took a fresh look at how soil samples were collected in the field. The glitch proved to be the conventional practice of taking soil samples at a depth of four to six inches.

"When we took samples down to 18 inches, which is the effective rooting zone of the rice plant, our field test results matched our lab and greenhouse test results," Norman said.

Solving the problem and designing an economical and reliable test protocol was a team effort, Norman said. The team included his former doctoral students and now Division of Agriculture professors, Chuck Wilson and Nathan Slaton, extension rice agronomist and director of the Soil Testing and Research Program, respectively.

Former graduate students Jeremy Ross, extension soybean agronomist, and Jacob Bushong, now with the USDA Natural Resources Conservation Service, were assigned different aspects of the project for their graduate studies.

Norman's current doctoral student, Trenton Roberts, designed and conducted the basic laboratory research to determine which organic nitrogen fractions in the soil at various depths are measured by the test. Roberts also gathered the vast amount of field data needed to prove that N-ST*R is able to predict the nitrogen fertilizer required to optimize rice yield on silt soils in Arkansas, Norman said. A recent addition to the team is Anthony Fulford, a doctoral student who will concentrate on developing N-ST*R for clay soils.

Cooperators in extending this new technology to other rice-producing states are university soil scientists Tim Walker, Mississippi State; Dustin Harrell, Louisiana State; and Gary McCauley at Texas A&M. The other states are a year or two behind Arkansas with field trials to document reliability of test protocols.

Control strategies for rice blast disease in Arkansas

Rice blast, caused by the fungus *Magnaporthe oryzae*, is considered one of the most successful and devastating plant diseases worldwide. Although all growth stages of the rice plant are affected, the disease most often develops during late boot and heading growth stages in Arkansas. Up to 100% grain loss can occur within individual fields over a significant portion of the Arkansas rice production area. Untold economic losses were experienced by rice producers when a multi-year blast epidemic devastated the new high-yield Newbonnet variety planted to over 60% of state acres during the mid 1980s. Smaller, equally damaging epidemics, have since occurred in high-yield blast susceptible varieties which, on occasion, have been planted to over 80 % of state rice acres.

With Newbonnet as a reminder and funding by the Rice Research and Promotion Board, we began a sustained research effort to develop efficacious control strategies for this erratic and overwhelming disease. This research has focused on interactions between essential components of disease including the environmental conditions favorable for disease development, virulent fungal strains causing the disease and susceptibility of the rice plant. Rice grower management ultimately impacts each disease component and overall plant susceptibility to rice blast.

Environmental

Plant canopy environmental conditions favoring fungal survival, spore germination and primary infection of leaves, leaf collars and the panicle are typically first to be discussed relative to rice blast disease. Conditions necessary for fungal infection include continuously moist conditions with periods of free water, a moderate to cool temperature and low to moderate light conditions.

Soil and root zone environmental conditions, although seldom considered, actually dictate blast progress in the plant. The soil contains the various mineral nutrients including N, Mn, P, K, Zn and Si necessary for plant growth. These nutrients also impact development of rice blast and other diseases. That excessive nitrogen (N) fertilization increases blast susceptibility is well established. In fact, susceptibility is increased in plants using nitrate fertilizers, the inorganic N in non-flooded soils, and is reduced in plants using ammonium fertilizers, the inorganic N under flooded soils. Available oxygen (O) content of the soil dictates the N form.

Research reveals an integrated relationship between the plant and soil environment variation around the plant roots. As the soil becomes saturated with irrigation water, available oxygen is consumed by plant and microbial activities. Impacted by flood depth, the competition for oxygen continues towards hypoxic extremes. Changes in oxygen availability in the root zone impact multiple hormones and metabolic processes of the rice plant. Relative to rice blast, root zone oxygen levels mediate plant production of ethylene which in turn mediate metabolic processes defining plant susceptibility to blast. The lower root zone oxygen levels attributable to continuous flood enhances blast resistance. A portion of the increased resistance is attributed to a slowed fungal growth within plant tissue as the plant vascular system adapts to moisture saturated soils.

The blast fungus

The blast fungus grows on dead plant tissue or other substrates to produce asexual spores which are carried on wind currents and randomly deposited throughout the plant canopy. The spore germinates to produce specialized infection structures which provide entry of infectious hyphae into plant cells. Within 9-16 hours, the entire infection process is complete. The fungus grows best on nodal tissue of leaf collars, leaf veins and panicle. The well known diamond shaped leaf lesions result from a more rapid growth along rather than between the leaf veins. After approximately 5 to 7 days, the disease cycle renews as hundreds of spores are released from individual lesions.

This complex fungus-host interaction is strictly controlled by inherent characteristics of the fungus and plant. The rice blast fungus survives by readily adapting to resistant rice variety utilized by growers. As a result, the contemporary rice blast fungus population is composed of numerous biological variants (races) capable of defeating most resistance genes deployed in Arkansas. Dr. J.C. Correll and others define the contemporary fungal population as being dominated by four of eight distinct DNA fingerprint groups containing four distinct vegetative mating types. It is worthwhile to note all rice varieties grown in Arkansas are susceptible to one or more blast races. As residuals from the massive Newbonnet epidemic, races IB-49 and IC-17 predominate in Arkansas, while races IB-1, IE-1, IE-1k, IG-1, and IH-1 occur less frequently.

The rice plant

The rice plant has evolved multiple mechanisms to counter parasitism by the blast fungus. Genetic resistance is the most widely known and utilized mechanism, with hundreds of unique blast resistance genes currently being discovered worldwide. These resistance genes are defined relative to their efficacy and relationship with the fungus.

Major resistance (R) genes confer complete and specific resistance to one or more rice blast races. Typically, R genes function to control the rice blast disease during or immediately after the primary infection process. Historically, newly released R gene varieties are defeated within one to three years by fungal adaptation. Pyramiding multiple major genes, partial resistance genes and/or QTL's into a single variety greatly extends the useful lifetime of R genes and provides a more durable rice blast

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Control strategies … *(Continued from page 7)*

control. Gene pyramiding, although difficult when using traditional breeding techniques, is facilitated using anther culture, rice hybridization and newer molecular techniques.

Partial resistance (PR) genes, in contrast, do not generally block blast infection but reduces disease severity through specific incomplete resistance to one or more blast races. PR genes support R genes, are responsive to cultural conditions and are associated with field (horizontal) resistance.

Quantitative Trait Loci (QTL's) also confer incomplete resistance by means of less defined clusters of minor genes which individually contribute to blast resistance. QTL's function to slow blast development and are associated with field resistance.

Field resistance

Field resistance, difficult to define and assay, is presumed to result from the combined action of PR genes, QTL's and changes in plant metabolism. Field resistance progressively slows progress of the blast disease by the continual reduction in number and size of leaf and panicle lesions, often leading to a disease-free plant later in the growing season. Growers and research scientists have long noted field resistance as being impacted by various cultural practices including irrigation and fertility practices.

Utilizing flood induced field resistance. While investigating the Newbonnet blast epidemics during the mid 1980s, we observed blast resistance comparable to R gene resistance could be induced in certain susceptible varieties by continuous deep flood. Working with inclined plots, blast susceptible varieties exhibiting large leaf lesions when growing upland or in a shallow flood progressively had fewer and smaller lesions as the depth of the continuous flood depth was increased. Less susceptible varieties developing leaf lesions in shallow flood conditions became blast free as the continuous flood depth was increased. Panicle blast and the subsequent grain loss was higher for plants growing in the shallow flood, while comparable plants growing in the continuous flood showed a greatly reduced panicle infections or were blast free. These and data from additional flood tests demonstrated complete blast control could be achieved for certain susceptible varieties by a careful maintained continuous-deep flood. Subsequent greenhouse and field research demonstrated flood induced field resistance is, as previously described, directly mediated by root zone environmental conditions being impacted by flood management. Duration and depth of permanent flood are critical to establishing proper field resistance for blast susceptible varieties.

Guided by flood depth test results and practical application, rice specialist Dr. R.D. Cartwright and county agents developed flood management recommendations to reduce or, in many cases, eliminate yield loss to rice blast in moderately-susceptible-flood-responsive varieties. Rice blast control by flood management contributed to the record-per-acre yields produced in Arkansas since 2004 when growing blast susceptible varieties including Wells and Francis.

Quantifying flood induced field resistance. Techniques are not currently available to accurately quantify field resistance of rice varieties. Some degree of flood induced resistance was observed with all compatible variety-race assays conducted to date. This strongly suggests the phenomenon is not race specific and occurs throughout the rice germplasm. In general, the magnitude of flood induced field resistance appears to characteristic for an individual variety.

Wells and Francis varieties require continuous permanent flood coupled with careful field monitoring to avoid unexpected outbreaks. They also represent the minimum acceptable magnitude of induced blast resistance necessary for a commercial variety. Historically, varieties Starbonnet, Cypress and Mars exhibit acceptable field resistance in moist soil but are subject to significant damage during high moisture stress. The potential exists for finding an enhanced field resistant variety within the rice germplasm pool that will grow upland in standard moist conditions and withstand damage during high to extreme moisture stress.

Germplasm evaluation for field resistance. Techniques are also unavailable to accurately detect field resistant varieties. In their absence, we rely upon the primary tools used by breeders and pathologists to evaluate blast resistance in new varieties. Basic blast data are gathered from artificially inoculated and natural infected GH and field nurseries. Optimum disease pressures are established by manipulating those environmental conditions known to impact blast infection and growth. These data plus additional data from multiple field plots throughout Arkansas production areas are utilized to compare observed blast resistance for experimental entries with that of established check varieties.

Prior experience with this system aids blast vulnerability assessments during breeding entry and variety development. Unfortunately, although test data from multiple experimental plots indicate a moderate to high field resistance, actual field resistance of new varieties is unknown until they are exposed to widespread grower use under adverse field conditions.

Future research efforts. During 2009, we began developing new inclined plots located on the RREC to further research flood induced field resistance. The new inclined test plots will provide for multiple planting dates, better flood management and annual rotation between plot location. Specific research objectives to be addressed are to:

1. Better quantify field resistance new cultivars, breeding lines and other genetic materials prior to release or advancement in breeding programs. Use side by side field performance comparisons with known tolerant cultivars to develop a quantifiable numerical estimate of blast field resistance comparable to the existing leaf and panicle blast rating system.

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Control strategies … *(Continued from page 8)*

2. Research the genetics of field resistance using the field resistance rating system coupled with modern molecular assays.
3. Investigate the interaction between flood parameters and other cultural practices particularly timing or rate of nitrogen applications.
4. Search for predictive infield assays to quantify field resistance being expressed by plants growing under moisture stress conditions.
5. Investigate flood management interactions with other rice diseases including sheath blight.

Fleet N. Lee,
Plant Pathologist

Severe leaf blast lesion symptoms on rice. Lesions produce spores which spread the disease to other leaves and the rice panicle.

Large area of severe leaf blast lesions. Lesions sufficiently large to inhibit panicle exsertion and grain formation.

Severe rotten neck blast symptoms. The fungus infected and destroyed the lower (neck) nodes of emerging panicles and prevented grain fill to seriously reduce rough rice yield.

Side by side comparison of a healthy panicle in grain with a blasted panicle which will produce no yield. The infection occurred at the node immediately below the panicle thus called a rotten neck or neck blast.

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Control strategies …

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Upland field nursery artificially inoculated with multiple blast races. Leaf lesion and panicle blast data from the nursery are utilized to estimate blast resistance for experimental lines.

Data collection from an artificially inoculated upland blast nursery.

Blast lesions on rice node tissue. All nodal tissue are subject to blast infection including stem node (joint) leaf collar, leaf vein, neck node and all nodes on the panicle.

Production field of Newbonnet rice located near Hickory Plains, Ark., during 1986. Yield loss with infected panicles was nearly 100% in the affected area. Comparable blast diseased field were common with thousands of acres affected statewide.

Production field of Wells rice during 2002. Panicle infection 100% in affected area. Field yield reduced an estimated 50%. Photo by Dr. R.D. Cartwright.

Production field of Francis rice during 2003. Panicle infection 100% in affected area. Field yield reduced an estimated 50%. Photo by Dr. R.D. Cartwright.

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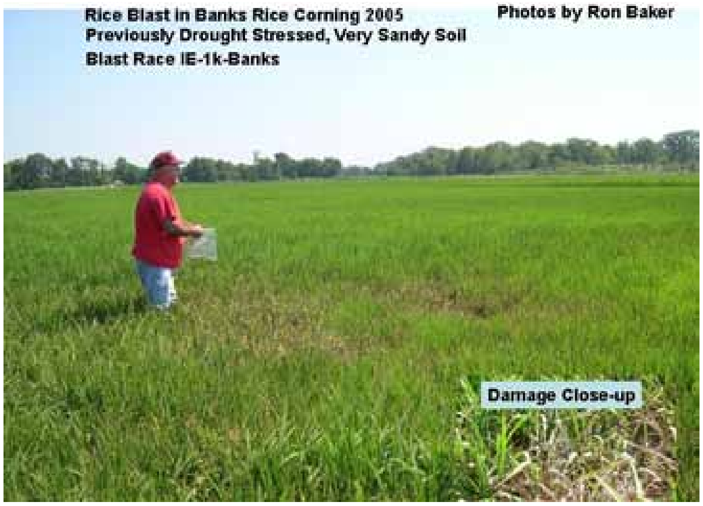
Control strategies … *(Continued from page 10)*



Severe leaf blast in drought stressed areas of a Banks production field near Corning, Ark., during 2005. Banks, a high yield variety, was subsequently discarded by grower in about three years. Photos by Ron Baker.

Original RREC inclined plots photographed from the upper shallow end of plots. Plants growing in the shallow end were intermittently irrigated and developed significant rice blast. Here the very susceptible variety M 201 plants were killed by blast. Plants in the deep continuous flood developed lesions but were sufficiently resistant to have survived.

Original RREC inclined plots photographed from continuous deep flood end (approximately 9 inches) with diseased M 201 plants being very obvious.

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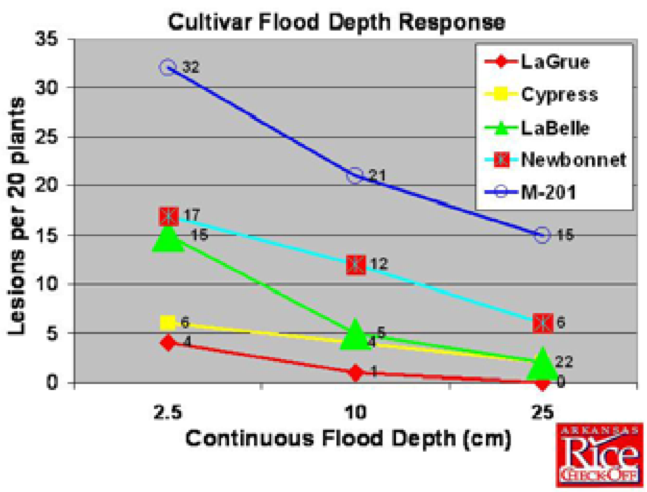
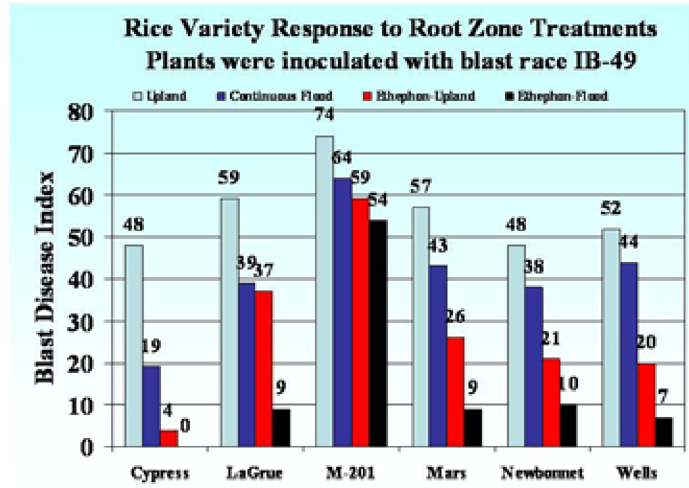
Control strategies … *(Continued from page 11)*



Lesion data collected from plants growing at critical depths along the inclined plots. Field resistant varieties LaGrue and Cypress much less blast damage than the other cultivars.



Data from short term greenhouse flood test using a leaf blast severity index. Test treatments were plants growing: upland with sufficient intermittent irrigation for growth, a continuous flood maintained, upland plus ethephon soil surface treatment and continuous flood with the ethephon soil surface. Plants were inoculated with blast race IB-49. Ethephon induces ethylene production. Test data indicate flood reduced blast severity in all varieties.