Sheath blight, caused by the fungus *Rhizoctonia solani* AG1-IA, is the most economically important disease in Texas and other southern rice-producing states. The disease is widespread and occurs every year. The disease was first reported in Japan in 1910, and was soon well established in many Asian countries (Lee and Rush, 1983). The pathogen is capable of infecting rice, soybeans, grass weeds, and hundreds of other plant species (Rush and Lee, 1992). The pathogen can survive and adopt to diverse environments worldwide. Thus, the disease occurs throughout rice production areas of the world, and has become one of the major biological constraints to rice production, the primary staple food for almost half of the world population.

**Grain Yield and Quality Losses**

Sheath blight can damage various parts of rice plants, resulting in significant losses in yield and milling quality. Infected leaf blades reduce effective leaf area that is associated with the production of carbohydrates, leading to partial fillings of grain. Reduction in effective leaf area is a major cause of yield loss by sheath blight. This effect is most severe when the flag leaf is infected before grain fill. Damage to leaf sheaths and culms also weakens rice plants, frequently resulting in lodging. The disease also attacks panicles. Poorly-filled or premature ripen grain contain less moisture and make it more likely to break during milling. Sheath blight can reduce total grain yield by as much as 50% (Groth, 2005; Marchetti and Bollich, 1991) and whole grain milling yield by up to 31% (Marchetti, 1983).

**Symptoms and Signs**

Correct disease diagnosis is critical to economically-wise sheath blight management. Sheath blight is relatively easily identified based on disease symptoms (e.g., sclerotia and mycelium) compared to other rice diseases. This disease is characterized by large oval lesions on leaf sheaths and irregular snakeskin-like lesions on leaf blades, and by the appearance of sclerotia and mycelium on some of the leaf sheaths and blades. Although rice plants at all stages of growth are susceptible to sheath blight, initial symptoms usually appear during the late tillering to internode elongation stages. The initial lesions on leaf sheaths are circular, oval or ellipsoid, and greenish-gray (Fig. 1A) and usually start to develop near the

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**Fig. 1. Initial (A) and late (B) symptoms of sheath blight on leaf sheaths.**
From the Editor ...

Impact of Drought on Rice

Welcome to the May Issue of Texas Rice. The severe drought that most of Texas is experiencing is posing major challenges to our state’s water supply. From the Lower Colorado to the Sabine River, water is the life-blood of the Texas rice industry and with each passing day water supplies are increasingly pushed to the limit. Many of the rice fields are in good shape with high uniformity of growth, but in fields where permanent flood is delayed some reduction in growth has been reported.

As the season progresses, we will see what happens in terms of insect and disease pressures. So far, it appears that insect pressures are less this year. Drought brings with it a decrease in the abundance of weeds that surround the rice fields or that are associated with adjacent unmanaged pastures. Drought negatively effects populations of sugarcane borer and Mexican rice borer, both of which feed and build-up on a number of grassy weed species. The net effect of a continuing drought will be decreased deadhearts and later on decreased whiteheads. Drought might also decrease stink bug injury, if the drought reduces the amount of vegetation available for stink bugs to feed on, and “if” the timing that host weeds dry off is not forced by drought to coincide with rice grain filling. If the timing of the senescence of weeds that surround rice fields occurs at the wrong time, it will, unfortunately, “push” the stink bugs into the adjacent rice fields. This problem can be partially addressed by maintaining cleared field margins around rice fields. Although this is not an exact science, the idea is to “encourage” any stink bugs (or stem borers) dispersing from mature weedy areas in the immediate vicinity of a cleared rice field margin to have to search in other directions to find suitable vegetation. If the clean areas are sufficiently wide, the majority of dispersing stink bugs will turn around and fly away from the rice prior to reaching the rice field edge. The wider the cleared area, the fewer the number of stink bugs reaching the rice.

Droughty conditions tend to cause daily maximum temperatures to increase and humidity to decrease. This is a mixed bag. Increased temperatures prior to flowering promote increased plant growth, which lead to increased yields. However, increased temperatures following the initiation of flowering increase plant respiration thereby decreasing metabolic efficiency, which can result in decreased seed set and lower yields if sufficiently severe. Low humidity at this stage of crop growth decreases pollen germination and can lower seed set. In contrast, lack of rainfall at this stage can actually increase pollen germination and increase seed set. Lower relative humidity is also less favorable for the development of many rice diseases. Continuing drought later in the season would increase the amount of high-temperature induced panicle blight, but possibly decrease the level of bacterial panicle blight.

This can all be rather confusing given the dynamic manner with which the rice plant and its associated insects and pathogens respond to the environment. Inevitably, drought introduces more problems than it does benefits, in the process increasing production costs and decreasing profitability. Only time will determine whether the drought continues and the extent of problems that it brings.

The drought in Texas and floods in other parts of the nation highlight the scale and importance of water. It is unfortunate that the U.S. lacks a coordinated

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Transformations of soil organic matter and nitrogen in a rice paddy are important for the evaluation of nitrogen fertilizer use efficiency and environmental protection. Irrigation of rice fields greatly affects nitrogen (N) and carbon (C) mineralization rates (Wang et al., 1993; Fierer and Schimel, 2002). Hence, it is important to understand the effects of wetting and drying cycles on microbial processes regulating C and N dynamics in rice ecosystems.

Laboratory and field studies have shown an increase in dissolved organic carbon in the soil after rewetting (Franzluebbers et al., 1994; Fierer and Schimel, 2002; Chow et al., 2006; Butterly et al., 2009). This increase is associated with microbial cells dying and breaking apart due to osmotic shock and release of low molecular weight organic compounds into solution (Lundquist et al., 1999; Fierer and Schimel, 2002), and the breakage of soil aggregates which release organic matter (Six et al., 1999; Denef et al., 2001). As a result, high levels of carbon dioxide emission are found following rewetting (Franzluebbers et al., 1994; Lundquist et al., 1999; Fierer and Schimel, 2002; Kostyanovsky and Dou, 2010).

While wet-dry cycling affects N and C transformations, little is known about the long-term implications of wet-dry cycling on the dynamics of N and C. Flooded rice soils commonly result in low N availability due to decreased nitrification (Xue and Yang, 2008) and adsorption of significant amounts of ammonium N (NH$_4^+$) in the interlayer of clay minerals (Zhang et al., 2005; Liu et al., 2008). Soils fertilized with N sources increase dissolved organic carbon production over time (Holgate et al., 2011).

At the Texas A&M AgriLife Research and Extension Center at Beaumont, we are conducting a study to elucidate the effects of wetting and drying on N and C transformations to assess N availability following urea fertilization. We collected representative surface and subsurface soil samples at Beaumont (fine textured soil) and Eagle Lake (Table 1).

<table>
<thead>
<tr>
<th>Site</th>
<th>Soil Horizon</th>
<th>Depth (ft)</th>
<th>Nitrate N (mg/kg)</th>
<th>Ammonium N (mg/kg)</th>
<th>Dissolved Organic Carbon (mg/kg)</th>
<th>Dissolved Organic Nitrogen (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaumont</td>
<td>Ap†</td>
<td>0.00 - 0.40</td>
<td>8.58±0.32</td>
<td>5.88±0.94</td>
<td>216±18</td>
<td>15.9±1.60</td>
</tr>
<tr>
<td>Beaumont</td>
<td>A†</td>
<td>0.40 - 0.90</td>
<td>2.93±0.33</td>
<td>5.80±0.26</td>
<td>120±19</td>
<td>5.18±1.35</td>
</tr>
<tr>
<td>Eagle Lake</td>
<td>Ap</td>
<td>0.00 - 0.25</td>
<td>5.59±0.35</td>
<td>5.74±0.36</td>
<td>217±6</td>
<td>16.9±0.50</td>
</tr>
<tr>
<td>Eagle Lake</td>
<td>A</td>
<td>0.25 - 0.80</td>
<td>4.69±0.36</td>
<td>3.20±0.16</td>
<td>177±6</td>
<td>13.1±0.60</td>
</tr>
</tbody>
</table>

† Ap – layer of soil that is plowed or cultivated.
‡ A – layer of soil underlying the cultivated layer.
(coarse-textured soil) in Spring 2010 (Table 1). Samples were air-dried and ground to pass a 2 mm sieve, then 100 g of soil was placed in 1 pt Kerr canning jars. Soil samples were incubated through 3 consecutive wetting and drying cycles over 95 days with and without urea fertilization at 185 lb/acre of N for Beaumont soil and at 200 lb/acre of N for Eagle Lake soil. Each wet-dry cycle included wetting the soil to saturation with 1 inch of standing water and consequentially drying to field capacity over a period of approximately 1 month. The purpose of the 3 drying cycles was to measure changes in soil N and C during the wet-dry cycling. Each treatment was replicated 9 times, resulting in 72 incubation jars with soil. At the end of each drying cycle, three incubation jars for each treatment were stored at 4°C prior to destructive sampling and analysis. Dissolved organic carbon and total dissolved nitrogen were measured in distilled water extraction, and potassium chloride-extractable ammonium N and nitrate N were analyzed. Dissolved organic N was calculated as dissolved nitrogen - (distilled water-extractable nitrate N + ammonium N). The effects of time and treatments on dissolved organic C and N were analyzed using the PROC MIXED function of SAS (SAS Institute, 2008).

The concentrations of ammonium N in Beaumont top soil (Ap, layer of soil that is plowed or cultivated) fertilized with urea decreased as a result of drying and rewetting, and resulted in lower concentrations than found in the subsoil horizon. The ammonium N levels in the Eagle Lake subsoil horizon decreased after 3 wetting and drying cycles in both urea-fertilized and unfertilized treatments. Urea hydrolysis and nitrification were the likely processes that affected the decrease in ammonium N in the treatments with time. Overall, ammonium N in the Eagle Lake soil was lower than in the Beaumont soil (Fig. 1). On average, extractable ammonium

Fig. 1. Concentrations of ammonium N (NH₄-N) in the wet-dry cycling incubation study from the topsoil (Ap) and subsoil (A) obtained from the sites in Beaumont and in Eagle Lake, Texas, 2010.

Fig. 2. Concentrations of nitrate N (NO₃-N) in the dry-wet cycling incubation study from the topsoil (Ap) and subsoil (A) obtained from the sites in Beaumont Eagle Lake, Texas, 2010.
N accounted for 10 to 40% of the total inorganic N. The nitrate N concentrations in Beaumont top soil and subsoil horizons were higher in the urea-fertilized than unfertilized treatments. The Eagle Lake soil showed a decrease in nitrate N concentrations after 2 wet-dry cycles (Fig. 2). The likely cause for the nitrate N decrease was emission of nitrous oxide. No significant effects of repetitive wetting and drying cycles were detected in the dissolved organic N concentrations for the Beaumont and Eagle Lake soils (Fig. 3), and in the dissolved organic C concentrations for the Beaumont soil. However, an increase in dissolved organic C after 3 wet-dry cycles in both unfertilized and fertilized Eagle Lake topsoil and subsoil horizons was found (Figure 4).

Rapid decrease of ammonium N in the Eagle Lake soil compared to Beaumont likely occurred as a result of increased nitrification due to sandy texture and high porosity. Availability of ammonium N for nitrification in the Beaumont soil was limited due to ammonia adsorption by the clay minerals, which results in a significant amount of ammonium being unavailable for nitrifiers (soil microbes that regulate nitrification) (Liu et al., 2008). Dissolution of organic matter during repeated wetting and drying is one of the likely supplies of dissolved organic N, which underwent mineralization and nitrification. That was a likely process for high levels of nitrate N in the unfertilized Eagle Lake soil. Decrease in the levels of nitrate N after 2 wet-dry cycles was possibly due to nitrifier denitrification, a soil microbially-mediated process that contributes to the development of the greenhouse gas nitrous oxide and causes losses of fertilizer nitrogen (Tiedje, 1994; Wrage et al., 2001; Johnson-Beebout et al., 2009). Relatively unchanged dissolved organic carbon concentrations in the wetting-drying stress-induced soil were likely controlled by respiration and further dissolution.
Nitrogen and Carbon Transformations ...

of organic matter from soil, as shown by previous studies (Fierer and Schimel, 2002; Kostyanovsky and Dou, 2010).

The results of this study demonstrate that periodic wetting and drying cycles can result in the conversion of ammonium N into nitrate N as a result of nitrification, and the subsequent decreases in nitrate N possibly due to nitrous oxide emission. Increases in the dissolved organic matter may be due to enhanced microbial mineralization. The study indicated that the availability of N for rice in the sandy soil at Eagle Lake is likely controlled by organic N mineralization. This emphasizes the significance of carbon sequestration management for sandy soils with decreased clay mineral adsorption. Our study suggests that soil N and preplant fertilizer N may be lost in the wet-dry cycling prior to permanent flooding in rice production. Further research will include the studies of microbial biomass, total C and N balance, and emissions of methane and nitrous oxide (greenhouse gases contributing to global climate change) to better understand stress influence on rice soil C and N cycling. These results will be used to improve N management in rice production.

For further information, please consult the following literature cited:


Nitrogen and Carbon Transformations ...


* Article by Drs. Kirill Kostyanovsky and Fugen Dou, Texas A&M AgriLife Research and Extension Center at Beaumont, TX.

Sheath Blight ...

Fig. 2. Early (A) and late (B) symptoms of sheath blight on leaf blade.

Fig. 3. Death of the flag leaf caused by sheath blight.

Fig. 4. Reduced filling of grains caused by sheath blight.

waterline. The lesions enlarge and coalesce forming bigger lesions with irregular outlines and grayish-white centers surrounded by dark brown borders (Fig. 1B). As lesions coalesce on the sheaths, entire leaves eventually die. Lesions on the leaf blades are more irregular shaped with dark green, brown or yellow-orange margins (Fig. 2A). The lesions usually coalesce on leaf blades producing a rattlesnake skin pattern (Fig. 2B). The development of sheath blight speeds up following the emergence of panicles. Under favorable environments, the disease may reach flag leaves and even panicles. The flag leaves may eventually be killed (Fig. 3). Diseased parts of the plants reduce grain filling (Fig. 4), especially in the lower portion of the panicles. Although the fungus may infect panicles, this usually does not contribute to significant yield loss. Most yield loss is caused by infection in leaf sheaths and leaf blades, especially flag leaves. The fungus from early infected sheaths can attack culms. The culms weakened by the infection are prone to collapsing or lodging (Fig. 5), leading to increased yield loss. Losses in yield also are associated with reduced ratoon crop production. Sclerotia (Fig. 6) consist of compacted or hard masses
of mycelium, which are the survival structures of the fungus, and form on the surfaces of sheaths and leaf blades. The pea-sized sclerotia are white when first formed, and then turn light or dark brown, serving as primary source of inoculum for the following cropping season. Colorless, web-like mycelium (mold), upon which the fungus depends for spread, appear on the surface of leaf sheaths and blades.

**Epidemiology**

The spread of sheath blight is largely dependent on inoculum density (Marshall and Rush, 1980), warm and high humidity conditions, and varietal resistance (Groth, 2005). Sclerotia in the soil and mycelium in infected plant debris serve as primary inoculum between crops. Sclerotia are capable of surviving for up to two years in the soil (Rush and Lee, 1992). After flooding, sclerotia float on the water surface, and attach and infect leaf sheaths near the waterline. Any factor that increases the amount of sclerotia tends to increase the incidence and severity of sheath blight. These factors include continuous rice, 1- to 2-year short rotations, and growing rice in rotation with soybeans. The same fungus causes aerial blight of soybeans. Growing rice in rotation with soybeans has been regarded as one of the major causes that has increased sheath blight over the last two decades in the southern United States. The fungus also infects many grass weeds including barnyardgrass, crabgrass and broadleaf signalgrass.

Sheath blight infestations occur at temperatures ranging from 73 to 95°F and are most severely when temperatures are 82 to 90°F and relative humidity is above 95%, which pretty much typifies Texas Gulf Coast summer weather. Sheath blight occurs wherever rice is grown and is usually more severe in the humid Gulf Coast rice-growing region than in the relatively less humid Mississippi Delta growing region (Groth and Lee, 2003). Dense plant canopies from heading through maturity create a micro-environment favorable for infections, with disease rapidly progressing at these growth stages.

Cultural management practices, such as high rates of fertilization and increased seeding rates, influence the incidence and severity of sheath blight. Excessive use of fertilizers, especially nitrogen, as well as high plant densities produce dense canopies and create a micro-environment of low light levels and high humidity conducive for the development of sheath blight. Dense canopies make it easy for the fungus to move and spread between leaves, tillers, and plants.

Varietal resistance to sheath blight is greatly influenced by plant morphology and canopy architecture. The widespread planting of susceptible semidwarf varieties has been one of the major factors contributing to the increase in sheath blight incidence and severity in Texas and throughout the world. Compact modern semidwarf varieties are prone to more damage by sheath blight than tall traditional varieties because of the shorter distance from the waterline (the usual initial infection court) and the panicles (Marchetii, 1983). Before the introduction
of semidwarf varieties in early 1980s, sheath blight was a minor disease in Texas and other southern states (Zhou, 2010). Varieties with erect leaf blades and relatively limited number of tillers tend to be well aerated and have less contact between leaves and tillers, creating an environment that is less favorable for sheath blight development. Although none of the currently available commercial varieties have acceptable levels of genetic resistance, varieties differ in their susceptibility to sheath blight (Zhou et al., 2011a; 2011b). Multiple genes conferring partial resistance to sheath blight have been identified (Liu et al., 2010). Partially resistant varieties tend to sustain less loss than susceptible varieties. They also tend to increase their ratooning, reduce the production and accumulation of sclerotia, and consequently reduce ratoon crop yield losses. A recent study at the Texas A&M AgriLife Research and Extension Center at Beaumont, indicated that there was a positive linear relationship between sheath blight severity in the main crop and plant population reduction in the ratoon crop (Fig. 7) (Zhou et al., 2011a).

Management

Several management options are available to help reduce yield losses caused by sheath blight. Producers are recommended to manage the disease through an integrated use of sound cultural practices, resistant varieties, and fungicide control. The following cultural management guidelines should be implemented to create a condition less favorable for disease development: 1) avoid excessive rates of nitrogen fertilization; 2) avoid excessive rates of seeding; 3) avoid continuous rice, alternate-year rice rotations, and rice-soybeans rotations; and 4) control grass weeds such as barnyardgrass, crabgrass and broadleaf signalgrass that can serve as hosts of the sheath blight pathogen.

Although highly resistant varieties are not commercially available, varieties that are moderately
resistant and moderately susceptible to sheath blight are available. Where possible, the least-susceptible varieties should be chosen, especially for problem fields. See Table 1 for the susceptibility of current commercial rice varieties to sheath blight under Texas environmental conditions (Zhou et al., 2010).

Fungicides are an effective tool for managing sheath blight. To maximize economic returns, fungicide applications should be justified based on 1) sheath blight occurrence history, 2) favorability of weather conditions, 3) susceptibility of the rice variety, 4) yield potential, and 5) ratoon crop potential. Because of the significant impacts of sheath blight from the main crop on disease severity in the ratoon crop, effective control of sheath blight in the main crop is critical to successful ratoon crop production.

Estimating sheath blight severity is vital in determining whether fungicide application is warranted. Field scouting should start at or soon after panicle differentiation (PD). The field should be sampled by walking in a zigzag pattern and randomly stopping to check for the presence of sheath blight and to determine the percentage of tillers infected. The stop is considered positive if one or more sheath blight lesions are present on tillers, while the stop is considered negative if no lesions are found. Ten to 40 stops should be sampled for a field depending on its size. This scouting process should be repeated weekly. The threshold for fungicide application is dependent on the infestation of sheath blight, varietal resistance, and ratoon potential. Table 2 lists the current treatment guidelines for fungicide application for sheath blight in the main crop in Texas (Zhou et al., 2010). Fungicides are recommended from 7 days after PD through 50 to 70% heading. A single application is usually enough to control sheath blight. Under most favorable disease development conditions and consideration for whether a ratoon crop will be produced, two applications may be needed.

Several fungicides are available for control of sheath blight (Table 3). Fungicides containing strobilurines (a fungicide family) provide good control of sheath blight. However, these fungicides are less effective for control of narrow brown leaf spot (caused
by *Cercospora janseana*) compared to the fungicides containing propiconazole. Fungicides containing both active ingredients are effective for control of both sheath blight and narrow brown leaf spot.

The Center’s plant pathology research emphasizes identifying resistance genes and breeding for resistant rice varieties. The program also has initiated the development of innovative alternative management options, such as biofumigation and beneficial microorganisms, to minimize the losses caused by sheath blight. These sustainable management options will be incorporated into current integrated pest management systems to make disease management more affordable to rice growers.

**Acknowledgements**

This work was supported, in part, by the Texas Rice Research Foundation.

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*Article by Dr. Xin-Gen Zhou, Texas A&M AgriLife Research and Extension Center at Beaumont, TX.*

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**Reducing the Severity of False Smut in Rice Fields**

In recent years, false smut (*Ustilaginoidea virens*) disease has increased to the point where it is recognized by farmers as potentially damaging to rice (Fig. 1) in Texas and elsewhere (Webster and Gunnell, 1992; Tsuda, et al., 2006; Zhou, et al., 2008). It has been labeled as a “minor” disease in the past largely because of the irregularity in which it has been observed across years, and from being overshadowed by “major” diseases that have the potential to cause significant economic losses.

Most farmers associate false smut with the ‘yellow or orange balls’ found on grain as they begin to fill, and which later turn olive, brown, or black as they...
mature. In severely affected fields, it is not unusual to observe a cloud of spores above the combine header during harvest. At that point, any reduction in grain yield that might be attributed to this disease has occurred and dark “balls” up to ½ inch diameter are mixed with the harvested grain.

False smut is a soil-borne fungus, where the spores released in late summer from one crop persist in the soil over winter, and infect the rice planted in subsequent years. The spores can remain viable in the soil for three years or more. There are no known visual symptoms of the disease until the grain begin to fill. At that time, spore balls emerge from between the hulls of infected kernels, covered at first by a silvery or off-white membrane that ruptures to reveal a coating of orange or yellow spores. (Webster and Gunnell, 1992). Infected florets do not contain a rice kernel and additional blanking of kernels has been observed around each infected grain. The combination of sporulation and blanking in rice panicles contributes to yield and quality losses. Currently, there is increasing concern about the level of contamination in harvested grain, as spore balls present an added expense for seed cleaning before grain or seed can be sold.

Controlling false smut through conventional approaches such as spraying fungicides may not be possible. Earlier in plant growth when fungicide applications might control the disease, there is no way to assess the degree of disease severity to determine if fungicide applications will be cost effective. By the time symptoms are visible, it is already too late to prevent yield losses. Current fungicides do not eliminate the disease and in severe cases have not provided adequate protection. Currently there is no reported resistance to this disease in commercial rice varieties (Cartwright, et al., 1994; Leung, et al., 2003), thus effective control of this disease will, at this time, be directed toward cultural practices.

Studies

In 2000, a long-term rotation study was initiated at the University of Arkansas Rice Research and Extension Center in Stuttgart. In 2006, a number of rotation, tillage, fertility, and variety treatments were selected as a starting point to monitor differences in

Fig. 1. False smut (*Ustilaginoidea virens*) disease of rice. Photo by Steven Brooks.

false smut severity. Rotations monitored in this study were continuous rice (R-R), rice-soybean (R-S), and rice-corn (R-C). Each rotation field contained no-till and conventional-till treatments. No-till fields were never tilled and all crop residues were left on the field while conventional-till fields were tilled in the fall and spring with crop residues burned following harvest. Each field was further divided and fertilized to represent a standard fertilizer application (at the beginning of the study) and an enhanced fertility treatment, which received additional nitrogen, phosphorus, and potassium fertilizer. The two fertility rates for rice were: 1) 100 lb/ac N, 40 lb/ac P\textsubscript{2}O\textsubscript{5}, 60 lb/ac K\textsubscript{2}O, and 2) 150 lb/ac N, 60 lb/ac P\textsubscript{2}O\textsubscript{5}, 90 lb/ac K\textsubscript{2}O. Nitrogen was applied as urea in a single pre-flood application when the plants were at the 4-5 leaf stage. Phosphorus and potassium were applied as triple-super phosphate and muriate of potash early in the spring and prior to tillage in the conventional-till plots. Phosphorus and potassium were incorporated in the conventional-till plots but not in the no-till plots. In 2006, Wells and Cybonnet were grown in all plots, while Wells and XL723 were grown in 2007 onward. Grain samples were collected at the combine
when each plot was harvested. The severity of false smut was determined by counting the number of spore balls in each grain sample and converting to number of spore balls per pound of grain at 12% moisture.

In 2007, false smut nurseries were established to evaluate disease severity in a range of varieties that received pre-flood nitrogen treatments of 100, 140, 180, and 220 lb/ac N. The varieties evaluated in 2007 were Cybonnet, Cypress, Wells, CLXL730, and XL723.

In 2006 through 2008, false smut was monitored in a series of studies that evaluated the effects of rotation [continuous rice (R-R), rice-soybean (R-S)], irrigation (flood, row-water), nitrogen source (urea, Agrotain, slow release), and N fertilization rates (120 lb/ac 2006-07; 100, 140, 180, 220 lb/ac, 2008) on the severity of false smut in two rice hybrids (CLXL 730 and CLXL 729). All nitrogen was applied at the 4-5 leaf stage with irrigation treatments applied immediately after fertilization. False smut samples were collected and evaluated in the same manner as the previous studies.

**Rotation**

False smut severity across fertility and tillage treatments was highest in the rice-soybean (R-S) rotation, which is the most common rotation in much of the south. There was a 45% reduction in false smut severity when soybeans were replaced with corn, and a 79% reduction in false smut in continuous rice (R-R) when compared to the rice-soybean (R-S) rotation and a 55% reduction compared to the rice-corn (R-C) rotation (Fig. 2). The same trends were observed when comparing the rice-soybean rotation to the continuous rice rotation in the flooded treatments of the irrigation x rotation study, but these differences were not as pronounced. In the latter study, the rotation treatments were in their first and second years. This indicated that changing a rotation sequence to reduce false smut may not result in the desired outcome the first couple of years following a rotation change, and that it may take a few seasons before maximum benefit is realized.

**Tillage**

No-till reduced false smut severity when compared to conventional-till regardless of crop rotation or fertility level in the long-term rotation study. When treatment combinations were averaged, there was a 69% reduction in false smut in the no-till plots when compared to the conventional-till plots (Fig. 3). There were differences in the magnitude of false smut reduction that were dependent on crop rotation. Largest reductions occurred when the rice-corn rotation was changed from conventional-till to no-till. No-till reduced false smut less in the continuous rice rotation when compared to other rotations. These results show that regardless of the rotation or fertility levels used in this study, there will be a significant reduction in false smut severity by changing from conventional-till to no-till. Grain yields in the two tillage treatments were similar.

**Irrigation**

Nearly all rice grown in the south is flood irrigated. However, there are some growers who routinely furrow-irrigate rice. Regardless of variety (CLXL730, CLXL729), rotation (continuous rice, rice-soybean), or nitrogen source (urea, Agrotain, slow-release), false smut was not found in the furrow-irrigated plots. It was in the flood-irrigated plots (Fig. 4). Whether these findings are consistent

Fig. 2. False smut severity in different crop rotations.

Continued on the next page
with commercial-field irrigation settings has not been extensively explored; however, the effect of irrigation method was dramatic in our tests. We recognize that furrow-irrigated rice may be a high risk for blast disease and other management problems. Growers should recognize this and select varieties that are less susceptible to these problems when attempting intermittent, furrow-irrigated, or pivot-irrigated rice systems.

**Variety**

In our studies, we did not identify a rice variety that was immune to false smut. All major rice varieties in the southern U.S. show susceptibility to false smut. Therefore, at this time changing variety alone is not an effective means of false smut control. However, we have identified rice lines that appear to be more susceptible to false smut, across all experiments, than others. For example, three varieties were used in the long-term rotation study and we found significant variety differences across rotation, tillage, and fertility levels. Overall, Cybonnet had the highest severity of false smut (46%) followed by Wells (23%) and XL 723 (6%). Of these three varieties, XL 723 had the highest grain yield.

**Nitrogen Fertility**

There are a number of reports indicating the severity of false smut increases as nitrogen fertilizer rates increase. This was also the case in our long-term rotation study where two nitrogen rates were used. When averaged across rotation, tillage, and variety treatment combinations, there was a 33% reduction in the severity of false smut when the nitrogen rate was reduced from 150 to 100 lb/ac N. Most farmers apply more than 150 lb/ac N, thus it should be possible to significantly reduce false smut by lowering nitrogen fertilizer rates. In our study, rice grain yields were not different between fertility levels, thus it was possible to reduce false smut and not reduce grain yields simply by reducing the amount of nitrogen applied.

It has been observed that the worst false smut often occurs in lush, potentially high yield situations, but this may simply be related to higher levels of nitrogen used to achieve the highest possible yield. For example, in our studies we found that for each variety, false smut generally increased with increasing grain yields (probably due to nitrogen fertility), but that another variety might achieve the same grain yield with less false smut (i.e. hybrid).

**Combined Management Changes**

Of the management changes that can be made to reduce false smut, variety and nitrogen fertility level would be the easiest for farmers to change. In our false smut nurseries, we found that different varieties respond differently to varying N rates. It is important not to apply N at rates that do little to increase grain yield yet dramatically increase false smut severity. For all varieties, there was little increase in grain yield at rates above 140 lb/ac N on our test soils, yet in all cases, increasing N above that level resulted in significant increases in false smut severity (Fig. 4). Varieties also differ in the N level that promotes extreme increases in false smut.

**Summary**

False smut is a disease that farmers can likely expect to see more of in the future. Disease severity will vary greatly from year to year, and currently, fungicide sprays are suppressive at best. However, there are management strategies that rice farmers can adopt that will significantly reduce the severity of this
disease. The current management practice of intensive cultivation and high N fertility rates that are used in a rice-soybean rotation are the most favorable for false smut disease. It is possible to reduce the severity of false smut by reducing tillage, not using a rice-soybean rotation, and possibly growing furrow-irrigated rice where other risks can be managed. Based on these studies, farmers should be very cautious about applying more than 140 lb/ac N on silt loam soils where false smut is a consistent concern, or avoid applying more than the recommended nitrogen fertilizer level for the variety and soil type.

For more information, please consult the following references:


* Article by Dr. Merle M. Anders (University of Arkansas Rice Research and Extension Center) and Dr. Steven A. Brooks (USDA ARS Dale Bumpers National Rice Research Center).

Editorial ...

national water delivery system to move water, in a highly coordinated fashion, from areas of excess to areas of need. California has its Central Valley Project and Tennessee has the Tennessee Valley Authority, while Illinois, Iowa, Minnesota, Missouri, and Wisconsin have the Upper Mississippi River Basin

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Association. Each system provides critical water delivery, flood control, as do several other local water authorities, but each is local or regional in nature and for the most part cannot move water from one region to another in a coordinated manner to balance areas having local excess supply with areas having local water shortages. I cannot think of a better use for our federal funds than to begin a long-term program of developing a coordinated national water management program.

The needs for a national water delivery system was made obvious earlier this month, while driving through West Memphis, Tennessee, traveling to Jonesboro, Arkansas, where a colleague and I attended one of three workshops that we had organized on post-harvest rice grain management. The Arkansas workshop, by the way, was a great success with over 60 participants. Anyway, while traveling through West Memphis, all I could see for miles was the tops of trees sticking out of water and elevated areas where houses were protected from the floods. The Mississippi River was over 3 miles wide at that point, spreading far beyond its banks as far as my eyes could see. When the two of us were driving back from the Jonesboro post-harvest grain management meeting, we were hit by torrential rains. As traffic was forced to a standstill I watched the feeder roads on both side of the highway quickly beginning to go under water, although we were several miles from the banks of the swollen river. Thank goodness the highway was on high-ground, otherwise I think I would have had to practice the swim. I wish we could move some of that water to Texas.

This issue of Texas Rice has three articles. The first article by Shane Zhou describes the effects of sheath blight, *Rhizoctonia solani*, on rice yield and grain quality, disease symptoms that occur on different parts of the plant, the seasonal pattern of disease outbreak, how varietal resistance is influenced by the density of the rice canopy, and the degree of control provided by different fungicides. An interesting part of this article described how disease severity can be partially controlled by avoiding planting at excessively high densities and by avoiding using extra high levels of nitrogen. Both of these conditions promote excessive leaf and tiller production which increase canopy density and promote increased disease severity.

The second article by Kirill Kostyanovsky and Fugen Dou describes the dynamics of nitrogen and carbon transformations as rice soils are exposed to repeated cycles of wetting and drying. These cycles are common during the fall and winter as a result of periodic rainfall, and during early spring when soils are flushed one to four or so times prior to permanent flood, with a greater number of flushes during droughty conditions, such as this year. Soil wetting causes osmotic shock, which breaks apart microbial cells releasing low molecular weight organic compounds and causing increased release of carbon dioxide into the environment. The amount of ammonium N in both Beaumont and Eagle Lake soils also decreases following repeated soil wetting and drying. Kirill’s and Fugen’s research has implications to timing fertilizer and irrigation applications.

The third article by Merle Anders and Steve Brooks focuses on the use of cultural practices to reduce the severity of false smut, *Ustilaginoidea virens*, in rice. Merle is a Rice Systems Agronomist with the University of Arkansas and is located at the Stuttgart Research Center. Merle’s research broadly focuses on agronomics of rice production. Steve until very recently was a Plant Pathology Research Scientist with USDA-ARS located at the Stuttgart Research Center. He is now employed as a plant pathologist with RiceTec in Alvin, Texas. Merle and Steve describe how crop rotation impacts the severity of false smut in rice. Some of the more striking results are the 79% reduction in false smut in back-to-back rice production compared with rice following soybeans. These results suggest rice is not as good of a host at producing overwintering spores. Nearly as impressive, no-till production resulted in a 70% reduction in false smut, while disease incidence was reduced by 44% by reducing nitrogen application to a rate that provides maximal yields. In other words, increasing nitrogen rates beyond the point where maximum yield is reached wastes money and increases disease severity. An interesting aspect of this paper focuses on comparing flood and furrow irrigated rice production. Furrow irrigated rice, although extremely rare, has advantages in terms of water savings, and
As of May 15, 2011, about 81.0% of the rice crop acreage in Texas had emerged seedlings (Fig. 1). In comparison, about 96.4, 86.9, 93.6, 94.0, and 84.0% had emerged seedlings as of April 15 in 2006, 2007, 2008, 2009, and 2010, respectively.

About 34.0% of the Texas rice acreage were at permanent flood as of May 15, 2011 (Fig. 2). In comparison, about 56.9, 27.4, 35.6, 32.0, and 16.6% were at permanent flood as of May 15 in 2006, 2007, 2008, 2009, and 2010, respectively.

I hope you enjoy reading this issue of Texas Rice.

Sincerely,

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

Fig. 1. Percentage of main rice crop acreage in Texas that had emerged seedlings by May 15 in 2006 to 2011.

Fig. 2. Percentage of main rice crop acreage in Texas at permanent flood by May 15 in 2006 to 2011.