1991

Rice diseases and disorders in Louisiana

D.E. Groth

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Rice Diseases and Disorders in Louisiana

D. E. Groth, M. C. Rush, and C.A. Hollier
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The authors thank Drs. Steve Linscombe, Richard Dunand, and Toni Marchetti for reviewing this manuscript and giving many helpful suggestions. The authors also thank Darlene Reagan for typing the manuscript.

Cover: Aerial view and closeup of severe sheath blight damage to a rice field in Vermilion Parish, 1987.

Louisiana Agricultural Experiment Station, K. W. Tipton, Director
Louisiana State University Agricultural Center, H. Rouse Caffey, Chancellor

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Rice Diseases and Disorders in Louisiana
D. E. Groth,1 M. C. Rush,2 and C. A. Hollier3

Introduction

Disease damage to rice can greatly impair productivity and sometimes totally destroy a crop. The United States does not have any of the destructive viral diseases present in other rice growing areas of the world (Oh, 1985). However, fungal diseases are prevalent and very destructive to Louisiana rice (Atkins, 1972, and Groth and Hollier, 1986). Bacterial leaf blight, caused by the bacterium Xanthomonas campestris pv. oryzae, has been found in several parishes (Rush et al., 1988). At present, no significant yield losses have been associated with this disease.

Direct losses to disease include reduction in plant stands, lodging, spotted kernels, fewer and smaller grains per plant, and a general reduction in plant efficiency. Indirect losses include the cost of fungicides used to manage disease, application costs, and reduced yields associated with special cultural practices that reduce disease, but may not be conducive to producing maximum yields.

The major diseases of rice in the United States are the fungal disease blast, caused by Pyricularia grisea (figures 1-4); stem rot, caused by Magnaporthe salvinii (Sclerotium oryzae)(figures 5-6); sheath blight, caused by Thanatephorus cucumeris (Rhizoctonia solani)(figures 7-10); brown spot, caused by Cochiobolus miyabeanus(Figure 11); narrow brown spot, caused by Sphaerulina oryzae (Cercospora janseana)(figures 12-13); and kernel smut, caused by Neovossia horrida(Figure 14). Seedling diseases caused by species of Achlya and Pythium (figures 15-16) also are important in water-seeded rice.

Minor diseases include crown rot (Figure 17), causal agent unknown; leaf scald, caused by Gerlachia oryzae(figures 18-19); leaf smut, caused by Entyloma oryzae (Figure 20); sheath rot, caused by Sarocladium oryzae (Figure 21); stackburn disease, caused by Alternaria padwickii (Figure 22); sheath spot, caused by Rhizoctonia oryzae (figures 23-24); crown sheath rot, caused by Gaeumannomyces graminis var. graminis (Figure 25); black kernel, caused by Curvularia lunata; seedling blights, caused by various fungi (Figure 26); bacterial leaf blight (Figure 27); false smut, caused by Ustilaginoidea virens (Figure 28); root rots, caused by several fungi; and several miscellaneous leaf, stem, and glume spotting diseases. Several diseases caused by sclerotial fungi are also found in

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Louisiana but are not significant (Shahjahan and Rush, 1979).

A disorder known as panicle blight (Figure 29) has become increasingly important. Little is known about its cause.

An undefined pathogen complex acting alone or with insect damage (feeding) also causes the grain and kernel discoloration called “pecky” rice (Figure 30).

The physiological disorders straighthead (Figure 31) and bronzing or zinc deficiency (Figure 32) occur throughout the southern rice area and are locally severe. Cold injury (Figure 33), salt damage (Figure 34), and nutrient deficiencies (Figure 35) often mimic disease symptoms.

Two minor diseases of rice in Louisiana are caused by small parasitic round worms called nematodes. These are white tip, caused by *Aphelenchoides besseyi* (Figure 36), and root knot, caused by *Meloidogyne* species.

The first step toward disease management is identification followed by careful field scouting. Diseases known to occur in Louisiana and their causal agents are listed in Table 1. A guide for rapid identification of the major diseases is given in the section entitled “Guide to Identifying Rice Diseases Present in Louisiana.” Knowing the level of resistance of the variety to major diseases can be useful in determining the probability of having problems warranting preventive management measures. A list of commercial varieties and their resistance levels to major diseases are shown in Table 2. Scouting information or disease thresholds and management information are summarized for the major disease in Appendix A.

Use of foliar fungicides to manage rice diseases is often justified under severe disease conditions (Lindberg, 1967; Rush, et al., 1977; Groth and Rush, 1988; and Groth, et al., 1990). Some factors which affect the probability of fungicide use being warranted included disease history in the field, the resistance of the variety, the yield potential, use (i.e., seed or grain), date of planting, and ratoon crop potential. Always follow label directions. Since the list of labeled fungicides may change, contact your local Cooperative Extension agent for current information on fungicides available for rice disease management.

**Rice Disease Identification**

Each year the Louisiana rice crop is affected by many diseases. Severity of symptoms often varies due to varietal resistance, environmental conditions, and plant growth stage. Also, not all symptoms typical of a disease occur on a single plant. It is very important to look at several plants, from all over the field, to establish an accurate diagnosis. In the text, all symptoms known to occur are described, but not all will be expressed. Use the section below, “Guide to Identifying Rice Diseases Present in Louisiana,” to decide which diseases are present in the field. The diseases in this guide are divided into sections based on what plant part is affected. However, several diseases may affect more than one part of a rice plant. When a disease is identified, additional information is available in the text and in Appendix A.
Guide to Identifying Rice Diseases Present in Louisiana

For identification of the major diseases, determine the part of the plant affected by the disease. Then refer to that section below. A list of the causal agents of all rice diseases known to occur in Louisiana is in Table 1.

I. PLANTED SEEDS AND SEEDLINGS

Water-seeded rice: seeds rotted after draining water from field, copper or greenish-brown spots on soil surfaces around or above rotted seeds; coarse, bristly mycelium radiating from seed (Achlya spp.) (Figure 15) or gelatinous matrix surrounding each affected seed (Pythium spp.) (Figure 16). Water-mold (Page 28)

Water-seeded rice: seedlings 1-4 inches tall dying in seedling flood or after flushing seeded field. Pythium Seedling Blight (Page 17)

 Drill-seeded or dry broadcast rice: seedlings 1-4 inches tall dying:
A. Brown spot on coleoptile or growing point (Figure 26); seedlings suddenly dying. Seedling Blight (Page 17)
B. Seedlings dying or turning white in patches or in short strips of drill row; fluffy white mycelium and small, round sclerotia (tan) may be present on soil surface at the base of affected seedlings after flushing seeded field. Sclerotium Seedling Blight (Page 17)

Seedlings at three to five-leaf stage dying, often in patches, may have linear reddish-brown lesion on sheath of small seedlings; older seedlings with purple-brown blotches made up of small spots aggregating; leaves yellow or bronze (Figure 32); lower leaves floating on surface of flood water; seedlings dying in deeper water and disappearing below surface of water. Bronzing (Page 29) (See also Salinity, Page 29, and Cold Injury, Page 29.)

II. ROOTS AND CROWN (ROOT-STEM INTERFACE)

Crown area decayed with soft rot, black or dark brown with streaks extending to the lower internodes of culms (Figure 17); fetid odor of bacterial soft rot, tillers dying one at a time; roots dying and turning black; adventitious roots produced at node above crown area. A similar discoloration of the crown may be caused by applying hormonal herbicide such as 2,4-D too early. Crown Rot (Page 14)

Roots turning black or brown, decayed, reduced root volume, roots dying. Root Rot (Page 17)

Roots with swollen areas, only found under dry-land conditions. Root Knot (Page 17)

III. LEAF BLADES

Lesions varying from small round, dark-brown spots, to oval spots with narrow reddish-brown margin and gray or white center with dark circular line (eyespot lesion) (Figure 1); spots becoming elongated, diamond-shaped or linear with gray dead area in center surrounded by narrow reddish-brown margin. Leaf Blast (Page 12)

Round to oval, dark-brown lesions with yellow or gold halo (Figure 11); as lesions enlarge, they remain round, with center area necrotic, gray and lesion margin reddish-brown to dark brown. Brown Spot (Page 13)
<table>
<thead>
<tr>
<th>Common Name</th>
<th>Pathogen Name or Cause</th>
</tr>
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<tbody>
<tr>
<td>Bacterial Leaf Blight</td>
<td>Xanthomonas campestris pv. oryzae (Ishiyama)</td>
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<tr>
<td></td>
<td>Dye</td>
</tr>
<tr>
<td>Black Kernel Blast</td>
<td>Curvularia lunata (Wokker) Boedyen</td>
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<tr>
<td>Blast</td>
<td>Pyricularia grisea Sacc. = P. oryzae Cavara</td>
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<td></td>
<td>[teleomorph: Magnaporthe grisea (Hebert) Barr]</td>
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<td>Brown Spot</td>
<td>Cochliobolus miyabeanus (Ito &amp; Kur.) Dreh.</td>
</tr>
<tr>
<td></td>
<td>[= Bipolaris oryzae (B. de Haan) Ellis]</td>
</tr>
<tr>
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<td>Low temperatures</td>
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<td>Crown Rot</td>
<td>Suspected cause is Erwinia chrysanthemi Burholder, McFadden &amp; Domock</td>
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<tr>
<td>Crown Sheath Rot</td>
<td>Gaeumannomyces graminis var. (Sacc.) Arx &amp; Oliver graminis</td>
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<tr>
<td>Downy Mildew</td>
<td>Sclerophthora macrospora (Sacc.) Thirum., Shaw and Nasras</td>
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<tr>
<td>False Smut</td>
<td>Ustilaginoidea virens (Cke.) Tak.</td>
</tr>
<tr>
<td>Grain Spotting and Pecky Rice</td>
<td>Feeding injury by the rice stink bug and damage by many fungi including Bipolaris oryzae</td>
</tr>
<tr>
<td></td>
<td>(B. de Haan) Ellis, Curvularia spp., Fusarium spp., Acrocylindrium oryzae Sawada, and</td>
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<tr>
<td></td>
<td>Gerlachia oryzae (Hashioka &amp; Yokosi) W. Gams (Cooke) Takahashi</td>
</tr>
<tr>
<td>Kernel Smut</td>
<td>Neovossia horrida Padw &amp; A. Khan</td>
</tr>
<tr>
<td></td>
<td>[= Tilletia barclayana (Bref.)] Sacc. &amp; Syd. (= Neovossia barclayana Bref.)</td>
</tr>
<tr>
<td>Leaf Scald</td>
<td>Gerlachia oryzae (Hashioka &amp; Yokogi) W. Gams</td>
</tr>
<tr>
<td></td>
<td>[=Rhychosporium oryzae=Hashioka &amp; Yokogi]</td>
</tr>
<tr>
<td>Leaf Smut</td>
<td>Entyloma oryzae H. &amp; D. Snydow</td>
</tr>
<tr>
<td>Narrow Brown Leaf Spot</td>
<td>Sphaerulina oryzina Hara</td>
</tr>
<tr>
<td></td>
<td>Cercospora janseana (Racib) O. Const. (= C. oryzae Miyake)</td>
</tr>
<tr>
<td>Panicle Blight</td>
<td>Cause unknown</td>
</tr>
<tr>
<td>Root Knot</td>
<td>Meloidogyne spp.</td>
</tr>
<tr>
<td>Root Rots</td>
<td>Pythium spinosum Sawada, Pythium dissotocum Drech., Pythium and Fusarium spp.</td>
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<tr>
<td>Rotten Neck (see Blast)</td>
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<tr>
<td>Salinity</td>
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<td>Seedling Blight</td>
<td>Bipolaris oryzae (B. de Haan) Ellis, Curvularia spp., Fusarium spp., Rhizoctonia solani Kuhn, Sclerotium rolfsii Sacc., and Gerlachia oryzae (Hashioka &amp; Yokosi) W. Gams</td>
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<table>
<thead>
<tr>
<th>Common Name</th>
<th>Pathogen Name or Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheath Blight</td>
<td><em>Thanatephorus cucumeris</em> (Frank) Donk. (= <em>Rhizoctonia solani</em> Kuhn)</td>
</tr>
<tr>
<td>Sheath Rot</td>
<td><em>Sarocladium oryzae</em> (Sawada) W. Gams &amp; D. Hawksw. (= <em>Acrocladium oryzae</em> Sawada)</td>
</tr>
<tr>
<td>Sheath Spot</td>
<td><em>Rhizoctonia oryzae</em> Ryker &amp; Gooch</td>
</tr>
<tr>
<td>Stackburn (Alternaria leaf spot)</td>
<td><em>Alternaria padwickii</em> Ganguly M. B. Ellis</td>
</tr>
<tr>
<td>Stem Rot</td>
<td><em>Magnaporthe salvinii</em> (Catt.) Krause &amp; Webster (= <em>Sclerotium oryzae</em> Catt.)</td>
</tr>
<tr>
<td>Straighthead</td>
<td>Undetermined, physiological, soil related</td>
</tr>
<tr>
<td>White Tip</td>
<td><em>Aphelenchoides besseyi</em> Christie</td>
</tr>
</tbody>
</table>

Long, narrow brown or reddish-brown lesion (Figure 12); lesions 0.5-3 cm long, parallel with leaf veins, usually restricted to the area between veins; lesions may occur on leaf sheaths. **Narrow Brown Leaf Spot** (Page 16)

Lesions consist of alternating wide bands of white, greenish-gray or tan with narrow bands of reddish-brown or brown (Figure 9); lesions begin at base of blade, spreading from leaf sheath, or from infection point on leaf blade. **Sheath Blight** (Page 24)

Lesions consist of wide bands of gray, dying tissue alternating with narrow reddish-brown bands (Figure 18); band pattern in chevrons from leaf tip or edges of the leaf; sometimes lesions are gray blotches at leaf edge with reddish-brown margin; advancing edge of lesion usually has a yellow or gold area (Figure 19) between reddish-brown margin and green, healthy tissues. **Leaf Scald** (Page 16)

Small (1-2 mm), black linear lesions on leaf blade (Figure 20); usually more lesions on upper-half of the leaf blade; lesions may have dark gold or light brown halo; leaf tip dries as plants approach maturity; lesions on sheaths of upper leaves. **Leaf Smut** (Page 16)

Round or oval white or pale tan spot with narrow red or reddish-brown margin (Figure 22); often two adjacent spots coalesce to form an oval double spot; lesions are from 0.5-1 cm in diameter; spots with small black fruiting structures in the center. **Stackburn** (Page 26)

Leaf tips turn white with a yellow area between the white tip and the healthy green area (Figure 36); white areas sometimes occur on leaf edges; flag leaf blade twisted with poor emergence of the panicle; kernels aborted or poorly filled; grain distorted or discolored. **White Tip** (Page 29)

Lesions consist of elongated lesions near the leaf tip or margin and start out water soaked in appearance; lesions, several inches in length, turn white to yellow
and then gray because of saprophytic fungi (Figure 27). **Bacterial Leaf Blight** (Page 11)

**IV. LEAF SHEATH AND STEM**

Water-soaked, gray-green lesion at water line (Figure 7) during tillering or early jointing stages of growth; lesions becoming oval, white or straw-colored in center with reddish-brown edge (Figure 8); lesions 1-2 cm wide and 3-4 cm long; lesions spreading up leaf sheaths and onto leaf blades; lesions discrete or forming a continuous band on sheath (Figure 9) or leaf (Figure 10) of alternating wide necrotic areas with narrow reddish-brown bands. **Sheath Blight** (Page 24)

Black, angular lesions on leaf sheaths at water line on plants at tillering or early jointing stages of growth (Figure 5); at later stages outer sheath drying, inner sheath discolored or with black angular lesion; culms discolored with dark-brown or black streaks; raised areas of dark fungus mycelium on surface; gray mycelium inside of culm or at maturity culm collapsed with small, round black sclerotia in dead sheath tissues and inside of culm (Figure 6). **Stem Rot** (Page 27)

Lesions oval, pale green, turning cream or white in the center with a broad dark reddish-brown margin (Figure 24); lesions remain separate, not forming large continuous lesions. **Sheath Spot** (Page 26)

Black to brown defuse lesions on the sheath near the water line (Figure 25). Perithecia necks protruding from upper surface and a thick fungal mat between leaf sheath and culm. **Crown Sheath Rot** (Page 14)

Reddish- or purple-brown, netlike pattern on sheath below the collar of lower leaf blades (Figure 13); lesion oval, 1-2 cm wide and 3-5 cm long; leaf blades turning yellow and drying. **Cercospora Net Spot** (See Narrow Brown Leaf Spot, Page 16)

General reddish discoloration of flag leaf sheath or reddish-brown or yellow-tan spots with dark, irregular ring pattern inside of spots (Figure 21); panicles emerging poorly; stem of panicle twisted; white “frosting” of conidia on inside of leaf sheath, florets of panicles on affected tillers discolored a uniform reddish-brown or dark brown. Grain does not fill or kernels are lightweight. **Sheath Rot** (Page 26)

Narrow red-brown lesions on flag leaf sheath or penultimate leaf sheath after panicles emerge; lesions 0.5-1.5 mm wide and up to 1-3 cm long; lesions run parallel with veins in sheaths, affecting the tissues between veins (Figure 12). **Narrow Brown Leaf Spot** (Page 16)

Collar of flag leaf discolored brown or chocolate-brown; leaf blade detaches from sheath as lesion dies and dries (Figure 3). **Blast on Flag Leaf Collar** (Page 12)

Culm nodes turn black or nodes become shrunken and gray as plants approach maturity; nodes purple to blue-gray with conidia of the pathogen; culms and leaves straw-colored above affected node; culms lodge at affected nodes. **Node Blast** (Page 12)

**V. PANICLE, FLORETS AND GRAIN**

**PANICLE:**

Node and surrounding area at base of panicle discolored brown or chocolate-
brown (Figure 4); stem of panicle shrivels and may break; node purplish or blue-gray with conidia of the fungal pathogen; panicle white or gray; florets do not fill and turn gray; panicle branches and stems of florets gray-brown lesions. **Rotten Neck Blast** (Page 12)

Panicles upright, not falling over or slightly bent over due to sterility; hulls distorted, beak-shape; plants may not head at all (Figure 31). **Straighthead** (Page 30)

Internodal area above or below node at the base of the panicle turns light brown or tan-brown; affected area dies and shrivels; kernels in florets of lower portion of the panicle do not fill. **Neck Blight**. (See **Brown Spot**, Page 13, and **Narrow Brown Leaf Spot** Page 16, for additional information.)

Single florets or several florets on a panicle branch turn light brown or straw-colored; floret stem with brown lesion; grain stops developing; florets turn gray. **Panicle Blast** (Page 12)

Panicles irregular, unable to emerge from the leaf sheath, and becoming twisted; panicle is small, normally remaining green longer than normal; no seeds produced. **Downy Mildew** (Page 15)

Panicles small; reduced number of spikelets; lemmas and paleas often absent on terminal portions of panicles. **White Tip** (Page 29)

**FLORETS AND GRAIN:**

Single florets or several florets per panicle with brown, reddish-brown, purple, or white surrounded by purple-brown spots (Figure 31). **Grain Spotting and Pecky Rice** (Page 15)

Maturing grain partially filled with or without grayish cast; powdery black mass on surface of the kernel and at seam between palea and lemma (Figure 14) (rubs off easily onto fingers). **Kernel Smut** (Page 15) (See also **Black Kernel**, Page 12)

Single florets or more commonly several florets in a panicle turn reddish-brown to dark brown. **Sheath Rot** (Page 26)

Single florets or several florets on a panicle branch turning light brown or straw-colored (Figure 29); grain stops developing and the florets turn gray. **Panicle Blight** (Page 17)

Maturing grain partially filled, shriveled, chalky, fuzzy black mass covering surface of the grain or at seam between palea and lemma (will not easily rub off on fingertips). **Brown Spot** (Page 13)

Large orange fruiting structure on one or two grains in maturing panicle; when orange membrane ruptures, a mass of greenish-black spores is exposed (Figure 28); grain replaced by one or more sclerotia. **False Smut** (Page 15)

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**Rice Diseases in Louisiana**

**Bacterial Leaf Blight**

Bacterial leaf blight is caused by the bacterium *Xanthomonas campestris* pv. *oryzae*. It was first identified in the United States in Texas and Louisiana during 1987 (Rush et al., 1988). No major losses have been associated with this disease
in the United States, but bacterial leaf blight in other parts of the world causes severe damage.

The blight bacterium overwinters in rice debris in the soil and on weed hosts. There is also a slight chance that seed may transmit the pathogen. The pathogen is spread by wind-blown rain, irrigation water, plant contact, and probably on plant debris on machinery. High humidity and storms favor disease development. Water-soaked areas appear on the leaf margins near the tips, enlarge, and turn white to yellow. As the lesions mature, they expand, turn white and then gray due to growth of saprophytic fungi (Figure 27). The lesion may elongate for several inches. Contact your Cooperative Extension agent if you suspect this disease. Accurate identification is important since the symptoms can be confused with other diseases, especially leaf scald, herbicide damage and other plant stress.

Management practices include rotation to nongrass crops, tilling to destroy plant debris, and avoiding contamination of the field through infected plant materials or irrigation water.

**Black Kernel**

The fungus *Curvularia lunata* causes black kernel. The fungus causes severe grain discoloration, and after milling, the kernels appear black. When infections are heavy, the fungus can also cause seedling blights or weakened seedlings. This disease is rarely severe enough that management practices would be recommended. Seed treatments to manage other diseases should reduce seedling damage. No other management measures are warranted.

**Blast**

Rice blast is caused by the fungus *Pyricularia grisea*. Depending on the portion of the plant affected, the disease is also called leaf blast, node blast, panicle blast, collar blast, and rotten neck blast. Blast has been one of the most important diseases in Louisiana, causing severe yield losses to susceptible varieties under favorable environmental conditions.

Blast can be found on the rice plant from the seedling stage to near maturity. The leaf blast phase occurs between the seedling and late tillering stages. Spots on leaves start as small white, gray, or blue tinged spots. Spots enlarge quickly under moist conditions to either oval diamond-shaped spots or linear lesions with pointed ends with gray or white centers and narrow brown borders (Figure 1). Leaves and whole plants are often killed under severe conditions (Figure 2). Lesions on resistant plants are small brown specks that do not enlarge.

On stem nodes, the host tissue turns black and becomes shriveled and gray as the plant approaches maturity. The infected area may turn dark purple to blue-gray because of the production of fungal spores. Culms and leaves become straw-colored above the infected node. Plants lodge or breakoff at the infected point, or are connected only by a few vascular strands. Some varieties are infected where the flag leaf attaches to the sheath at the collar (Figure 3). The lesion turns brown or chocolate brown to gray, and the flag leaf becomes detached from the plant as the lesion area becomes dead and dry.

Rotten neck symptoms appear at the base of the panicle starting at the node
The tissue turns brown to chocolate brown and shrivels, causing the stem to snap and lodge. If the panicle does not fall off, it may turn white to gray, or the florets that do not fill will turn gray. Panicle branches and stems of florets also have gray-brown lesions.

Scouting a field for blast should begin early in the season during the vegetative phase and continue through the season to heading. Leaf blast will usually appear in the high areas of the field where the flood has been lost or is shallow. Areas of heavy nitrogen fertilization and edges of the fields are also potential sites of infection. If leaf blast is in the field or has been reported in the same general area, and if the variety is susceptible, fungicidal applications are advisable to reduce rotten neck blast.

The pathogen overwinters as mycelium and spores on infected straw and seed. Spores are produced from specialized mycelium called conidiophores and become windborne at night in the presence of dew or rain. The spores are carried by air currents and land on healthy rice plants. The spores germinate under high humidity and dew conditions and infect the plant. Generally lesions will appear 4-7 days later, and additional spores are produced. Plants of all ages are susceptible.

Medium grain varieties are more susceptible to blast, especially during the leaf phase, than the long grain varieties grown in Louisiana.

Environmental conditions that favor disease development are long dew periods, high relative humidity, and warm daytime temperatures with cool nights. Agronomic practices that favor disease development include excessive nitrogen levels, late planting, and dry soil (loss of flood). Several physiologic races of *P. grisea* exist, and disease development varies, depending upon variety-race interactions.

The disease can be reduced by planting resistant varieties (Table 2), maintaining a 4- to 6-inch flood (Kim, 1986), proper nitrogen fertilizer, avoiding late planting, and by applying a fungicide recommended by the Louisiana Cooperative Extension Service.

**Brown Spot**

Brown spot, caused by the fungus *Cochiobolus miyabeanus*, is one of the most prevalent rice diseases in Louisiana. The disease is also called Helminthosporium leaf spot. When *C. miyabeanus* attacks the plants at emergence, the resulting seedling blight causes sparse or inadequate stands and weakened plants. Leaf spots are present on young rice; however, the disease is more prevalent as the plants approach maturity and the leaves begin to senesc. Yield losses from leaf infection or leaf spots are probably not serious. When the fungus attacks the panicle, including the grain, economic losses occur. Heavy leaf spotting is an indication of some unfavorable growth factor, usually a soil problem.

The pathogen also attacks the coleoptiles, leaves, leaf sheath, branches of the panicle, glumes, and grains. The fungus causes brown, circular to oval spots on the coleoptile leaves of the seedlings (Figure 26). It may cause seedling blight.

Leaf spots are found throughout the season. On young leaves, the spots are smaller than those on upper leaves. The spots may vary in size and shape from
minute dark spots to large oval to circular spots (Figure 11). The smaller spots are dark brown to reddish-brown. The larger spots have a dark brown margin and a light, reddish-brown or gray center. The spots on the leaf sheath and hulls are similar to those on the leaves.

The fungus attacks the glumes and causes a general black discoloration. The fungus also attacks the immature florets, resulting in no grain development or kernels that are lightweight or chalky.

Brown spot is an indicator of unfavorable growth conditions. These unfavorable growth conditions include insufficient nitrogen, inability of the plants to use nitrogen because of rice water-weevil injury, root rot, or other unfavorable soil conditions. As the plants approach maturity, brown spot becomes more prevalent, and the spots are larger on senescing leaves.

Damage from brown spot can be reduced by maintaining good growing conditions for rice by proper fertilization, crop rotation, land leveling, proper soil preparation, and water management. (See Linscombe et al, 1987 for specific recommendations.) Seed-protectant fungicides reduce the severity of seedling blight caused by this seedborne fungus. Some varieties are less susceptible than others (Table 2).

**Crown Rot**

Crown rot is suspected to be caused by a bacterial infection (possibly *Erwinia chrysanthemi*). It is a minor disease usually associated with the variety Saturn. Symptoms first appear during tillering. The crown area is decayed, with soft rotting, becoming black or dark brown with discolored streaks extending into the lower internodes of culms (Figure 17). There is a fetid or putrid odor characteristic of bacterial soft rots, and tillers start dying one at a time. The roots also die and turn black. Adventitious roots are produced at the node above the crown area. A similar discoloration of the crown can be caused by misapplied herbicides. Control practices are not available.

**Crown Sheath Rot**

Crown sheath rot is caused by the fungus *Gaeumannomyces graminis var. graminis*. Other names for this disease include brown sheath rot, Arkansas foot rot, and black sheath rot. This disease has been considered a minor disease of rice, but recent reports from Texas suggest severe damage can occur. The pathogen kills lower leaves, thus reducing photosynthetic activity, causes incomplete grain filling, and plants can lodge.

Symptoms appear late in the season, usually after heading. Sheaths on the lower part of the rice plant are discolored brown to black (Figure 25). Reddish-brown mycelial mats are found on the inside of infected sheaths. Dark perithecia are produced within the outside surface of the sheath. Perithecia are embedded in the sheath tissues with beaks protruding through the epidermis. This disease can easily be confused with stem rot.

The fungus survives as perithecia and mycelia in plant residues. Ascospores are windborne during moist conditions. The fungus has been reported to be seedborne.
Management practices have not been worked out for this disease.

**Downy Mildew**

Downy mildew is caused by the fungus *Sclerophthora macrospora*. In early growth stages, infected seedlings are dwarfed and twisted with chlorotic, yellow to whitish spots. Symptoms are more severe on the head. Due to failure to emerge, panicles are distorted, causing irregular, twisted and/or spiral heads that remain green longer than normal. No control measures are recommended.

**False Smut**

False smut, caused by the fungus *Ustilaginoidea virens*, is a minor disease in the United States. The disease is characterized by large orange to brown-green fruiting structures on one or more grains of the mature panicle (Figure 28). When the orange covering ruptures, a mass of greenish-black spores is exposed. The grain is replaced by one or more sclerotia. All varieties appear to have a high level of resistance, and disease control measures are not required.

**Grain Spotting and Pecky Rice**

Many fungi infect developing grain and cause spots and discoloration on the hulls or kernels. Damage by the rice stink bug, *Oebalus pugnax* F., also causes discoloration of the kernel. Kernels discolored by fungal infections or insect damage are commonly called pecky rice (Figure 30). This is a complex disorder in rice that involves many fungi, the white-tip nematode, and insect damage. High winds at the early heading stage may cause similar symptoms. Proper insect control and disease management will reduce this problem.

**Kernel Smut**

This fungal disease is caused by *Neovossia barclayana*. Symptoms are observed at or shortly before maturity. A black mass of smut spores replaces all or part of the endosperm of the grain. The disease is easily observed in the morning when dew is absorbed by the smut spores. The spore mass expands and pushes out of the hull where it is visible as a black mass (Figure 14). When this spore mass dries, it is a powdery material and comes off easily on fingers. Rain washes the black spores over adjacent parts of the panicle. Compared with normal grain, affected grains are a lighter, slightly grayish color.

Usually only a few florets may be affected in a panicle. However, fields have been observed in Louisiana with 20-40 percent of the florets affected on 10 percent or more of the panicles in a field. Smutted grains produce kernels with black streaks or dark areas. Milled rice has a dull or grayish appearance when smutted grains are present in the sample. Because fewer kernels break when parboiled rice is milled, kernel smut can be a severe problem in processed rice. Growers are docked in price for grain with a high incidence of smut.

This disease is usually minor in Louisiana, but can become epidemic in local areas. Some varieties are more susceptible to this disease and should be avoided where smut is a problem. Spores of the fungus are carried on affected seeds and overwinter in the soil of affected fields. The pathogen attacks immature, developing grain, and is more severe when rains are frequent during flowering. Specific
control measures are not available.

**Leaf Scald**

This disease, caused by *Gerlachia oryzae*, is common and sometimes severe in Central and South America. It is present in the southern rice area of the United States and is observed in Louisiana annually.

The disease affects leaves, panicles, and seedlings. The pathogen is seed-borne and survives between crops on infected seeds. The disease usually occurs on maturing leaves. Lesions start on leaf tips or from the edges of leaf blades. The lesions have a chevron pattern of light (tan) and darker reddish-brown areas (Figure 18). The leading edge of the lesion usually is yellow to gold in color (Figure 19). Fields appear yellow or gold. Lesions from the edges of leaf blades have an indistinct, mottled pattern. Affected leaves dry and turn straw-colored.

Panicle infestations cause a uniform light to dark, reddish-brown discoloration of entire florets or hulls of developing grain. The disease can cause sterility or abortion of developing kernels.

Control measures are not recommended, but foliar fungicides used to manage other diseases have activity against this disease.

**Leaf Smut**

Leaf smut, caused by the fungus *Entyloma oryzae*, is a widely distributed, but somewhat minor, disease of rice. The fungus produces slightly raised, black spots (sori) on both sides of the leaves (Figure 20) and on sheaths and stalks. The blackened spots are approximately 0.5-5.0 mm long and 0.5-1.5 mm wide. Many spots can be found on the same leaf, but they remain distinct from each other. Heavily infected leaves turn yellow, and leaf tips die and turn gray. The fungus is spread by airborne spores and overwinters on diseased leaf debris in soil.

Leaf smut occurs late in the growing season and causes little or no losses. Control measures are not recommended.

**Narrow Brown Leaf Spot**

Narrow brown leaf spot, caused by the fungus *Cercospora janseana*, varies in severity from year to year and is more severe as rice plants approach maturity. Leaf spotting may become very severe on the more susceptible varieties and causes severe leaf necrosis. Some premature ripening, yield reduction, and lodging occurs.

Symptoms include short, linear, brown lesions most commonly found on leaf blades (Figure 12). Symptoms also occur on leaf sheaths, pedicels, and glumes. Leaf lesions are 2-10 mm long and about 1 mm wide. They tend to be narrower, shorter and darker brown on resistant varieties and wider and lighter brown with gray necrotic centers on susceptible varieties. On upper leaf sheaths, symptoms are very similar to those found on the leaf. On lower sheaths, the symptom is similar to a “net blotch” or Cercospora sheath spot in which cell walls are brown and intracellular areas are tan to yellow (Figure 13).

The primary factors affecting disease development are (1) susceptibility of varieties to one or more prevalent pathogenic races, (2) prevalence of pathogenic races on leading varieties, and (3) growth stage. While rice plants are susceptible
at all stages of growth, the plants are more susceptible from panicle emergence to maturity.

Plant breeders have found differences in susceptibility among rice varieties (Table 2), but resistance is an unreliable control method as new races develop readily. Some fungicides used to reduce other diseases also may have activity against narrow brown leaf spot. Low nitrogen favors development of this disease.

**Panicle Blight**

The cause of panicle blight is unknown. It can be very severe on certain varieties of rice. The disease is characterized by brown or straw-colored discoloration of florets on a panicle branch (Figure 29). Lesions are not apparent below the grain. The grain stops developing and the florets turn gray.

**Root Knot**

Species of the nematode meloidogyne cause root knot. The disease symptoms include enlargement of the roots and the formation of galls or knots. The swollen female nematode can be found in the center of this tissue. Plants are dwarfed, yellow, and lack vigor. The disease is rare and yield losses low. The nematode becomes inactive after prolonged flooding.

**Root Rot**

Root rots are caused by several fungi including *Pythium spinosum, P. dispersatum*, other *Pythium* spp., and several other fungi. The rice plant is predisposed to this disorder by a combination of factors including physiological disorders, insect feeding, especially feeding of rice water weevil larvae, extreme environmental conditions, and various other pathogens.

Symptoms can be noted as early as emergence. Roots show brown to black discoloration and necrosis. As the roots decay, nutrient absorption is disrupted, the leaves turn yellow, and the plants lack vigor. With heavy root infections, plants lack support from the roots and lodge, causing harvest problems. Often plants with root rot show severe brown leaf spot infection.

The disease is referred to as feeder root necrosis when the small fine roots and root hairs are destroyed. When this happens, no lodging occurs, and symptom development is not as apparent on the upper plants.

Fertilizer usually reduces the above-ground symptoms although actual nutrient utilization is impaired. Rice water weevil control greatly reduces root rots. Draining fields stimulates root growth, but can cause problems with blast, weeds, or efficiency of nutrient utilization.

**Seedling Blight**

Seedling blight or “damping off” is a disease complex caused by several seedborne and soilborne fungi including species of *Cochliobolus, Curvularia, Sarocladium, Fusarium, Rhizoctonia*, and *Sclerotium*. Typically, the rice seedlings are weakened or killed by the fungi. Environmental conditions are important in disease development, with cold, wet weather having the most detrimental effect.

Seedling blight causes stands of rice to be spotty, irregular, and thin. Fungi
Fig. 7.- Initial sheath blight infection. Fig. 8.- Sheath blight.
Fig. 9.- Typical sheath blight symptoms on sheath.
Fig. 10.- Typical sheath blight symptoms on leaves.
Fig. 11.- Brown leaf spot. Fig. 12.- Narrow brown leaf spot.
Fig. 1.-Leaf blast. Fig. 2.-Rice with heavy leaf blast.
Fig. 3.-Collar blast. Fig. 4.-Rotten neck blast.
Fig. 5.-Early stem rot infections. Fig. 6.-Stem rot showing rotted culm with sclerotia.
Fig. 19.-Typical symptoms of leaf scald. Fig. 20.-Leaf smut.
Fig. 21.-Sheath rot. Fig. 22.-Stackburn lesions on leaf.
Fig. 23.-Early sheath spot symptoms. Fig. 24.-Typical sheath spot.
Fig. 13.-Net blotch symptoms of narrow brown leaf spot disease.
Fig. 14.-Kernel smut.  Fig. 15.-Achylia water-mold.
Fig. 16.-Pythium water-mold.  Fig. 17.-Crown rot.
Fig. 18.-Early leaf scald symptoms.
Fig. 31.-Straight head. Fig. 32.-Bronzing. Fig. 33.-Seedling cold injury.
Fig. 34.-Seedling salt damage. Fig. 35.-Nutrient deficiency.
Fig. 36.-White tip.
Fig. 25.- Crown sheath rot. Fig. 26.- Seedling blight.  
Fig. 27.- Bacterial leaf blight.  Fig. 28.- False smut.  
Fig. 29.- Panicle blight.  Fig. 30.- Pecky rice
enter the young seedling and either kill or injure them. Blighted seedlings that emerge from the soil die soon after emergence. Those that survive generally lack vigor, are yellow or pale green, and do not compete well with healthy seedlings.

Severity and incidence of seedling blight depends on three factors: (1) percentage of the seed that is infested by seedborne fungi, (2) soil temperature, and (3) soil moisture content. Seedling blight is more severe on rice that has been seeded early when the soil is usually cold and damp. The disadvantages of early seeding can be partially overcome by seeding at a shallow depth. Conditions that tend to delay seedling emergence favor seedling blight. Some blight fungi that affect rice seedlings at the time of germination can be reduced by treating the seed with fungicides.

Seeds that carry blight fungi frequently have spotted or discolored hulls. However, seed can be infected and still appear to be clean. Cochiobolus miyabeanus, one of the chief causes of seedling blight, is seedborne. A seedling attacked by this fungus has dark areas on the basal parts of the first leaf (Figure 27).

If rice seed is sown early in the season, treating the seed is likely to mean the difference between getting a satisfactory stand or having to plant a second time (Rush, 1973). Unless unfavorable weather conditions prevail, little benefit is received from treating rice seed that is to be sown late in the season.

The soilborne seedling blight fungus Sclerotium rolfsii kills or severely injures large numbers of rice seedlings after they emerge when the weather is humid and warm at emergence. A cottony white mold develops on the lower parts of affected plants. This type of blight can be checked by flooding the land immediately.

Treatment of the seed with a fungicide is recommended to improve or ensure stands. Proper cultural methods for rice production, such as proper planting date or shallow seeding of early planted rice, will reduce the damage from seedling blight fungi.

Water and soilborne fungi in the genus Pythium attack and kill seedlings from germination to about the three-leaf stage of growth. Infected roots are discolored brown or black, and the shoot suddenly dies and turns straw-colored. This disease is most common in water-seeded rice, and the injury is often more visible after the field is drained. This disease may also occur in drill-seeded rice during prolonged wet, rainy periods.

Seed treatment, planting when temperatures favor rapid growth of seedlings, and draining the field are the best management measures for seedling disease control.

Sheath Blight

Sheath blight has been the most economically significant disease in Louisiana since the early 1970's (Lee and Rush, 1983). The disease is caused by Rhizoctonia solani, a fungal pathogen of both rice and soybeans. On soybeans, it causes the aerial blight disease.

Several factors have contributed to the development of sheath blight from minor to major disease status. These include the increased acreage planted to
susceptible long-grain varieties, the increase in the acreage of rice grown in rotation with soybeans, the increased use of broadcast seeding, and the higher rates of nitrogen fertilizers used with the modern commercial rice varieties. The disease is favored by dense stands with a heavily developed canopy, high temperature, and high humidity.

Sheath blight is characterized by large oval spots on the leaf sheaths (Figure 9) and irregular spots on leaf blades (Figure 10). Infections usually begin during the late tillering-joint elongation stages of growth. The fungus survives between crops as structures called sclerotia or as hyphae in plant debris. Sclerotia or plant debris floating on the surface of irrigation water serve as sources of inoculum that attack and infect lower sheaths of rice plants at the water-line. Lesions about 0.5-1 cm in width and 1-3 cm in length are formed a little above the water-line on infected culms (figures 7-8).

Fungus mycelium grows up the leaf sheath, forms infection structures, infects, and causes new lesions. The infection can spread to leaf blades (Figure 10). The lower leaf sheaths and blades are affected during the jointing stages of growth. After the panicle emerges from the boot, the disease progresses rapidly to the flag leaf on susceptible varieties. With very susceptible varieties, the fungus will spread into the culm from early sheath infections. Infected culms are weakened, and the tillers may lodge or collapse.

The fungus can spread in the field by growing from tiller to tiller on an infected plant or across the surface of the water to adjacent plants. The fungus also grows across touching plant parts, for example from leaf to leaf, causing infections on nearby plants. Infected plants are usually found in a circular pattern in the field because the fungus does not produce spores and must grow from plant to plant.

The lesions have grayish-white or light green centers with a brown or reddish-brown margin (figures 7-8). As lesions coalesce on the sheath, the blades develop a yellow-orange color and eventually die. As areas in the field with dead tillers and plants increase in size, they may coalesce with other affected areas to cause large areas of lodged, dead, and dying plants. Damage is usually most common where wind-blown, floating debris accumulates in the corners of cuts when seedbeds are prepared in the water.

Sheath blight also affects many grasses and weeds other than rice, causing similar symptoms. Sclerotia that survive between crops are formed on the surface of lesions on these weed grasses, as well as on rice and soybeans. The sclerotia are tightly woven masses of fungal mycelium covered by an impervious, hydrophobic coating secreted by the fungus.

Disease severity can be reduced by integrating several management practices. Dense stands and excessive use of fertilizer both tend to increase the damage caused by this disease. Broadcast seeding tends to increase stand and canopy density. Rotation with soybeans or continuous rice increases the amount of inoculum in field soils. Fallow periods, with disking to control growth of grass weeds, will reduce inoculum in the soil. The pathogen also is known to infect sorghum, corn, and sugarcane when environmental conditions are favorable for disease development (O’Neill, Rush, Horn, and Carver, 1977).
Medium-grain rice varieties are more resistant to sheath blight than most of the long-grain varieties (Marchetti, 1983). Several recently released long-grain varieties are more resistant to sheath blight than the older long-grain varieties (Table 2).

Fungicides are available to reduce this disease. Consult a Cooperative Extension agent for latest information on fungicides for sheath blight management.

**Sheath Rot**

This disease is caused by the fungal pathogen *Sarocladium oryzae*. Symptoms are most severe on the uppermost leaf sheaths that enclose the young panicle during the boot stage. Lesions are oblong or irregular oval spots with gray or light-brown centers and a dark reddish-brown, diffuse margin (Figure 21), or the lesions may form an irregular target pattern. On U.S. rice varieties, the lesion is usually expressed as a reddish-brown discoloration of the flag-leaf sheath. Early or severe infections affect the panicle so that it only partially emerges. The unemerged portion of the panicle rots, turning florets red-brown to dark brown. Grains from damaged panicles are discolored reddish-brown to dark brown and may not fill. A powdery white growth consisting of spores and hyphae of the pathogen may be observed on the inside of affected sheaths. Insect or mite damage to the boot or leaf sheaths increases the damage from this disease.

This disease affects most rice varieties. The disease is usually minor, affecting scattered tillers in a field. Occasionally, larger areas of a field may have significant damage. Control measures are not recommended. Fungicidal sprays used in a general disease management program reduce damage.

**Sheath Spot**

This disease is caused by the fungus *Rhizoctonia oryzae*. The disease resembles sheath blight, but is usually less severe. The lesions produced by *R. oryzae* are found on sheaths midway up the tiller or on leaf blades (Figure 23). Lesions are oval, 0.5-2 cm long, and 0.5-1 cm wide. The center of the lesion is pale green, cream, or white with a broad, dark reddish-brown margin (Figure 24). Lesions are separated on the sheath or blade and do not form the large, continuous lesions often found with sheath blight. The pathogen attacks and weakens the culm under the sheath lesion on very susceptible varieties. The weakened culms lodge or break over at the point where it was infected. Lodging caused by sheath spot usually occurs midway up the culm.

This disease is usually minor on Louisiana rice. Some fungicides used to manage sheath blight also reduce sheath spot.

**Stackburn**

This disease was first observed on rice growing in Louisiana and Texas. Stackburn or Alternaria leaf spot is caused by the fungal pathogen *Alternaria padwickii*. It is now common on rice around the world.

The disease is present in all rice fields in Louisiana. Only occasional spots are observed, but the disease may be more severe in restricted areas of a field. The spots are typically large (0.5-1 cm in diameter), oval or circular, with a dark brown margin or ring around the spot (Figure 22). The center of the spot is initially tan,
and eventually becomes white or nearly white. Mature spots have small dark or black dots in the center. These are sclerotia of the fungus. Grain or seeds affected by the disease have tan to white spots with a wide, dark-brown border. The disease causes discoloration of kernels, or the kernels stop development and grains are shriveled.

This fungus is the most common seedborne fungus in Louisiana and may cause seedling blight. The disease is more common on panicles and grain than on leaves in Louisiana.

No specific control recommendations are available, but seed-protectant fungicides will help reduce the seedling blight caused by this pathogen and will reduce the number of spores available to cause leaf infections.

**Stem Rot**

Stem rot caused by the fungus *Sclerotium oryzae* is an important disease in Louisiana. Frequently, losses are not detected until late in the season when it is too late to initiate control practices. Stem rot causes severe lodging, which reduces combine efficiency, increases seed sterility, and reduces grain filling.

The first symptoms are irregular black angular lesions on leaf sheaths at or near the water line on plants at tillering or later stages of growth (Figure 5). At later stages of disease development, the outer sheath may die, and the fungus penetrates to the inner sheaths and culm. These become discolored and have black or dark brown lesions (Figure 6). The dark brown or black streaks have raised areas of dark fungal mycelium on the surface and gray mycelium inside the culm and rotted tissues. At maturity the softened culm breaks, infected plants lodge, and many small, round, black sclerotia develop in the dead tissues.

The pathogen overwinters as sclerotia in the top 2-4 inches of soil and on plant debris. During water-working and establishment of early floods, the hydrophobic sclerotia float on the surface of the water and often accumulate along the edge of the field and on levees due to wind action.

After a permanent flood is established, the sclerotia float to the surface, contacts the plant, germinate, and infect the tissues near the water line. The fungus then penetrates the inner sheaths and culm, often killing the tissues. The fungus continues to develop, forming many sclerotia in the stubble after harvest.

Most commercial varieties of rice are not highly resistant to stem rot. The disease is favored by high nitrogen levels. Early maturing varieties are usually less affected by stem rot. In addition, applications of potassium fertilizer reduce disease severity in soils where potassium is deficient. Stem rot is more serious in fields that have been in rice production for several years.

Suggested management measures include using early maturing varieties, avoiding very susceptible varieties, burning stubble or destroying by cultivation after harvest to destroy sclerotia, using crop rotation when possible, applying potassium fertilizer, avoiding excessive nitrogen rates, and using foliar fungicides recommended by the Cooperative Extension Service. Several cultural practices may reduce stem rot. These include fluctuating the water level in the field so stagnant water does not remain at the same level on the lower leaf sheaths, and
draining water from the field at the tillering and early jointing stages of growth, while keeping the soil saturated. However, these practices may lead to the development of leaf blast and other problems.

**Water-Mold and Seed-Rot**

With the extensive use of the water-seeding method of planting rice, it has become more difficult to obtain uniform stands of sufficient density to obtain maximum yields. The most important biological factor contributing to this situation is the water-mold or seed-rot disease caused primarily by fungi in the genera *Achlya* and *Pythium*. Recently, certain *Fusarium* spp. also have been found associated with molded seeds (Rush, 1985). The disease is caused by a complex of these fungi infecting seeds. The severity of this disease is more pronounced when water temperatures are low or unusually high. Low water temperatures slow the germination and growth of rice seedlings, but do not affect growth of these pathogens. In surveys conducted in Louisiana during the early 1970’s and 1980’s, an average of 45 percent of water-planted seeds were lost to water-mold.

In addition to the direct cost of the lost seeds and the cost of replanting, water-mold also causes indirect losses due to the reduced competitiveness of rice with weeds in sparse or irregular stands. Also, replanting or overseeding the field causes the rice to mature late when conditions are less favorable for high yields due to unfavorable weather and high disease pressure.

Water-mold can be observed through clear water as a ball of fungal strands surrounding seeds on the soil surface. After the seeding flood is removed, seeds on the soil surface are typically surrounded by a mass of fungal strands radiating out over the soil surface from the affected seeds (figures 15-16). The result is a circular copper-brown or dark green spot about the size of a dime with a rotted seed in the center. The color is caused by bacteria and green algae which are mixed with the fungal hyphae.

*Achlya* spp. (Figure 15) normally attack the endosperm of germinating seeds, destroying the food source for the growing embryo and eventually attacking the embryo. *Pythium* spp. (Figure 16) usually attack the developing embryo directly. When the seed is affected by the disease, the endosperm becomes liquified and oozes out as a white, thick liquid when the seed is mashed. The embryo initially turns yellow-brown and finally dark brown. If affected seeds germinate, the seedling shoot and root are attacked and the seedling is stunted. When infection by *Pythium* spp. takes place after the seedling is established, the plant is stunted, turns yellow, and grows poorly. If the weather is favorable for plant growth, seedlings often outgrow the disease and are not severely damaged.

The disease is less severe when rice is water-seeded when weather conditions favor seedling growth. High and low temperatures averaging above 65 degrees F favor seedling growth, and water-mold is less severe. Seeds should be vigorous and have a high germination percentage. Seed with poor vigor will be damaged by water-mold fungi when water-seeded.

Treat seed with a recommended fungicide at the proper rate to reduce water-molds and seed diseases (Rush, 1973 and 1985). A list of recommended fungicides
is available from a Cooperative Extension Service agent. Most rice seed is treated by the seedsman and is available to the grower already treated. Seed-protectant fungicides differ in their effectiveness. Information concerning recent results from seed-protectant fungicide trials can be obtained from a Cooperative Extension agent or the LSU Rice Research Station. In field tests, these fungicides have increased stands over those produced by untreated seeds from 25-100 percent.

**White Tip**

This disease is caused by the nematode *Aphelenchoides besseyi*. Characteristic symptoms which appear after tillering include the yellowing of leaf tips, white areas in portions of the leaf blade (Figure 36), stunting of affected plants, twisting or distortion of the flag leaf, and distortion and discoloration of panicles and florets. Leaf tips change from green to yellow and eventually to white. The tip withers above the white area, becoming brown or tan and tattered or twisted. Resistant varieties may show few symptoms and still have yield loss. The nematode infects the developing grain and is seedborne.

This disease is present endemically in Louisiana, but is considered a minor rice disease. Fumigation of seeds in storage will reduce the nematode population. Other specific control measures are not recommended.

**Physiological Disorders**

**Bronzing**

Bronzing is caused by zinc deficiency. This disorder is characterized by purple-brown blotches made up of small spots coalescing on leaf blades, and by leaves becoming yellow, orange, or bronze (Figure 32). White patches or areas may form across leaf blades. Lower leaves float on the surface of the flood water, and seedlings may die when the permanent flood is applied. On older plants, the lower leaves die and disappear below the water surface. This disorder is controlled by adding zinc to soil at preplant or by spraying plants with chelated zinc.

**Cold Injury**

Cold weather affects rice development most at the seedling or reproductive stages of growth. Seedling damage is expressed as a general yellowing of the plants, or as yellow or white bands across the leaves where a combination of wind and cold temperature damaged the plants at the soil line (Figure 33). Cold weather (<60 degrees F) present during the reproductive stages cause panicle blanking or blighting. Individual florets or the whole panicle may be white when they emerge. Adjusting planting date to avoid cold temperatures eliminates this problem.

**Salinity**

Soil alkalinity or salinity, and water salinity injure rice. This is characterized by areas of stunted, chlorotic plants in the field (Figure 34). Under severe conditions, leaves turn from yellow to white, and plants die. Affected areas usually have dead or dying plants in the center or on high spots, with stunted yellow or white plants surrounding that area, and green, less affected, plants in lower areas. Salt deposits may be seen on the edges of leaves, on clods of soil, and other high areas of the field. Damage is reduced by flushing with water low in salt.
**Straighthead**

This is a physiological disorder associated with sandy soils, fields with arsenic residues, or fields having anaerobic decomposition of large amounts of organic matter incorporated into the soil before flooding. Panicles are upright at maturity because the grain does not fill or panicles do not emerge from the flag leaf sheath. Hulls (palea and lemma) may be distorted and discolored, with portions missing or reduced in size.

Distorted florets with a hook on the end are called “parrot beak” (Figure 31) and are typical of straighthead. Plants are darker green or blue-green and often produce new shoots and adventitious roots from the lower nodes. These symptoms can be mimicked by herbicide damage. Management is by using resistant varieties and draining at the first internode elongating stage of growth to dry the soil until it cracks (Bollich et al., 1990).
Table 2.—Reaction of rice varieties commonly grown in Louisiana to common diseases and disorders

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Long-grain Blast</th>
<th>Sheath Blight</th>
<th>Brown Spot</th>
<th>Narrow Brown Leaf Spot</th>
<th>Leaf Smut</th>
<th>Straighthead</th>
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<td>MS</td>
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<table>
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<tr>
<th>Cultivar</th>
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<th>Sheath Blight</th>
<th>Brown Spot</th>
<th>Narrow Brown Leaf Spot</th>
<th>Leaf Smut</th>
<th>Straighthead</th>
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<tr>
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*R* = resistant, *MR* = moderately resistant, *MS* = moderately susceptible, *S* = susceptible, and *VS* = very susceptible. Varieties labeled *S* or *VS* for a given disease or disorder may be severely damaged under conditions favoring disease development.
Glossary

Adventitious - Refers to a structure arising from an unusual place, such as roots growing from stems or leaves.

Anaerobic - Refers to an organism able to live and grow without air or free oxygen.

Bacterium (pl. bacteria) - A one-celled microscopic organism that lacks chlorophyll and multiplies by fission (splitting).

Biological Control - Disease control by means of predators, parasites, competitive microorganisms, and antibiotic producing microorganisms, which restrict or reduce the population of the pathogen.

Chevrons - Stripe-like pattern consisting of several curved or V-shaped bands.

Chlorosis - Yellowing of normally green tissue caused by the destruction of the chlorophyll or the partial failure of the chlorophyll to develop.

Coalesce - The coming together of two or more lesions to form a large spot or blotch.

Conidiophore - Specialized fungal hypha bearing conidia.

Conidium (pl. conidia) - A fungal spore formed asexually, usually at the top or side of a specialized hypha (conidiophore).

Culm - The jointed stem of grass.

Embryo - The microscopically small plant attached to the kernel endosperm under the lemma near the point of attachment of the rice seed to the panicle.

Endosperm - Primarily carbohydrate in the form of starch comprising most of the rice seed and used during germination and early plant growth by the embryo and developing seedling.

Epidemic - The extensive development of a disease on a crop.

Endemic - The normal presence of a disease in a crop year after year in less than epidemic amounts.

Floret - The rice flower including the lemma, palea, pistil, and stamens.

Fungus (pl. fungi) - A filamentous microorganism lacking chlorophyll.

Hypha (pl. hyphae) - A single thread or filament of a fungus.

Inflorescence - A flower cluster (the panicle in rice).

Lemma - The larger of two enclosing structures which form the hard outer covering of a rice seed (together with the palea make up the hull).

Lesion - A localized area of diseased tissue of a host plant.

Main Shoot - The first noticeable above-ground portion of a rice plant originating directly from the seed.

Mycelium (pl. mycelia) - A mass of fungus hyphae; the vegetative body of a fungus.

Necrotic - Dead.

Nematode - Generally microscopic, unsegmented roundworm, usually thread-like, free-living or a parasite of plants or animals.

Palea - The smaller of two enclosing structures which form the hard outer covering of a rice seed.

Panicle - A many branched inflorescence composed of several to many spikelets.
and/or florets and their supporting structure.

**Pathogen** - A specific living agent that causes infectious disease.

**Photosynthesis** - The process by which plants absorb light energy and convert it to carbohydrate.

**Ratoon Crop (second crop)** - Regrowth of rice from the stubble of the first crop which grew from seed.

**Resistance** - The inherent ability of a host plant to suppress, retard, or prevent entry or subsequent activity of a pathogen or other injurious factor.

**Sclerotium (pl. sclerotia)** - Dense, compacted mass of hyphae, resistant to unfavorable conditions, capable of remaining dormant for long periods, and able to germinate upon the return of favorable conditions.

**Senescence** - The process of aging leading to death following the completion of growth in plants and individual plant parts.

**Shoot** - An immature stem made up of leaves originating from the crown of the rice stem before stem elongation.

**Spore** - A minute propagative unit of fungi that functions as a seed, but differs from a seed in that a spore does not contain a preformed embryo.

**Susceptibility** - The inability of a plant to resist the effect of a pathogen or other damaging factor.

**Water-mold** - Fungi in the class Oomycetes that attack germinating rice seeds in water-planted rice.
Selected References


Appendix A
Scouting and Management Practices Recommended for Major Rice Diseases

BLAST
Scouting or Determining Need
Varieties with low levels of resistance should be scouted for leaf blast during the vegetative stages of growth. Leaf blast is more likely when the flood is lost, excessive nitrogen is used, or rice is planted late in the growing season. Sandy soils and tracts near tree lines are probable areas where blast will occur. There are no predictive systems to foresee when rotten neck blast will occur. Since significant damage is already done when the disease is first detected, preventive sprays are required on susceptible varieties, especially when blast has been detected in the region.

Management Practices
Plant varieties resistant to blast. Avoid late planting (after the 15th of May). For leaf blast, reflood if field has been drained. Maintain flood at 4-6 inches. Do not over fertilize with nitrogen. Apply a fungicide if necessary. Contact your Cooperative Extension agent for latest information on available fungicides and timing.

SHEATH BLIGHT
Scouting or Determining Need
Rice following rice or soybeans is more likely to be affected. Dense stands and excessive nitrogen favor disease development. Varieties should be scouted from mid-tillering until heading. The field should be sampled at several locations to determine the percentage of tillers infected. Spraying a fungicide is warranted if 5-10 percent or 10-15 percent of the tillers are infected on susceptible or moderately susceptible varieties, respectively.

Management Practices
Avoid dense stands and excessive nitrogen fertilizer. Most long-grain varieties have little resistance to sheath blight. Medium-grain varieties are more resistant. Timing and rate of fungicide applications are critical for good sheath blight management. Check with your Cooperative Extension agent for latest information on available fungicides. Fallow periods, with disk ing to control grasses in the field (which serve as sources of inoculum) and break down crop residue help reduce disease pressure.

BROWN SPOT
Scouting or Determining Need
Disease is most severe when plants are nitrogen deficient or under other stresses. Plants become more susceptible as they approach maturity.

Management Practices
Maintain good growing conditions through proper fertilizer, land leveling, good soil preparation and other cultural practices. Use recommended seed-protectant fungicides to reduce inoculum. Correct stress conditions in the field. All varieties
are susceptible, but some are more susceptible than others.

**NARROW BROWN LEAF SPOT**

**Scouting or Determining Need**
Disease is most severe from panicle emergence to maturity. Several pathogenic races are present, and new races develop to affect resistant varieties.

**Management Practices**
Many commercial varieties have acceptable levels of resistance to this disease. Check with your Cooperative Extension agent for latest information on the use of available fungicides. Apply fungicides at recommended rate and timing.

**STEM ROT**

**Scouting or Determining Need**
Most commercial varieties are susceptible. Infection takes place at the water line and angular black lesions form. The number of infected tillers may reach 100 percent in areas of the field where debris and sclerotia from the previous crop have collected after being windblown on the water surface.

**Management Practices**
Application of potassium will reduce disease severity where potassium is deficient. Early maturing varieties are less affected by stem rot. Destroying the sclerotia in stubble by crop rotation, tillage, or burning can reduce disease pressure. Vary water depth during the season. Water deeper than the initial infection points will encourage infected sheaths to rot, and will prevent spread into the culm. Shallow water will often allow infected sheaths to dry out and pull away from the culm.

**WATER-MOLD AND SEED-ROT**

**Scouting or Determining Need**
The fungi causing this disease are soil- and waterborne. They occur in most rice fields. The seed-rot and water-mold disease are most severe under flooded conditions when the water is cold.

**Management Practices**
Seed should be treated with recommended fungicides. Check with your Cooperative Extension agent for recent information on effective seed-protectant fungicides. Draining the seeding flood and flushing as needed helps prevent water-mold. Seeding should not begin until the mean daily temperature reaches 65 degrees F.

**SEEDLING BLIGHT**

**Scouting or Determining Need**
The fungi causing this disease can be seedborne or soilborne. They are common and are normally present on seeds or in soil. Seedling blight is common in drill-seeded or dry broadcast rice.

**Management Practices**
Treatment of seed with seed-protectant fungicides is an effective measure for reducing seedling blight. Check with your Cooperative Extension agent for recent information on effective seed-protectant fungicides.
GRAIN SPOTTING AND PECKY RICE

Scouting and Determining Need

Since these diseases are normally associated with insect damage, scout for the rice stink bug. Fields should be monitored from immediately after pollination until kernels begin to harden. Sample with a sweep net and count the number of insects collected. If the number of stink bugs exceeds 30 per 100 sweeps during the first two weeks after heading, the field should be treated with a labeled insecticide. During the dough stages’ fields should be treated when 100 or more stink bugs are collected per 100 sweeps.

Management Practices

Control of the stink bugs with insecticides is the only management measure for grain spotting and pecky rice.

KERNEL SMUT, LEAF SMUT, SHEATH ROT, SHEATH SPOT, LEAF SCALD, STACKBURN, ROOT ROT, ROOT KNOT, WHITE TIP, PANICLE BLIGHT, DOWNY MILDEW, FALSE SMUT, BACTERIAL LEAF BLIGHT, BLACK KERNEL, CROWN ROT, CROWN SHEATH ROT

Scouting or Determining Need

These diseases rarely occur with enough severity to warrant disease control measures or scouting.

Management Practices

Control measures are not available or recommended for these diseases. Varieties differ in their reaction to these diseases, but extensive evaluations have not been conducted. Fungicides used to manage other major diseases reduce several of these diseases. Check with your Cooperative Extension agent for the latest information.