Diseases

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Acknowledgement

We thank Dr. Bob Webster for his generous gift of the Rice Disease Identification Guides provided in this section. These guides provide color photographs and information on Bakanae, Rice Blast, Stem Rot and Aggregate Sheath Spot. Please refer to these guides at the end of this section for additional information.

Introduction

Microorganisms such as fungi, bacteria and viruses are known to cause plant diseases and limit the health, quality and production potential of crop plants. There are many factors that determine the incidence and severity of a specific disease in the field. There are three principal elements that must be present for the occurrence of a plant disease: a susceptible host, a pathogen, and favorable environmental conditions for disease development. All of the diseases discussed in the following text are fungal diseases. No bacteria or viruses are known to cause diseases of rice in California. The following discussion and Disease Identification Guides are meant to provide you with the tools needed to identify rice diseases in California and understand the interaction among the rice plant, pathogen and environment. With this information, you will be able to make informed disease management decisions based on biology. Remember that the best tools you have are your eyes so be sure to scout your fields regularly so you may make the most educated decision regarding your livelihood.

Seed Rot and Seedling Disease

Seed rot and rice seedling diseases may be caused by *Achlya klebsiana* and *Pythium* species. These diseases are widespread throughout the rice growing areas of California and may occur wherever rice is water seeded. Seed rot and seedling disease often result in poor establishment of uniform stands.

Symptoms of seed rot and seedling disease appear shortly after seeding. The most common sign of the pathogen is whitish fungal hyphae growing over the surface of the seed and young seedling. Algae often colonize the mycelium, turning it green. A dark circular spot may also occur on the soil surface around infected seed due to the growth of algae and bacteria on the fungal hyphae and infected seed. Seed that are infected shortly after seeding often don’t germinate because the endosperm or embryo is rapidly destroyed. Growth of seedlings may be greatly impeded when seeds are infected following germination. Symptoms of seedling disease may include stunting, yellowing or rotting of the seedlings.

Unfavorable conditions for seed germination and seedling growth favor the development of these diseases. Cool weather at planting is the most common factor that predisposes seed and seedlings to these diseases because of decreased germination and seedling development rates. Once seedlings are established, seedlings will often outgrow the disease under environmental conditions favorable for seedling growth with little effect on plant growth and survival.

The seed rot and seedling disease fungi survive in the soil and produce zoospores (swimming spores) in response to flooding of the soil. Zoospores are attracted to cracks in the seed coat where the endosperm is exposed or to the germinating seedlings. Feeding by midge or tadpole shrimp may predispose seed or seedlings to seed rot and seedling disease.

Laser leveling and maintaining a flood of 4 inches promotes rapid germination and stand establishment without the loss of weed control often associated with draining for stand establishment. Planting high quality seed with 85% germination or more when water temperatures are favorable for seed germination and growth (> 70°F) is an important cultural management practice for these diseases. In recent years, higher seeding rates have been used to compensate for seed rot and seedling disease.

Bakanae

Bakanae disease of rice is widely distributed in Asia and was first recognized in Japan in 1828. The word bakanae is a Japanese word that means "foolish seedling" and describes the excessive elongation often seen in infected plants. Symptoms of elongated seedlings led to the identification of bakanae in California rice fields in 1999. The disease has now become widespread throughout the rice growing areas of California and some infested fields suffered significant yield losses in 2002. As bakanae is a new disease in California, there are still a lot of unanswered questions about how the pathogen and disease will behave in a new climate and how best to manage it.

Bakanae is caused by the fungus *Gibberella fujikuroi* (anamorph *Fusarium fujikuroi*). The fungus infects plants through the roots or crowns and grows systemically within the plant where it produces the growth hormones gibberellin, which causes plant elongation, and fusaric acid, which causes stunting. The types of symptoms produced by an infected plant may be dependent upon the strain of the fungus and nutritional conditions. The most visually striking symptoms of the disease are chlorotic, elongated, thin seedlings that are often several inches taller than healthy seedlings. Infected seedling may also be stunted and chlorotic, exhibiting a rot and crown rot. Infected seedlings usually die. Older plants infected with the fungus may exhibit abnormal elongation, stunting or normal growth and if they survive to maturity produce no panicle or empty panicles. As death approaches infected plants, leaf sheaths are usually covered with a mass of white or pinkish growth and sporulation of the fungus near the waterline. Leaves sheaths of infected plants may also turn a blue-black color with the production of sexual reproduction structures called perithecia.

Bakanae is primarily a seedborne disease and may be moved from one location to another on infested seed. Airborne spores of the fungus may contaminate seed after heading or during harvest. The fungus does not appear to infect the seed internally but rather contaminate the outside of the seed coat. Survival of the fungus in crop residue or the soil is thought to play a minor role in the disease cycle of bakanae.

Planting clean seed is the most effective management method for Bakanae. Destruction of crop residue in fields infested with the pathogen may provide some limited benefits by limiting the amount of inoculum that may carry over to the next crop. Field trials in 2002 indicated that a sodium hypochlorite soak solution may be more effective in reducing bakanae incidence than the recommended rates of the available seed treatment materials Maxim and Nusan. An amendment to an existing agricultural use label for seed treatment was obtained in 2003 to allow the use of Ultra Clorox Germicidal Bleach for bakanae control. The product label specifies using a thoroughly premixed solution of five gallons of product to 100 gallons of water, seed is soaked for two hours, then drained and soaked in fresh water for the remaining time. If you choose to use a registered seed treatment, use only in accordance with the product label. Fungicide seed treatments will continue to be evaluated for bakanae management.

Stem Rot

Stem rot disease occurs in most rice growing regions of the world and is caused by the fungus *Magnaporthe salvinii*. The stem rot pathogen is most often found in its sclerotial state, *Sclerotium oryzae*, in the field. The initial symptoms of stem rot appear after mid-tillering as very small irregular black lesions on the outer leaf sheath of the tiller at the waterline. As the season progresses, the lesions enlarge and the fungus moves inward, infecting interior leaf sheaths. Infected leaf sheaths often die and slough off throughout the season. In severe cases, the fungus will penetrate and rot the culm killing the entire tiller. Tiny black sclerotia (hard resting structures) often form within diseased leaf sheaths. Sclerotia and white fungal mycelium may also be found inside the culm of severely infected plants near maturity.

The fungus overwinters mostly as sclerotia associated with diseased crop residue. When the field is flooded for the following season, the sclerotia float to the surface and infect developing seedlings at the waterline. When young plants are infected, tillers are often killed or fail to produce panicles. In severe cases where the culm is infected, yield and quality may be significantly reduced. Disease incidence and severity is positively correlated with the number of sclerotia present in the upper layer of soil prior to planting.

Management of stem rot is dependent upon cultural control methods. Since sclerotia overwinter in crop residue, one of the most valuable management tools is limiting the amount of inoculum that carries over from one season to the next. Burning of crop residue in the fall is a very effective method of reducing sclerotial inoculum levels in a field and reducing the amount of crop residue available for sclerotia to form on while overwintering. Swathing at ground level and removing the straw from the field is nearly as effective as burning. Incorporation of straw and winter flooding has also proven helpful in reducing carry over of sclerotia to the following season.

Although all of the California rice varieties are susceptible to the stem rot pathogen, some are more tolerant to the disease than others. Stem rot susceptibility may be found in the Characteristics of Public California Rice Varieties under the Agronomy Fact Sheet section of the UCCE Rice Project web page (address in reference section). Stem rot is more severe in denser stands of rice and with excessive levels of nitrogen fertilization. Manage agronomic factors in an attempt to establish 10-15 plants per square foot and use only the minimum amount of nitrogen required for optimum productivity to minimize the severity of stem rot.

Aggregate Sheath Spot

The fungus *Rhizoctonia oryzae-sativae* causes aggregate sheath spot disease of rice. Lesions of the disease first appear at the waterline during the tillering stage as oval lesions with gray-green to straw-colored centers surrounded by a brown margin. Additional margins often appear around the initial lesion forming concentric bands. As the season progresses, aggregate sheath spot lesions move upward and form lesions on the upper leaf sheaths. Lesions often coalesce and cover the entire leaf sheath. Leaves of infected leaf sheaths turn bright yellow and eventually die. Under favorable conditions, the disease may spread to the flag leaf or panicle rachis and result in partially filled panicles.

Rhizoctonia oryzae-sativae produces irregular brown sclerotia that are larger than stem rot sclerotia on the surface of infected leaf sheaths and cylindrical sclerotia inside the cells of infected tissue. Excess nitrogen fertilization does not increase the severity of aggregate sheath spot as it does for stem rot. The same cultural management methods used for stem rot may be used for aggregate sheath spot. The disease cycles of the two diseases are very similar so reducing the carry over of sclerotia to the following season is key. Quadris fungicide is registered for use on rice in California as a protectant against aggregate sheath spot to prevent the movement of disease to the top of the plant and should be used only in accordance with the product label.

Rice Blast

Rice blast disease is caused by the fungus *Pyricularia grisea* and is widely distributed throughout the rice growing regions of the world but was only recently identified in California in 1996. The incidence of rice blast has been relatively low in the past couple of years but is known as a sporadic disease and is only considered to be a serious problem in the Southern U.S. every five to eight years. Blast is considered to be the most important disease of rice worldwide and may cause crop losses of up to 50% in some parts of the world when conditions are favorable for disease development. *Pyricularia grisea* may infect most aboveground parts of a rice plant including leaves, leaf collars, nodes, panicles and grains. Rice blast disease may be called by different names depending on the part of the plant infected.

Symptoms of leaf blast typically consist of elongated diamond-shaped lesions with gray or whitish centers and brown or reddish brown margins. Leaf collars may also be infected by the fungus and produce a brown or reddish-brown necrotic area at the junction of the leaf blade with the sheath creating a “collar rot” symptom. Collar rot may lead to death of the entire leaf, which may have a significant effect on yield when occurring on the flag leaf. Stem node infections result in a blackened node and may result in complete death of the tiller above the infection point. “Neck blast” is considered to be the most destructive phase of the disease and occurs when the fungus infects the node just below the panicle resulting in a brown or black lesion that encircles the entire node. Depending on the time of infection and progress of the pathogen, neck blast may result in blanking of the panicle or incomplete grain filling. In addition, panicle branches and spiklet pedicles may also be infected resulting in reduced yield and/or milling quality.

Infected seed and crop residue are thought to be the most important sources of fungal inoculum in California. Only a small amount of starting inoculum is needed to produce a high incidence of rice blast disease as the pathogen may go through several reproductive cycles per season under favorable conditions. Each cycle consists of a spore of the fungus infecting a plant, producing a new lesion, and producing thousands of new spores that may infect other plants within a matter of 7-10 days under favorable conditions. With each spore capable of producing a new lesion, this disease may increase rapidly in a suitable environment. The fungal spores are dispersed by air and may be carried long distances so it is possible to develop collar and neck rot in a field with no previous signs of leaf blast.

Rice blast development is favored by high nitrogen fertilization, extended periods of leaf wetness, high relative humidity, little or no wind and nighttime temperatures of 63-73°C.

Spores are produced and released only under high relative humidity conditions and infection of the plant requires a lengthy period of free moisture before the process is complete. In general, environmental conditions appear to be permissive but not optimal for rice blast development in California rice fields.

Planting resistant cultivars is one of the primary methods of managing rice blast in many areas of the world. Currently, all of the California rice cultivars are susceptible to this disease and it may be sometime before a commercially available blast-resistant variety is available in California. Several cultural practices are helpful in managing rice blast. Destruction of crop residue in infested fields, planting clean seed, water seeding, maintaining a continuous flood and avoiding excessive nitrogen fertilization are recommended to limit the incidence and severity of rice blast. Quadris fungicide is registered for use on rice in California as a protectant against neck blast and should be used only in accordance with the product label.

Kernel Smut

Kernel smut is generally considered a minor disease of rice in California and is caused by the fungus *Tilletia barclayana*. This disease may cause yield and quality losses. Kernel smut is characterized by a black mass of spores (chlamydospores) that replace the endosperm of individual kernels near maturity. Generally, a panicle may only have a few smutted kernels at random locations. Kernel smut is most noticeable early in the morning when dew causes infected kernels to swell and erupt in a black ooze of spores.

The disease cycle of kernel smut is rather complicated. The fungus may overwinter in or on seed or in the soil as chlamydospores dislodged during the harvest of infected grain. When fields are flooded the following spring, chlamydospores float to the surface and germinate to produce primary sporidia. Large numbers of secondary sporidia are produced from the primary sporidia and are forcibly discharged into the air where they may infect individual florets or kernels.

Short and medium grain rice varieties are less likely to have significant amounts of kernel smut compared to long grain varieties. This resistance is thought to be due to the fact that long grain varieties have a longer duration of anthesis and a larger floret opening resulting in a greater chance of encountering a spore.

Kernel smut is a difficult disease to manage. Plant certified seed and avoid excessive nitrogen fertilization that may favor disease development. If a field has a history of kernel smut, consider planting short or medium grain rice varieties and avoid the more susceptible long grain varieties.

References

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