JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

A Complete Review On Seed Borne Fungal Diseases, Identification And Management

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ABSTRACT

A disease is an irregular condition that damages or improperly makes the plant work. Illnesses are perceived promptly by their side effects - noticeable changes in the plant that are associated. As microorganisms, the organic entities that cause infections are known. Infections in rice are caused by various types of microorganisms, development, nematodes, infections and mycoplasma-like creatures.Problems or irregularities may also be caused, for example, by abiotic factors, low or high temperatures beyond the cutoff points for ordinary rice production, lack or abundance of dirt and water supplements, pH and other soil conditions affecting the accessibility and take-up of supplements, poisonous substances such as soil-generated H2S, water pressure and decreased light. Such issues and abnormalities allude to physiological infections in a general sense. Here we will discuss only the routine rice infections caused by their detection and management by fungus.

Keywords: Seed borne mycoflora; *Rhizoctonia solani*; *Aspergillus niger*; crop protection; agar plate method; fungicides.

INTRODUCTION

India is one of the largest cereal crop growers and cereal crop importers. The country's complex agro-ecological conditions are ideal for the growth of annual cereal crops. Seed propagates ninety percent of food crops. Various seed-borne diseases affect the most commonly grown crops in the agricultural zone (wheat, rice, maize). Cereal crops are interchangeably called grain crops. The primary basis of crop production is considered to be seed and is one of the most significant input factors available for smallholder farmers [1].The top 5 bowls of cereal in the world ranked by their production tonnage are maize (corn), rice (paddy), wheat, barley and sorghum. Some studies in this regard are explained here. These crops are also among the world's top 50 agricultural commodities, with maize ranking second only to sugarcane. Third position is rice (paddy), wheat - 4th, barley - 12th and sorghum - 30th. No. 42 was ranked for another cereal, millet. This protein and starchrich cereal crop are also highly susceptible to various pests and diseases, along with some abiotic limitations, and some storage grain moulds cause considerable losses [2].Botanically, however, despite their interchangeable use, the seed and the grain are not the same. In rice, the brown rice and the enveloping rice hull compose of the kernel. Brown rice is the true fruit of the plant (a type of fruit called caryopsis) and consists of seeds fused together and inseparable from the coat of the crop. During storage, seed contamination of pathogens may decrease seed vigour, germination and have a negative effect on appearance.Botanically, however, despite their interchangeable use, the seed and the grain are not the same. In rice, the brown rice and the enveloping rice hull compose of the kernel. Brown rice is the true fruit of the plant (a type of fruit called caryopsis) and consists of seeds fused together and inseparable from the coat of the crop. During storage, seed contamination of pathogens may decrease seed vigour, germination and have a negative effect on appearance [3].These plants are also defined by the FAO's description of cereals as annual plants (including rice, canary grass, buckwheat and triticale) generally belonging to the gramineous family, producing grains used in fruit, feed and seed and in the manufacture of industrial products such as ethanol. It should also be stressed that only certain crops harvested for dry grain should be restricted to "cereal crops" Traditional cereal crops tend to be grass plants cultivated as a source of mature botanical fruits called caryopsis here.

Here in this regard, the term is now also used to include pseudocereals (or pseudograins) which, like cereals that do not belong to the grass family, are primarily used as staple food.

In addition, only because it is inseparable from the inner seed does the harvesting of the small, outer fruit wall or pericarp become essential. Also, although cereals are defined as annual plants, some may also be perennial. Rice and sorghum can be grown in various geographical zones as Ratoon crops.

Washington State University (2010) has indicated that for the next two decades, perennial grains will be highly available. In many countries, research is ongoing on the production of perennial grains, mainly wheat. The world's food security depends on adequate crop output of small seed cereals, which is the lowest source of concern and needs approximately 70 absorbable energy sources[4].Rice is the second small seed cereal grown on the basis of seed output, with an area under cultivation of around 154 million hectares, with a global production of 720 million tons[5]. Different research studies have shown that pathogens are the most significant factors that cause not only seed ageing, but also quality degradation in poor storage conditions. As a consequence, rotting or irregular development of seedlings occurs in nurseries[6,7]. Several studies have suggested that seed-borne fungi are the majority of these pathogens that contribute to the development of abnormal seedlings[8].So far, more than 100 species of fungi on rice seeds have been described. Their magnitude, however, is also different depending on the time of sampling, place and varieties [8,9,10]. Seeds, since they embody major principles, are subject to policies and regulations. Development of food and food protection are primarily focused on seeds. Seeds are a gift from nature, from past generations and from different cultures. It is our inherent obligation to protect them and move them on to future generations.Seed-borne mycoflora are carried over by infected seeds and they cause deterioration of seed and affect seed germination which causing seedling mortality in soil, and further infection of foliage is observed at the adult stage. Fungi including *Alternaria* sp., *Curvularia*sp., *Fusarium* sp., *Helminthosporium*sp., *Penicillium* sp., *Momnoniella*sp., *Aspergillus* sp., *Mucor* sp., and *Rhizopus* sp, have been found associated with the seeds of cereal crop and among these, *Alternaria* sp. as well as *Aspergillus* sp. are known to be the most destructive pathogen of cereal crop seed.

Fungal diseases of rice seed

1. Rice Blast

Symptoms

The fungus targets all areas of the rice plant that are aboveground. Depending on the site of symptom rice blast is referred as leaf blast, collar blast, node blast and neck blast. [11] [11]

Leaf blast: Leaf blade lesions are elliptical or spindle-shaped and have brown borders and graycenters. Lesions enlarge and coalesce under favorable circumstances, gradually destroying the leaves. [11] [11]

Node blast: an infection of the node of the stem that turns blackish and quickly breaks.

Neck blast: A grayish brown lesion girdles the infected neck, which causes the panicle to fall over when the infection is serious.

Causal organism: Pyricularia grisea (Cooke) Sacc.[11]

Epidemiology: Spikelet infection can occur anytime during grain maturation. Lesions may be identified by inoculation test until about 20 d after heading. The incubation period is from 5 to 12 d at 20-30 °C. On varieties with leaf resistance, spikelets are susceptible [13].

Management

Cultural practices:

The factors that encourage the incidence and spread of the disease are the excessive application of nitrogen fertilizer, water stress, the presence of contaminated debris in the field and the use of infested seeds. Destroying diseased crop debris decreases the inoculum that overwinters in the field. The use of nitrogen above the prescribed amount and as a single application substantially increases the incidence of disease and the seriousness of disease. The average incidence of leaf blasting at the panicle primordia level was 73% in high-N, 60% in normal-N and 43% in split-N treatments[14].It is also recommended that an optimum dose of nitrogen be added in split doses based on the results of soil testing. Silicon (Si) is known to decrease the rate of appressorial penetration by the blast fungus. Results of Hayasaka et al. (2008) have shown that the percentage of appressorial penetration decreased 5 times after 111 h and the percentage of penetration that formed to lesions decreased 2.5 times as the amount of Si application increased from 0-0.8 g per plant. [15]

Chemical control:

To control rice blast disease, the use of chemicals, primarily fungicides and antibiotics, is based on two techniques: seed treatment prior to sowing, and foliar spraying or dusting of rice plants in the field. For rice blast safety, a broad variety of systemic fungicides with different modes of action are used. Plant Protection Activators (PDAs), Melanin Biosynthetic Inhibitors (MBIs), Chlorine Biosynthesis Fungicides (CBIs) and quinol site mitochondrial respiration inhibitors are listed as the majority of fungicides effectively used to manage rice blast disease [16,17].The effectiveness of these fungicide classes is highly dependent on the type of fungicide used, the time and method of application, the degree of disease during application, the effectiveness of forecasting systems, and the presence and/or emergence of strains that are resistant to fungicides. The use of fungicides with different rotational or combination modes of action ensures greater fungicide efficacy and also decreases the occurrence of fungicide-resistant strains.

Biological control:

An efficient approach to biological regulation is self-sustaining, reliable and typically more lasting. Disease reduction by the biological control approach is possible by reducing pathogen inoculum (decreased development and release of viable spores, decreased survival and reduced spread), reducing pathogen infection of the host, and reducing the severity of the pathogen attack. Biocontrol of rice blast primarily relies on the use of antagonistic bacteria and induction of host resistance. Trichoderma harzianum (at 4 g kgG1 seed) seed treatment has been shown to reduce the severity of rice blast disease by 10-25%[18].Treatment with streptomyces for infected rice seedlings showed an 88.3 percent reduction in rice blast disease[19]. There are many rice rhizobacteria that occur naturally and are found to prevent rice blast infections. Spence et al. (2014) isolated and recognized such bacteria and found that EA105, a pseudomonas isolate, significantly reduced the disease by reducing the development of appressoria (by 90 percent) and by inhibiting 76 percent of fungal growth.

In order to induce systemic resistance against rice blast, plant growths that encourage rhizobacteria are found. [20] Mediated Systemic Resistance (ISR) is one of the mechanisms by which P. fluorescens 7-14 and P. putida V14i inhibit blast diseases.Increased levels of salicylic acid due to bacteria-induced ISR have been found to contribute 25 percent to the suppression of rice blast[21].

2. Brown Spot

Symptoms

Brown spot may be manifested as seedling blight or mature plants as a foliar and glume disease. The fungus develops thin, circular, brown lesions on seedlings, which can gird the coleoptile and cause primary and secondary leaves to distort. The fungus can also infect and cause black decoloration of the roots in some cases. The seedlings infected are stunted or destroyed. The fungus develops circular to oval lesions on the leaves of older plants that have a light brown to graycenter surrounded by a reddish-brown border .[11]

Causal Organism: Bipolarisoryzae (Breda de Haan) [11]

Location of the fungus in seed: In hollow glumes and pedicels, diseased hulls are more frequent than in the lemma and palea. Hilum and placenta infections in grains are more serious than in other areas[22].

Occurrence of disease in seedlings. Lesions occur on the coleoptiles, sheaths, and lower leaves in upland and box nurseries, contributing to blight.

Epidemiology: The magnitude of the disease is affected by the host plants' nutritional conditions. Nutrient deficiencies such as Fe, Mn, Mg, K, Si, Ca, and N are associated with disease outbreaks [23,24].Root rot caused by high boot and head temperatures affects nutrient absorption and causes significant damage[25].

Management

Cultural methods

Using disease free seeds as the disease is seed borne.

• Alternative & collateral hosts elimination.

• The most economical method of regulation is the use of resistant varieties.

Growing varieties such as ADT 44, PY 4, CORH 1, CO 44, CAUVERY, BHAVANI, TPS 4 and Dhanu are resistant.

The most significant factors in managing the brown spot appear to be ensuring adequate nutrition for optimal plant growth and prevention of water stress.

• In usually productive rice soils, the disease is rarely seen.

Until planting, soils that are considered to be low in plant-available silicon should be adjusted with calcium silicate slag and the field should be well irrigated to prevent water stress.

Preventive methods

• Pseudomonas fluorescens seed treatment @ 10g/kg of seed followed by 2.5 kg of seedling dip @ or products/ha dissolved in 100 liters and 30 minutes of dipping.

• Captan or Thiram crop soak/seed treatment at 2.0g/kg of seed
• Agrosan or Ceresan 2.5 g/kg seed treatment to fend off the stage of seedling blight;
• Since the fungus is seed transmitted, a hot water seed treatment (53-54°C) for 10-12 minutes can be beneficial before sowing. This treatment controls primary infection at the seedling stage. Presoaking the seeds for 8 hours in cold water improves the efficacy of the procedure.

Chemical methods

Good control of the disease was provided by seed treatment with tricyclazole followed by spraying of mancozeb + tricyclazole at the tillering stage and late booting stage. It is also advisable to use edifenphos, chitosan, iprodione, or carbendazim in the field.

3. Sheath Blight

Symptoms

In general, lesions are found on the sheaths of the leaves, while leaf blades can also be affected. The initial lesions are small, ellipsoid or ovoid, and greenish-gray and typically grow near the water line in lowland fields. They enlarge and can coalesce under favorable conditions, creating larger lesions with an irregular outline and a grayish-white core with dark brown borders. The appearance of many broad spots on the sheath of a leaf normally causes the entire leaf to die. [11]

Causal Organism: *Rhizoctonia solani Kuhn*

Epiderminology

When susceptible varieties are grown under favorable conditions such as warm temperatures (28 to 32 ° C), high humidity (95 percent or above), and dense stands with a heavily developed canopy, infection spreads most rapidly. During the late tillering to joint elongation stages of plant development, the disease sometimes begins and becomes more active as the rice plant moves to the (reproductive) stage of panicle differentiation. Sheath blight also infects and causes similar symptoms to weed hosts. Sclerotia are produced from rice and weed hosts on the surface of infected tissues and live in the soil between crops.In addition, other crops, including soybeans, sorghum, maize and sugar cane, are also infected by the fungus, which increases the inoculum in the soil. The use of highly susceptible semi-dwarf rice varieties, short rotations with non-host crops, overuse of nitrogen fertilizer, and increased stands that establish favorable microenvironments in the canopy are factors that favor the production of sheath blight. [26].

Disease Management [27]

An integrated management approach, consisting of resistant or moderately resistant varieties, sound cultural practices, and foliar fungicide

Cultural Practices

Varietal selection:

The selection of rice varieties is the first significant step in reducing disease-related crop yield losses. There are currently no varieties of rice with complete resistance against sheath blight. Rice varieties with different resistance levels are, however, available. Generally, most hybrid varieties are more resistant than most inbred varieties to the disease. Medium-grain varieties have more sheath blight resistance than most long-grain varieties. Therefore, the most efficient way to reduce the damage caused by the illness is to select a rice variety that is less susceptible or moderately resistant to sheath blight.

Field sanitation: By destroying weed hosts and other collateral hosts that could harbor sclerotia, levels of inoculum can be reduced. However, for the management of sheath blight, this approach is not very effective or not feasible.

Crop rotation: In field soils, continuous rice or rotation with alternate fungus hosts such as soybeans enhances inoculum. Fallow periods are viable management procedures, along with efforts to reduce the inoculum by destroying collateral and weed hosts that could harbor sclerotia.

Chemical Control

One of the most effective instruments for controlling sheath blight may be fungicides. To reduce production costs and maximize production returns, a single fungicide application is currently recommended. For effective control of sheath blight, the timing of the application is critical. During the development of the rice crop via heading, the disease should be scanned and monitored periodically. The application should be made between panicle differentiation plus five days and heading when the level of the disease reaches the level of the economic threshold during the growth stage.In many situations, applications for foliar fungicides may be economically justified for reducing sheath blight losses if 1) the pressure of the disease is sufficiently high; 2) susceptible varieties of rice are cultivated; 3) the crop has a high yield potential in the absence of sheath blight; and 4) the environmental conditions are favorable for the disease to spread to the upper parts of the rice plant. The aim of fungicide applications is to suppress the vertical development of sheath blight and reduce the grain yield and loss of quality caused by the disease. It is important to be careful not to overuse fungicides with a single mode of action, as this could increase the risk of fungicide resistance development.Sheath blight resistance to azoxystrobin has been found for the first time in 2011 in southeast Louisiana, USA.

Figure : 1 Bakanae disease

Bakanae

Symptoms

The classic and most conspicuous symptom of the disease is the hypertrophic effect or abnormal elongation of plant. It is even possible to observe these symptoms from a distance. Thin, yellowish green, the affected plants may be several inches taller than normal plants and may produce adventitious roots at the lower nodes of the culm. Diseased plants have few tillers and leaves quickly dry up. The tillers affected usually die before reaching maturity; they carry empty panicles when infected plants survive.

Causal Organism: *Fusarium fujikuroi*Nirenberg

Location of the fungus in seed.The fungus is found in empty glumes and pedicels of diseased seeds [22]. A higher percentage of empty glumes and proximal parts of the hulls were isolated from the fungus than from the distal parts of the hulls.

Epidemiology:In a submerged field, when elongated seedlings are transplanted, withering starts 10 d later, and with time the number of withered hills increases. When apparently healthy seedlings are selected for transplanting from a nursery where 30 percent of the seedlings elongate, 5-10 percent of the hills start to elongate 2 wk later. On the sheaths, stems, and nodes, these hills bear conidia that become an inoculum source for panicle infection. At night, dispersion of conidia and ascospores occurs. Conidia from infected seeds detach and infect healthy seeds during soaking of seeds for pregermination. A dry seed can absorb a conidial suspension within 5 min through a pore where the pedicel is attached [27,28]

Management [30]

Clean seed planting is Bakanae's most efficient method of management. By limiting the amount of inoculum that can be carried over to the next crop, destruction of crop residue in fields infested with the pathogen may provide some limited benefits. It is effective to soak the seed in a sodium hypochlorite soak solution to reduce the incidence of bakanae. Ultra-Clorox Germicidal Bleach has been labeled for Bakanae control since 2003. The product label specifies that the seed is soaked for two hours, then drained and soaked in fresh water for the remaining time, using a thoroughly pre-mixed solution of five gallons of product per 100 gallons of water.Alternatively, the label specifies that 2.5 gallons of product per 100 gallons of water is used in a thoroughly premixed solution; the seed is soaked for 24 hours, then drained and planted within 12-24 hours.

Figure :2 False Smut of rice

False Smut

False smut disease, also known as green smut

Symptoms

In the joint area of the palea and lemma, a mass of mycelia coated with a gray membrane appears. The membrane bursts and the spore balls grow from yellow to dark-green. Then the spore balls' surface breaks. The outermost layer is made up of chlamydospores, the second orange layer of mycelia and chlamydospores, and the inner white layer of mycelia, glumes, and anthers. Within the ball, sclerotia are produced[31,32]

Causal Organism: Ustilaginoidea virens

Epidemiology:

The fungus persists in the soil as dark brown to black, thick-walled spiny spores for many years (teliospores). In order to create infection hyphae, germinating teliospores generate basidiospores that must fuse with other basidiospores of the opposite mating type (growing strands of the fungus). Infection hyphae infect cells of corn plants that are growing and starting to spread. Recently infected plant tissue will turn yellow and almost instantly starts to grow to eventually produce the characteristic tumor-like galls consisting of both fungal and plant tissue. While galls grow most commonly on the ears, they may also develop on the tassels, stalks, leaves, and less frequently on the root. Fungal threads expand in the galls as the galls swell and mature, allowing dark streaks to form before the cells eventually mature into large amounts of teliospores. The fleshy, soft gall finally thins and dries, bursting open to expose dusty black spores within. The teliospores' pigment and thick walls allow them to withstand harsh conditions and to overwinter in the soil. [33]

Management

This disorder does not have effective treatment measures. Excessive nitrogen tends to favor disease production in other regions, as does late planting or any condition that delays the crop's maturity. The occurrence of disease is reduced by early planting, standardized crop growth and recommended nitrogen rates. In Arkansas, propiconazole fungicides applied during full boot resulted in suppression of this disease with a 5080% decrease in galls in the grain harvested [30].

Figure: 3 Kernel smut of rice

Kernel smut

Symptoms

Kernel smut is characterized by a black mass of spores (chlamydospores) that substitute for the near-maturity endosperm of individual kernels. Generally, a panicle can only have a few smutted kernels at random locations. Kernel smut is most evident when dew causes infected kernels to swell and erupt in a black ooze of spores in the early morning.[11]

Causal organism: Tilletiabarclayana

Epidemiology:

Kernel smut is considered a mild rice disease in general. In southern U.S. rice growing areas, it is more prevalent during rainy years and in areas of fields receiving high rates of nitrogen fertilizer. Disease surveys found that short and medium grain varieties had lower incidence rates than long grain varieties for kernel smut. As their florets are open wider and longer during flowering, long grain rice varieties may be more susceptible to kernel smut. Since the fungus is prevalent in the rice growing regions of California, no attempt has been made to limit infested seed lots.[30]

Management

Kernel smut is a difficult illness to manage. Plant-certified seeds and prevent unnecessary fertilization of nitrogen that can encourage the production of disease. Stop planting the more prone long grain varieties if a field has a history of kernel smut. Fungicides containing propiconazole (QuiltXcel, Stratego) are registered for use on rice in California and can provide some defense against kernel smut and should be used only in compliance with the product label.[30]

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