Agri Articles

(e-Magazine for Agricultural Articles)

Volume: 04, Issue: 06 (NOV-DEC, 2024)

Available online at http://www.agriarticles.com

Sheath Blight of Rice: A Major Disease of Non-Aromatic Rice

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Rice (*Oryza sativa* L.) is an important cereal crop serving as staple food for more than half of the world's population. The rice crop is attacked by more than 70 diseases caused by fungi, bacteria, viruses and mycoplasma like organisms. Among these, sheath blight caused by *Rhizoctonia solani* Kuhn is one of the most widespread diseases which are known to cause substantial quantitative and qualitative losses. The disease is prevalent in most rice-growing states in India, resulting in severe yield losses up to 69%.

Geographical distribution and economic significance

Although Yano in Japan in the year 1901 initially reported the sheath blight disease. Miyake in 1910 gave the first authentic record of *Sclerotium irregulare*, the pathogenic organism of rice sheath blight. Reinking discovered in the year 1918 that the *R. solani* group inflicted sheath blight disease in the Philippines and in the year 1926, Palo confirmed that sheath blight disease of rice in the Philippines is caused by *R. solani*. Since the disease was originally identified in oriental countries, in 1973 it was given the name 'Oriental sheath blight of rice'. The disease has now been reported in temperate and tropical rice-growing regions around the world including Africa, Burma, Bangladesh, China, Fiji, UK, Nigeria, USA, Colombia, Cuba, Brazil, Germany, India, Formosa, Indonesia, Korea, Madagascar, Malaysia, Nigeria, Netherland, Papua, Philippines, New Guinea, Russia, Sri Lanka, Senegal, Surinam, Taiwan, Trinidad, USA and Vietnam. In India, the disease was firstly reported by Paracer and Chahal (1963) from the Gurdaspur district of Punjab and now it has become a massive production constraint in all rice-producing regions including Haryana.

Depending on the cultivars, disease severity, crop stage at the time of infection and environmental factors in different countries, the disease has been observed to cause yield losses varying from 4 to 58 percent.

The Pathogen

Sheath blight of rice is caused by the imperfect or sclerotial stage of basidiomycetous fungus *R. solani* with the perfect basidial or teleomorph stage as *Thanatephorus cucumeris* (Frank) Donk. Ogoshi (1975) characterized the Rhizoctonia genus as follows: (a) branching at right angles near the distal end of cells in young, vegetative hyphae (b) the formation of a branch septum near the point of origin (c) constriction of the branch at the origin (d) the formation of a dolipore septum (e) no clamp connection (f) no conidium except for moniloid cells (g) no rhizomorph. In sheath blight complex, *R. oryzae* and *R. oryzae-sativae*, also associated in addition to *R. solani*. *Rhizoctonia solani* was found to be the most virulent and widespread species among 186 *Rhizoctonia*-like fungal strains isolated in China.

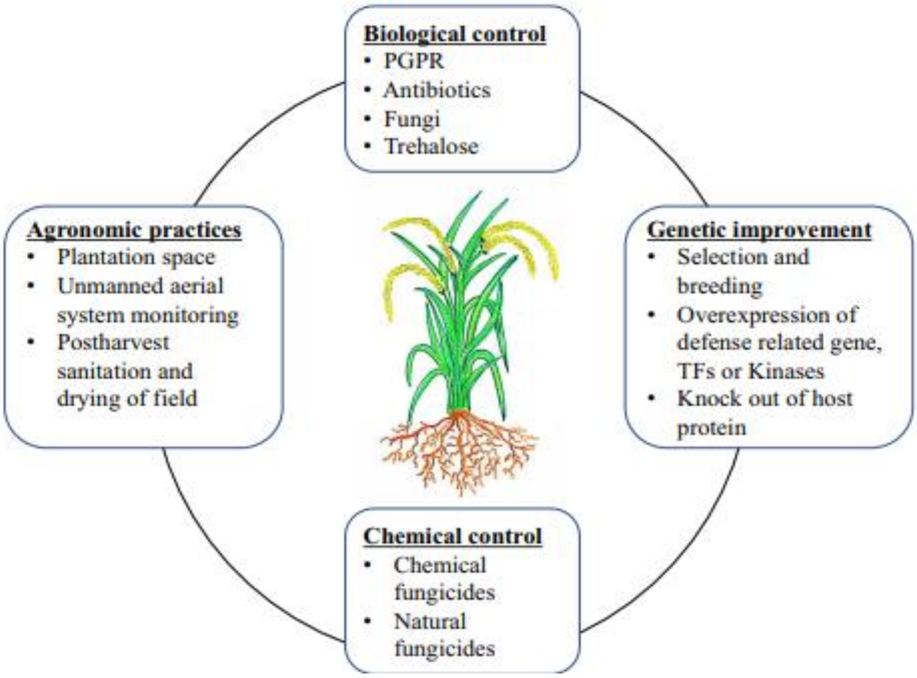
Symptoms

The disease appears at tillering stage as greenish-grey, 1 to 3 cm long elliptical or oval to irregular spots on the leaf sheath with a brown margin at or above the waterline. The presence of numerous similar spots on the leaf sheath lends it a snake-like appearance. Under favourable environmental conditions, the infection quickly spreads to upper plant parts as well as neighbouring plants, eventually killing the entire leaf, tiller and plant. The fungus is not able to produce spores and spreads from plant to plant, so infected plants in the field are usually seen in a circular pattern. Brown silky mycelium and medium brown to dark brown sclerotia are observed loosely attached to the lesions under moist conditions but they easily separate from the plants as they mature. Webster and Gunnell 1992 found that sclerotia present in the rice field is responsible for primary infection and secondary infection is done when hyphae in the lesion are spread to the upper parts. *R. solani* produces two different types of mycelium: straight and branch and lobate, the latter of which is contagious. Lobate mycelium covers the lesion, whereas straight mycelium can expand beyond it without producing infection. Sclerotia of *R. solani* that are present in the soil float to the water surface and attach to rice stems, causes sheath blight. Sheath blight symptoms normally develop upwards on the rice stems after infection near the waterline. The infection was usually at its worst at the time of tillering stage, when the canopy of rice is dense and relative humidity was high, creating an ideal condition for disease spread both horizontally and vertically.

Management

Significant advancements have been achieved in pinpointing pathogenesis-related genes in both rice and the pathogen; however, the underlying mechanisms still lack clarity. Studies focusing on disease management strategies have explored the utilization of agronomic techniques, chemical control, biological agents, and genetic improvements. Research related to disease management practices has addressed the use of agronomic practices, chemical control, biological control and genetic improvement:

An alternative method for managing diseases sustainably, without the need for chemicals, is the development of disease-resistant cultivars. Disease-resistant cultivars offer several advantages, including a decrease in disease occurrence and an increase in grain and milling yields. However, efforts to breed resistance against ShB have only been moderately successful so far, primarily due to the limited availability of resistance sources in cultivated rice or wild related species. Nonetheless, there are rice cultivars available for cultivation that range from susceptible to moderately resistant to ShB. The current lack of effective resistant cultivars has resulted in growers increasingly relying on chemical fungicides.



Fungicides are commonly employed to combat rice ShB infection. There are two types of fungicides available: systemic and non-systemic. Currently, systemic fungicides from the strobilurin group are extensively used to combat the rice ShB pathogen. Among the strobilurins, the azoxystrobin fungicide is widely utilized due to its effective action against ShB pathogen infestation. This fungicide is a derivative of β-methoxyacrylate and was the first registered fungicide of its kind. It is marketed as Quadris 2.08 SC (Syngenta, Raleigh, NC). Azoxystrobin is considered one of the top fungicides in the U.S. for controlling sheath blight. Whenever a pathogen becomes resistant to a pesticide in use, it is crucial to have a readily available replacement. Due to the unpredictable behavior of pathogens towards chemicals, it is necessary to develop nonchemical control methods. Antagonism between organisms is a common occurrence in ecosystems, particularly among soil microorganisms. The natural interference between beneficial soil microorganisms and plant pathogens creates a buffer zone that inhibits or reduces disease development.

Rhizosphere-isolated soil bacteria that are free-living and have demonstrated beneficial properties for plants are referred to as plant growth-promoting rhizobacteria (PGPR). In addition to their role in enhancing plant and root growth, PGPR also plays a direct role in increasing nitrogen uptake, solubilizing phosphate, synthesizing phytohormones, and producing iron-chelating siderophores. PGPR contributes to pathogen suppression through various mechanisms such as antagonism, competition for resources and space, and triggering systemic resistance (ISR). Combining PGPR with other methods for controlling soil borne diseases may enhance their effectiveness through an integrated approach.

Conclusion

Rice cultivation in numerous countries involves planting in the same field year after year, leading to increased vulnerability to sheath blight of rice which is incited by *Rhizoctoniza soalni* Kuhn. As time passes, pathogen levels build up in the soil, potentially causing widespread disease outbreaks. Relying solely on chemical treatments or any other single method is inadequate for effectively managing rice sheath blight diseases. A comprehensive approach that integrates all available disease management strategies may offer more effective pathogen control. Integrated disease management (IDM) for rice sheath blight diseases encompasses a holistic, ecological approach to plant pathogen control, combining various control methods to address the limitations of each individual method.