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Rice Sheath Blight: A Review of the Unsung Fatal Diseases

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By 2050, there will be 9.2 billion people on the planet, up from 6.1 billion in 2000. Increasing agricultural yields is necessary to meet the growing worldwide demand for food in light of the projected large growth in the human population. The global population is predicted to increase by 1.2% annually, or roughly 77 million people, at the current rate (Fernando, 2006). The bulk of the yearly population growth occurs in six nations: Bangladesh, Nigeria, Indonesia, China, India, and Pakistan. Of these, the four Asian nations that consume the most rice cereal are Bangladesh, China, India, and Pakistan. Despite considerable advancements in agricultural science over the past 50 years, a sizable portion of the global population is undernourished and hungry. The culture that benefits the country is agriculture. Rice (*Oryza sativa* L.) is an important staple food for nearly 50% of the global population (Heinrichs *et al*., 2017). Amongst the important rice-producing nations in the world, India ranks second to China in terms of area and production. Out of 782 million tons (m t) of global rice production from 167.1 million hectares (m ha), India produced 116.42 m t in 44.5 m ha (rainy season: 102.13 m t from 39.27 m ha). The two primary biotic stressors that restrict rice production are diseases and insect pests. The environment in which rice is farmed affects the frequency of diseases and insect pests. The degree of damage resulting from various biotic stressors varies significantly based on the predominant factors influencing the number of these pests during a specific year or season. Farmers growing rice suffer heavy losses due to the depredations of insect-pests when they fail to take remedial measures. A number of diseases also take their toll.

Rice is affected by a series of epidemic as well as devastating diseases. Rice Sheath Blight (ShB) is one of the detrimental diseases of rice. Rice sheath blight disease caused by *R. solani* is a destructive disease that leads to massive yield loss and degradation of rice. This disease was first reported by Miyake from Japan in 1910 referred as 'Oriental leaf and sheath blight'. Although from India it was first reported by Pancer and Chahal in 1963. Sheath blight is caused by excessive nitrogenous fertilizer application, high temperatures, and high humidity. Although there isn't a commercial variety that is immune to this disease, land races can be utilized to obtain novel genes for abiotic stress tolerance, disease resistance, and sources of features that increase yield (Shakiba and Eizenga, 2014). The vast host range and significant genetic variability of the causative organism make managing ShB diseases challenging.

Pathogen Characteristics

Previously the causal organisms were thought to be *Corticium sasakii* (Shirai), *C. vagum*. *Schlerotium irregulrae* and *R. solani* Kuhn (1858). But, *R.solani* is accepted to be the causal organism and *T. cumuris* to represent the perfect stag. The pathogen is soil borne saprotrophic and facultative parasite. It has a wide host range and worldwide distribution. The movement of the pathogen is limited as there is lack of spores and survives in unfavorable conditions by formation of dormant hyphae and sclerotia. *R. solani* is a basidiomycete fungus and it does not produce any asexual spores. Vegetative mycelium is produced which is colourless but becomes brown as it grows and mature. *R. solani* possess pale to dark brown rapidly growing mycelium. There is a formation of septum in the branch near the point of origin. Sclerotia formed varying in size but uniform in texture. The outer cells of the sclerotia were darker and thick walled. *T. cumuris* represents the sexual stage of *R. solani* (Parmeter, 2007).

Disease Symptoms

A plant disease symptom is the physiological or phenotypic expression of a pathogen's effective invasion of the host. A symptom is an observable or otherwise discernible abnormality that results from a disease or condition. The symptoms are also seen in tillering to heading stage. Initially lesions occur on the sheaths with the diameter of 0.5-3 cm occurring below the leaf collar. Later, the lesions extent to 1cm in width and 2-3 cm in length. Oval or elliptical or irregular greenish grey coloured spots are formed. When the spots enlarge, the center of the spots becomes greyish white with blackish brown irregular border. Blightening occurs as formation of several lesions and they coalesce with each other. As the disease severity increases, the infection extends to the inner sheaths which cause death of the whole rice plant.

Management strategies

Rice plants respond to various stresses in their surroundings by comprising attack by pests and pathogens like bacteria, fungi, virus, and nematodes. Plant defense responses correspond to the type of attacking external agent. The plant capacity to respond to an infection is determined by both the host and pathogen genetic traits. To protect against pathogen infection plants have conferred various defense mechanisms such as, gene-for-gene interactions, and signal transduction networks that require jasmonic acid and ethylene. However, a virulent pathogen overcomes a plant's defense mechanism by evading the effects of activated defenses, avoiding triggering plant defenses, or suppressing the plant's resistance reactions.

Biological control: The ecosystem is full with species that are antagonistic to one another, with soil microorganisms being the most common. Natural disruption between advantageous soil. Plant pathogens and bacteria cause a buffer zone, which prevents or lessens the onset of illness. Depending on the features of the phyllosphere or rhizosphere, different microbial defense systems may function alone or in concert. It's an intriguing field to manage the plentiful beneficial bacteria in soil to boost plant health and root and shoot growth. Plant health and soil fertility are influenced by microbial interactions in the rhizosphere. Several strains of *P.fluorescens* have been suceesfully used for biological control of sheath blight of rice.

Chemical control: A vast range of fungicides differing in modes and formulations are available in the market for the management of sheath blight disease. The fungicides which come under the strobilurins group, are widely used to combat sheath blight disease. Among the strobilurins group fungicides, the azoxystrobin fungicide is widely used as it is very much effective in managing this lofty disease. Another effective chemical against sheath blight is validamycin which is used throughout Asia. Bavistin and Benlate seed treatment, soil application of Benlate, Kitazin, and Hinosan seed treatment, and foliar application of Topsin-M have all been shown to be successful in lowering *R. solani* seed-borne infection, controlling the incidence of sheath blight, and increasing paddy grain yield. Besides, the combination treatments of fungicidal formulations such as carbendazim + mancozeb, propiconazole + difenconazole, carbendazim + epoxiconazole and carbendazim 25% + flusilazole 12.5% SE (Goswami *et al*., 2012) have been found promising against sheath blight in different parts of the country. Benlate and zineb sprays were also effective in checking air-borne infection and secondary spread of the disease. In multilocation testing under AICRIP, tricyclazole + propiconazole (Filia 52.5 SE), trifloxystrobin 25% + tebuconazole 50% (Nativo 75 WG), metominostrobin 20 SC and hexaconazole 75 WG were highly effective in checking disease severity and in improving grain yield.

Conclusion

Sheath blight of rice caused by *Rhizoctonia solani* Kuhn. is of worldwide occurrence and is known to cause substantial yield losses. It is a major production constraint in high yielding varieties under intensive rice production systems. The pathogen has a very wide host range and exhibits considerable pathogenic and molecular variability. Due to non-availability of resistant cultivars, the management of sheath blight primarily relies on chemical control. Globally, there has been a notable advancement in a number of areas related to the illness. However, more research is needed on pathogenic diversity, namely on the mapping of the pathogen's virulence gene or genes and the host's resistant genes, as well as the mechanism and genetics of resistance. More research is required to understand the molecular and biochemical aspects of disease resistance and pathogenesis. It is necessary to find and use resistant donors with high levels of resistance against various anastomosis groups in the field.

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