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False Smut Disease an emerging thread of Rice productivity in Manipur

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Introduction

Rice is of the Gramineae or Poaceae grass family, scientifically known as *Oryza sativa*. The carbohydrates rich major cereal crop is the most remarkable around the globe which prefers warm climates during the warm summer months. Manipur is closely intertwined with the history of rice cultivation, which served as a pivotal factor in shaping subsistence, social organization and political authority. The main staple food of the state is rice in fact, 100% of the population consume rice for their sustenance. The state has 0.18 million ha under rice cultivation, which covers both irrigated and rainfed areas. 90% of gross cropped area (GCA) of the state is under paddy cultivation (Singha and Mishra, 2015). More than 80% of the total population in Manipur are engaged in agriculture and allied sectors (Roy *et al*, 2018). However, farmers are still facing various constraints during cultivation of rice crop in Manipur (Thangjam and Jha, 2020). Thus, rice research has to be geared up to develop strategies for alleviating losses due to pests and diseases. One such disease is the rice false smut (RFS) disease that threat to yield and grain quality. Reduction of constraints caused by pest and disease infestation in rice cultivation can achieve food security and socio-economic development.

False smut of rice can cause rice yield losses ranging from 3 to 70 % depending on weather conditions and rice cultivars (Baite *et al*. 2021). False smut was first reported in Arkansas in 1997 and is now likely widespread where rice is grown. False smut directly impacts grain yield and quality by partially or completely replacing rice kernels with fungal spore masses. This substitution disrupts normal grain development, leading to significant reductions in both quantity and quality of a harvest. However, the false smut fungus produces two types of mycotoxins, ustiloxins and ustilaginoidins (Wang *et al*. 2019b). Both mycotoxins are carcinogenic and pose a threat to human and animal health through the consumption of contaminated rice grains and straw. However, for the past five to six years, false smut of rice, also known as *kambongsatpi* in local language, has

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been emerging as an important disease affecting rice-grain production. The disease has been increasing in an alarming proportion widely in the eastern and north-eastern part of India. Among the farmers, the disease has been considered as an omen of good harvest as it appears to be more prevalent in seasons favourable for good growth and high yield. But they must be aware of the threat due to vigorously increasing disease incidence. Understanding the extent of the disease and development of proper management strategies is the need of the time.

Disease Symptoms and Epidemiology

Usually, the disease is sporadic in the field and also in an individual ear, only a few grains are affected. However, in severe cases, many smut balls may aggregate together (Singh, 1990). If infection occurs before fertilization, most of the glumes remain sterile without any visible sign of infection. Typical large, velvetty, green smut balls (pseudomorphs) develop when infection occurs after fertilization (Kulkarni and Moniz, 1975). False smut symptoms are readily visible outside of rice kernels, as opposed to kernel smut, where symptoms are generally only visible during harvest or at late maturity stage. *Ustilaginoidea virens* infects rice plants during panicle development. The signs and symptoms of false smut become visible generally two to three weeks after flowering. False smut is characterized by the replacement of rice kernels by globose, velvety spore balls with powdery chlamydospores (Schneider and Groth 2018; Sun *et al*. 2020). Immature smut balls are orangish yellow (Fig 1), whereas mature smut balls turn to greenish black (Fig 2). The false smut fungus infects rice flowers and replaces the inner organs with fungal mycelia (Tanaka *et al* 2008*;* Tang *et al* 2008). The false smut fungus produces two different overwintering structures, chlamydospores at the asexual stage and sclerotia at the sexual stage. Sclerotia can maintain a high rate of germination for up to 5 years, enabling long-term infection in the field (Yong *et al* 2018). Both chlamydospores and sclerotia can produce conidia upon germination, which can be the primary source of inoculum.

Fig 1. Progressing to yellow-orange

Fig 2. Maturing to greenish-black

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Disease Cycle

The false smut pathogen survives in both rice seed and soil via sclerotia and chlamydospores. Sclerotia, a high-density fungal hyphae mass that is produced at the sexual stage, can remain dormant for several years (Yong *et al*., 2018). They also overwinter on collateral host/ alternate hosts on many grasses and wild rice. These spores served as primary inoculums. The infection time is an important factor in determining the loss. If it occurs in early stage of flower opening, the ovary is destroyed and the loss is high whereas if the infection is in the later stage, then the grains set and the mycelium invades the endosperm and produces mass of spores. The disease is favored by rainfall accompanied by cloudy days during the period between flowering and maturity of the grain with RH > 90% and temperature 25-35^{0}C. The climatic condition of Manipur is highly suitable for the development of the disease. Therefore, it has been becoming one of the most important diseases of major concerned.

Management Strategies

Proper management strategies must be taken up against the disease. Successful control of kernel smut and false smut relies on employing management strategies to reduce damage to an acceptable level. In Arkansas, cultivars with documented resistance to false smut are limited, with the bulk of the current rice cultivars being on the order of moderately susceptible, or very susceptible phenotypes (Hardke *et al* 2024). However, unlike other rice diseases, kernel smut and false smut are difficult to control using individual management strategies because of an incomplete understanding of their in-season disease infection process and the lack of effective management tools. The disease infection process and the impact of weather conditions and plant growth stage on disease development are not well understood. No scouting methods are available to detect and predict the development of false smut during the cropping season because the symptoms and signs of the disease are observed only at or shortly before maturity. Rice cultivars with acceptable levels of resistance are not commercially available. Therefore, an integrated management approach should include avoiding late planting, the excessive application of pre-flood nitrogen fertilizer and preventative fungicide applications in fields with a history of disease or where cultivars with known susceptibility to false smut are planted.

Conclusion

False smut of rice is known to occur in almost all the rice growing areas in the world. At present, there is a need to understand the importance of this disease and develop all the necessary

precautionary measures to prevent yield loss. Although losses due to plant diseases may be reduced by the use of disease resistance cultivars, crop rotation or sanitation practices, fungicides are often essential to maximize crop yields. The development and use of resistant cultivars is the most effective and economical approach to minimize the damage caused by kernel smut and false smut and maximize production returns. Unfortunately, no cultivars or genotype sources with high levels of resistance have been identified so far. Recent progress in genomics studies has provided some understanding of the pathogenicity and infection mechanisms of false smut fungi. However, more research is needed to better understand the mechanism and genetics of resistance in rice, virulence in the pathogens, and the impacts of surrounding environments on pathogen–host interactions. On the other hand, Fungicides play important role in improving food quality and they also contribute to food safety by controlling many fungi that produce mycotoxins such as aflotoxins, ergot toxins, fusarium toxins, patulin and tenuazonic acid (Knight *et al* 1997). However, to maintain their effectiveness and to minimize their effect on human health and on the environment, they should be used in a rational and informed way. Hence, there is a need to develop more resistant varieties against the disease. Researchers must focus on released of new resistant local varieties that will serve as a boon for the farmers. If the disease is not checked right now, it may take the shape of an epidemic in few years.

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