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AGRI JOURNAL WORLD
VOLUME 3 ISSUE 1 JANUARY, 2023

RICE FALSE SMUT (*VILLOSICLAVA VIRENS*) – SPORADIC DISEASE BECOMES EPIDEMIC

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ABSTRACT

False smut of rice was one of the minor and sporadic diseases worldwide. However, in recent days this minor disease is becoming a major concern causing huge yield loss and a reduction in the quality of the grains. The major reasons are changes in cultivar profile, including large-scale cultivation of high-yielding and hybrid varieties, intensive rice cultivation methods with high nitrogen demand, and climate change. However, epidemics vary significantly among types, fields, and cropping seasons. In addition, the severity of infection differs among varieties and growing conditions. Therefore, there is a need to develop suitable management methods for treating the disease to minimize direct economic losses.

INTRODUCTION

Rice (*Oryza sativa*) is prone to be infected by several plant pathogens, including fungal, bacterial, and viruses. Due to the climatic change, the rice crop is being devastated by minor diseases that earlier remained below the economic threshold. False smut, caused by fungal pathogen *Ustilaginoidea virens* (Cooke) Takahashi [teleomorph: *Villosiclava virens* (Nakata) Tanaka & Tanaka] is emerging as one of the potential threat to rice cultivation, replacing the whole rice grain into a blackish spore ball. Because of the sporadic nature of the disease, emphasis was not given in the past for managing this disease in India. In some parts of Southern India, it is popularly known as "Laxmi" disease and was believed to be a mark of a bumper harvest. However, from the year 2000 onwards, it has been reported as an epidemic disease and has become a major production constraint in several rice-growing regions in India. The disease infestation has increased due to the large-scale adoption of high-yielding and hybrid cultivars, intensive cultivation methods with heavy dependency on chemical fertilizers (high nitrogen) and apparent changes in climatic conditions. The disease occurrence has been reported in over 40 countries worldwide. In India, most rice-growing states *viz*., Punjab, Haryana, Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh, Gujarat, Jammu and Kashmir, and Pondicherry are reported to have false smut infestation. The intensity of the disease was so high that the release of spore mass in the atmosphere around the infested field caused a smoky black appearance. More than 50 smut balls per panicle could be seen in severe infection. Depending on disease intensity and prevalent rice varieties in different states of India, the yield loss due to false smut disease has been estimated between 0.2 to 49%. Infection by *V. virens* in rice causes sterility of the spikelets and reduces 1000-grain weight. The percentage of chaffy grains in spikes increases with the disease intensity. Around 10% of disease incidence caused about 25% chaffiness leading to a 9% reduction in 1000 grain weight and a reduced germination rate to 35%. This disease causes direct economic loss to the rice-growing farmers, and the pathogen also produces mycotoxin, i.e. ustiloxin, which is poisonous to humans and animals' health.

SYMPTOMS OF RICE FALSE SMUT

False smut is visible only after panicle emergence. In a rice panicle, the random infection could be seen in only some spikelets, which later converted into false smut balls. It can infect the spikelets during the flowering stage, and the infected spikelets have individual rice grains transformed into a mass of spore balls. At the early infection stage, it typically forms a white fungal mass protruding from the inner space of a spikelet. Later, it transforms into a smut ball of light-yellow-orange colour and turns into a greenish-black ball. Numerous chlamydospores are found on the outer layer of the mature smut ball, which is often covered by sclerotia in autumn. Apart from the infested grains in a panicle, the rest remain normal.

BIOLOGY OF THE PATHOGEN

False smut pathogen belongs to the kingdom: Fungi, phylum: Ascomycota, class: Ascomycetes, subclass: Sordariomycetes, order: Hypocreales, family: Clavicipitaceae, genus: *Villosiclava*, and species: virens and its anamorphic stage are *Ustilaginoidea virens*. The colony growth of *V. virens* is very slow in potato sucrose agar medium, with an approximate growth rate of 20 to 25 mm in diameter per week. The conidia of *V. virens* are hyaline, elliptical or oval, single-celled, having diameters ranging from 3 to 5 µm. Conidia may develop into rounded chlamydospores having prominent spines on the surface upon maturity or under unfavourable growth conditions. Sclerotia, which is the sexual structure of *V. virens*, can be formed in a smut ball. After passing several months of dormancy, sclerotia germinate and produce fruiting bodies from stromata, which ultimately generate ascospores.

EPIDEMIOLOGY AND DISEASE CYCLE OF RICE FALSE SMUT

Cloudy weather, high relative humidity (>90%), temperature ranging from 25-35 ºC and moderate rainfall during the flowering period favours disease development. Soil with high nitrogen content also favours disease development. The pathogen also survives through alternate hosts *viz.*, *Echinochloa crusgalli*, *Digitaria marginate*, *Panicum* sp. and *Imperata cylindrica.*

Fig 1. Disease symptoms of rice false smut: (A)–(C) yellow, orange and dark green false smut balls at early, middle, and late stages. (D) Colony of *U. virens* in PSA medium (E) Chlamydospores of *U. virens* from false smut balls (F) Conidia of *U. virens* in PSA

Villosiclava virens form chlamydospores and sclerotia late in the season, which fall in the soil and can survive for at least four months in the winter. Sclerotia germinate and produce ascocarp-containing ascospores, which act as a primary inoculum source for rice plants. In contrast, the chlamydospores are a secondary source of infection that may be coming from the airborne route. Rice spikelets get infected by *V. virens* at the late booting stage and produce false smut balls covered with dark-green chlamydospores. Occasionally, sclerotia are formed on the surface of false smut balls in late autumn when high day-night temperature fluctuation occurs. In this, both chlamydospores and sclerotia may serve as sources for primary infection. The occurrence of rainfall at the rice booting stage is a major environmental factor that causes epidemics of rice false smut disease. False smut galls emerge about 20 days after the initial infection of kernels in the rice panicle during flowering. This infection results in one or more kernels being replaced by globose, yellowish-green, velvety smut balls on mature heads of plants. It releases powdery dark green spores once it bursts open.

MANAGEMENT OF RICE FALSE SMUT

A successful management strategy for false rice smut is yet to be developed. However, the following measures should be taken as possible management strategies:

- Field sanitation- removal of weed hosts and plant debris
- Apply neem cake at 150 kg/ha
- Use disease-free seeds for sowing
- Seed treatment with *Pseudomonas fluorescence/Trichoderma viride* at 10 g/kg of seeds or Carbendazim at 2.0g/kg seeds before sowing.
- Avoid late sowing and application of higher nitrogen doses favours the development of disease
- Early planting of the crop should be done.
- Avoid monocropping and follow the crop rotation with non-host crops
- Foliar spray with *Pseudomonas fluorescence/Trichoderma viridae* 5g/lit of water at 15-20 days after transplanting or at the pre-flowering stage.
- At tillering and pre-flowering stages, Spray with Hexaconazole, Propiconazole, or Tebuconazole at 1ml/lit or Carbendazim + Mancozeb 2g/lit or Chlorothalonil 2g/lit.
- Application of copper oxychloride at 2.5 g/litre or Propiconazole @ 1.0 ml/litre at boot leaf and milky stage to prevent the infection.
- During harvesting, diseased plants should be removed and destroyed to avoid the fall of sclerotia in the field. This could reduce the build of primary inoculum for the next crop.

CONCLUSION

False smut of rice was one of the minor and sporadic diseases worldwide. It has become an epidemic due to changes in cultivar profile, including large-scale cultivation of high-yielding and hybrid varieties, intensive rice cultivation methods with high nitrogen demand, and climate change. However, epidemics vary significantly among types, fields, and cropping seasons. In addition, the severity of infection differs among varieties and growing conditions. Therefore, adopting suitable management methods for treating the disease can help minimize direct economic losses.

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