An Overview of Integrated Management of Bakanae Disease in Rice

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Abstract

Bakanae is known as a seed-borne fungal disease (*Fusarium moniliforme*). This disease infects plants through the roots or crowns. Then it goes systemically throughout the whole plant. Infected plants look abnormal with pale, thin leaves, have fewer tillers, and the grains are partially filled or empty. Bakanae disease is increasing in rice crops and become a major problem, particularly with basmati rice in northern India. The disease infects normally when infected seeds are sown, and when the pathogen is on plant or in the soil. Bakanae can transmit through air or water that carries the fungal spores and infect one plant to another. It can also be transmitted through operations done on the farm such as harvesting and other cultural practices. Contaminated seeds have fungal spores that are transmitted to healthy seeds. Due to this disease, up to 95% yield losses were reported. Use disease-free seeds to minimize the occurrence of the disease. Saltwater can be used to separate lightweight, infected seeds during soaking. The most effective result is obtained from seed treatment. There is a strong need for the development of an integrated approach for the management of this disease to sustain rice production, especially in Basmati/scented varieties.

Keywords: - Bakanae Disease, Integrated Management, Rice, *Fusarium moniliforme*

Introduction

Rice (Oryza sativa L.) is one of the world's most important food crops and is a staple food for more than 2.7 billion people. India is second largest producers of rice after China. After China and India, the next largest producers of rice are Indonesia, Bangladesh, Vietnam, Myanmar, and Thailand. The seven countries all have an average production output of more than 80% of global production. FAO estimated world paddy production in 2016 at 3.9 million to 751.9 million tons. The Food and Agriculture Organization has a major forecast of rice production worldwide in 2017 and set at 758.9 MT, which is an increase of 0.9 percent per year (FAOSTAT, 2017). In India, an area under 44.6 m ha is produced by 80 million tons (paddy) with an average yield of 1855 kg/ha. It has grown in almost every province. West Bengal, Uttar Pradesh, Madhya Pradesh, Bihar, Orissa, Andhra Pradesh, Assam, Tamilnadu, Kerala, Punjab, Maharashtra, and Karnataka are the major rice-growing provinces and contribute to 92% of localization and production. It is estimated that by the year 2021, India needs to produce 113.3 mt of rice to meet the country's growing food needs (Kumar, 2009). Bakanae disease affects more in rice crop. The first known report of the 'Bakanae' disease comes from Japan as far back as 1828. The disease was first scientifically described in 1898 by Shotaro Hori (Japanese researcher), who showed that the pathogen was a fungus, *Fusarium heterosporium* made a mark of bakanae on rice plants. It was later incorporated into the Gibberella genus under the name *G. fujikuroi* (Sawada) (Ito and Kimura, 1931) in India, the Bakanae incidence is increasing at an alarming rate, and is estimated to have lost a yield from 15-95 percent. It is reported to have originated in Eastern Uttar Pradesh, Haryana, Punjab, Assam, Andhra Pradesh, and Tamil Nadu

(Pannu et al. 2012) in Haryana, bakanae has contracted a serious disease after its first record since Kharif 1988 especially in aromatic species (Dodan et al. 1997).

Symptoms

The most telling sign of Bakanae is the long, thin appearance of the plant. This is a result of gibberellins, or growth hormones, which the fungus disguises itself.

• Check the seedling bed to find the seedlings that look unhealthy. Infected seedlings have sores on the roots, and can die before implantation or soon after.

• Look for unusual plants. Infected plants are a few inches shorter than normal plants. They are also small, with blue and green leaves.

• Check the growth of white powder on the ground or in the lower part of infected plants.

• Look for roots growing from above-ground nodules on the stem.

• Growth of white fungus in the crown region

Pathogen

Initially, the causal body with the influence of Bakanae disease was identified as *Fusarium moniliforme* Sheldon (Nirenberg, 1976). Causes of the disease *Fusarium monliforme* (sex category: *Gibberella fujikuroi*) belong to the kingdom Mycota, Division Eumycota, and Ascomycotina class. The pathogen produces both sexual and asexual characters. Asci are cylindrical, piston-shaped, flat, and 90-102 x 7-9 µm. They are 4- to 6- spored but rarely have 8 spored.

Disease Management

Physical method

Sunder *et al.* (2014) experimented with CCSHAU, rice research station, Kaul, Haryana on the management of bakanae disease and observed the disease incidence decrease in plots where the nursery was uprooted in standing water. On the basis of result, the incidence of bakanae disease was less CSR 30 and more in Pusa Basmati 1121, because CSR30 planted with nursery uprooted in standing water and Pusa Basmati 1121 planted with nursery uprooted under *vattar* condition. The maximum disease that occurs under *vattar* condition might be attributed to the facilitation of pathogen entry through injured roots which is more in this condition of nursery uprooting.

Gupta *et al.* (2015) concluded in a review that the management of this disease in agronomical practices is the use of clean non infested seeds. Because the pathogen mainly carries seeds, therefore, clean seeds should be used to reduce the occurrence of the disease. Hot water treatment is the best alternative for chemicals in organic cultivation.

Chemical method

Gupta and Kumar (2020) observed in the experiment Integrated Management of Bakanae Disease in Basmati Rice conducted at ICAR, Regional Station, Karnal. The disease incidence was minimum (5.1%) in plants raised from carbendazim 50%WP treated seedling and sown on soil amended with FYM+*Tv*. The highest disease incidence (27.3%) was recorded in non-amended plots (control) transplanted from the nursery of untreated seeds and the seedlings just dipped in water before the time of transplanting.

Singh and Sunder (2012) studied that fungicides like carbendazim, thiophanate-methyl, pefurazoate, benomyl, Ferimzone, pefurazoate, propiconazole provided effective disease control in a seed dressing, seed dip, soil drenching, seedling treatment, and field application.

Gupta *et al.* (2015) work on integrated seed treatment at ICAR, Regional station, karnal. Revealed that the seedling grown from the nursery of 0.2% carbendazim treated seed has significantly less incidence of bakanae disease (10.2%) followed by seedlings grown from the nursery of *Trichoderma viride* treated seed (11.7%). Nursery from untreated seeds embedded in untreated soil has a high incidence of disease (15.4%).carbendazim seed treatment gave10.3% disease as against 14.3% in *Trichoderma viride* seed treatment and15.4% disease incidence in untreated seeds transplanted in untreated or unamended plots. The disease control in FYM+T. viride treated soil was having better results than untreated. The disease incidence was minimum in soil treated with FYM+T. viride (10.3%) followed by soil treated only T. viride (11.8%) and more incidence (13.6%) in untreated soil.

Pal *et al.* (2019) A pot experiment was conducted and seeds were inoculated with pathogen inoculums by soaking the seeds overnight in pathogen culture suspension. These seeds were treated with bio-agents and chemicals. Minimum (22.85%) disease incidence was recorded in case of seed treated with Trichoderma-S7followed by 35.30, 37.52 and 38.33% disease incidence was recorded in case of seed treated with Trichoderma-S1+Nativo, Nativo alone, and TrichodermaS7+Nativo respectively. A maximum of 76.6% disease incidence was recorded in the case of control.

Hossain *et al.* (2016-2018) studied an experiment that uses non-chemical to manage bakanae disease. In post-harvest operations like winnowing and sundry of the seeds before storage have a significant effect on the incidence of bakanae disease in rice seeds of BR1 and BRRI dhan44. In the case of BR1, un-winnowed seeds had 20.0-27.25% initial seed infection, compared to the winnowed seeds that had 13.25-22.25% infection. Winnowing + sundry gave remarkable lower (8.00-12.75%) seed-borne infection over winnowing alone. Similarly, un-winnowed seeds of BRRI dhan44 had 20.75-36.00% infection. The minimum 10.00-17.25% infection was recorded from winnowed + sundried treatment. The infection range was 16.50-27.25% in the winnowed seed.

Jena *et al.* (2018) observed on a experiment that the minimum growth of mycelial and sporulation was recorded in treatments having Carbendazim 12% + mancozeb63% (SAAF), Trifloxistrobin + Tebuconazole (Nativo), ICF-110 and Tebuzonazole (Folicure), Propiconazole25% EC (Tilt), Carbendazim 50% WP (Bavistin) with100% reduction at 0.05% (500 ppm) concentration. Most of the chemical fungicides were result to be effective at 0.075% (750 ppm) concentration except Tricyclazole 18 %+Mancozeb 62% (merger) and azoxistrobin (Amister) which showed less effect on the growth of mycelial.

Biological Method

Bramaramba and Nagamani (2013) Concluded that the most common biocontrol agent *Trichoderma strictipilis*, *T. atroviride*, and *T. neokoningii* reduce plant growth of the bakanae pathogen.

Wyawahare et al. (2012) Studied and observed In India, *T. viride* and *P. fluroscenes* only and in combination are effective in the treatment of bakanae rice disease. Lower diseases were reported in the FYM 10t / ha + *Trichoderma* + *Pseudomonas*.

Lee *et al*. (1990) and Rosales *et al*. (1997) Reported that seed treatment and soil incorporation of *Pseudomonas aureofaciens* and other antagonistic bacteria suppressed the growth of the pathogen and reduced bakanae incidence by 71.7 to 96.3%.

Cultural Method

There are various cultural methods to control the spreading of disease from one season to the next like removal of the alternate hosts on which it overwinters, use of resistant varieties, soil solarization, or adjustment in sowing time, etc.

Naeem, M., *et al*. (2016) *Gibberrlla fujikouri* has a long survival time and its primary source of infection is seeds and the secondary source is overwintered spores whether in soil and on the alternate host. The disease is observed seed-borne and soil-borne. Some QTLs (Qbk1, Qb1, and Qb2) found in fine varieties which are proved to be beneficial against the disease.

Ghazanfar, M.U., *et al*., 2013 and Ahmad, I., *et al*. (2014). At storage we can reduce the moisture level up to 8% and maintaining hygienic conditions can minimize the chances of disease infestation in a subsequent generation. Sowing of coarse varieties can be enhanced instead of finer varieties to reduce the risk of disease.

Fiyaz *et al*. (2014) The Invitro seedling screening method was developed to select the resistant rice germplasm against Bakanae disease (Lee *et al*., 2011). High precision rapid methodology to screen various rice germplasm against Bakanae disease and found genotypes namely, Athad apunnu, C101A51, Chandana, IR 58025B, Panchami, PAU201, Pusa 1342, and Varun Dhan as highly resistant for Bakane disease.

Conclusion

Bakanae is a serious disease of rice in India with disease incidences ranges (1.2-40%) as a result of yield losses of up to 95% across the rice-growing countries of the world. The pathogen initially survives in seed but also known to survive in soil. The disease needs to be recognized along with the development and commercialization of more effective strains of bio-control agents for disease management. Cultural practices need to be developed and performed which can reduce the soil-borne pathogen and geographical areas need to be located for the production of disease-free seed. New molecules need to be tested especially as seedbed drench or seedling dip or foliar application for effective disease management. Integrated management including the development of resistant varieties, the use of efficient biocontrol and chemicals method for seed treatment, and foliar application in the field is required for the management of bakanae disease.

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