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Prevalence and Incidence of Bakanae disease of Rice in Northern India

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ABSTRACT

Bakanae disease is one of the newly emerged increasing problems of rice, particularly with basmati rice in northern India. In India, bakanae disease incidence has been increasing considerably and low to moderate disease incidences have been reported. The disease was found with 100% prevalence in all states/district surveyed viz., Uttar Pradesh, Uttarakhand, Punjab, Haryana, Rajasthan and Bihar. Disease incidence from 1.2 - 11.7 % in Uttar Pradesh, 2.1 - 3.2 % in Uttarakhand, 10.5 - 40.00% in Punjab, 2.1 - 2.8 % in Haryana, 2.4 - 13.6 % in Rajasthan and 1.8 - 8.7 % in Bihar was recorded on different basmati aromatic rice cultivars. It was also inferred by the farmers' interaction during the surveys that the most efficient method for bakanae disease management is seed treatment with carbendazim @ 2.0 g/kg or carbendazim + thiram (1:1) @ 2.5 g/kg seed.

Keywords: Bakanae disease, Disease incidence, prevalence, rice

INTRODUCTION

Rice is one of world's most favoured staple foods grain and about more than 90% of the world's rice is produced and consumed in Asian countries (Singh *et al.,* 2013). In India, the total area under rice cultivation during the year 2013 was 43.52 million hectares with annual production of 159.20 million tons of paddy with an average productivity of 3.59 t/ha (FAO stat 2014). Presently, India emerged as the leading exporter of rice which exported 7.1 million tonnes of rice (both Basmati and non basmati) during 2011-12, that earns valuable foreign exchange for the country. Rice production trend had kept in pace with population growth rate during last five decades. Currently, the rice production in the country is passing through serious constraints like, plateauing of yield, water scarcity, soil mineral stress, increased use of agro-inputs, irregular monsoon, flash floods, water logging, labour scarcity, intensive pests and diseases attacks and lack of policy innovations (Singh *et al.,* 2012b and Singh *et al.,* 2014). Therefore, from the food and livelihood security point of view, India needs to grow more rice. The places or regions where rice is grown need special attention and all efforts need to be directed towards enhancing the productivity. Maximum yields per unit area of land can be achieved and sustained only through high yielding rice varieties and pest management technologies (Singh *et al.,* 2012a and Singh *et al.,* 2012c). Rice crop production is constrained by several biotic and abiotic factors (Singh *et al.,* 2012a and Singh *et al.,* 2014). Among the various biotic factors affecting rice production and productivity, rice diseases caused by fungus, bacteria, virus and nematodes are the most significant constraints responsible for low yield of this crop in India (Ling, 1980; Kumar *et al.,* 2013). The annual losses due to rice diseases are estimated to be 10-15 per cent on an average basis worldwide (Kumar *et al.,* 2013). Presently, the rice disease profile has been changed in response to altering in rice production situations the diseases like bakanae, sheath rot, false smut and grains discoloration which were minor and occurring sporadically in the past are newly emerging

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diseases and causing considerable yield losses recently (Kumar *et al*., 2013).

Bakanae is a Japanese word which means bad or naughty seedling refers to the abnormal elongation, "thin noodle seedling", "foolish seedling", and "stupid rice crop" (Sun and Snyder, 1981). The disease is caused by *Fusarium fujikuroi* Nirenberg [telomorph: *Gibberella fujikuroi* (sawada) Ito] also known as foot rot or elongation disease is one of the important diseases in all the rice growing countries (Sharma and Thind, 2007). The disease is reported to be caused by one or more *Fusarium* species and complex of disease symptoms including seedling blight, root rot, crown rot, stunting and, the most classical symptoms of etiolation, hypertrophy effect or excessive elongation of infected plants, foot rot, seedlings rot, grain sterility and grain discolouration with ultimate effect on grain yield and seed quality have been recorded from different regions of the world (Ou, 1985; Sun and Snyder, 1981). It is one of the newly emerged increasing problems of rice, particularly on basmati rice in India during recent years (Pannu *et al*., 2012). It is one of the major fungal diseases of rice including blast, sheath blight, brown spot and sheath rot in India (Sharma and Thind, 2007). It is difficult to develop bakanae resistant rice varieties due to the high genetic variation of the causal pathogens (Serafica and Cruz, 2009). Although both blast and bakanae are becoming a threat for sustainable rice production due to high genetic variation of the causal pathogens, but bakanae is more alarming compared to blast as the disease is not influenced solely by environment and mainly infection increases through "passive transmission" from the infected seeds.

In recent years, bakanae disease has been spreading and being reported from newer parts of Asia. In China, Japan, Thailand, Pakistan, Bangladesh and Nepal bakanae has become a major disease since last decade and 10-70 percent disease incidence was recorded in basmati and improved rice cultivars. In India, bakanae disease incidence has been increasing considerably and moderate to severe yield losses ranging from 15-25 percent have been reported from Eastern U.P., Assam, Andhra Pradesh, Tamilnadu, Haryana and Punjab (Rathaiah *et al*., 1991, Sunder *et al*., 1998 and Pannu *et al*., 2012). Bakanae is, therefore, a major concern in the affected rice growing areas of India and also becoming more alarmed threat for sustainable rice production in other parts of the rice growing world. The research on bakanae disease and its sustainable management is need of hour and must be given top priority for disease free quality seed production, realizing higher yield potential of aromatic rice and to get edge in rice trade at international market before it is too late. Hence, the present research paper is an attempt to collect all the information related to bakanae disease prevalence and incidence in Northern India to help researcher, farmer, and planner to bring sustainable management of this new emerging disease.

MATERIALS AND METHODS

Exhaustive surveys have been made in different districts of northern states during main rice growing season to monitor the occurrence and distribution of the disease from 2006 to 2014. In each field, an overall view of the rice crop obtained and made general observations for the presence or absence of disease symptoms to know the prevalence and to record the incidence of the bakanae disease.

Prevalence and incidence of the bakanae disease were calculated with the help of the following formulas

$$\text{Per cent Prevalence} = \frac{\text{Locations showing bakanae symptoms}}{\text{Total locations}} \times 100$$

[Eq. 1]

Disease incidence in the field: Procedure for observation

The disease incidence was recorded from the five plots of 10 m^2 area selected in every sampling area. Disease symptoms were observed in surveyed places at different growth stages of rice either seedling growth, tillering, booting, heading/anthesis, milky, dough, yellow-ripe or mature stages. The per cent disease incidence was calculated as follows (Teng and James, 2001), with slight modifications (Zainudin *et al*., 2008).

$$\text{Per cent disease incidence} = \frac{\text{Total number of infected plants}}{\text{Total number of plants in 10 m2 plots}} \times 100$$

[Eq.2]

Disease incidence in term of percentage of infected hills for each plot in experimental field was calculated by the following formula (Hossain *et al*., 2011).

Disease Incidence (DI) = Infected hills per plot/Total hills per plot x100 [Eq. 3]

RESULTS AND DISCUSSION

Symptoms of Disease as Observed in Northern India

The bakanae disease attacks basically on all parts of the plant *viz*., the roots, crowns, stems, leaf sheaths, and

panicles throughout the season.

Symptoms in nursery: The infected seedlings are frequently identified on the basis of tall and yellow plants in the nursery fields. Diseased seedlings appear to be taller, more slender, and slightly chlorotic, yellowish-green to pale in colour in advanced stage and abnormally elongated primary leaves have been seen in nursery fields. (Fig.1 a & b).The disease occurs in seed-beds, but does not kill the attacked seedlings immediately. Rice seedlings that grow from the infected seeds are likely to display bakanae symptoms. These typical symptoms of bakanae were also observed by Ou, 1985.

Symptoms in field: The most common symptom of the disease is yellowing and excessive elongation of infected plants which were observed both in nursery as well as in field from a distance. The disease starts appearing in the fields in the form of slight yellowish, weak, abnormally elongated plants, which in due course of time grow faster than others (Fig.2a). Bakanae infected fields were uneven throughout the growing season. The development of adventitious roots from the lower nodes of the culms and presence of whitish fungal growth on the lower parts of the plants have been observed from Bihar, Uttar Pradesh, Rajasthan, Uttarakhand and

Fig.1 a & b: Yellowish-green and taller bakanae infected plants in nursery

Table1: Statewise Bakanae disease incidence on different cultivars of paddy

State	Districts	Per cent disease incidence in different cultivars					
		PS 1121	PS 2511	Pusa 1401	Pusa 1509	Taraori basmati	Pusa 1176
Uttar Pradesh	Bijnor	11.7	7.9	6.7	4.1	2.3	-
	Moradabad	10.4	7.6	7.4	4.7	2.6	-
	Bareilly	2.8	3.2	2.5	-	1.2	-
	Meerut	3.8	2.6	5.3	1.8	2.8	-
	Gautambudh Nagar	2.3	2.5	2.2	1.4	-	-
Uttarakhand	Udham Singh Nagar	2.1	2.4	-	-	-	-
	Haridwar	2.5	2.5	-	-	-	-
	Kashipur	3.0	3.2	-	-	-	-
Punjab	Ludhiana	14.7	10.5	12.7	17.5	-	-
	Khanna	15.8	14.4	12.3	40.0		
Haryana	Karnal	2.8	2.1	-	2.3	2.1	-
Rajasthan	Kota	13.6	8.2	-	2.4	-	-
	Bundi	11.8	4.6	-	3.8	-	
Bihar	Samastipur	3.6	1.8	-	-	-	8.7
	Muzaffarpur	4.8	2.2	-	-	-	5.2
	Patna	5.7	1.3	-	-	-	4.6

-Variety was not found in surveyed area during the study.

Punjab (Fig.2c). Leaves dried up quickly from below and die one after another in a few weeks (Fig.2b). In India, infected plants developed adventitious roots from the lower nodes of the culms and presence of white to pinkish fungal growth also have been noticed as other diagnostic features of the disease.

Prevalence and incidence of bakanae disease:

Bakanae disease of rice first described in Japan and now widely distributed in Asia and other rice growing countries of the world and if no control measures are taken, it may be a limiting factor for rice production. The disease is a cause of major concern in rice growing areas of India and becoming a serious threat for sustainable rice production. Different key locations of Northern India were examined time to time during 2006 – 2014 in main growing season of rice to made general observations on the presence or absence of bakanae disease in fields. The disease was found with 100% prevalence in all states/ district surveyed viz., Uttar Pradesh, Uttarakhand, Punjab, Haryana, Rajasthan and Bihar. In India, bakanae disease incidence has been increasing considerably and low to moderate disease incidences have been reported. In Bijnor district of Uttar Pradesh disease incidence was recorded up to 11.7 % in cultivar Pusa 1121, 7.9 % in Pusa 2511, 6.7 % in Pusa 1401, 4.1% in Pusa 1509 and 2.3 % in Taraori basmati. In Uttarakhand, disease incidence was observed from 2.1 -3.2 % in different cultivars during the year 2008- 2011. In Bihar, during the year 2012 to 2014 the bakanae disease incidence was recorded 3.6 – 5.7 % in Pusa 1121, 1.8 - 2.2 in Pusa 2511 and 4.6 – 8.5 % in Pusa 1176 cultivars from different districts (Table 1). In Punjab state up 40 % bakanae incidence was recorded in Pusa 1509 cultivar in Khanna district, however overall incidence in the state was observed 15-20 % during the year 2014. The reason behind the high incidence of bakanae in Khanna district was sowing of untreated seed as indicated by concerned farmer and scientist (Personal communication). In Rajasthan, the incidence of bakanae disease was noticed upto 13.6 % in cultivar Pusa 1121 and 8.2 % in Pusa 2511 and 3.8 % in Pusa 1509 during the year 2014. In India, moderate to severe qualitative and quantitative yield losses to rice crop under field conditions ranging from 15-25 percent have been reported from Eastern U.P., Assam, Andhra Pradesh, Tamilnadu, Haryana and Punjab. (Rathaiah *et al*., 1991, Sunder *et al*., 1998 and Pannu *et al*., 2012). The foot-rot or bakanae disease, caused by *Fusarium moniliforme* Sheldon, has become an economically important disease in basmati rice in Punjab, during the last one decade. In Haryana state, bakanae disease was recorded for the first time during *Kharif* 1988 on both the groups of paddy *i.e.*, high yielding dwarf and scented tall varieties (Sunder *et al*., 1998). Earlier, Rathaiah *et al*., (1991) had studied that the lowest bakanae incidence (4.17%) resulted in 3.04 per cent grain yield loss. Apart from yield losses studies, the bakanae pathogen was also found to be associated in highest percentage (1-24%) in seed of different basmati rice cultivars (Bashyal and Aggarwal, 2013) that showed the profound effect of the disease on seed quality.

Disease Management approaches prevalent among farmers

The various methods being used for managing rice diseases include use of resistant varieties, cultural practices, biological and chemical control (Sharma *et al*., 2007 and Singh *et al*., 2012c). All these methods have varying degrees of success in managing rice diseases. The most important disease control tactics used worldwide after resistant varieties is chemical control. The bakanae disease is mainly seed borne and planting of clean inoculum-free non infested seed is most effective management method for this disease. In India, seed treatment with carbendazim @ 2.0 g/kg or carbendazim + thiram (1:1) @ 2.5 g/kg seed emerged as most popular and effective method among the farmers for the management of bakanae disease in all the surveyed places. Dry seed treatment with benomyl or benomyl

Fig.2 a: Yellowish, abnormally elongated plants

Fig.2 b: Drying of plants

Fig.2 c: Whitish fungal growth

+ thiram, or thiram or carbendazim at 1-2% of seed weight gives good control (Bagga and Sharma, 2006).

CONCLUSION

The Indian incidence of bakanae disease of rice has increased steadily particularly on aromatic rice cultivars in all rice growing states, which causes both qualitative and quantitative yield losses to rice crop under field conditions. The research on bakanae disease and its sustainable management is need of hour and must be given top priority for disease free quality seed production, realizing higher yield potential of aromatic rice and to get edge in rice trade at international market before it is too late.

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