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Research Article

IMPACT OF FRONT LINE DEMONSTRATION ON MANAGEMENT OF BAKANAE DISEASE IN BASMATI RICE (*ORYZA SATIVA* L.) IN AMBALA DISTRICT (HARYANA)

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Abstract Paddy (*Oryza sativa* L.) growing areas of Haryana indicated that the incidence of bakanae caused by *Fusarium moniliforme* Sheld. In India, bakanae disease incidence has been increasing considerably and low to moderate disease incidences have been reported. The major constraint for low productivity of basmati rice in the Ambala District of Haryana is lack of awareness about the management of bakanae disease and non adoption of recommended package of practices of improved cultivation. Currently, seed treatment with Carbendazim @ 2.0 g/kg or Carbendazim + Thiram (1:1) @ 2.5 g/kg seed is the most important disease management strategy used by the farmers in worldwide after the use of resistant varieties. To replace this old age disease management strategy Krishi Vigyan Kendra, Ambala Haryana suggested one foliar spray of Sixer (Mancozeb 63% + Carbendazim 12%) W.P. fungicide @ 600gr/ acre at booting stage of rice after following seed treatment strategy. KVK conducted 20 front line demonstrations on high yielding variety of basmati rice (PB 1121) during kharif season 2014 and 2015. An average yield of PB 1121 in FLDs ranged from 41.12 to 43.25 q/ha whereas in local practices 36.00 and 37.50 q/ha during 2014 and 2015, respectively and percent incidence of bakanae disease also recorded in demonstration plots ranged from 7% to 5% in compression to local check 19% to 12% during 2014 and 2015, respectively. It was recorded that the percentage increase yield with high in demonstration plots over local check was recorded in range of 14.5% to 13.29 %. Similarly, the extension gap ranged between 5.12 to 5.75 q/ha during the years 2014 and 2015, respectively.
Key words: Bakanae, Extension gap, Fusarium moniliforme, Percent incidence, Technology gap

Introduction

Bakanae disease caused by *Fusarium fujikuroi* Nirenberg [*F. moniliforme* (Sheld.), telomorph: *Gibberella fujikuroi* Sawada, Wollenweber] emerged as a significantly important disease in recent times in Asia and other rice growing countries of the world (Singh and Sunder, 2012). Rice is one of world's most favored 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). In Haryana, bakanae has attained the status of a major disease after its first record since kharif 1988 particularly on scented tall varieties (Dodan *et al*. 1997). A highly positive correlation (r = 0.999) has been established between disease incidence and loss in grain yield of paddy (Sunder *et al*. 1997). Higher rice yield can only be obtained through improved cultivars and integrated crop and pest management technologies (FAO, 1995; Kumar *et al*., 2013; Prajapati *et al*., 2013). Now-adays, the scenario of rice diseases is changing due to extensive use of fertilizers, irrigations, pesticides and high yielding cultivars. The minor diseases like, false smut, bakanae, sheath rot and grain discoloration which were of less significance earlier, are now emerging as serious threat to rice cultivation. *F. moniliforme* is primarily a seed-borne pathogen which infects the seedlings at the time of germination or at an early growth stage (Ou 1985). Injured roots have been reported to serve as potential entry source of *Fusarium* spp. in different crops. In rice, injury to the roots mainly occurs during nursery uprooting depending upon the soil moisture. The incidence of bakanae disease has increased steadily, particularly on aromatic rice cultivars in all rice growing states of India which causes severe qualitative and quantitative yield losses to rice crop (Bashyal *et al*., 2014; Gupta *et al*., 2014). Some fungicides particularly the organomercurials and benzimidazoles have been reported to be effective in suppressing the fungal growth in vitro and bakanae incidence in field (Kauraw 1981, Sunder *et al*. 1998). The research on bakanae disease and its sustainable management are the need of the 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.

History: Bakanae disease was first identified during 1828 in Japan. Hori Shotaro (1898) first time demonstrated the fungus *Fusarium heterosporium* Nees induced the bakanae symptom in rice plants. It was later put in the genus *Gibberella* under the name *G. fujikuroi* (Sawada) (Ito and Kimura, 1931). There has been disagreement among plant pathologists for the nomenclature of bakanae fungus. In 1930s, the imperfect stage of the fungus was described by H.W.Wollenweber (1935) as *Fusarium moniliforme* (Sheldon) and the perfect stage *Gibberella fujikuroi* (Sawada) Wr. The terms 'Fujikuroi' and 'Saw' in *G. fujikuroi* (Sawada) Wr. were derived from the name of two distinguished Japanese plant pathologists, Yosaburo Fujikuro and Kenkichi Sawada (Watanabe and Umehara, 1997). In India, the prevalence and incidence of bakanae disease has been reported particularly on basmati rice cultivars (Bashyal *et al*., 2014; Gupta *et al*., 2014).

Geographical distribution and economic significance: The yield losses ranging from15-25% have been reported from Uttar Pradesh, Assam, Andhra Pradesh, Tamilnadu, Haryana and Punjab states of India. (Pavgi and Singh, 1964; Rathaiah *et al*., 1991; Pannu *et al*., 2012; Sunder *et al*., 2014). 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. Apart from yield losses studies, the bakanae pathogen was also found to be associated in highest percentage (1-24%) in seeds of different basmati rice cultivars (Butt *et al*., 2011; Bashyal and Aggarwal, 2013) and showed the profound effect of the disease on seed quality. The observations and surveys from 2008-2014 in Northern states of India also showed the incidence of bakanae disease ranged from 1.2-40%, especially in basmati rice cultivars (Gupta *et al*., 2014).

Symptomatology: Bakanae disease of rice is also known as "foot rot" in India, "white stalk" in China, "man rice" in the Philippines and "bakanae-byo or elongation disease" in Japan. Bakanae is a Japanese word which means bad or naughty seedling referring to the abnormal elongation, "thin noodle seedling", "foolish seedling" or "stupid rice crop" (Sun and Snyder, 1981). The bakanae infected seedlings appeared as taller with chlorotic stems and leaves which become yellowish green to pale in colour in later stages. Diseased plants showed yellowish green elevated flag leaves with more horizontal orientation. The disease can build up in a crop very fast and a field with bakanae will remain uneven throughout the growing season. Therefore, it can be observed in nursery beds as well as in field from a distance (Fig. A).

Host range of the pathogen Primary hosts: Primary hosts of bakanae pathogen have been reported as rice, maize, barley, sorghum, sugarcane, wheat, pine, rye and asparagus from Asia, Africa, South East Asia and United States (Hseieh *et al*., 1977; Kuhlman, 1982; Puhalla and Spieth, 1985; Wulff *et al*., 2010; Petrovic *et al*., 2013).

Alternate hosts: Alternate hosts viz., tomato, cowpea, banana, subabool, proso millet, early water grass and barnyard grass have been found susceptible to bakanae disease and may also serve as reservoir of inoculum in the field (Anderson and Webster, 2005; Carter *et al*., 2008).

Chemical seed treatment: Currently, the seed treatment with chemicals is the most common management practice for bakanae disease in India (Gupta *et al*., 2014) and widely practiced in most of East Asia. Bagga and Sharma (2006) found seedling treatment with carbendazim or benlate (0.1%) for 6 and 8 h, significantly reduced the disease incidence up to 92%. Dip the seed in bavistin 50 WP (0.05%) plus streptocycline (0.01%) solution for 12 h and smearing the seeds with talc formulation of *Trichoderma harzianum* (15 g/kg seed) immediately before nursery sowing and seedling root dip for 6 hrs in *T. harzianum* biopowder (15 g/liter water) was found most effective against bakanae disease (Pannu *et al*., 2009). 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.

The technology gap, extension gap and technological index (Samui *et al*., 2000) were calculated by using following formula as given below equations [Eq. 1-4]:

Percent increase yield=	$\frac{\text{Demonstration yield-farmers yield}}{\text{Farmers yield}}$	x 100 Eq. 1
Technology gap=	Potential yield - Demonstrated yield	Eq. 2
Extension gap=	Demonstration yield - Yield under existing practice	Eq. 3
Technology index=	$\frac{\text{Potential yield - Demonstrated yield}}{\text{Potential yield}}$	x 100 Eq. 4

Methods and materials

The FLD was conducted to study the percent incidence of bakanae disease and gaps between potential yield and demonstration yield, extension gap and technology index. Results of 20 frontline demonstrations conducted during kharif 2014 and 2015 in 8.0 ha area on farmer's field of five villages of Ambala district indicated that the cultivation practices under FLDs viz. demonstrated high yielding basmati variety of rice (PB 1121). The basmati variety *Pusa Basmati* 1121, released from IARI (New Delhi) of 145 days duration which is sown in the first fortnight of June. Before nursery raising seeds was treated with Carbendazim @ 2.0g/kg of seed. About 25-30 days old seedling having 5 to 6 leaf stage was transplanted in first fortnight of July. Transplant two-three seedlings per hill in line at spacing of 20x15 cm (33 hills/sq. meters). The cultural practices were performed uniformly and equally to all the FLD plots. The crop was raised following standard agronomic practices of irrigation and Nitrogen (N_2) and Phosphorus (P_2O_5) fertilizers were applied @ 90:30 kg/ha. All P_2O_5 and 1/2 N_2 was applied at the time of transplanting and rest of N_2 were applied at panicle initiation stage. At booting stage one spray of Sixer (Mancozeb 63% + Carbendazim 12%) W.P. fungicide @ 600g/acre was applied and timely inter culturing operations like weeding and control of pest was followed through recommended chemicals at economic threshold level.

Result and Discussion

The average FLDs yield was recorded 41.12 and 43.25 q/ha during 2014 and 2015, respectively, which were found 14.22 and 15.33 per cent consequently, increased over local check. Percent incidence of bakanae disease was recorded minimum in FLD plots range 7 and 5 per cent during 2014 and 2015, respectively which were found maximum in local check range 19 and 12 per cent consequently during 2014 and 2015. Data further shows that the yield of PB 1121 in the year 2015 was increased successively which clearly speaks of the positive impact of FLD over local check of basmati rice (Table 1).

The results indicate that FLDs has given a good impact over farming communities of Ambala district as they were aware by the applying of one spray of sixer at booting stage of rice plant after following seed treatment strategy. It's help to reduce disease incidence of bakanae. Moreover, from first year onwards, farmers cooperated enthusiastically in carrying out FLDs which leads to encouraging results in the second year. The similar results of yield enhancement in chick pea in front line demonstration had also documented by Singh *et al* (2014).

The technological gap 13.88 and 11.75 q/ha in the year 2014 and 2015, respectively showing cooperation of the farmer's, for adopting such types of demonstrations which is help full to generate and encouraging results in subsequent year. The technology gap observed may be unavailability of specified fungicide for the management of bakanae disease at the time of occurrence and agro climatic conditions also responsible. The existing gap which ranged from 5.12 to 5.75 q/ha during the period of study emphasized the need to educate the farmers regarding how to recognize to the specified diseases and its effective management strategy, through conducting of on/off training programme on IDM, to organize plant health camping at village level and provide litterateurs also. All these extension activities help to the farmers for adapting to the new and improved agricultural technologies, that are reserve this trend of wide extension gap between farmers and technologies.

The technology index shows the feasibility of the evolved technology at the farmer's field. The lowest value of technology index which indicate the more feasibility of the technology. As such, decreased the technology index from 25.24 to 21.36 per cent indicated that the demonstrated technology was feasible (Table 1).

The benefit cost ratio of the front line demonstration revealed that B:C ratio from recommended practice were subsequently higher than the local check i.e. farmers practices (Table 2).

During the data of both years of the demonstration plots. Average net return per hectare from the demonstration was Rs. 64,743.00 and Rs. 1,08208.00, while from the local check Rs. 50,812.00 and Rs. 92,200.00 during the 2014 and 2015, respectively. The benefit cost ratio of demonstration was found 3.58 and 4.42 while in local check 2.88 and 4.05 during the year 2014 and 2015, respectively. Similar finding was reported by Sharma (2003) in moth bean.

Fig. 1

[Symptom of bakanae disease in basmati rice variety (PB 1121) at farmer field]

Table 1: Productivity, technology gap, technology index, extension gap of basmati rice verity (PB 1121) as grown under FLD and local variety.

Years	Area	No. of FLDs	Demonstration Yield (q/ha)			Yield of Local check (q/ha)	Potential yield (q/ ha)	Increased yield (%)	Extension gap (q/ha)	Technology gap (q/ha)	Technology index (%)	Incidence of (%)	
			Highest	Lowest	Average							Demo.	Local check
2014	4.0	10	47.50	35.00	41.12	36.00	55.00	14.22	5.12	13.88	25.24	7	19
2015	4.0	10	47.50	37.50	43.25	37.50	55.00	15.33	5.75	11.75	21.36	5	12

Table 2: Economic Impact of basmati rice verity (PB 1121) as yield under FLD and traditional package of practices.

Years	Cost of Cultivation (Rs./ha)		Gross Return (Rs./ha)		Net Return (Rs./ha)		BC Ratio	
	Demo.	Local check	Demo.	Local check	Demo.	Local check	Demo.	Local check
2014	25000.00	27000.00	89743.00	77812.00	64743.00	50812.00	3.58	2.88
2015	31600.00	30200.00	139808.00	122400.00	108208.00	92200.00	4.42	4.05

Conclusion

The present study of front line demonstrations produces a significant positive result and gives researchers an opportunity to demonstrate the effectiveness of management of bakanae disease by one spray of Sixer (Mancozeb 63% + Carbendazim 12%) W.P. fungicide at booting stage of rice plant after seed treatment. It's also help to reduce per cent disease incidence of bakanae disease and enhance to the productivity potential and profitability of rice crop after adopting the recent developed technology under real farming situation, which they have advocating for long time. The results of front line demonstrations convincingly brought out that the yield of basmati rice verity (PB 1121) could be increased 14.22 per cent to 15.33 per cent and reduce disease incidence of bakanae 7 per cent to 5 per cent during year 2014 and 2015, respectively with intervention on one spraying of Sixer (Mancozeb 63% + Carbendazim 12%) W.P. fungicide at booting stage. From the above findings it can also concluded that use of one spraying strategy of fungicide at booting stage, after following seed treatment strategy reduced the extension and technology gap to a great extent. This will sustainably increase the income of the farmers of the Ambala district.

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