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Epidemiology and Management of Foot Rot in Basmati Rice

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ABSTRACT

Foot rot disease of Basmati rice is known for causing huge economic losses in all the basmati producing areas every year. The present study was carried out at Regional Research Station, Gurdaspur during kharif 2012-13 and 2013-14 to investigate the role of growing environment on disease development, extent of loss caused by the disease and effective management of the disease. Data analysis revealed that early transplanting of basmati rice (10thJune) resulted in maximum disease incidence (24.2%) while, the lowest disease (3.6%) was recorded under late transplanting (10thJuly). The higher air temperature associated with early planting contributed significantly in symptom development. The correlation coefficient between foot rot incidence and maximum air temperature was found to be significantly positive (0.85; $p<0.01$). The soil temperature also showed highly positive correlation at 5 cm (0.62) and 20 cm (0.60) depth. The rainfall during transplanting to tillering was negatively associated (-0.71; $p<0.05$) with bakane development and thus causing in high infection during early transplanting. Similarly, age of nursery also expressed significant effect on disease incidence and highest disease (19.7%) was registered while seedlings of 50 daysage were used for transplanting. The yield loss varied from 3.8 to 47.2per cent depending on the infection level. The set of experiment with different control methods as treatments showed that seed treatment with Bavistin 50 WP @ 0.2% + seedling dip treatment in Bavistin 50 WP @ 0.2% + uprooting the infected seedlings in the nursery was most effective and can control the disease (92.2%) in the field. Thus, foot rot disease of basmati rice can be controlled by altering growing environment accordingly and through management manipulation and judicious use of chemical control.

Key Words: Basmati rice, Epidemiology, Foot rot, Management, Yield loss.

INTRODUCTION

Rice (*Oryzasativa* L.) is the second most important food crop in the world. The potential production of rice is limited by various biotic and abiotic factors. Among biotic factors, foot rot disease (Bakanae disease) caused by the fungus *Fusarium moniliformae* Sheldon is one of the most important and widely distributed in all the rice growing areas of the world (Sunder and Satyavir, 1997). The most typical symptoms produced by the disease include yellowish green thin leaves, abnormal stem elongation, less tillering and rooting of root-stem joint as well as the first node. This disease is considered as economically important in all the rice growing areas and can cause substantial yield loss under favourable environmental conditions (Saremi *et al,* 2008; Yasin *et al,* 2003; Zhang *et al,* 2000).

The fungus (*Fusarium moniliformae* Sheldon) causing the foot rot disease is seed as well as soil borne (Ahmad and Raza, 1991). It can spread to new areas through infected seed. Thedisease development is further elevated by high temperature and high dose of nutrients specially nitrogen (Nyall, 1999). As a result, the most economical and safest way to combat the foot rot pathogen till date is seed or seedling treatment with fungicides (Chandler, 2005; Bagga and Sharma, 2006) and related management practices. Therefore, a thorough investigation on favourable environmental conditions governing the disease appearance and severity will help in deciding management practices for effective control of the disease. So, the present study was designed to study the effect of different dates of transplanting, age of nursery and various environmental factors on foot

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root incidence, to estimate the yield losses caused by foot rot under different growing environments and to evaluate the effectiveness of Bavistin 50WP (Carbendazim) as seed treatment, soil drenching, dusting and seed dip treatment.

MATERIALS AND METHODS

The field experiments were conducted in the experimental area of Punjab Agricultural University, Regional Research Station, Gurdaspur during kharif 2012-13 and 2013-14. The experiments were laid out in randomized complete block design (RCBD) with plot size of 4m X 3m. The infected seed of Basmati rice (*Oryza sativa*) cv. PusaBasmati 1121 was used to sow the nursery for different experiments. In order to study the effect of date of transplanting, 30 days old seedlings were transplanted on four different dates viz. 10thJune, 20thJune, 30thJune and 10thJuly. Furthermore, the effect of age of nursery on the incidence of Bakanae disease was studied by transplanting nursery at the age of 30, 40 and 50 days after sowing. The per cent disease incidence was calculated by using the following formula:

Different levels of the disease *viz*. 0, 5, 10, 15, 20, 30, 40 and 50 per cent were maintained purposively using infected nursery/seedlings in another set of experiment to estimate the yield loss due to foot rot. The transplanting was done on 10thJuly. The yield losses at different disease levels were calculated at maturity by harvesting each plot separately. The crop was raised as per recommended practices. The correlation and analysis were carried out to establish the relationship between disease level and grain yield.

The effectiveness of the fungicide Bavistin 50WP (Carbendazim) as seed treatment, seedling dip, spraying and dusting was studied in different combinations (seed treatment + spray just before transplanting; seed treatment+ dusting just before transplanting; seed treatment + dusting three days before transplanting; seed treatment + spray 20 days after nursery sowing; seed treatment + spray 25 days after nursery sowing; seed treatment + spray 30 days after nursery sowing; seed treatment + seeding dip treatment + uprooting of infected plants in nursery; seed treatment + seedling dip treatment) for management of the disease. The fungicide was used at a concentration of 0.2 % for spraying, seed and seedling treatment while dusting was done at a rate of 20g/ m2.

RESULTS AND DISCUSSION

Effect of growing environment on foot rot incidence

The infected nursery transplanted at different dates showed disease incidence at differential rate. At tillering stage, the data on per cent disease incidence indicated significant effect ($p<0.05$) of growing environment on disease development (Table 1). The graphical values established that advancement of transplanting date in each season had significantly (LSD0.05=1.36) increased foot rot incidence. Consequently, the 10thJune transplanted rice manifested the highest foot rot incidence (24.2%) and the lowest disease incidence was recorded under 10thJuly transplanted crop in both the seasons. The above results were also supported by the yield data. It is obvious from the

Table 1. Effect of date of transplanting on disease incidence and grain yield of basmati.

Sr. No.	Date of transplanting	Disease incidence (%)	Yield (q/ha)
1.	10th June	24.2	22.0
2.	20th June	14.1	26.3
3.	30th June	10.7	29.2
4.	10th July	3.6	31.8
	LSD 0.05	1.36	1.01

Table 2: Correlation coefficients between foot rot incidence and environmental variables

	DI	AT.MAX	AT.MIN	RF	ST5
DI					
AT.MAX	0.85**				
AT.MIN	-0.07	0.10			
RF	-0.71*	-0.92**	-0.06		
ST5	0.62	0.93****	0.20	-0.92**	
ST20	0.60	0.92**	0.22	-0.91**	1.00****

**** - (p < .001), ***- (p < .001), ** - (p < .01), * - (p < .05)

DI = Disease Incidence; AT. MAX = Maximum air temperature; AT.MIN = Minimum air temperature; RF = Rainfall; ST5 = Soil temperature @5cm; ST20 = Soil temperature @20cm

above findings that transplanting of Basmati rice before first week of July may lead to greater yield loss due to the higher disease attack. Bagga*et al* (2007) have also reported highest disease incidence (7.2%) in early transplanted (June 19) followed by July 10thtransplanting (4.3%) and the lowest under July 31sttransplanted crop.

Zhang *et al* (2000) also reported that the symptom development reached pick at 3-leaf seedling stage. The maximum air temperature (Tmax) was highest (37.3±3°C) under early (10thJune) transplanted crop and gradually decrease with delay in planting time and subsequently registered lowest (32.9±1.7°C) under July 10 transplanting (Table 3). The Pearson's correlation coefficient (Table 2) also confirmed a significant positive association (r = 0.85, p<0.01) between foot rot incidence and maximum air temperature. Nvall (1999) also reported that the foot rot disease was favoured by high air temperature during initial growth stage. However, minimum air temperature (Tmin) during all the growing environments remained closer to each other. Thus, Tmin showed no significant effect (r = -0.07) on foot rot incidence under different planting dates.

The resulted data indicated that edaphic temperature at 5 cm (34.6±2.2°C) and 20 cm (34.2±1.6°C) remained high during early transplanted environment (Table 3). These gradually decreased with delay in planting and lowest temperature attained under July 10 transplanted crop. The Bakanae pathogen is a soil borne fungus

Table 3.Distribution of different environmental variables under different dates of transplanting.

Sr. No.	Date of transplanting	Distribution of Tmax(°C)	Distribution of Tmin(°C)	Distribution of soil temperature (5cm)(°C)	Distribution of soil temperature (20cm) (°C)
1.	10thJune	Sd=3.01 T=37.3	Sd=1.70 T=25.2	Sd=2.20 T=34.6	Sd=1.67 T=34.2
2.	20thJune	Sd=2.31 T=35.2	Sd=1.49 T=25.4	Sd=1.86 T=33.0	Sd=1.45 T=32.8
3.	30thJune	Sd=1.74 T=34.1	Sd=1.37 T=25.3	Sd=1.54 T=32.2	Sd=1.20 T=32.2
4.	10thJuly	Sd=1.74 T=32.9	Sd=1.06 T=25.2	Sd=.0.97 T=31.3	Sd=0.71 T=31.4

and chiefly affected by soil temperature and alters its activity with fluctuation in soil temperature. It has been reported that soil temperature as high as 35°C is most conducive for foot rot development in rice (Kazempour and Elahinia, 2007). The correlation analysis also indicated high positive coefficients with 5 cm (r = 0.62) and 20 cm (r = 0.60) depth soil temperature indicating more disease incidence at higher temperature regime.

The total rainfall was varied among four transplanting dates (Figure 1). The pooled data of both the seasons (kharif 2012-13 and 2013-14) presented in faceted bubble plot in the above figure indicated gradual increase in total rainfall under delayed planting as monsoon become active during July in this part of India. This resulted in significant negative association (r = -0.71, p<0.05) with disease incidence. As rainfall brings down air and soil temperature, the low rainfall in early-planted basmati rice contributed to higher infection by the pathogen. Thus, different growing environments altered disease development significantly in the field in both the years.

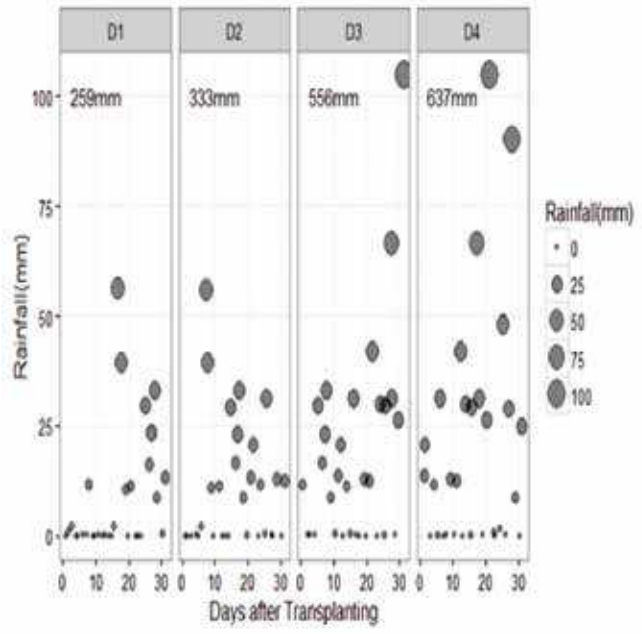

Figure 1: Distribution and statistics of rainfall under different dates of transplanting

Effect of age of nursery on foot rot incidence

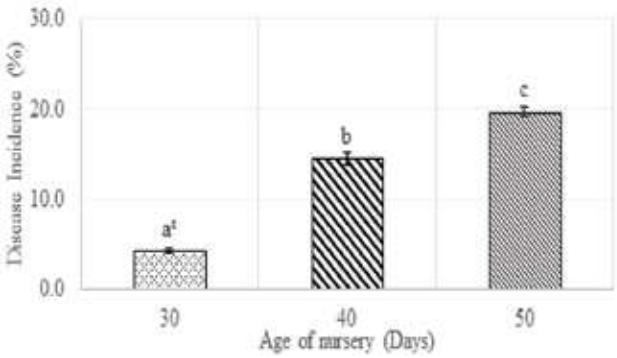

Figure 2: Effect of age of nursery on disease incidence

ε - Means with the same letter are not significantly different (LSD0.05 = 0.91)

The results of the set of experimental plots where basmati rice Pusa 1121 seedlings were transplanted at an age of 30 days, 40 days and 50 days, showed distinct effect of age of nursery on foot rot incidence in both the seasons. Per cent disease incidence differed significantly (LSD 0.05 = 0.91) among age of nursery used for planting (Figure 2). The highest foot rot attack (19.7%) was observed with oldest seedlings (50 d) and the lowest (4.2%) was observed with 30 d sold nursery. This may be resulted because the disease seedlings in the nursery served as a source of inoculum. In case, the infected seedlings are not uprooted at an early stage, the fungal spores get easily carried away by wind or water to the adjacent healthy plants, therefore, increasing the number of infected plants (Nvall, 1999).

Effect of foot rot incidence on grain yield

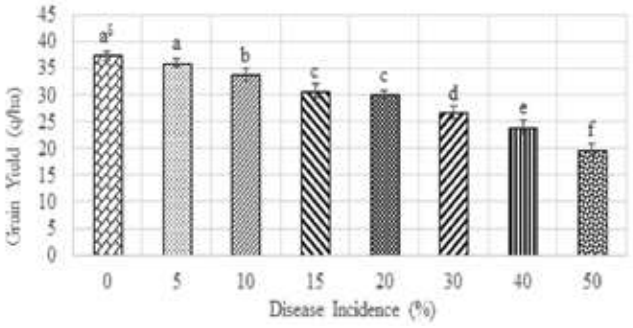

Figure 3: Effect of level of disease incidence on grain yield

δ - Means with the same letter are not

significantly different (LSD0.05 = 1.62)

The analysed pooled data of grain yield indicated a least significant difference (LSD) of 1.62 ($p<0.05$) among different treatments of per cent disease level (Figure 3). It was noted that yield under control and low level of incidence (5%) was at par, however, significant loss was registered under 10% disease incidence. The loss increased with increase in per cent disease and the lowest yield (19.8q/ha) was obtained under 50% disease incidence. A correlation analysis produced highly significant negative correlation ($r = -0.9953$, $p<0.001$) between foot rot incidence and rice yield indicated severe economic loss if necessary control measures were not taken up timely. There were earlier evidences of economic loss caused by bakanae disease in many parts of South East Asia. The disease, under favourable conditions, is known to cause 20-50 per cent yield loss in Japan, 70per cent to almost complete loss in Australia, 3.7-14.7per cent in Thailand, 5-23per cent in Spain, 3-95per cent in India, 40per cent in Nepal, 6.7-58.0per cent in Pakistan (Saremi*et al,* 2008) and up to 75per cent in Iran (Yasin*et al,* 2003).

Effect of Bavistin 50WP (carbendazim) on the incidence of foot rot

The efficacy of Bavistin 50 WP evaluated as seed treatment, seedling dip treatment, foliar spray and dusting to minimize/control economic loss due to foot rot is presented in Table 4. It was observed that the most effective treatment for the control of foot rot was seed treatment with Bavistin @ 0.2% + seedling dip treatment in Bavistin @ 0.2% solution + uprooting the infected seedlings in the nursery. This treatment recorded lowest disease incidence (0.18%) among all the treatment combinations and recorded a significant disease control of 92.16per cent. When the infected seedlings were not uprooted in the nursery but seed and seedlings were treated with the fungicide, the disease control of 70.18per cent was achieved. Spray of Bavistin @ 0.2% in the nursery before transplanting also reduced the disease incidence. Spray on 20, 25 and 30 days old nursery reduced foot rot incidence by 48.5, 52.6 and 52.3 per cent, respectively. However, there was no effect of fungicide on disease incidence when spray was made immediately before transplanting or after transplanting. Also, the dusting of Bavistin 50WP @ 20 g/ m2 had no effect on the incidence of foot rot. Bhalli*et al* (2001) reported that Derosal (carbendazim) was most effective in inhibiting the mycelia growth of *Fusarium moniliformae* causing foot rot under in-vitro conditions while, under field conditions the fungicide was very effective as seed treatment and soil drenching. Pannu*et al* (2009) observed that seed treatment + seedling dip in Bavistin 50WP proved to be highly effective in checking the foot rot disease of basmati in fields. Seedling treatment with Bavistin or Benomyl @0.1% for 6 and 8 hr, respectively was found to effectively reduce the foot rot disease (Bagga and Sharma, 2006). Iqbal *et al* (2013) recorded that Daconil followed by Bavistin exhibited best results against foot rot when used as seed dressing at a concentration of 0.25per cent. A significant reduction in the incidence of foot rot and increase in grain yields with Bavistin, Emisan-6 and Benomyl was observed by Biswas and Das (2002). It was further observed that foot rot can be reduced to some extent if infected seedlings are uprooted as early as possible because this will reduce the spread of inoculum in the nursery and subsequent carriage to the field. From the above observations, It can be concluded that there is a direct relationship between disease incidence and reduction in yield. For the proper management of foot rot in basmati rice, an integrated approach should be followed. Healthy disease free seed should be used for sowing.

For producing good seed, the crop should be sprayed with Tilt 25EC @0.1% (propiconazole) at flowering stage. Before sowing nursery, treat the seed with Bavistin 50WP @0.2% for 10-12 hr. Diseased seedlings should be removed in the nursery as and when they appear. Transplanting should be done preferably during first fortnight of July only after dipping the seedling roots in Bavistin @0.2%

Table 4. Effect of different control measures using Bavistin on incidence of foot rot.

Sr. No.	Treatment	Disease Incidence (%)	Disease Control (%)	Grain Yield (q/ha)
1.	Seed treatment + spray just before transplanting	10.72	14.3	30.63
2.	Seed treatment+ dusting just before transplanting	10.10	19.26	30.86
3.	Seed treatment + dusting 3d before transplanting	11.04	11.75	29.76
4.	Seed treatment + spray 20 d after nursery sowing	6.44	48.52	33.16
5.	Seed treatment + spray 25 d after nursery sowing	5.32	52.67	33.56
6.	Seed treatment + spray 30 d after nursery sowing	10.03	19.82	31.13
7.	Seed treatment + seeding dip treatment + uprooting of infected plants in nursery	0.18	92.16	36.63
8.	Seed treatment + seedling dip treatment	3.73	70.18	34.4
9.	Control	12.51	-	29.13
	CD ($p<0.05$)	0.34	-	0.30

for 6 hr. In this way we can combat the problem of foot rot in basmati rice fields.

CONCLUSION

Basmati rice which is extensively practiced in sub mountain region of Punjab, face economic loss year after year due to foot rot disease. The disease incidence increased as the transplanting date was advanced which was attributed to the higher air and soil temperature regime during early transplanting. However, rainfall activity was negatively correlated, thus lowest symptom development was observed under late transplanting (July,10). So,early transplanting of basmati rice before second week of July is not advisable for effective control of the disease. The age of nursery also had significant role in disease development and the aged (50 d) seedlings showed more incidence as compared to the younger (40 d followed by 30 d) nursery. To minimize the infection of foot rot, transplanting of nursery older than 30 d is not advisable. It is further recommended to uproot any infected seedling with bakanae symptom in the nursery to prevent further infection in the transplanted field. The control using seed treatment with Bavistin 50 WP @ 0.2% solution + seedling dip treatment in Bavistin 50 WP @ 0.2% + uprooting the infected seedlings in the nursery was found to be the best for controlling foot rot in basmati rice.

REFERENCES

Ahmad M I and Raza T (1991). Association of Fusarium moniliformae Sheld with the rice seeds and the subsequent infection in Pakistan. *IRRN*. **16**:19-20.

Bagga P S and Sharma V K(2006). Evaluation of fungicides as seedling treatment for controlling bakanae/foot rot (Fusarium moniliformae) disease in basmati rice. *J Mycology and Plant Path* **59**: 305-308.

Bagga P S, Sharma V K and Pannu P P S (2007). Effect of transplanting dates and chemical seed treatments on foot rot disease of basmati rice caused by Fusarium moniliforme. *Pl Dis Res* **22**: 60-62.

Bhalli J A, Aurangzeb M and Iiyas M B (2001). Chemical control of Bakanaedisease of rice caused by Fusarium moniliformae. *J Bio Sci* **1**(6):483-484.

Biswas S and Das S N (2002). Efficacy of fungicides for the control of Bakanae disease of rice. *Ann Pl Protec Sci* **10** (2):288-290.

Chandler J (2005). Cost reduction in SIT programmes using exosect auto-dissemination as part of area wide integrated pest management. *Int J Pest Control* **42**(2):257-260.

Iqbal M, Javed N, Yasin S I, Sahi S T and Wakil W (2013). Studies on chemical control of Bakanae disease (Fusarium moniliformae) of rice in Pakistan. *Pakistan J Phytopathology* **25**(2):146-154.

Kazempour M N and Elahinia S A (2007). Biological control of Fusarium fujikuroi, the causal agent of bakanae disease by rice associated antagonistic bacteria. *Bulgarian J Agric Sci* **13**:393-408.

Nyall R F(1999). Field Crop Diseases. Iowa State University Press, USA. p-1021.

Pannu P P S, Singh N, Rewal H S, Sabhikhi H S and Raheja S (2009). Integrated management of foot rot of basmati rice. *Plant Dis Res* **24**(1):84.

Saremi H, Ammarellou A, Marefat A and Okhovat S M (2008). Binam a rice cultivar, resistant for foot rot disease on rice caused by Fusarium moniliforme in North-West, Iran. *Int J Bot* **4**: 383-389.

Sunder S and Satyavir (1997). Survival of Fusarium moniliformein soil enriched with different nutrients and their combinations. *Indian Phytopath* **50**: 474-81.

Yasin S I, Khan T Z, Akhtar K M, Muhammad A and Mustaq A (2003). Economic evaluation of bakanae disease of rice. *Mycopath* **1**(2): 115-17.

Zhang H J, Bao S Z, Shen Y J, Gong C G and Zhu D Y (2000). Change in trait of bakanae disease-infected leggy rice seedlings and its influence in rice yield. *Acta Agril Shanghai* **16**(1): 67-71.

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