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Short Communication

Quantification of resistance among basmati rice genotypes to neck blast, *Pyricularia oryzae* Cavara

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Abstract

Level of resistance to neck blast disease (Pyricularia oryzae) was assessed in 69 rice germplasm lines including susceptible checks (Pusa 1401 and Pusa Basmati 1121) and resistant check (Tetep) under both artificial inoculation and natural epiphytotic conditions. Based on susceptibility index (Sx) value, the level of resistance among the genotypes was classified into moderately resistant (MR), moderately susceptible (MS), susceptible (S) and highly susceptible (HS) categories in comparison with controls. Sx differed significantly among test genotypes ranging from 2.83 to 12.83. Four genotypes *viz*., Pusa Basmati 1637, INGR 15001, INGR 15002 and Tetep exhibited a moderate level of resistance with Sx value < 3, AUDPC value between 70-140, lesion length between 2-5mm, respectively. Only one entry RYT 3672 showed a moderately susceptible reaction to the disease having Sx value of 5.98, AUDPC value of 169.8 and lesion length of 8.34 mm. AUDPC was positively correlated with lesion length. None of the test entry showed complete resistance to the disease. These entries can be used as donors for strengthening neck blast breeding programme in rice.

Key words: Neck blast, susceptibility index (Sx), AUDPC, RaRUDPC, *Pyricularia oryzae*

Rice (*Oryza sativa* L.) is the most important cereal crop and is widely cultivated throughout the world. India is leading exporter of 'Basmati rice' in the global market but still, its yield per unit area is very low due to losses in grain yield owing to the occurrence of diseases like blast, bakane/foot rot, and sheath blight. Among these diseases, blast of rice caused by *Pyricularia oryzae* Cavara (P.s. *Magnaporthe oryzae* B. Couch) is most devastating resulting in huge change to rice production (Barman and Chattoo 2005). In India, seven epidemics of rice blast disease have been reported causing huge yield losses ranging from 20-100 per cent (Vasudevan et al. 2014) and with each unit increase in neck blast disease incidence, there is a loss of yield around 0.23 g per plant (Koutroubas et al. 2009). Thus, the disease can have a bigger impact on the Indian economy as 50-80 per cent of Basmati is exported to the international and domestic market.

Earlier this disease was restricted particularly to the Amritsar, Bathinda, Patiala, Ferozepur, Roopnagar and Hoshiarpur districts of Punjab state (Prasad et al. 2011) but now it is appearing as major threat to Basmati cultivation and is prevalent throughout the Punjab state. The high prevalence is contributed by the cultivation of susceptible varieties along with widespread increase in area under Basmati cultivation in the recent past. The disease can be managed effectively through the use of chemical fungicides but may lead to high production cost, pesticide residue (Anonymous, 2018) in grains as well as environmental pollution, hence, breeding for host plant resistance is the most economical and viable method to manage rice blast. The present study was conducted to quantify the level of susceptibility of different Basmati genotypes to *Pyricularia oryzae* and to identify neck blast resistant donors.

Field experiments were conducted at two diverse locations *viz*., Ludhiana under artificial inoculated conditions and at Rice and Wheat Research Centre, at Malan, a hotspot location in Himachal Pradesh under natural epiphytotic conditions in *kharif* 2017. A total of 69 Basmati germplasm lines including susceptible checks (Pusa Basmati (PB) 1121 and Pusa Basmati 1401) and resistant check (Tetep) were grown at both the locations following standard cultivation practices.

Each entry was artificially inoculated with the most virulent isolate (NB-7) of *Pyricularia oryzae* using

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bit wrap technique (Jain et al. 2017) at 50 % flowering stage at appropriate time to prevent desiccation of fungal conidia. The inoculated plants were sprayed with water two to three times daily in order to maintain the humidity. Observations were recorded in terms of disease incidence (%), disease severity, incubation period (IP50) and lesion length as described below.

Measurement of disease incidence

Individual necks were observed for the appearance of typical symptoms of neck blast 16 days after inoculations. Total number of inoculated necks (N) and total number of necks having developed typical symptoms of neck blast (Σx) were recorded within each test entry. Percent disease incidence was calculated by using the formula:

$$\text{Per cent Disease Incidence} = \frac{\Sigma x}{N} \times 100$$

PDI = Per cent Disease Incidence

For recording the incubation period (time elapsed between inoculation and symptom appearance) each and every inoculated neck was observed carefully daily. IP 50 (when 50% of inoculated necks started exhibiting typical lesions) was recorded for each genotype separately. Assessment was performed until 16 DAI. Lesion length (mm) on necks was measured with the help of a ruler at 16 DAI.

Disease severity (0-9 scale) was recorded at 4, 7, 10, 13 and 16 days after inoculation (DAI) as per scale based on lesion length (Jain et al. 2017). Panicle blast severity was calculated as per SES scale IRRI (2002) using the following formula:

$$\text{Panicle blast severity} = \frac{10*n_1+20*n_3+40*n_5+70*n_7+100*n_9}{N}$$

where n_1-n_9 are the number of panicles with score 1-9 based on lesion length and "N" is the total number of panicle observed.

Table 1. Reaction of rice germplasm lines against neck blast disease under artificial inoculation conditions

S.No.	Group	Varieties	AUDPC	RaRUDPC	Lesion length (mm)	Disease incidence (%)	IP 50 (days)	Susceptibility index (Sx)	Host response (Sx based)
1.	A	RYT 3390, RYT 3404, RYT 4323, RYT 3428, RYT 3432, RYT 3433, RYT 3435, RYT 3517, RYT 3518, RYT 3521, RYT 3525, RYT 3630, RYT 3633, RYT 3648, RYT 3649, RYT 3650, RYT 3651, RYT 3653, RYT 3654, RYT 3655, RYT 3656, RYT 3658, RYT 3659, RYT 3661, RYT 3664, RYT 3665, RYT 3666, RYT 3667, RYT 3669, RYT 3670, RYT 3671, RYT 3674, RYT 3675, RYT 3676, RYT 3677, RYT 3678, PB 1121, BAS 386, PB 1509, PB 1401, Pb 2, Pb 3, Pb 4 and Pb 5	221.4-339 [a-b]	0.84-1.42	9.18-15.92 [a-b]	76-96 [a]	5.6-8.8 [a]	8.01-12.83	HS
2.	B	RYT 3426, RYT 3427, RYT 3429, RYT 3430, RYT 3522, RYT 3631, RYT 3632, RYT 3634, RYT 3644, RYT 3645, RYT 3646, RYT 3647, RYT 3652, RYT 3657, RYT 3660, RYT 3662, RYT 3668, RYT 3672, RYT 3673 and CSR 30	177.6-232.8 [a-b]	0.67-0.87	8.24-11.94 [a-b]	84-96 [a]	5.6-9.4 [a]	6.02-7.95	S
3.	C	RYT 3673	169.8 [a-b]	0.66	8.34 [a]	84 [a]	7 [a]	5.98	MS
4.	D	INGR 15001, INGR 15002, Tetep and PB 1637	79.2-95 [a]	0.31-0.32	2.74-2.89 [a]	80-84 [a]	6.4-7.0 [a]	2.83-2.91	MR

HS = Highly susceptible, S = Susceptible, MS = Moderately Susceptible, MR = Moderately resistant

Area under disease progress curve (AUDPC) was calculated as per Shaner and Finney (1977).

$$\text{AUDPC} = \sum_{i=1}^{n}[(Y_{i+n1} + Y_i)/2][X_{i+1} - X_i]$$

where,

Y_i = Panicle blast severity at the *i*th observation; X_i =time (days) at the *i*th observation; n = total number of observations

For calculating the relative level of resistance among the test genotypes, the Susceptibility index (Sx) values were calculated as per the procedure described by Yuen and Forbes (2009):

$$Sx = Sy \frac{Dx}{Dy}$$

where *Sy* and *Dy* represent, respectively, the assigned susceptibility scale value and observed disease progress value (AUDPC or RaRUDPC) for the standard genotype (Pusa Basmati 1401, susceptible check). Sx and *Dx* represent, respectively, the calculated susceptibility scale value and observed disease progress value for the genotype in question (individual test entry).

Disease assessment under natural epiphytotic conditions at the hotspot location was done considering each test entry and observations for neck blast incidence and disease severity were recorded as per SES scale (IRRI, 2002). Statistical analysis of the data was done with SPSS 20 software and analysis of variance was calculated at 95% confidence interval for each parameter.

Among 69 entries evaluated under artificial inoculation conditions only 4 entries *viz*., Pusa Basmati 1637, INGR 15001, INGR 15002 and Tetep were found moderately resistant against the disease (Table 1). The disease incidence (%) and IP 50 (days) among all the genotypes varied from 80-95 % and 6.2-9.4, respectively, which were statistically at par under artificial inoculation conditions. Therefore, to measure the relative level of resistance among different genotypes susceptibility index (Sx) was calculated. The entries with <3 score of susceptibility index (Sx) were considered as moderately resistant. Only one entry RYT 3672 showed a moderately susceptible reaction with Sx value of 5.98. However, 20 entries were found susceptible and 44 showed highly susceptible reaction with susceptibility index (Sx) values ranging from 6 to 8.

Longest lesion length was recorded on genotype, Pusa Basmati (PB) 1401 (15.92 mm) followed by Punjab Basmati (Pb) 4 (15.84mm) which was significantly higher than all other genotypes except Pb B 4, Pb B 5, Pb B 3, Pb B 2, PB 1509 and several RYT numbers (Table 1) and hence these were found to be highly susceptible to neck blast. A minimum lesion length was measured on Tetep (2.74 mm), INGR 15001 (2.84 mm), INGR 15002 (2.84 mm) and PB 1637 (2.84 mm) and were designated as moderately resistant. Almost similar results were obtained under the natural epiphytotic conditions at the hotspot location and hence the results were not presented. Four genotypes *viz*., Tetep, PB 1637, INGR 15001 and INGR 15002 showed moderately resistant reaction with disease incidence of <25 per cent. However, out of 60 test entries, 34 genotypes showed susceptible reaction and 31 genotypes were observed as highly susceptible with disease incidence ranging from 26-50% and >50% respectively. The average lesion length produced on all the genotypes ranged from 4.2-14.8 mm and the average panicle blast severity was calculated ranging between 17.5-62.3 per cent.

Significant differences were obtained among the genotypes under artificial inoculation conditions with respect to AUDPC value and lesion length (mm) but results are insignificant in terms of I.P 50 (days) and disease incidence (%). Results also revealed that genotypes significantly differed with respect to the level of resistance under both artificial inoculation conditions as well as natural epiphytotic conditions.

Various research workers have evaluated rice/basmati genotypes for blast resistance using different assessment criteria from different parts of the world. Zewadu et al (2017) screened 46 Korean rice accessions against rice blast disease using different parameters viz., disease severity, lesion size and area under disease progress curve (AUDPC) and reported that only three genotypes like SRHB-133, SPHB-93 and SRHB-78 showed resistant reaction in both the field and screenhouse conditions. The lowest lesion size was also measured from these genotypes. Kumar et al. (2010) also evaluated 22 elite *indica* rice genotypes against blast disease under artificial inoculation conditions based on disease severity (%) and AUDPC values. Out of 22 genotypes, 13 rice genotypes showed resistant reaction with disease severity less than 46 % and AUDPC value of 1000 respectively. Similarly, various workers in India and abroad have evaluated Basmati and non-Basmati genotypes against blast under natural or artificially modulated conditions and identified resistant sources

namely, Baigon Mumji and Adi Batta (Turaidar et al. 2018).

Breeding for disease resistance is a most effective method for blast management. Though many resistant varieties to *P. oryzae* have been developed, the resistance is not long lasting, because of the highly variable nature of the pathogen (Lang et al. 2009; Rama Devi et al. 2015). Hence, development of broad-spectrum and durable resistant varieties is essential for containing this disease. Thus, the genotypes identified as moderately resistant to neck blast in this study can be exploited further for blast resistance breeding programmes.

Authors' contribution

Conceptualization of research (JJ, SJ, JS); Designing of the experiments (JJ, SJ, JS); Contribution of experimental materials (JJ, JSL, SU); Execution of field/lab experiments and data collection (JJ, SU, JS, SJ); Analysis of data and interpretation (JJ, SU, JS); Preparation of manuscript (JJ, JS).

Declaration

The authors declare no conflict of interest.

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