

Influence of age of rice plant on bacterial blight disease development

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ABSTRACT

Gene x Environment (GE) interactions are well known in influencing the gene expression. Bacterial blight (BB) of rice is the most important disease influencing heavy losses under congenial conditions. In the present study response of resistance genes identified against BB is studied under Chhattisgarh condition. Eighty nine genotypes were chosen to study the influence of age of the plant on resistance against bacterial blight development at three growth stages i.e. seedling, maximum tillering and boot to flowering. Results indicated that the genotypes, crop growth stages and their interaction were significant. Two years data indicated that the genotypes IRBB-52; CRMAS-2231-31; IRBB-55; IRBB-54 and CRMAS-2231-34 had the least infection and five genotypes i.e. TN-1; IR-8; Tetep; IR-24 and IR-64 had the maximum infection. The over all general mean of the genotype response at different growth stages clearly indicated that maximum bacterial blight developed at boot stage to flowering stage though; there were exceptions within in the genotypes.

Key words: rice, genotypes, resistance, bacterial blight, *Xanthomonas oryzae* pv. *oryzae*

Bacterial blight (BB) of rice caused by *Xanthomonas oryzae* pv. *oryzae* is one of the most extensively studied disease with particular emphasis on resistant cultivars and their nature of resistance. The gene expression depends largely on the climatic conditions of that region, also on the virulence spectrum. Many virulent isolates of BB are reported to be prevalent in Chhattisgarh (Thrimurthy *et al.*, 1993 and AICRIP reports, 2002-2007). It is very useful to know the performance of different resistant genes under Chhattisgarh condition for better planning of the strategies for resistant breeding against this disease. Present study was undertaken to study the influence of age of rice plant on different genotypes.

For studying the effect of plant age on bacterial blight development was recorded at three growth stages *i.e.* seedling, maximum tillering and boot to flowering. Eighty nine resistant genotypes (including isogenic lines, differentials, pyramids and susceptible check) were chosen for this study. This study was conducted at Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during wet season 2007-08 and dry season 2008-09 under factorial randomized block design with

three replications. The genotypes were tested under direct sown condition, seeded in two meter row length. Three replications with four rows for each genotype were maintained to test one row at one growth stage as specified above. The plants were clip inoculated (Kauffman *et al.*, 1973) as per the growth stage. The disease developed was recorded after 21st day of inoculation and scoring was made. Basal fertilizers were incorporated at the rate of 60 Kg N and 50 Kg P. Two top dressings at the rate of 30 Kg N ha⁻¹ were given at tillering and panicle initiation stage of the crop. The per cent disease developed was recorded after 21st day of inoculation.

Most of the recorded resistance reaction to field isolate of this region was as per the standard evaluation system (IRRI, 1996). The genotypes IRBB-52, CRMAS-2231-31, IRBB-55, IRBB-54 and CRMAS-2231-34 had the least infection, while TN-1, IR-8, Tetep, IR-24, and IR-64 had the maximum infection. The genotypes also responded differently at different growth stages.

The over all general mean of the genotype response at different growth stages clearly indicated

Table 1. Response of genotypes to disease development at different growth stages

Varieties	Genotypes	Disease severity (%)			
		Seedling Stage	Max. Tillering Stage	Boot Stage	Over all Mean
IRBB-1	Xa 1	44.38 (41.77)	24.87 (29.91)	52.55 (46.46)	40.6 (39.38)
IRBB-3	Xa 3	11.72 (20.02)	3.14 (10.2)	41.64 (40.19)	18.83 (23.47)
IRBB-4	Xa 4	15.55 (23.22)	30.98 (33.82)	49.25 (44.57)	31.93 (33.87)
IRBB-5	Xa 5	27.3 (31.5)	37.07 (37.5)	49.06 (44.46)	37.81 (37.82)
IRBB-7	Xa 7	33.24 (35.21)	15 (22.79)	46.61 (43.06)	31.62 (33.68)
IRBB-8	Xa 8	9.2 (17.66)	7.49 (15.88)	17.55 (24.77)	11.41 (19.44)
IRBB-10	Xa 10	14.43 (22.33)	35.9 (36.81)	61.8 (51.82)	37.38 (36.99)
IRBB-11	Xa 11	16.66 (24.09)	44.34 (41.75)	39.5 (38.94)	33.5 (34.93)
IRBB-14	Xa 14	13.65 (21.68)	40.06 (39.27)	38.83 (38.54)	30.85 (33.16)
IRBB-50	Xa 4 + xa 5	9.95 (18.38)	14.48 (22.36)	34.54 (36.00)	19.65 (25.58)
IRBB-51	Xa 4 + Xa 13	8.77 (17.22)	15.24 (22.98)	16.8 (24.2)	13.6 (21.47)
IRBB-52	Xa 4 + Xa 21	3.27 (10.42)	5.56 (13.64)	3.37 (10.57)	4.07 (11.54)
IRBB-53	xa 5 + Xa 21	5.73 (13.85)	7.81(16.23)	3.89(11.37)	5.81(13.82)
IRBB-54	xa 5 + Xa 21	5.18 (13.15)	3.98 (11.5)	6.17 (14.38)	5.11 (13.01)
IRBB-55	xa 13 + Xa 21	5.29 (13.3)	3.17 (10.26)	6.57 (14.85)	5.01 (12.8)
IRBB-56	Xa 4 + xa 5 + xa 13	2.51 (9.12)	0.87 (5.34)	14.81 (22.63)	6.06 (12.36)
IRBB-57	Xa 4 + xa 5 + Xa 21	4.86 (12.73)	7.98 (16.4)	13.36 (21.44)	8.73 (16.86)
IRBB-58	Xa 4 + xa 13 + Xa 21	30.19 (33.33)	5.02 (12.95)	13.78 (21.79)	16.33 (22.69)
IRBB-59	Xa 5 + xa 13 + Xa 21	7.57 (15.97)	33.54 (35.39)	12.24 (20.47)	17.78 (23.95)
IRBB-60	Xa 4 + xa 5 + xa 13+ Xa 21	1.84 (7.8)	40.31 (39.41)	15.44 (23.14)	19.2 (23.45)
CRMAS-2231-1	xa 5	15.74 (23.38)	48.69 (44.25)	13.7 (21.72)	26.04 (29.78)
CRMAS-2231-2	xa 5	37.75 (37.91)	29.00 (32.58)	24.63 (29.75)	30.46 (33.41)
CRMAS-2231-3	xa 5	29.76 (33.06)	26.85 (31.21)	25.6 (30.39)	27.4 (31.55)
CRMAS-2231-4	xa 5	25.08 (30.05)	41.81 (40.28)	13.24 (21.33)	26.71 (30.56)
CRMAS-2231-5	xa 5	22.18 (28.1)	36.29 (37.04)	16.26 (23.78)	24.91 (29.64)
CRMAS-2231-6	xa 5	13.69 (21.71)	27.22 (31.45)	22.26 (28.15)	21.05 (27.1)
CRMAS-2231-7	xa 13	9.44 (17.89)	5.54 (13.62)	11.74 (20.04)	8.91 (17.18)
CRMAS-2231-8	xa 13	6.23 (14.45)	5.7 (13.81)	12.56 (20.76)	8.16 (16.34)
CRMAS-2231-9	xa 13	6.48 (14.74)	5.46 (13.51)	11.18 (19.53)	7.7 (15.93)
CRMAS-2231-10	xa 13	7.86 (16.29)	5.02 (12.95)	6.12 (14.32)	6.34 (14.52)
CRMAS-2231-11	xa 13	12.05 (20.31)	4.2 (11.82)	7.44 (15.82)	7.89 (15.98)
CRMAS-2231-12	xa 13	12.5 (20.7)	1.3 (6.54)	11.29 (19.64)	8.36 (15.63)
CRMAS-2231-13	Xa 21	17.88 (25.02)	2.33 (8.79)	15.59 (23.26)	11.94 (19.02)
CRMAS-2231-14	Xa 21	13.99 (21.96)	1.66 (7.41)	23.05 (28.69)	12.9 (19.35)
CRMAS-2231-15	Xa 21	25.48 (30.31)	5.37 (13.4)	25.47 (30.31)	18.77 (24.67)
CRMAS-2231-16	Xa 21	18.85 (25.73)	4.41 (12.12)	24.58 (29.72)	15.94 (22.52)
CRMAS-2231-17	Xa 21	21.51 (27.63)	5.2 (13.19)	13.33 (21.41)	13.35 (20.74)
CRMAS-2231-18	Xa 21	20.27 (26.75)	5.93 (14.09)	13.61 (21.65)	13.27 (20.83)
CRMAS-2231-19	xa 5 + xa 13	11.16 (19.52)	27.34 (31.52)	33.21 (35.19)	23.9 (28.74)
CRMAS-2231-20	xa 5 + xa 13	24 (29.33)	42.32 (40.58)	26.6 (31.04)	30.97 (33.65)
CRMAS-2231-21	xa 5 + xa 13	15.25 (22.99)	26.58 (31.03)	19.04 (25.87)	20.29 (26.63)
CRMAS-2231-22	xa 5 + xa 13	25.54 (30.36)	26.96 (31.28)	20.79 (27.12)	24.43 (29.59)
CRMAS-2231-23	xa 5 + xa 13	24.08 (29.38)	28.86 (32.49)	35.14(36.36)	29.36(32.74)
CRMAS-2231-24	xa 5 + Xa 21	12.49 (20.69)	22.04(28)	34.38(35.9)	22.97(28.2)
CRMAS-2231-25	xa 5 + Xa 21	9.95 (18.39)	25.8 (30.52)	33.95 (35.64)	23.23 (28.18)
CRMAS-2231-26	xa 5 + Xa 21	6.17 (14.39)	29.42 (32.84)	35.98 (36.86)	23.86 (28.03)

Contd. Table 1

Varieties	Genotypes	Disease severity (%)			
		Seedling Stage	Max. Tillering Stage	Boot Stage	Over all Mean
CRMAS-2231-27	xa 5 + Xa 21	11.14 (19.5)	14.84 (22.66)	37.71 (37.89)	21.23 (26.68)
CRMAS-2231-28	xa 5 + Xa 21	11.26 (19.61)	26.81 (31.18)	40.76 (39.68)	26.28 (30.15)
CRMAS-2231-29	xa 13 + Xa 21	8.55 (17)	11.41 (19.74)	12.63 (20.81)	10.86 (19.18)
CRMAS-2231-30	xa 13 + Xa 21	11.11 (19.47)	12.78 (20.95)	11.93 (20.2)	11.94 (20.21)
CRMAS-2231-31	xa 13 + Xa 21	5.32 (13.34)	2.55 (9.19)	6.91 (15.24)	4.93 (12.59)
CRMAS-2231-32	xa 13 + Xa 21	5.04 (12.97)	3.94 (11.44)	12.79 (20.96)	7.26 (15.12)
CRMAS-2231-33	xa 13 + Xa 21	6.56 (14.83)	1.47 (6.97)	12.51 (20.71)	6.85 (14.17)
CRMAS-2231-34	xa 5 + xa 13 + Xa 21	6.28 (14.51)	0.9 (5.43)	9.14 (17.6)	5.44 (12.51)
CRMAS-2231-35	xa 5 + xa 13 + Xa 21	8.1 (16.54)	1.44 (6.9)	14.64 (22.5)	8.06 (15.31)
CRMAS-2231-36	xa 5 + xa 13 + Xa 21	6.28 (14.51)	1.2 (6.28)	19.28 (26.05)	8.92 (15.61)
CRMAS-2231-37	xa 5 + xa 13 + Xa 21	6.72 (15.02)	4.63 (12.42)	23.89 (29.26)	11.75 (18.9)
CRMAS-2231-38	xa 5 + xa 13 + Xa 21	19.75 (26.39)	3.67 (11.04)	24.54 (29.69)	15.98 (22.37)
CRMAS-2231-39	xa 5 + xa 13 + Xa 21	13.37 (21.45)	1.78 (7.66)	16.65 (24.08)	10.6 (17.73)
CRMAS-2231-40	xa 5 + xa 13 + Xa 21	25.5 (30.33)	3.91(11.41)	16.31 (23.82)	15.24 (21.85)
CRMAS-2231-41	xa 5 + xa 13 + Xa 21	19.75 (26.39)	3.01 (9.98)	13.52 (21.57)	12.09 (19.31)
CRMAS-2231-42	xa 5 + xa 13 + Xa 21	6.9 (15.22)	10.49 (18.9)	20.55 (26.96)	12.65 (20.36)
CRMAS-2231-43	xa 5 + xa 13 + Xa 21	8.2 (16.64)	10.86 (19.24)	24.05 (29.37)	14.37 (21.75)
CRMAS-2231-44	xa 5 + xa 13 + Xa 21	7.05 (15.4)	12.17 (20.42)	25.07 (30.05)	14.76 (21.95)
CRMAS-2231-45	xa 5 + xa 13 + Xa 21	24.77 (29.84)	11.87 (20.15)	25.58 (30.38)	20.74 (26.79)
CRMAS-2231-46	xa 5 + xa 13 + Xa 21	6.7 (15)	11.28 (19.62)	25.26 (30.17)	14.41 (21.6)
CRMAS-2231-47	xa 5 + xa 13 + Xa 21	8.95 (17.41)	11.33 (19.67)	23.62 (29.08)	14.63 (22.05)
CRMAS-2231-48	xa 5 + xa 13 + Xa 21	10.97 (19.34)	12 (20.27)	13.48 (21.54)	12.15 (20.38)
CRMAS-2231-49	xa 5 + xa 13 + Xa 21	13.28 (21.37)	7.01 (15.35)	17.11 (24.43)	12.47 (20.38)
CRMAS-2231-50	xa 5 + xa 13 + Xa 21	6.8 (15.11)	0.86 (5.33)	16.63 (24.06)	8.09 (14.83)
IR-24	Xa 18	64.79(53.6)	52.05(46.17)	43.31 (41.15)	53.38 (46.98)
IR-64	-	70.82 (57.3)	45.53 (42.44)	33.68 (35.48)	50.01 (45.07)
K-20	-	3.2 (10.3)	8.26 (16.7)	21.48 (27.61)	10.98 (18.21)
BJ-1	xa 5 + xa 13	37.02 (37.48)	12.27 (20.5)	42.73 (40.82)	30.67 (32.93)
Haskalmi	-	43.27 (41.13)	19.71 (26.36)	57.05 (49.05)	40.01 (38.85)
Chuguku-45	-	20.86 (27.17)	39.49 (38.93)	49.99 (44.99)	36.78 (37.03)
IET-8585	-	27.57 (31.67)	23.56 (29.04)	54.67 (47.68)	35.27 (36.13)
IR 20	Xa 4	20 (26.57)	1.51 (7.05)	38.38 (38.28)	19.96 (23.96)
IET-8520	-	30.61 (33.59)	19.31 (26.07)	29.4 (32.83)	26.44 (30.83)
Jawa-14	Xa 1 + Xa 3 + Xa 12	23.12 (28.74)	1.62 (7.3)	7.76 (16.17)	10.83 (17.4)
Chemposelak	-	27.83 (31.84)	24.06 (29.37)	5.44 (13.49)	19.11 (24.9)
IR 72	-	22.29 (28.17)	45 (42.13)	32.95 (35.03)	33.41 (35.11)
IR 8	Xa11	67.96 (55.53)	50.95 (45.55)	59.45 (50.45)	59.46 (50.51)
PR-111	-	18.89 (25.76)	61.11 (51.42)	56.48 (48.72)	45.49 (41.97)
Tetep	Xa 1 + Xa 2 + Xa 12	58.63 (49.97)	57.9 (49.55)	51.41 (45.81)	55.98 (48.44)
TKM-6	Xa 4	18.2 (25.26)	26.23 (30.81)	37.4 (37.7)	27.28 (31.25)
Zenith	Xa 6	22.7 (28.45)	29.46 (32.87)	42.92 (40.93)	31.69 (34.09)
RP Bio-226	-	14.92 (22.72)	1.6 (7.27)	1.64 (7.35)	6.05 (12.44)
TN-1	Xa 14 (Susceptible check)	49.87 (44.92)	80.26 (63.62)	51.18 (45.67)	60.43 (51.41)
General Mean	18.17 (25.23)	18.54 (25.5)	25.28 (30.19)	20.67 (25.39)	
		Sem+	CD (P<0.05)		
Variety (V) =		0.18	0.5		
Stage of inoculation (T) =		0.03	0.1		
V x T =		0.31	0.86		

Values in the parantheses represents Arc sine transformed values. * Average of three replications

that maximum bacterial blight developed at boot stage to flowering stage though, there were exceptions within the genotypes. The seedling stage also showed infection next to booting to flowering stage. Maximum tillering stage had less infection as compared to other stages.

The overall mean per cent disease severity was 18.17 % with the ranges between 1.84 % (IRBB-60) to 67.96 % (IR-8) observed at seedling stage. The minimum per cent disease pressure was in IRBB-60 (1.84 %), which possessed the gene(s) *Xa 4 + xa 5 + xa 13 + Xa 21* followed by IRBB-56. The mean maximum per cent disease pressure in seedling stage was recorded in IR-8, which was also known to be susceptible (Table 1). The overall mean per cent disease severity at maximum tillering varied between 0.86 % (CRMAS-2231-50) to 48.69 % (CRMAS-2231-1). The minimum disease severity was recorded in CRMAS-2231-50 which possessed the gene(s) *xa 5 + xa 13 + Xa 21* followed by IRBB-56. The maximum disease pressure was observed in CRMAS-2231-1 (48.69%) and also in susceptible check (TN-1) (80.26 %). At boot to flowering stage, the disease severity was in the range of 1.64% (RP Bio-226) to 61.80% (IRBB-10). The minimum was recorded in RP Bio-226 (1.64%) followed by IRBB-52 (3.37%), and the maximum disease pressure was observed in IRBB-10 (61.80 %).

The general disease development pattern was more at boot to flowering stage infection followed by seedling stage. At maximum tillering stage more genotypes recorded low disease per cent. However, 31 genotypes out of the 89 showed more disease development at maximum tillering stage inoculated than at seedling stage. Though, at boot to flowering stage maximum number of genotypes showed more disease than seedling and maximum tillering stages; in general, there were also genotypes that recorded less disease intensity at this stage than maximum tillering stage which numbered to 19. The genotypes that scored less disease at boot to flowering stage than at seedling stage numbered to 22. The genotypes consistently recorded resistant reactions at all the three stages of study were IRBB-52; CRMAS-2231-31; IRBB-55; IRBB-54 and CRMAS-2231-34. Single resistant gene possessing genotypes recorded more disease severity in general at all growth stages with exceptions like IRBB-3; IRBB-8; CRMAS-2231-1; CRMAS-2231-7; CRMAS-2231-8; CRMAS-2231-9; CRMAS-2231-10;

CRMAS-2231-11; CRMAS-2231-12; CRMAS-2231-13; CRMAS-2231-14; CRMAS-2231-15; CRMAS-2231-16; CRMAS-2231-17; CRMAS-2231-18 and IR-20 than genotypes with genes pyramided.

Variation in per cent disease development was also recorded within the marker aided selections of the gene combination CRMAS genotypes. The genotypes that recorded resistant reaction both at seedling and maximum tillering stage were IRBB-56; IRBB-52; IRBB-53; IRBB-54 and IRBB-55. The interaction between the genotype and stage of infection on per cent disease development was significant. The genotype IRBB-60 recorded the least per cent disease severity at seedling stage followed by IRBB-56, IRBB-52 and IRBB-57, respectively.

Similarly, the genotype CRMAS-2231-50 recorded the least per cent disease severity at maximum tillering stage followed by IRBB-56. At boot to flowering stage RP-Bio-226 recorded the least damages. Most of the genotypes responded to the infection differently and confirmed also that resistant gene expression varies according to the stage of the crop. Khare and Thrimurthy (2006) also reported that disease severity at late stage were less as compared to seedling stage corroborating with the present findings. On the contrary Hossain *et al.* (1982) reported that disease severity increased with the age of the plant in the variety tested and also in the mutants developed. Gene specific (*Xa 21*) adult plant resistance was also reported by Sahu (1987). Thrimurthy *et al.* (2005) also reported that variations occurred within the marker aided selections of same genotypes which might be due to the virulence of the pathogen population existing and also the congenial condition prevailing.

The present investigation indicated that most of the genotypes responded to the infection differently confirming that gene (s) expression may also depend upon the stage (*i.e.* growth stage) of the host plant. The genotypes that consistently recorded resistant reactions at all the three stages are IRBB-52; CRMAS-2231-31; IRBB-55; IRBB-54, CRMAS-2231-34, IRBB-60, IRBB-56, K-20 and IRBB-57 and may be recommended for Chhatisgarh region. Variations are also observed in disease resistance within the variety of same genes back ground which might be due to the additional factors present in the variety.

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