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EVALUATION OF RICE GENOTYPES FOR RESISTANCE AGAINST BACTERIAL LEAF BLIGHT

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Abstract

Assessment of losses in yield and yield components by bacterial leaf blight of 11 rice genotypes viz., PARC-291, PARC-292, PARC-293, PARC-294, PARC-295, PARC-296, PARC-297, PARC-298, PARC-299, PARC-300, PARC-301 were carried out under natural field conditions of Mansehra. Significant differences were observed for all the traits studied. Lowest infection was shown by PARC-301 with a disease scoring of 42.5, minimum and statistically equivalent number of days to 50% heading observed in PARC-294 (79 days), PARC-296 (81.3 days) and PARC-299 (81.3 days), maximum plant height 68.5 cm in PARC-298, maximum 25 tillers in PARC-292, maximum value for spike length showed by PARC-296 (21.6 cm), maximum number of grains in PARC-292 (161.3), PARC-292 and PARC-298 out yielded in straw yield and grain yield with a value of 5.6 kg/plot and 2.567 kg/plot, respectively. The genotypes PARC-298, PARC-299 and PARC-301 showed resistance to bacterial leaf blight and out yielded in grain yield. These genotypes are recommended for general cultivation and further use in breeding programmes.

Introduction

Rice (*Oryza sativa* L.), a member of the family Graminae is widely grown in tropical and subtropical regions (Ezuka & Kaku, 2000). Approximately 90% of the world's rice is grown in the Asian continent and constitutes a staple food for 2.7 billion people worldwide (Salim *et al*., 2003). In Pakistan it is the second most important staple food after wheat and is also one of the main export items of the country. During 2005-2006 the crop was grown over an area of 2621.4 thousands hectares with 5547.2 thousands tones production (Anon., 2005-2006). Rice is grown in all the provinces of Pakistan. The main group of varieties is Basmati and IRRI.

It is however unfortunate that such an important crop is attacked by many kinds of diseases, of which bacterial leaf blight (BLB) caused by *Xanthomonas oryzae* is one of the most destructive diseases throughout the world (Mew, 1987). Bacterial blight is considered important disease in various parts of rice growing areas of Pakistan (Kamal *et al*., 1968). Among the major diseases of rice, bacterial leaf blight causes substantial loss in quality and quantity of the crop. Blight of rice affect filling of the grains and emergence of panicles, about 28-30% yield reduction was observed in susceptible cultivars (Shahjahan *et al*., 1991). The disease may weaken the seedling and in older plants the loss of grain may be 4.578-29.1% (Bedi & Gill, 1960). There is a report of loss in rice crop due to blight up to 59-90% (Ghose *et al*., 1970). The main symptoms of the disease are water soaked stripes along the margin of leaf blades, which later on enlarge and turn yellow. These lesions may cover the entire blade, may extend to the lower end of leaf sheath. Similar symptoms may occur on glumes of green grains. The organism

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survives in the rhizosphere of weed hosts, infected straw and root stubble and disseminate by wind and water. Cultivation of resistant varieties is alone easy and safe way to protect the crop against bacterial leaf blight. Bacterial leaf blight has the potential to become a destructive bacterial disease of rice in Pakistan and can cause huge losses mainly because of the lack of information regarding the pathogen and its effective measure of control. Therefore the present study was conducted with the following objectives. (i) To increase rice yield by the development of resistant varieties, (ii) To investigate and recommend effective measure for the control of bacterial leaf blight of rice and (iii) To evaluate different rice varieties for resistance against bacterial leaf blight.

Materials and Methods

Rice genotypes viz., PARC-291, PARC-292, PARC-293, PARC-294, PARC-295, PARC-296, PARC-297, PARC-298, PARC-299, PARC-300 and PARC-301 were the materials used for evaluation. The genotypes were obtained from NARC Islamabad. Sowing for nursery production was done during the third week of May 2006. The experiment was conducted at the Agricultural Research Station Baffa (Mansehra). The 30 days old nursery was transplanted into the field in Randomized Complete Block Design with three replication. The plot size used was 3 x 5 m, six rows of each variety were sown per plot and the row-to-row and plot-to-plot distance was kept at 20-cm. Puddling was done in accordance with the approved procedures. Fertilizer, weeding, pesticides and irrigation were done as per requirement of rice crop. Harvesting was completed in third week of October 2006. The data were recorded on disease scoring according to standard formula as following.

$$\text{Disease scoring} = \frac{\text{Lesion leaf length}}{\text{Total leaf length}} \times 100$$

Number of days to 50 % heading, plant height (cm), tillers per plant, spike length (cm), number of grains per spike, straw yield kg/plot and yield kg/plot.

Results and Discussion

It has been witnessed during the last century that breeding crop plants is the only area for securing the global food problem. The breeding methods along with some innovation are used for evolving and screening crops (Ahmad *et al*. 2008, Khan *et al*. 2008, Gul *et al*. 2007, Nisar *et al*. 2007 and Ahmad, 2001). Statistical analysis (Table 1) revealed significant differences for all the traits studied. Trait wise discussions are presented below:

Disease scoring: The analysis revealed significant differences among varieties for disease scoring. The variety PARC-301 was the most resistant one having least disease score value, followed by PARC-293, PARC-294, PARC-298, PARC-299 and PARC-300 with statistically similar disease scoring and these varieties were found most resistant ones. Bacterial leaf blight is considered important disease at various parts of rice growing areas of Pakistan Among the major disease of rice; Bacterial leaf blight causes substantial loss in quantity and quality of the crop. Bacterial leaf blight attacks on leaves and leaf sheath of rice plant at tiller and booting stage (Ou, 1972; Akhtar, 2003; Chunming *et al*., 2005).

Table 1. Analysis of variance for the traits studied.

Traits	Mean Squares			CV%
	Replications (df=2)	Genotypes (df=10)	Error (df=20)	
1. Disease scoring	72.73	112.35**	45.49	12.73
2. Days to 50% heading	14.66	213.28**	6.86	2.3
3. Plant height	82.37	17.49**	24.53	10
4. Number of tillers/plant	0.39	10.26**	4.19	9.6
5. Spike length	12.65	64.32**	8.33	17.09
6. Number of grains/spike	0.93	451.42**	137.40	8.48
7. Straw yield kg/plot	0.26	2.64**	0.52	16.36
8. Grain yield kg/plot	0.26	0.54**	0.07	15.58

Days to 50% heading: The statistical analysis of the data revealed significant difference among genotypes for 50% heading (Table 1). Data on days to 50% heading of rice varieties are presented in Table 2. The highest number of days to 50% heading was recorded in PARC-300 (104) and PARC-291 (103) followed by PARC-295 (90), PARC-298 (88.3), PARC-293 (86.3), PARC-301 (86.3), PARC-292 (83.7), PARC-297 (82.3), PARC-296 (81.03), PARC-299 (81.3) and PARC-294 (79). Blight of rice affect filling of the grains and emergence of panicles and about 28-30% yield reduction was observed in susceptible cultivars (Shah Jahan *et al*., 1991; Karish *et al.,* 2003 and Inamullah *et al*., 2006a).

Plant height: Statistical analysis revealed significant differences among the genotypes for plant height (Table 1). PARC-298 was the tallest among all the cultivars with 68.5 cm while PARC-299 (60.5 cm), PARC-296 (60 cm), were statistically similar followed by PARC-293 (58.5cm), PARC-297 (58.3cm), PARC-294 and PARC-292. However the variety PARC-301 and PARC-295 were shortest in plant height. Tall varieties often lodges, therefore shortest plant height is desirable. Dat *et al*., (1978), Belaya (1979) and Ponciano *et al*., (2004) have reported similar results for plant height.

Number of tillers per plant: The difference among the varieties for number of tillers per plant was found significant (Table 1). The variety PARC-292 ranked on top among the varieties with 25 tillers (Table 2) followed by PARC-298 with 24.3, PARC-296 (22.7), PARC-297, and PARC-301 (21) each. PARC-291, PARC-293, PARC-294, PARC-295, PARC-299 and PARC-300 were statistically similar in performance having least number of tillers. Tillers number is an important yield component, more number of tillers are required. PARC-292 and PARC-298 produced highest number of tillers and thus performed better in number of grains, straw yield and grain yield. Similar results have also been reported by Chum & Lin (1977), Chakravarty & Barthakur (1980), Sendhira *et al.,* (2002) and Inamullah *et al*., (2006b).

Spike length: The analysis of variance showed significant difference for spike length (Table 1). Maximum spike length was recorded in PARC-296 (21.6 cm), PARC-298 (20 cm), PARC-293 (19.8cm), PARC-294 (19.2 cm), PARC-297 (17.9 cm), PARC 299 (17.5cm) and PARC-301 (13.9cm), while shortest spike length was recorded in PARC-300 (10cm). Spike length is an important yield contributing trait, increased spike length adds towards more number of grains and hence increased spike length is desirable. The previous workers like Lee & Yun (1980), Lai & Thai (1981) and Zhou *et al*., (2001) have also reported similar results.

Table 2. Performance of rice genotypes for disease scoring, days to 50% heading, plant height (cm), number of tillers per plant, spike length (cm), number of grains per spike, straw yield kg/plot and yield kg/plot.

S. No.	Varieties	Disease scoring	Days to 50 % heading	Plant height (cm)	No Tillers per plant	Spike length (cm)	No. of grain per spike	Straw yield kg/plot	Yield kg/ plot
1	PARC 291	55.2 ABC	103 A	50.5 CD	19.3 C	10.5 DE	128.3 BC	3.767 CD	1.600 C
2	PARC 292	55.6 ABC	83.7 CDE	56.6 BC	25.0 A	19.8 AB	161.3 A	5.667 A	1.867 BC
3	PARC 293	51.5 BC	86.3 BCD	58.9 BC	20.3 C	19.8 AB	128.3 C	5.167 AB	1.867 BC
4	PARC 294	47.5 BC	79 E	57.7 BC	20.3 C	19.2 ABC	121.7	3.000 D	1.667 C
5	PARC 295	66.1 A	90 B	47.2 D	20.0 C	15.6 BCD	147.3 AB	4.333 ABC	0.863 D
6	PARC 296	56.8 AB	81.3 E	60 AB	22.7 ABC	21.6 A	141.3 ABC	5.500 A	1.867 BC
7	PARC 297	55.5 ABC	82.3 DE	58.3 BC	21.0 BC	17.9 ABC	142.3 ABC	5.167 AB	2.033 B
8	PARC 298	51.3 BC	83.3 BC	68.5 A	24.3 AB	20.0 AB	127.3 BC	4.833 ABC	2.567 A
9	PARC 299	52.5 BC	81.3 E	60.5 AB	20.3 C	17.5 ABC	143.7 ABC	3.000 D	2.200 AB
10	PARC 300	48.0 BC	104 A	42.2 D	20.3 C	10.0 E	128.0 BC	4.500 ABC	1.600 C
11	PARC 301	42. 5 C	86.3 BCD	47.6 D	21.0 BC	13.9 CDE	150.0 AB	3.833 BCD	1.600 C
		LSD=11.49	LSD=4.463	LSD=8.437	LSD=3.488	LSD=4.918	LSD=19.96	LSD=1.235	LSD=0.476
		CV=12.73%	CV=2.98%	CV=8.96%	CV=9.6%	CV=17.09%	CV=8.48%	CV=16.36%	CV=15.58%

Number of grains per spike: The analysis of variance showed significant difference among the varieties for number of grains per spike (Table 1.). The highest number of grains were produced by the varieties PARC-292(161.3) followed by PARC-301 (150.0), PARC-295(147.3), PARC-299(143.7), PARC-297(142.3) and PARC-296(141.3). The least number of grains per spike was recorded in PARC-294(121.7) and PARC-293(128.3) (Table 2). The number of grains per spike increases yield by increasing the number of productive branches, and also increase lodging resistance and ease of harvesting (Hanada, 1978; Giri & Laxmi, 2000).

Straw yield: Straw yield was also found significant among varieties (Table 1). The highest straw yield was produced by varieties PARC-293(5.667kg/plot), PARC-296 (5.5kg/plot) followed by PARC-293(5.157kg/plot) and PARC-297 (5.167kg/plot). The least straw yield was produced by the variety PARC-299 and PARC-294 (3.0kg/plot). Maski & Ohyama, 1976 and Tano, *et al*., (1976) and Wade, *et al*., (1999) have also reported similar results.

Grain Yield: Analysis of variance showed significant difference among the varieties for grain yield (Table 1). Highest grain yield of 2.567 kg/ plot by PARC-298 followed by PARC-299 (2.20kg/plot) and PARC 297 (2.03kg/plot). Lowest grain yield of 0.863 kg/plot was shown by PARC-295. Observation of yield and three other characters indicated that selection for yield together with number of tillers per plant and number of grain per panicle would be the most effective method for increasing yield. Selection for two or more character was more effective than selection for a single character (Chang & WU, 1976). There may be 50% reduction in yield due to severe infection (Mew, *et al*., 1993; Shahjehan *et al*., 1991; Rao *et al*., 2002 and Yonghong *et al*., 2005).

References

Ahmad, H. 2001. Genetic studies in some *Brassica* species and their hybrids. Ph.D. Thesis Department of Botany, University of the Punjab, Lahore.

Ahmad, H., M. Islam, I. A. Khan, Haidar Ali, H. Rahman and Inamullah. 2008. Evaluation of Advance Rapseed Line HS-98 for yield attributes and biochemical characters. *Pak. J. Bot*. 40: 1099-1101.

Akhtar, M.A. 2003. Inoculum builds up of bacterial blight of rice in rice-wheat cropping area of Punjab in relation to zero tillage. *Asian Journal of plant sciences*, 2: 548-550.

Anonymous. 2006. *Agricultural Statistics of Pakistan.* Government of Pakistan, Ministry of food, agricultural and livestock (Economic Wing), Islamabad. pp. 13-17.

Bedi, K.S. and H.S. Gill. 1960. Losses caused by the brown leaf spot disease of rice in Punjab. *Indian Phytopath*., 13: 161-164.

Belaya, L.P. 1979. *The Genetics of Plant Height in Rice*. Vsesoyuznyl Institute *Risa Krasnodar*, USSR. pp. 65-130.

Chakravarty, D.N. and B.C. Barthakur. 1980. Mineral deficiency symptom of three high yielding varieties of rice. *Research Bulletin, Assam Agricultural University*. pp. 1-8.

Chang, W.L. and H.P. Wu. 1976. Comparison of yield stability among pure, mixed and hybrid population of rice. *Botanical Bulletin of Academia Sinica*. pp. 54-62.

Chum, Y.Y. and C.S. Lin. 1977. Studies on the effect of rice yield and agronomic characteristics under low temperature and high humidity conditions. *Journal of Agricultural Research of China*. pp. 51-56.

Chumming. W., Chungehaosu, H. Zhai and J. Wan. 2005. Identification of Q T Ls under laying resistance to a virulent strain of *Xanthomonas oryzae* P.V., *Oryzae* in rice cultivars DV 85. *Field Crop Research*, pp. 337-347.

DAT. T.V., M.L. Peterson and J. N. Rutger. 1978. Performance of rice composites dimorphic for plant height and for pubescent. *Crop Science*, pp. 1-4.

Ezuka, A. and H. Kaku. 2000. A historical review of bacterial blight of rice. *National Institute of Agro-biological Research Bulletin*, Japan. pp. 207.

Ghose, R. L.M., M.B. Ghatege and V. Subrahmanyan. 1970. *New Dehli Agricultural Research India*, pp. 474.

Giri. C.C. and G. Vijaya Laxmi. 2000. Production of transgenic rice with agronomically useful genes. *Biotechnology advance*, pp. 653-683.

Gul, S., H. Ahmad, I.A.Khan and M. Alam. 2007. Assessment of Genetic Diversity in Tea genotypes through RAPD Primers. *Pak. J. Biol. Sci*. 10: 2609-2611.

Hanada, K. 1978. The effect of top pinching on the growth of lateral branches in casters. *Japanese Journal of Tropical Agriculture*. pp. 123-132.

Inamullah, F. Mohammad, G. Hassan, Sirajuddin and S. Ali. 2006b. Genetics of important traits in bread wheat (*Triticum aestivum* L.) using diallel analysis. *Sarhad. J. Agric*., 21(4): 617-622.

Inamullah, H. Ahmad, F. Mohammad, G. Hassan, Sirajuddin, and R. Gul. 2006a. Diallel analysis of the inheritance pattern of the agronomic traits of bread wheat. *Pakistan Journal of Botany*, 38(4): 1169-1177.

Kamal, M and S. M. Moghal. 1968. Studies on plant diseases of South West Pakistan. *Plant Science*, pp. 15-20.

Khan, H., Hidayat-ur-Rahman, H. Ahmad, H. Ali, Inamullah and Mukhtar Alam. 2008. Magnitude of combining ability of sunflower genotypes in different environments. *Pak. J. Bot*. 40:151-160.

Krish, K., K.K. Poovannan, R. Nandakumar and K. Thamilarasi. 2003. A high throughout functional resistance on rice against the sheath blight pathogen. *Plant Science*, pp. 969-976.

Lai, K.L. and K.S. Tai. 1981. Physiological and ecological studies on the grain development of rice. *Journal of the Agricultural Association of China*, pp. 19-32.

Lee, J.H. and J.H. Yun. 1980. Relationships of physiological activity and anatomical structure to the wilting phenomena in rice. *Crop Science*, pp. 1-7.

Masaki, S. and Y. Ohyama. 1976. Detailed analysis of Non-structural carbohydrates in rice straw. *Bulletin of National Institute of Animal Industry*, pp. 69-74.

Mew, T.W. 1987. Current status and future prospects of research on bacterial blight of rice. *Annual Review of Phytopathology*, 25: 259-382.

Mew. T.W., A.M. Alvarez, J.E. leach and J. Seillgs. 1993. Focus on bacterial bright of rice. *Plant Disease*, 77: 5-12.

Nisar, M., A. Ghafoor, M. Rasheed Khan, H. Ahmad, A. S. Qureshi and Haidar Ali. 2007. Genetic diversity and geographic relationship among local and exotic Chickpea germplasm. *Pak. J. Bot*., 39: 1575-1581.

Ou, S.U. 1972. *A rice disease.* Common Wealth Institute. Kew, Surrey, England, pp. 365.

Poneiane, G., K. Webb, J. Bai, C.V. Cruf and F. Jan. 2004. Molecular characterization of the avr x a_7 10 cus from *Xanthomonas oryzae* P.V. *Oryzae* field isolation. *Physiological and molecular plant pathology*, pp. 145-153.

Rao, A.V., S.T. Krishna and A.S.R. Prasad. 2002. Combining ability of rice. *Indian Journal of Agricultural Science*, 50(3): 193-197.

Salim, M., M. Akram, M.E. Akhtar and M. Ashraf. 2003. Rice, *A production Hand Book. Pakistan Agricultural Research Council, Islamabad*. pp. 70.

Sendhira, D., F.J. Zapata, G.B. Gregorio, M.S. Alejar, H.C. Dela Cruz, T.F. Padolina and A.M. Galvez. 2002. Development of the first salt-tolerant rice cultivar through indica/indic anther culture. *Field Crops Research*, pp. 103-110.

Shahjehan, A.K.M., H.U. Ahmad, M.A.T. Mia, M.A. Sharma and N.S. Nahar. 1991. Out break of leaf blight in rice crop in Bangladesh. *Iran*, 16: 21.

Tano, A., B.E. Haryu and K. Kameaka. 1976. Influence of cultivation and drying method after cutting on rice straw quality. *Bulletin of National Institute of Animal Industry*. pp. 75-80.

Wade. L.J., S. Fukai, B.K. Samson, A. Ali and M.A. Mazid. 1999. Rain fed lowland rice: Physical Environment and Cultivars Requirement. *Field Crop Research,* pp. 3-12.

Yonghong, W., Y. Oxue and Jiayangli. 2005. Towards Molecular breeding and improvement of rice in China. *Trends in plants Science,* pp. 610-614.

Zhou, Sang-wook PARC, Gruszewski and Jarge. 2001. Purification of an Iso form of patatin with antimicrobial activity against *Phytopathora infestans*. *Plant Phytopathology,* pp. 647-655.

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