Research Article

Assessment of Rice Genotypes against Bacterial Leaf Blight Resistance

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Abstract | This study was performed to assess resistance potential of 142 indigenous accessions along with two check cultivars against bacterial leaf blight disease at the University of Agriculture, Peshawar-Pakistan during 2011 rice crop growing season. On artificial inoculation with *Xanthomonas oryzae* pv. *Oryzae*, the fundamental agent of bacterial leaf blight, most of the studied rice accessions and the two commercial rice cultivars displayed susceptible reactions. Seven rice accessions viz. UoA-2, UoA-5, UoA-11, UoA-48, UoA-53, UoA-102, and UoA-123 showed moderate levels of resistance while eleven rice accessions viz. UoA-4, UoA-6, UoA-22, UoA-41, UoA-60, UoA-67, UoA-68, UoA-84, UoA-126, UoA-129 and UoA-133 displayed strong resistance against the disease. The use of these resistant rice accessions are, therefore, recommended for deploying bacterial leaf blight resistant genes into commercial rice cultivars.

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Introduction

Bacterial leaf blight caused by *Xanthomonas oryzae* pv. *Oryzae* (Ishiyama, 1922; Swing et al., 1990) is one of the most destructive diseases of rice crop (Mew, 1987) in all the rice growing regions of the world. The disease was first reported by Japan's farmers in 1884-85 while later its prevalence was reported in different rice growing regions of the world including Australia, Bangaldesh, India, Sri Lanka, Thailand, The Philippines, USA, West Africa and Vietnam (Ezaku and Kuka, 2006). The incidence of this disease in Pakistan was reported by Mew and Majid (1977) while its occurrence on a wider scale in the entire country was observed in subsequent studies (Akhtar and Akram, 1987; Akhtar et al., 2003). Recently, there has been an increased incidence of bacterial leaf blight in all rice growing zones of the country including "Kaller" belt which is famous for superior basmati rice type cultivation (Khan et al., 2000; Akhtar et al., 2003). This disease reduces the crop yield up to 30% in case of mild infection (Shahjehan et al., 1991) while under severe infection the yield of rice crop could be reduced even up to 90-100% (Ghose et al., 1970) and Personal observations in the rice fields). Unfortunately, the available commercial rice germplasm of the country is lacking resistance against this disease (Akhtar, 2005; Shah et al., 2009). Thus, there is an urgent need to develop bacterial leaf blight resistant rice cultivars. The indigenous germplasm sources mostly comprising accessions and landraces possess resistance against various diseases and insect pests. These indigenous germplasm sources need to be studied for identification of bacterial leaf blight resistance. The present study was, therefore, aimed to assess the resistance potential of indigenous rice germplasm against the bacterial leaf blight disease.

Materials and Methods

The experiment was performed at the Research Farm of Department of Plant Breeding and Genetics (PBG), The University of Agriculture, Peshawar-Pakistan during 2011 rice crop growing season. The germplasm comprised 142 indigenous rice accessions provided by Institute of Agriculture Biotechnology and Genetic Resources (IABGR), National Agricultural Research Centre (NARC) Islamabad and two check cultivars (Super-Basmati and IR-6). These rice accessions were collected from northern regions of Pakistan. Nursery was raised in the last week of May while transplantation of seedlings in to well puddled field was done during the last week of June. The experiment was planted in a simple lattice design with two replications. Each genotype was planted in single-row plot with maintaining row length of two meter and row to row distance of 30 cm. The genotypes were assessed for bacterial leaf blight resistance both under field conditions and artificial inoculation. Incidence of the disease on each accession was recorded on percentage basis in each plot during the last week of August. The studied genotypes were inoculated with the mixture of virulent isolates of *Xanthomonas oryzae* pv. *Oryzae* prevailing in the Khyber Pakhtunkhwa, Pakistan. The inoculum was organized in distilled water and its concentration was adjusted to almost 10^8 cfu/ml. Ten leaves of each genotype were cut at approximately 5 cm from the tip using scissors dipped into the prepared inoculum and then after 15 days of inoculation lesion lengths were calculated. Rice accessions were classified into different categories of resistance and susceptibility on the basis of mean leaf lesion length of each genotype over two replications using the following standard International Rice Research Institute (IRRI) procedure (Chaudry, 1996) (Table 1).

Results and Discussion

On account of favorable humid conditions in the crop growing season, the incidence of bacterial leaf blight disease did occur. The rice genotypes evaluated in the study were also screened for bacterial leaf blight resistance using artificial inoculation. Highly significant differences ($P \leq 0.01$) among the evaluated rice genotypes were observed for lesion length. Disease incidence (%) and response of rice genotypes on artificial inoculation are presented in Table 2. Out of 144 rice genotypes used in the study, 124 rice accessions and the two check cultivars (Super-Basmati and IR-6) were observed moderately susceptible to high susceptible against this disease. More than 50% plants in these entries were affected with the occurrence of bacterial leaf blight under natural conditions. The inoculated plants in these entries displayed leaf lesions constituting >25% of their total leaf lengths. Seven rice accessions viz. UoA-2, UoA-5, UoA-11, UoA-48, UoA-53, UoA-102, and UoA-123 showed moderate levels of resistance against bacterial leaf blight and up to 25% plants in these accessions were affected with this disease under natural conditions. On artificial inoculation, accessions UoA-2, UoA-5, UoA-11, UoA-48, UoA-53, UoA-102, and UoA-123 displayed leaf lesions which constituted 22.2, 18.1, 14.6, 16.1, 23.2, 18 and 21.7% of their total leaf lengths, respectively. Eleven rice accessions UoA-4, UoA-6, UoA-22, UoA-41, UoA-60, UoA-67, UoA-68, UoA-84, UoA-126, UoA-129 and UoA-133 showed resistance against this disease and less than 1% plants in these accessions were affected with the disease. The affected plants in these entries manifested less than 5% leaf lesion lengths of their total leaf lengths.

Table 1: *Disease incidence, lesion size and disease rating of rice genotypes against bacterial leaf blight.*

Disease Rating	Lesion Size (Percent of leaf length)	Category
1	0-3	Highly resistant
2	4-6	Resistant
3	7-12	Resistant
4	13-25	Moderately Resistant
5	26-50	Moderately susceptible
6	51-75	Susceptible
7	76-87	Susceptible
8	87-94	Highly Susceptible
9	95-100	Highly Susceptible

The results of this study are compatible with the earlier findings of Akhtar et al. (2005), Waheed et al. (2009) and Akhtar et al. (2005) screened all the available cultivars of Pakistan and reported lack of resistance in the cultivated germplasm of the country. Shah et al. (2009) assessed 14 wild rice species and three rice cultivars, Bas-385, KS-282 and IR-6 of Pakistan against bacterial leaf blight using artificial inoculation. Only wild rice species *O. nivara*, *O. longistaminata*

Table 2: *Disease incidence, lesion size and disease rating of rice genotypes against bacterial leaf blight.*

Accession No.	Disease Incidence (%)	Lesion size (Percent of leaf length)	Disease rating	Category
UoA-1	70	56.8	6	S
UoA-2	15	22.2	4	MR
UoA-3	56	55.3	6	S
UoA-4	0	2.6	1	HR
UoA-5	23	18.2	4	MR
UoA-6	0	3.6	1	HR
UoA-7	100	65	6	S
UoA-8	100	72.2	5	MS
UoA-9	100	80.3	6	S
UoA-10	55	44.5	5	MS
UoA-11	12	14.6	4	MR
UoA-12	54	60.9	6	S
UoA-13	83	71.4	6	S
UoA-14	60	75.9	6	S
UoA-15	93	70.7	6	S
UoA-16	93	80.6	6	S
UoA-17	100	79.1	6	S
UoA-18	86	75.2	6	S
UoA-19	61	66.9	6	S
UoA-20	97	87	6	S
UoA-21	58	54.2	6	S
UoA-22	0	2.6	1	HR
UoA-23	50	41.8	5	MS
UoA-24	95	29	5	MS
UoA-25	58	54.3	6	S
UoA-26	93	48.1	5	MS
UoA-27	83	44.3	5	MS
UoA-28	55	26.9	5	MS
UoA-29	99	35.2	5	MS
UoA-30	52	33.2	5	MS
UoA-31	100	68.6	6	S
UoA-32	93	42.7	5	MS
UoA-33	60	56.7	6	S
UoA-34	100	64.3	6	S
UoA-35	98	30.7	5	MS
UoA-36	54	50.2	6	S
UoA-37	84	50	5	MS
UoA-38	58	38.6	5	MS
UoA-39	51	43.3	5	MS
UoA-40	100	100	7	HS
UoA-41	0	4.7	1	HR
UoA-42	73	43	5	MS
UoA-43	43	47	5	MS
UoA-44	77	47.3	5	MS
UoA-45	59	31.3	5	MS
UoA-46	97	88.5	7	HS
UoA-47	100	90.4	7	HS
UoA-48	20	16.1	4	MR
UoA-49	84	46.1	5	MS
UoA-50	57	47.4	5	MS
UoA-51	57	84.4	6	S
UoA-52	79	84.2	6	S
UoA-53	13	23.2	4	MR
UoA-54	60	45.1	5	MS
UoA-55	95	95	7	HS
UoA-56	94	94.4	7	HS
UoA-57	100	98.	7	HS
UoA-58	100	99.3	7	HS
UoA-59	98	99	7	HS
UoA-60	0	3.8	1	HR
UoA-61	66	76.3	6	S
UoA-62	82	94.8	7	HS
UoA-63	100	96.5	7	HS
UoA-64	64	69.4	6	S
UoA-65	77	83.3	6	S
UoA-66	98	87.6	6	S
UoA-67	0	2.8	1	HR
UoA-68	0	1.1	1	HR
UoA-69	95	88.2	7	HS
UoA-70	57	59.3	6	S
UoA-71	83	49.7	5	MS
UoA-72	87	67.7	6	S
UoA-73	100	100	7	HS
UoA-74	73	59.4	6	S
UoA-75	56	51.3	6	S
UoA-76	100	94.5	7	HS
UoA-77	80	57.2	6	S
UoA-78	90	50	5	MS
UoA-79	87	66.7	5	MS
UoA-80	56	26	4	MS
UoA-81	60	73.5	6	S
UoA-82	100	60.1	6	S
UoA-83	67	59.6	6	S
UoA-84	0	3.6	1	HR
UoA-85	100	65.2	6	S
UoA-86	100	77.9	6	S
UoA-87	93	52.4	6	S
UoA-88	68	63.5	6	S
UoA-89	100	65.9	6	S
UoA-90	100	54.7	6	S

UoA-91	84	72.9	6	S
UoA-92	100	60.9	6	S
UoA-93	100	100	7	HS
UoA-94	70	100	7	HS
UoA-95	100	98.5	7	HS
UoA-96	61	90.6	7	HS
UoA-97	100	93.3	7	HS
UoA-98	100	97	7	HS
UoA-99	85	80.3	6	S
UoA-100	100	100	7	HS
UoA-101	100	100	7	HS
UoA-102	10	18.0	4	MR
UoA-103	100	100	7	HS
UoA-104	61	63	6	S
UoA-105	100	70.4	6	S
UoA-106	89	90.1	7	HS
UoA-107	97	67.4	6	S
UoA-108	100	100	7	HS
UoA-109	63	48.2	5	MS
UoA-110	100	100	7	HS
UoA-111	100	100	7	HS
UoA-112	100	100	7	HS
UoA-113	100	100	7	HS
UoA-114	100	100	7	HS
UoA-115	100	100	7	HS
UoA-116	91	98.3	7	HS
UoA-117	100	100	7	HS
UoA-118	100	100	7	HS
UoA-119	93	100	7	HS
UoA-120	100	98.5	7	HS
UoA-121	100	100	7	HS
UoA-122	100	100	7	HS
UoA-123	10	21.7	4	MR
UoA-124	100	100	7	HS
UoA-125	100	100	7	HS
UoA-126	0	2.9	1	HR
UoA-127	99	94.3	7	HS
UoA-128	98	89.2	7	HS
UoA-129	0	3.5	1	HR
UoA-130	94	92.9	7	HS
UoA-131	80	84.9	6	S
UoA-132	95	97.7	7	HS
UoA-133	0	1.8	1	HR
UoA-134	90	90.1	7	HS
UoA-135	100	93	7	HS
UoA-136	93	85.6	6	S
UoA-137	97	66.8	6	S
UoA-138	81	91.9	7	HS
UoA-139	88	84.1	6	S
UoA-140	100	77.9	6	S
UoA-141	98	95.4	7	HS
UoA-142	85	91.6	7	HS
IR-6 (Check cultivar)	65	67.9	6	S
Super Basmati (Check cultivar)	72	75.7	6	S

HR: *Highly Resistant;* **R:** *Resistant;* **MR:** *Moderately Resistant;* **MS:** *Moderately Susceptible;* **S:** *Susceptible;* **HS:** *Highly Susceptible*

and *O. grandiglumis* displayed resistance against bacterial leaf blight while the three cultivars used in the study showed susceptibility against this disease. Waheed et al. (2009) evaluated 11 rice genotypes against bacterial leaf blight under natural conditions and reported strong resistance in only one genotype, PARC-301. In the present study the two cultivars manifested high levels of susceptibility against bacterial leaf blight while some of the indigenous rice accessions showed strong levels of resistance against the disease. The indigenous rice accessions and wild rice species thus need to be explored for possible transfer of bacterial leaf blight resistance genes into the cultivated germplasm of the country.

Conclusions

Most of the studied accessions and two commercial rice cultivars displayed susceptible reaction against bacterial leaf blight both under usual field conditions and with the artificial inoculation. Rice accessions UoA-4, UoA-6, UoA-22, UoA-41, UoA-60, UoA-67, UoA-68, UoA-84, UoA-126, UoA-129 and UoA-133 showed strong resistance against bacterial leaf blight. The genetic potential of these genotypes could be used in bacterial blight resistance breeding programs to deploy bacterial blight resistant genes into commercial rice cultivars.

Authors Contribution

ZR conducted research, analysed the data, results and discussion. SMAS supervised the whole study. HR, FM and MAR helped in data analysis as well as manuscript editing. IA helped in data analysis.

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