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Evaluation of Rice Germplasm against Bacterial Leaf Blight of Rice caused by *Xanthomonas oryzae* pv. *oryzae*

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ABSTRACT: Bacterial leaf blight (BLB) of rice caused by *Xanthomonas oryzae* pv. *oryzae* (*Xoo*) is the most destructive disease of rice, the staple food of almost half of the world's population, causing yield loss of 20-30 per cent. Use of host resistance is considered to be the most effective, economical, and environmentally sustainable approach for the management of the disease. From Indian Institute of Rice Research (IIRR), Hyderabad, 91 and 104 germplasm were obtained during 2019 and 2020, respectively, and screened under epiphytotic conditions to identify the source of resistance against BLB. During 2019-20, none of the germplasm was found resistant and only 34 germplasm (L9-19201, LP-18204, RRX-719, WGRH-18, MR-8222, RH-169269, CRHR-105, CRHR-106, SAVA-5065, MP-3020, NK-5251, RNC-0050, IRH-120, IIRRH-136, IRH-122, US-312, TMRH-5559, MEPH-153, RRX-426, US-368, PHI-19103, RH-169292, IIRRH-134, RNE-0122, IIRRH-137, CRHR-148, DLRH-6, PR-121, MEPH-155, NPH-X28, PHI-19101, MTUHR-2105, TNTRH-99, Improved Samba Mahsuri) were found moderately resistant. Whereas, during 2020-21, 33 germplasm lines (KAVERI-7299, UPLRH -179510, RRX-848, JGL-275, US-330, US-314, PR-124, Local Check Variety (LCV), NPH-X628, JKRH-2709, PHI-20102, PHI-20104, US-348, MEPH-157, PR-113S-7004, VNR-225, RRX-890, DLRH-9, MEPH-158, MEPH-159, HRI-174 (NCH), Local Check Variety (LCV), KAVERI- 7623, RRX-708, US-310, JKRH-3333 (NCH-1), 27P63 (NCH-2), WGL-14 (NCV-1) IR-64, RP-BIO-226,IR-50 and Swarnadhan) were found moderately resistant.

Keywords: Rice, screening, susceptible, blight, germplasm, resistance, disease.

INTRODUCTION

Rice is one of the major food crops of the world especially that of the South Asian countries like India, Pakistan, Bangladesh, China, Vietnam and Korea. It is a staple food in India, and occupies a prime position in the country's economy (Srinivasan and Gnanamanickam 2005). Bacterial leaf blight (BLB), caused by *Xanthomonas oryzae* pv. *Oryzae* (*Xoo*) is one of the most destructive diseases of rice occurring throughout the world (Swings *et al*., 1990; Ishiyama, 1922; Mew *et al*., 1993). The incidence of *Xoo* limits the production of this staple food of more than half the world's population (Salim *et al*., 2003). BLB became serious due to the introduction of improved, high yielding varieties, with high nitrogen requirement, close spacing and inadequate resistance to *Xoo* (Eamchit and Mew 1982). The disease was first noticed in Fukuoka prefecture of Kyushu Island, Japan, in 1884-85 (Ezukaand Kaku, 2000).

In India, BLB was first noticed from Koloba district of Maharashtra, during 1959 (Srivastava and Rao 1966). In general, the disease is reported to be responsible for a yield loss of 20-50 per cent, depending upon stage of the crop, severity of infection, weather conditions and cultivar response (Srivastava, 1967; Amna, 2008). The disease is known to occur in epidemic form in many parts of the world, causing losses to the extent of 6-60% or even upto 81% in some cultivars (Shehzad *et al*., 2012). BLB adversely affects grain filling and emergence of panicles, about 28-30% yield reduction was observed in susceptible cultivars by Shahjahan *et al*. (1991). The disease appears at all the growth stages of the crop, initiating two main symptoms *i.e*., leaf blight or wilt or Kresek and yellow leaf (Gnanamanickam *et al*., 1999). 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, and may extend to the lower end of leaf sheath. Similar symptoms may occur on glumes of green grains. The causal organism (*Xoo*) survives in the rhizosphere of weed hosts, infected straw and root stubble and disseminate by wind and water (Shahjahan *et al*., 1991).Chemical control of BLB is not feasible due to non-availability of effective bactericide (Khush *et al*., 1989). Though biocontrol agents have been reported to manage the disease to some extent, but their field application is not widely adopted (Khush *et al*., 1989). Therefore, identification of resistant source against the disease is the most effective, eco-friendly and sustainable approach to manage the disease. The efficiency of breeding for resistant programme is mainly dependent on two important variables, availability of resistant genetic sources and variation within the pathogen population. Breeding for resistance is thus the best option to encounter the disease (Chen *et al*., 2002). The availability of several genes responsible for resistance may help the breeders to go for various breeding strategies like gene rotation, gene deployment and gene pyramiding. Therefore, the present study is aimed to evaluate rice germplasm for exploring the source of resistance against bacterial leaf blight.

MATERIALS AND METHODS

The present investigation was undertaken to find the resistant sources of rice against BLB, at Research Farm, SKUAST-J, Chatha, during *Kharif* 2019 and 2020 under epiphytotic conditions. Ninety one germplasm lines (US-317, HRI-201, ARRH-23664, IIRRH-130, PR-124, IRH-121, SHX-468, RRX-533, USD-339, JKRH-2789, IIRRH-131, MUTUHR-2104, Gontra Bindhan-3, RRX-445, RH-169257, PHI-19106, IIRRH-135, CRHR-122, RNE-0148, HRI-174, NDR-359, US-308, MTUHR-2107, CRHR-145, TNRH-294, JKRH-3333, 27P63, WGL-14, L9-19201, LP-18204, RRX-719, WGRH-18, MR-8222, RH-169269, CRHR-105, CRHR-106, SAVA-5065, MP-3020, NK-5251, RNC-0050, IRH-120, IIRRH-136, IRH-122, US-312, TMRH-5559, MEPH-153, RRX-426, US-368, PHI-19103, RH-169292, IIRRH-134, RNE-0122, IIRRH-137, CRHR-148, DLRH-6, PR-121, MEPH-155, NPH-X28, PHI-19101, MTUHR-2105, TNTRH-99, Improved Samba Mahsuri, RRX- 556, NPX-X4, RH-169035, US-314, CO-51, NPH-101, SAVA-5055, Indam-300-007, LP-19301, US-326, PHI-19107, RRX-633, PHI-19108, Basmati-370, RNC-0158, IIRRH-132, IIRRH-133, PR-113, NPH-X29, HRI-202, PHI-19104, PHI-19105, MP-3310, CP-800, IIRRH-138, HRI-203, CRHR-150, BPT-520 and MEPH-152) were collected All India Coordinated Rice Improvement Programme (AICRIP) Centre, Division of Genetics and Plant Breeding, Faculty of Agriculture, SKUAST-Jammu, Chatha during *Kharif* season of 2019-2020 for screening against BLB under epiphytic conditions. Whereas, one hundred four germplasm of rice (KAVERI-7299, UPLRH-179510, RRX-848, JGL-275, US-330, US-314, PR-124, Ranbir basmati, NPH-X628, JKRH-2709, PHI-20102, PHI-20104, US-348, MEPH-157, PR-113S-7004, VNR-225, RRX-890, DLRH-9, MEPH-158, MEPH-159, HRI-174 (NCH), SJR 5, KAVERI-7623, RRX-708, US-310, JKRH-3333 (NCH-1), 27P63 (NCH-2), WGL-14 (NCV-1), IR-64, RP-BIO-226,IR-50, Swarnadhan, HRI-207, NPH-X73, YPH-4009, UPLRH-179524, TMRH-21210, MP-3110, Pusa RH-59, VNR-227, RALLIS-19303, PHI-20103, RRX-809, NS-1202, RNRH-12, Pusa RH-61, IIRRH-144, RNRH-18, US-357, IRH-126, TNRH-303, US-312 (NCV), Basmati-370, KAVERI-7425, PHI-20106, PHI-20109, US-375, IIRRH-145, NRH-30, NDR-359 (NCV), PR-121, Sava- 3701, HRI-206, GK-5003 Pro, NPH-X63, VNR-226, Improved Samba Mahsuri, HR-12, Nidhi, Benibhog, Ajaya, Tetep, PAN-2430, JKRH-1601, PHI-20101, Pusa RH-60, MEPH-156, CO-51 (NCV), HRI-208 NPH-X5, S-4003, YPH-4129, UPLRH-179520, UPLRH-162122, RRX-805, IRH-124, IIRRH-143, RNRH-78, Gontra Bidhan-3 (NCV), HRI-204, Marshal-135 Pro, HRI-205, PHI-20107, PHI-20108, IIRRH-146, TN1 RALLIS-19608, MEPH-161, BPT-5204 (NCV2), Vikramarya, CH-45, CO-39 and KAVERRI-7317) were also collected from All India Coordinated Rice Improvement Programme (AICRIP) Centre, Division of Genetics and Plant Breeding, Faculty of Agriculture, SKUAST-Jammu, Chatha during *Kharif* season of 2019-2020 for screening against BLB under epiphytic conditions. The seedlings of these germplasm were raised in nurseries on first week of July during 2019 and 2020, adopting all the normal agronomic practices. Transplanting was done on 7th August, 2019 and 10th August, 2020. Each germplasm was grown in two rows of 2 m length, with row to row spacing of 50 cm and plant to plant spacing of 15 cm. Ten plants of each germplasm/variety were randomly selected and tagged for recording observations on the severity of BLB. For creating/initiating disease, 30th days after transplanting, individual plants were inoculated with three-day old culture of *Xoo*, multiplied on nutrient broth (Kauffman *et al.*, 1973). Irrigation was given immediately after the inoculation to create high humidity for build-up of infection. Disease severity was recorded on 1-9 scale at tillering stage. Percent average lesion area of leaves were measured for disease severity using the following scale:

$$\text{Disease severity} = \frac{n(1) + n(3) + n(5) + n(7) + n(9)}{tn}$$

n= Number of leaves showing severity score of 1, 3, 5, 7, 9

tn = Total number of leaves scored

Disease response

Scale used for assessing disease severity of bacterial blight of rice (IRRI, 2004).

Score	Affected lesion area	Response
1	1-5%	R
3	6-12%	MR
5	13-25%	MS
7	26-50%	S
9	51-100%	HS

RESULTS AND DISCUSSION

Screening of rice genotypes against bacterial leaf blight of rice during kharif 2019. Based on disease reaction, 91 germplasm lines obtained from Indian Institute of Rice Research, Hyderabad, were grouped into five categories i.e. resistant, moderately resistance, moderately susceptible and susceptible (Table 1, 2). None of the germplasm lines expressed resistant reaction while, 28 lines (US-317, HRI-201, ARRH-23664, IIRRH-130, PR-124, IRH-121, SHX-468, RRX-533, USD-339, JKRH-2789, IIRRH-131, MUTUHR-2104, Gontra Bindhan-3, RRX-445, RH-169257, PHI-19106, IIRRH-135, CRHR-122, RNE-0148, HRI-174, NDR-359, US-308, MTUHR-2107, CRHR-145, TNRH-294, JKRH-3333, 27P63, WGL-14) showed moderately resistant reaction.

The disease severity for moderately resistant varieties varies between 5.69-11.91 per cent. Thirty four germplasm lines (L9-19201, LP-18204, RRX-719, WGRH-18, MR-8222, RH-169269, CRHR-105, CRHR-106, SAVA-5065, MP-3020, NK-5251, RNC-0050, IRH-120, IIRRH-136, IRH-122, US-312, TMRH-5559, MEPH-153, RRX-426, US-368, PHI-19103, RH-169292, IIRRH-134, RNE-0122, IIRRH-137, CRHR-148, DLRH-6, PR-121, MEPH-155, NPH-X28, PHI-19101, MTUHR-2105, TNTRH-99, Improved Samba Mahsuri) showed moderately susceptible reaction, having disease severity between 14.61-24.67 per cent. Twenty eight germplasm lines (RRX-556, NPX-X4, RH-169035, US-314, CO-51, NPH-101, SAVA-5055, Indam-300-007, LP-19301, US-326, PHI-19107, RRX-633, PHI-19108, Local Check Variety (LCV), RNC-0158, IIRRH-132, IIRRH-133, PR-113, NPH-X29, HRI-202, PHI-19104, PHI-19105, MP-3310, CP-800, IIRRH-138, HRI-203, CRHR-150, SJR5, Basmati 370, Ranbir Basmati BPT-520) showed susceptible reaction, with disease severity ranging between 25.21- 45.63 per cent. One germplasm line (MEPH-152) showed highly susceptible reaction, having disease severity of 69.47 per cent.

Table 1: Screening of rice germplasm against bacterial leaf blight during 2019.

Sr. No.	Germplasm lines	Disease severity (%)	Reaction	Score
1.	LP-19201	14.61	MS	5
2.	RRX-556	35.67	S	7
3.	LP-18204	21.98	MS	5
4.	RRX-719	19.87	MS	5
5.	US-317	8.89	MR	3
6.	WGRH-18	17.56	MS	5
7.	NPX-X4	34.67	S	7
8.	MR-8222	23.44	MS	5
9.	HRI-201	9.71	MR	3
10.	RH-169035	43.56	S	7
11.	ARRH-23664	8.98	MR	3
12.	RH-169269	19.87	MS	5
13.	IIRRH-130	8.57	MR	3
14.	CRHR-105	24.67	MS	5
15.	CRHR-106	17.45	MS	5
16.	US-314	40.45	S	7
17.	CO-51	37.43	S	7
18.	PR-124	9.87	MR	3
19.	Basmati 370	33.24	S	5
20.	NPH-101	31.76	S	7
21.	IRH-121	6.78	MR	3
22.	SHX-468	11.67	MR	3
23.	SAVA-5055	25.29	S	7
24.	Indam-300-007	23.76	S	7
25.	SAVA-5065	16.51	MS	5
26.	LP-19301	39.87	S	7
27.	MEPH-152	69.47	HS	9
28.	RRX-533	7.89	MR	3
29.	US-326	43.76	S	7
30.	PHI-19107	39.72	S	7

31.	RRX-633	35.67	S	7
32.	US-339	8.58	MR	3
33.	PHI-19108	45.63	S	7
34.	JKRH-2789	7.63	MR	3
35.	RNC-0158	27.56	S	7
36.	MP-3020	19.47	MS	5
37.	NK-5251	15.65	MS	5
38.	IIRRH-131	8.67	MR	3
39.	RNC-0050	17.65	MS	5
40.	IIRRH-132	40.65	S	7
41.	MUTUHR-2104	6.78	MR	3
42.	IIRRH-133	30.87	S	7
43.	IRH-120	15.78	MS	5
44.	IIRRH-136	21.65	MS	5
45.	IRH-122	17.72	MS	5
46.	US-312	18.98	MS	5
47.	Gontra Bidhan-3	6.78	MR	3
48.	PR-113	39.73	S	7
49.	TMRH-5559	19.87	MS	5
50.	MEPH-153	18.54	MS	5
51.	RRX-426	19.78	MS	5
52.	US-368	24.67	MS	5
53.	NPH-X29	36.87	S	7
54.	RRX-445	6.98	MR	3
55.	PHI-19103	18.76	MS	5
56.	HRI-202	43.76	S	7
57.	RH-169292	21.67	MS	5
58.	PHI-19104	39.78	S	7
59.	PHI-19105	43.78	S	7
60.	RH-169257	8.92	MR	3
61.	IIRRH-134	21.67	MS	5
62.	PHI-19106	5.69	MR	3
63.	MP-3310	43.78	S	7
64.	IIRRH-135	7.86	MR	3
65.	CP-800	43.54	S	7
66.	CRHR-122	11.34	MR	3
67.	RN E-0122	22.7	MS	3
68.	IIRRH-137	16.78	MS	5
69.	CRHR-148	21.78	MS	5
70.	RNE-0148	9.65	MR	3
71.	DLRH-6	21.89	MS	5
72.	IIRRH-138	43.21	S	7
73.	HRI-174	9.56	MR	3
74.	NDR-359	11.67	MR	3
75.	PR-121	21.67	MS	5
76.	MEPH-155	21.87	MS	5
77.	US-308	11.9	MR	3
78.	NPH-X28	18.98	MS	5
79.	PHI-19101	23.56	MS	5
80.	HRI-203	39.65	S	7
81.	MTUHR-2105	20.98	MS	5
82.	MTUHR-2107	10.87	MR	3
83.	TNTRH-99	23.78	MS	5
84.	CRHR-145	8.9	MR	3
85.	TNRH-294	11.91	MR	3
86.	CRHR-150	33.87	S	7
87.	JKRH-3333	11.91	MR	3
88.	27P63	11.98	MR	3
89.	WGL-14	9.87	MR	3
90.	BPT-5204	35.78	S	7
91.	Improved Samba Mahsuri	20.19	MS	5

Table 2: Reaction of rice germplasm against bacterial leaf blight during year 2019.

Germplasm lines	Affected lesion area (%)	Categories	Number of germplasm lines
None	1-5%	Resistant	None
US-317, HRI-201, ARRH-23664, IIRRH-130, PR-124, IRH-121, SHX-468, RRX-533, USD-339, JKRH-2789, IIRRH-131, MUTUHR-2104, Gontra Bindhan-3, RRX-445, RH-169257, PHI-19106, IIRRH-135, CRHR-122, RNE-0148, HRI-174, NDR-359, US-308, MTUHR-2107, CRHR-145, TNRH-294, JKRH-3333, 27P63, WGL-14	6-12%	Moderately resistant	28
L9-19201, LP-18204, RRX-719, WGRH-18, MR-8222, RH-169269, CRHR-105, CRHR-106, SAVA-5065, MP-3020, NK-5251, RNC-0050, IRH-120, IIRRH-136, IRH-122, US-312, TMRH-5559, MEPH-153, RRX-426, US-368, PHI-19103, RH-169292, IIRRH-134, RNE-0122, IIRRH-137, CRHR-148, DLRH-6, PR-121, MEPH-155, NPH-X28, PHI-19101, MTUHR-2105, TNTRH-99, Improved Samba Mahsuri	13-25%	Moderately susceptible	34
RRX- 556, NPX-X4, RH-169035, US-314, CO-51, NPH-101, SAVA-5055, Indam-300-007, LP-19301, US-326, PHI-19107, RRX-633, PHI-19108, Basmati 370, RNC-0158, IIRRH-132, IIRRH-133, PR-113, NPH-X29, HRI-202, PHI-19104, PHI-19105, MP-3310, CP-800, IIRRH-138, HRI-203, CRHR-150, BPT-520	26-50%	Susceptible	28
MEPH-152	51-100%	Highly susceptible	

Screening of rice genotypes against bacterial leaf blight during kharif 2020. During 2020 also, based on their reaction towards the disease, 104 germplasm lines were grouped into five categories i.e. resistant, moderately resistance, moderately susceptible and susceptible. Data presented in Table 3 and 4 indicate that none of the germplasm lines expressed resistant reaction, while, 33 lines (KAVERI-7299, UPLRH - 179510, RRX-848, JGL-275, US-330, US-314, PR-124, Local Check Variety (LCV), NPH-X628, JKRH-2709, PHI-20102, PHI-20104, US-348, MEPH-157, PR-113S-7004, VNR-225, RRX-890, DLRH-9, MEPH-158, MEPH-159, HRI-174 (NCH), Local Check Variety (LCV), KAVERI- 7623, RRX-708, US-310, JKRH-3333 (NCH-1), 27P63 (NCH-2), WGL-14 (NCV-1) IR-64, RP-BIO-226, IR-50 and Swarnadhan) showed moderately resistant reaction, with disease severity varying between 7.43-11.98 per cent. Thirty nine lines (HRI-207, NPH-X73, YPH-4009, UPLRH-179524, TMRH-21210, MP-3110, Pusa RH-59, VNR-227, RALLIS-19303, PHI-20103, RRX-809, NS-1202, RNRH-12, Pusa RH-61, IIRRH-144, RNRH-18, US-357, IRH-126, TNRH-303, US-312 (NCV), Local Check Variety (LCV), KAVERI-7425, PHI-20106, PHI-20109, US-375, IIRRH-145, NRH-30, NDR-359 (NCV), PR-121, Sava-3701, HRI-206, NPH-X63, VNR-226, Improved Samba Mahsuri, HR-12, Nidhi, Benibhog, Ajaya and Tetep) showed moderately susceptible reaction, with disease severity of14.62-23.65 per cent. Thirty one lines (PAN-2430, JKRH-1601, PHI-20101, Pusa RH-60, MEPH-156, CO-51 (NCV), HRI-208, GK-5003 Pro, NPH-X5, S-4003, YPH-4129, UPLRH-179520, UPLRH-162122, RRX-805, IRH-124, IIRRH-143, RNRH-78, Gontra Bidhan-3(NCV), HRI-204, Marshal-135 Pro, HRI-205, PHI-20107, PHI-20108, IIRRH-146, RALLIS-19608, MEPH-161, BPT-5204 (NCV2), Vikramarya, TN1, CH-45 and CO-39) showed susceptible reaction, with disease severity of 27.56-46.78 per cent. One germplasm line (KAVERRI-7317) showed highly susceptible reaction having disease severity of 78.41 per cent.

Table 3: Disease severity of rice germplasm against bacterial leaf blight during 2020.

Sr. No.	Germplasm lines	Disease severity (%)	Reaction	Score
1.	HRI-207	15.57	MS	5
2.	PAN-2430	33.78	S	7
3.	NPH-X73	23.21	MS	5
4.	8.23YPH-4009	21.65	MS	5
5.	KAVERI-7299	9.53	MR	3
6.	UPLRH-179524	14.65	MS	5
7.	JKRH-1601	35.78	S	7
8.	TMRH-2110	22.42	MS	5
9.	UPLRH-179510	11.67	MR	3
10.	PHI-20101	45.19	S	7
11.	RRX-848	11.19	MR	3
12.	MP-3110	17.43	MS	5
13.	JGLL-275	7.89	MR	3
14.	Pusa RH-59	21.54	MS	5
15.	VNR-227	18.32	MS	5
16.	Pusa RH-60	45.33	S	7
17.	MEPH-156	46.78	S	7
18.	US-330	11.75	MR	3
19.	US-314 (NCH)	8.34	MR	3

20.	CO-51 (NCV)	33.78	S	7
21.	PR-124	7.89	MR	3
22.	SJR 5	35.67	S	7
23.	HRI-208	28.69	S	7
24.	GK-5003 Pro	27.56	S	7
25.	RALLIS-19303	19.41	MS	5
26.	NPH-X5	44.65	S	7
27.	KAVERI-7317	78.41	HS	9
28.	NPH-X628	11.31	MR	3
29.	S-4003	35.78	S	7
30.	YPH-4129	45.67	S	7
31.	UPLRH-179520	37.61	S	7
32.	JKRH-2709	10.67	MR	3
33.	UPLRH-162122	34.71	S	7
34.	PHI-20102	11.19	MR	3
35.	RRX-805	29.56	S	7
36.	PHI-20103	22.17	MS	5
37.	RRX-809	17.89	MS	5
38.	PHI-20104	7.43	MR	3
39.	NS-1202	19.87	MS	5
40.	IRH-124	43.78	S	7
41.	US-348	8.56	MR	3
42.	IIRRH-143	37.47	S	7
43.	RNRH-12	16.97	MS	5
44.	Pusa RH-61	23.34	MS	5
45.	IIRRH-144	18.59	MS	5
46.	RNRH-18	19.67	MS	5
47.	MEPH-157	7.7	MR	3
48.	RNRH-78	41.67	S	7
49.	US-357	15.67	MS	5
50.	IRH-126	19.65	MS	5
51.	TNRH-303	21.73	MS	5
52.	US-312 (NCH)	22.34	MS	5
53.	Gontra Bidhan 3 (NCV)	43.71	S	7
54.	PR-113	7.93	MR	3
55.	Ranbir Basmati	37.23	S	7
56.	HRI-204	39.43	S	7
57.	KAVERI-7425	19.76	MS	5
58.	Marshal-135 Pro	43.52	S	7
59.	HRI-205	34.83	S	7
60.	S-7004	8.73	MR	3
61.	PHI-20106	14.76	MS	5
62.	VNR -225	8.43	MR	3
63.	PHI-20107	45.42	S	7
64.	RRX-890	11.93	MR	3
65.	PHI-20108	27.79	S	7
66.	DLRH-9	9.62	MR	3
67.	PHI-20109	21.47	MS	5
68.	US-375	18.94	MS	5
69.	IIRRH-145	23.65	MS	5
70.	MEPH-158	7.83	MR	3
71.	NRH-30	17.45	MS	5
72.	IIRRH-146	39.15	S	7
73.	MEPH-159	7.76	MR	3
74.	HRI-174 (NCH)	9.43	MR	3
75.	NDR-359 5(NCV)	15.91	MS	5
76.	PR-121	15.78	MS	5
77.	Basmati 370	9.54	MR	3
78.	Sava-3701	19.67	MS	5
79.	HRI-206	21.56	MS	5
80.	RALLIS-19608	45.91	S	7
81.	NPH-X63	17.38	MS	5
82.	KAVERI-7623	8.38	MR	3
83.	VNR-226	21.51	MS	5
84.	RRX-708	7.91	MR	3
85.	US-310	8.67	MR	3
86.	MEPH-161	27.68	S	7
87.	JKRH-3333(NCH-1)	7.83	MR	3
88.	27P63 (NCH-2)	6.97	MR	3
89.	WGL-14 (NCV-1)	11.98	MR	3

90.	BPT-5204 (NCV-2)	29.67	S	7
91.	Improved Samba Mahsuri/ADT-49 (RCV)	19.87	MS	5
92.	HR-12	21.56	MS	5
93.	IR-64	11.67	MR	3
94.	TN1	29.45	S	5
95.	Vikramarya	43.87	S	7
96.	Nidhi	14.62	MS	5
97.	CH-45	45.68	S	7
98.	Benibhog	23.76	MS	5
99.	Ajaya	19.57	MS	5
100.	C0-39	45.39	S	7
101.	RP-BIO-226	7.43	MR	3
102.	IR-50	11.87	MR	3
103.	Swarnadhana	7.93	MR	3
104.	Tetep	17.89	MS	5

Table 4: Reaction of rice germplasm against bacterial leaf blight during year 2020.

Germplasm lines	Affected lesion area (%)	Categories	Number of germplasm lines
None	1-5%	Resistant	None
KAVERI-7299, UPLRH -179510, RRX-848, JGL-275, US-330, US-314, PR-124, NPH-X628, JKRH-2709, PHI-20102, PHI-20104, US-348, MEPH-157, PR-113S-7004, VNR-225, RRX-890, DLRH-9, MEPH-158, MEPH-159, HRI-174 (NCH KAVERI- 7623, RRX-708, US-310, JKRH-3333 (NCH-1), 27P63 (NCH-2), WGL-14 (NCV-1), IR-64, RP-BIO-226,IR-50 and Swarnadhan	6-12%	Moderately resistant	31
HRI-207, NPH-X73, YPH-4009, UPLRH-179524, TMRH-21210, MP-3110, Pusa RH-59, VNR-227, RALLIS-19303, PHI-20103, RRX-809, NS-1202, RNRH-12, Pusa RH-61, IIRRH-144, RNRH-18, US-357, IRH-126, TNRH-303, US-312 (NCV), KAVERI-7425, PHI-20106, PHI-20109, US-375, IIRRH-145, NRH-30, NDR-359 (NCV), PR-121, Sava-3701, HRI-206, NPH-X63, VNR-226, Improved Samba Mahsuri, HR-12, Nidhi, Benibhog, Ajaya and Tetep	13-25%	Moderately susceptible	38
PAN-2430, JKRH-1601, PHI-20101, Pusa RH-60, MEPH-156, CO-51 (NCV), HRI-208, GK-5003 Pro, NPH-X5, S-4003, YPH-4129, UPLRH-179520, UPLRH-162122, RRX-805, IRH-124, IIRRH-143, RNRH-78, Gontra Bidhan-3 (NCV), HRI-204, Marshal-135 Pro, HRI-205, PHI-20107, PHI-20108, IIRRH-146, RALLIS-19608, MEPH-161, BPT-5204 (NCV2), Vikramarya, CH-45, TN1, SJR 5, Basmati 370, Ranbir Basmati and CO-39	26-50%	Susceptible	34
KAVERRI-7317	51-100%	Highly susceptible	1

DISCUSSION

Identification of resistance source is the key factor in developing rice resistant cultivar against BLB. While screening the rice germplasm against *Xoo*, it was recorded that out of 104 germplasm lines screened during kharif 2019, none of the germplasm line expressed resistant reaction while, 28 lines showed moderately resistant reaction, 34 lines were moderately susceptible, 28 lines had susceptible reaction, and one germplasm line showed highly susceptible reaction. Similarly, during kharif 2020, none of the germplasm line expressed resistant reaction, while 31 lines showed moderately resistant reaction, 38 lines showed moderately susceptible reaction, 34lines showed susceptible reaction, and one germplasm line showed highly susceptible reaction.

During 2019, out of total germplasm, 30.76 percent were moderately resistant, 37.36 percent moderately susceptible, 30.76 percent showed susceptible and 0.01098 percent highly susceptible reaction towards BLB. Similarly during 2020, out of total germplasm lines 31.73 percent were moderately resistant, 37.5 percent moderately susceptible, 29.80 percent susceptible and 0.009 percent highly susceptible. Variation in reaction of germplasm lines towards the disease may be explained by the fact that they had different genetic makeup. Varietal differences in susceptibility of rice plant to BLB have been well demonstrated by many workers (Ardel- hak *et al*., 1982; Prasad and Singh, 1985; Prasad *et al*., 1998; Chauhan *et al*., 2000; Mashraff *et al*., 2004 and Anita *et al*., 2005). Screening of 71 rice germplasm against *Xoo* exhibited that Siruguppa, 3 genotypes *viz.*, Ajaya, TKM-6 and IR-8 were resistant IR-72, Tetep, PR-111, Zenith, CRMAS-2231-23 and Govind were moderately resistant, whereas, 23 were moderately susceptible, 24 were susceptible and 15 were highly susceptible (Thimmegowda *et al.*, 2011). Screening of 522 rice lines against *Xoo* showed 16 lines as resistant, 70 as moderately resistant, while the remaining were either susceptible (95) or highly susceptible (341) (Pandey *et al*., 1999). Evaluation of 104 local rice varieties/lines for resistance to *Xoo* under field conditions, from 1996 to 1998, showed that IR64, IR8 and Shadab were moderately resistant, while 50, 44 and 7 genotypes showed moderately susceptible, susceptible and highly susceptible response against the *Xoo*, respectively (Tasleem-uz-zaman *et al*., 2000). Out of eleven rice

genotypes evaluated for resistance against BLB, PARC-301 was the most resistant, having least disease score, followed by PARC-293, PARC-294, PARC-298, PARC-299 and PARC-300 which were statistically at par (Waheed *et al*., 2009). Screening of 55 varieties against *Xoo*, exhibited that, 26 varieties were resistant against the disease. IR-72102-3-107-1-1-2 and P-52-9-2 were found moderately resistant and DM-1-30-3-99 was found moderately resistant (Khan *et al*., 2009). Out of 40 rice genotypes screened against *Xoo*, none showed significantly resistant response against the pathogen, only six were moderately resistant, eight were graded as moderately susceptible, while 19 were susceptible and six highly susceptible (Naqvi *et al*., 2015). Screening of 11 rice genotypes against *Xoo* showed that 4 genotypes as resistant, 3 were moderately resistant and 4 were moderately susceptible (Nahiyan *et al*., 2016). Field screening of 150 rice genotypes for resistance against BLB was done under natural condition during 2018 and 2019. During 2018, 6 genotypes exhibited resistant (R), 81 moderately resistant (MR), 59 moderately susceptible (MS) and 4 susceptible (S) response. While, in 2019, among the tested 315 rice genotypes, none of the genotypes were resistant, 183 were moderately resistant, 131 moderately susceptible and 1 susceptible reaction to BLB (Acharya and Sujata 2021).

CONCLUSION

None of the germplasm line were found resistant during both the years of crop seasons. Twenty eight germplasm lines (US-317, HRI-201, ARRH-23664, IIRRH-130, PR-124, IRH-121, SHX-468, RRX-533, USD-339, JKRH-2789, IIRRH-131, MUTUHR-2104, Gontra Bindhan-3, RRX-445, RH-169257, PHI-19106, IIRRH-135, CRHR-122, RNE-0148, HRI-174, NDR-359, US-308, MTUHR-2107, CRHR-145, TNRH-294, JKRH-3333, 27P63, WGL-14) found moderately resistant against BLB during 2019 and thirty one germplasm lines (KAVERI-7299, UPLRH -179510, RRX-848, JGL-275, US-330, US-314, PR-124, NPH-X628, JKRH-2709, PHI-20102, PHI-20104, US-348, MEPH-157, PR-113S-7004, VNR-225, RRX-890, DLRH-9, MEPH-158, MEPH-159, HRI-174 (NCH), KAVERI- 7623, RRX-708, US-310, JKRH-3333 (NCH-1), 27P63 (NCH-2), WGL-14 (NCV-1) IR-64, RP-BIO-226, IR-50 and Swarnadhan), found moderately resistant against BLB during 2020, should be incorporated in breeding programme to create rice BLB resistance. It will be useful in exploring resistance genes.

FUTURE SCOPE

Identification of resistance source and genes are key factors in breeding rice resistant cultivar against bacterial blight disease. Disease response vary among genotypes. Data collection will be continued to identify BLB resistant genotypes 4 weeks after inoculation for final confirmation. However, selected genotypes will be screened with host resistant DNA markers for identifying genes controlling both horizontal and race specific resistance. The resistant genotypes should be incorporated in breeding programme for resistance against BLB and these genotypes will be useful in exploring new genes against BLB.

Conflict of Interest. None.

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