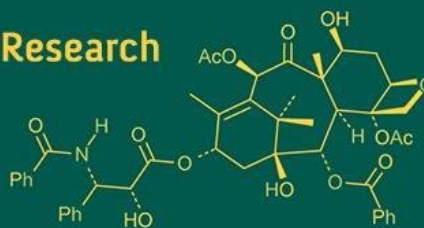


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Screening of rice genotypes against bacterial leaf blight and assessment of yield losses in Chhattisgarh

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Abstract

The present investigation entitled "Screening of rice genotypes against bacterial leaf blight and assessment of yield losses in Chhattisgarh" was performed in the department of Plant Pathology, College of Agriculture, IGKV, Raipur, (C.G.). Bacterial leaf blight (BLB) disease is caused by *Xanthomonas oryzae* pv. *oryzae* is one of the most devastating diseases. In Chhattisgarh BLB has become a major production constraint among the rice diseases. However, breakdown of resistance of a variety often occurs after few years of release due to genetic adaptation of the pathogen. Regular screening of the genotypes is utmost for developing the resistant genotypes. Considering the point, this investigation effort has been made to screen the rice genotypes against BLB under artificial and natural field condition. In the study, plants were assessed by measuring disease severity. The total 112 and 120 rice hybrid entries were screened for two *Kharif* seasons 2023-24 and 2024-25 under artificial inoculation against bacterial leaf blight of rice. Despite high disease pressure (LSI of 7.78 and 7.19, respectively), 29733 and 31475 entries showed resistance reactions and majority of entries proving susceptible or highly susceptible. Similarly, evaluation of 25 rice genotypes under natural field conditions genotypes such as Kala Namak and Maheshwari showed resistance. In contrast, susceptible genotypes like TN-1, Swarna and IR-64 suffered significant reductions in grain weight and yield loss from 12.50% in Kala Namak to 35.68% in Swarna.

Keywords: *Xoo*, PDI, BLB, PSA

Introduction

The "Rice is life" theme emphasizes the importance of Rice (*Oryza sativa* L.) as the most important staple food crop for more than half of the population in India and one-third of the world's population depends on rice to meet their dietary requirement (Annegowda *et al.*, 2021) [2]. Rice is considered as queen of the cereal crops. In India the area and production of rice is 47.83 mha and 135.75 mt in 2022-23 respectively, and productivity is 28.8q/ha (4th Advance Estimates, Ministry of Agriculture & Farmer Welfare, Government of India, 2022-23). Chhattisgarh is a state in central India; with a geographical area of 137.90 lakh hectares. It is a significant rice-growing state in India, where rice is both a vital staple meal for the people living there and a significant role of the state's economy. Bacterial leaf blight caused by *Xanthomonas oryzae* pv. *oryzae* (Ishiyama, 1992 and Swings *et al.*, 1990) [6, 15] is one of the most destructive diseases in both irrigated and rainfed condition (Mew, 1987) [11]. In India, the Kolaba district of Maharashtra was the first report of rice with bacterial leaf blight were made (Kaul, 1959) [8]. According to reports, it results in annual losses of 20-30% in Japan, 60% in India (Pingali and Hossain, 1997) [12]. The extent of yield loss due to this disease depends on the crop varieties, season, stages of the crop at which they are infected, severity of the diseases which is highly influenced by the climatic conditions and level of nitrogenous fertilizers applied. Depending on the stage of infection and severity of the disease under natural condition, the extent of loss has been reported to vary from 6-60% (Srivastava *et al.*, 1966) [14]. Some other workers have reported the disease causes 20-40% yield loss at tillering stage and overall, 50-80% yield loss in case of severity (Ullah *et al.*, 2022) [16].

2. Materials and Methods

2.1 Collection and Isolation of the pathogen

Leaf samples showing typical bacterial leaf blight (BLB) symptoms were collected from

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infected rice fields during the maximum tillering or flag leaf stage. After collecting the samples, the pathogen *Xoo* was isolated in a laminar airflow and isolation chamber that had been previously sterilized with formaldehyde, ethyl alcohol and UV radiation. The BLB pathogen was isolated from naturally infected rice leaves following Kotasthane (2003) [9]. Infected leaf segments were surface sterilized with 0.1% sodium hypochlorite or mercuric chloride, rinsed with sterile distilled water, and placed in moist chambers for 24-48 hours. Bacterial ooze from cut ends was collected and streaked onto Wakimoto's Potato Sucrose Agar (PSA). After incubation at $24-27 \pm 1$ °C for 72 hours, typical yellow, smooth, convex colonies of *Xanthomonas oryzae* pv. *oryzae* were observed.

2.2 Screening of rice hybrid lines for bacterial leaf blight of rice under artificial inoculation method

The current study was conducted in the Department of Plant Pathology, Collage of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur during the *Kharif* season 2023-24 and 2024-25 the research was carried out on a bunded rice field under irrigated conditions. In the I.G.K.V. Research field, 112 and 120 rice entries were grown. The rice entries were shown in a common two-row pattern with 20 cm spacing between rows. Seed placing was done approximately at a 2-3 cm interval. NPK fertilizer was applied per hectare. 50% of nitrogen and entire dose of phosphorus were given as first basal dose and remaining nitrogen applied in two split doses. The plants were inoculated for initiating disease, 30th days after transplanting, individual plants were inoculated with three-day old culture of *Xoo*, multiplied on broth (Kauffmann, 1973) [7]. Irrigation was given immediately after the inoculation to create high humidity for build-up of infection with leaf clipping method at the flag leaf stage. The disease severity was measured by adopting 0-9 scale by using standard evaluation system (SES) for rice developed by International Rice Research Institute, Philippines (IRRI, 2013) [5]. Disease severity will be estimated by using following formula;

$$\text{Disease severity} = \frac{\text{Sum of all disease rating}}{\text{Total number of ratings} \times \text{Maximum disease grade}} \times 100$$

Table 1: Disease severity scale for bacterial leaf blight disease

Disease score	Lesion area (%)	Disease reaction
1	1-5	Highly Resistant (HR)
3	6-12	Resistant (R)
5	13-25	Moderately Resistant (MR)
7	26-50	Susceptible (S)
9	51-100	Highly Susceptible (HS)

2.3 Screening of rice genotypes for bacterial leaf blight under natural condition and yield losses

During the *Kharif* 2022-23, the research was carried out on a bunded rice field under irrigated conditions. In the I.G.K.V. Research field, 25 rice genotypes were grown. The rice genotypes $17 \times 2 \text{ m}^2$ were shown in a common pattern with 20 cm spacing between rows. Seed placing was done approximately at a 2-3 cm interval. NPK fertilizer was applied per hectare. 50% of nitrogen and entire dose of phosphorus were given as first basal dose and remaining nitrogen applied in two split doses. Disease severity was

recorded on 0-9 scale at tillering stage.

Loss in grain weight (GW)

For calculating loss in grain weight, samples were dried and their grains were separated from both healthy and diseased plants. Loss (%) in grain weight was calculated using the following formula:

$$\% \text{ loss in 100 GW} = \frac{W1 - W2}{W1} \times 100$$

Where,

GW= Grain weight,

W1= Weight of 1000-grain obtain from healthy plants

W2= Weigh of 1000-grain obtain from the disease plants

3. Results and Discussions

3.1 Screening of rice hybrid lines against bacterial leaf blight of rice during *Kharif* 2023-24

The experimental result showed that total 112 rice hybrid entries were screen at against the bacterial leaf blight disease under field conditions during 2023-24. The location severity index (7.78) under artificial inoculation condition, such disease pressure of bacterial leaf blight was recorded on selected infected leaf at flag leaf stages on 0-9 scale and the reaction presented in the table no. 2.

The one rice entries were recorded resistant (score-3) 29733 and the six rice entries were recorded moderately resistant (score-5) *i.e.*, 29690, 29694, G.BIDHAN-3 (NCV), 29727, 29735, 28P67 (OBCH-1), while forty seven rice entries were recorded susceptible (score-7) *i.e.*, 29689, 29691, 29679, 29702, 29703, 29706, 29711, 29714, 29715, 29717, 29718, 29719, RCV(PR-113.), 29721, 29722, 29725, 29727, 29729, 29731, 29736, 29737, 29738, 29739, 29740, 29742, RCV(PR-121), 29745, 29746, HRI174 (NCH), 29747, 29748, TN1 (LCV), 29750, NDR359 (NCV), 29753, Bio799 (CBCH-2), 29756, 27P63 (NCH-2), 29758, WGL14 (NCV1), RCV(ISM), 29763, BPT5204 (NCV2), 29764, RP-Bio-226, Swamadhan, Nidhi, whereas fifty eight rice entries were recorded highly susceptible (score-9) *i.e.*, 29685, 29686, 29687, (PR-124), 29688, US314 (NCH), 29692, 29693, CO51 (NCV), 29695, 29696, 29698, 29699, 29700, 29701, 29704, 29705, HR12 (LCV), 29707, 29708, 29709, 29710, 29712, US312 (NCH), 29713, 29716, 29720, 29723, 29724, 29726, 29730, 29732, 29734, TN1 (NCV), 29741, 29743, 29744, 28999, 29749, 29751, 29752, 29754, 29755, 29757, 29759, 29760, JKRH3333 (NCH), 29761, 29762, IR-64, Rasi, Tetep, CO-39, CH-45, Benibhog, Ajaya, IR-50 and Vikramarya was recorded highly susceptible.

3.2 Screening of rice hybrid lines against bacterial leaf blight of rice during *Kharif* 2024-25

The experimental result showed that 120 rice entries were also screened against the bacterial leaf blight disease under field conditions during 2024-25. The location severity index was under artificial inoculation condition (7.19) under such disease pressure of bacterial leaf blight was recorded on selected infected leaf at flag leaf stages on 0-9 scale and the reaction presented in the table no 3.

The three rice entries were recorded resistant (score-3) 31475 and the twenty four rice entries were recorded moderately resistant (score-5) *i.e.*, 31438, 31442, US-314 (NCH), 31445, Rasi(LCV), Varadhan (LCV), ISM, 31453,

31459, DRR Dhan 62, 31463, 31472, 31476, 31483, Jaya(RCV), 31487, 31488, NDR-359 (NCV), 31490, 31493, 31496, IR-50, Ajaya, RP-Bio-226 while fifty six rice entries were recorded susceptible (score-7) *i.e.*, 31433, 31434, CO-51 (NCV), 31435, 31436, Tetep, 31437, MTU-1153 (RCV), 31441, 31443, 31446, 31448, 31450, 30556, IR-64, HR-12, Wazphek, 31451, 31452, 31458, 31454, 31457, MTU-1010 (RCV), 31458, 31460, 31461, IR-64, Tetep, ISM, 31467, 31468, 31471, 31473, 31474, 31477, 31478, 31479, 31480, 31482, 31484, 31486, DRR Dhan-38 (LCV), 31489, 31491, 31492, 31494, 31495, 27P63 (NCH), 31497, 31499, BPT-5204 (NCV-2), 31500, HR-12, Vikramarya, Nidhi, CH-45, Benibhog, Swarnadhan, Tetep, whereas thirty-eight rice entries were recorded highly susceptible (score-9) *i.e.*, 31432, 31437, 31444, 31447, 31449, TN-1, DRR Dhan 53, DRR Dhan 51, DRR Dhan 62, Gontra Bidhan-3 (NCV), 31455, 31456, 31462, US-312 (NCH), TN1, HR-12, DRR Dhan 53, DRR Dhan 51, Wazphek, 31464, 31465, 31466,

31469, 31470, US-321 (NCH), AZ8433DT(OBCH), 31481, 31485, WGL-14 (NCV-1), 31498, ADT-49 (RCV), IR-64, Rasi, TN-1, CO-39 was recorded highly susceptible. The present findings align with Srinivas *et al.*, (2023) [13], who screened 30 rice genotypes at Navsari Agricultural University under artificial inoculation. Three genotypes (NVSR-466, NVSR-396, ISM) were moderately resistant, 12 were susceptible, and checks GR-11 and TN-1 were highly susceptible. Similarly, Dubey *et al.*, (2022) [4] evaluated 74 genotypes under sodic soil at Kumarganj, Ayodhya, and found 10 resistant, 25 moderately resistant (including checks Pusa-44 and Kala Namak), and 8 moderately susceptible genotypes. Acharya and Sujata (2021) [1] screened 150 genotypes in 2018 and 315 in 2019 under natural conditions. In 2018, 6 were resistant, while in 2019, none showed full resistance, though many were moderately resistant.

Table 2: Screening of national hybrid screening nurseries rice genotypes for bacterial leaf blight under artificial inoculation conditions 2023-24

S. No.	Score	Reaction	Frequency distribution	Varieties/entries
01	1	HR	-	-
02	3	R	1	29733
03	5	MR	6	29690, 29694, G. BIDHAN-3 (NCV), 29727, 29735, 28P67 (OBCH-1)
04	7	S	47	29689, 29691, 29679, 29702, 29703, 29706, 29711, 29714, 29715, 29717, 29718, 29719, RCV(PR-113.), 29721, 29722, 29725, 29727, 29729, 29731, 29736, 29737, 29738, 29739, 29740, 29742, RCV(PR-121), 29745, 29746, HRI174 (NCH), 29747, 29748, TN1 (LCV), 29750, NDR359 (NCV), 29753, Bio799 (CBCH-2), 29756, 27P63 (NCH-2), 29758, WGL14 (NCV1), RCV(ISM), 29763, BPT5204 (NCV2), 29764, RP-Bio-226, Swamadhan, Nidhi
05	9	HS	58	29685, 29686, 29687, (PR-124), 29688, US314 (NCH), 29692, 29693, CO51 (NCV), 29695, 29696, 29698, 29699, 29700, 29701, 29704, 29705, HR12 (LCV), 29707, 29708, 29709, 29710, 29712, US312 (NCH), 29713, 29716, 29720, 29723, 29724, 29726, 29730, 29732, 29734, TN1 (NCV), 29741, 29743, 29744, 28999, 29749, 29751, 29752, 29754, 29755, 29757, 29759, 29760, JKRH3333 (NCH), 29761, 29762, IR-64, Rasi, Tetep, CO-39, CH-45, Benibhog, Ajaya, IR-50 and Vikramarya
Total Varieties/ entries				112
LSI (Location severity index)				7.78

Table 3: Screening of national hybrid screening nurseries rice genotypes for bacterial leaf blight under artificial inoculation conditions 2024-25

S. No.	Score	Reaction	Frequency distribution	Varieties/entries
01	1	HR	-	-
02	3	R	1	31475
03	5	MR	24	31438, 31442, US-314 (NCH), 31445, Rasi (LCV), Varadhan (LCV), ISM, 31453, 31459, DRR Dhan 62, 31463, 31472, 31476, 31483, Jaya (RCV), 31487, 31488, NDR-359 (NCV), 31490, 31493, 31496, IR-50, Ajaya, RP-Bio-226
04	7	S	56	31433, 31434, CO-51 (NCV), 31435, 31436, Tetep, 31437, MTU-1153 (RCV), 31441, 31443, 31446, 31448, 31450, 30556, IR-64, HR-12, : Wazphek, 31451, 31452, : 31458, 31454, 31457, MTU-1010 (RCV), 31458, 31460, 31461, IR-64, Tetep, ISM, 31467, 31468, 31471, 31473, 31474, 31477, 31478, 31479, 31480, 31482, 31484, 31486, DRR Dhan-38 (LCV), 31489, 31491, 31492, 31494, 31495, 27P63 (NCH), 31497, 31499, BPT-5204 (NCV-2), 31500, HR-12, Vikramarya, Nidhi, CH-45, Benibhog, Swarnadhan, Tetep,
05	9	HS	38	31432, 31437, 31444, 31447, 31449, TN-1, DRR Dhan 53, DRR Dhan 51, DRR Dhan 62, Gontra Bidhan-3 (NCV), 31455, 31456, 31462, US-312 (NCH), TN1, HR-12, DRR Dhan 53, DRR Dhan 51, Wazphek, 31464, 31465, 31466, 31469, 31470, US-321 (NCH), AZ8433DT(OBCH), 31481, 31485, WGL-14 (NCV-1), 31498, ADT-49 (RCV), IR-64, Rasi, TN-1, CO-39
Total Varieties/ entries				120
LSI (Location severity index)				7.19

3.3 Screening of rice genotypes for bacterial leaf blight under natural condition and yield losses

A total of 25 rice genotypes were evaluated under natural conditions for their response to bacterial leaf blight (BLB) and corresponding yield losses. Significant variation was observed among the genotypes in terms of disease severity

and yield reduction. The disease severity among genotypes ranged from 23.21% (Maheshwari) to 68.54% (TN-1). Based on the standard 1-9 disease scoring scale, genotypes were categorized as Resistant (R), Moderately Resistant (MR), Susceptible (S), or Highly Susceptible (HS). Two genotypes such as Maheshwari and Kala Namak recorded

resistance lower disease severity, eight genotype recorded as moderate resistance like Karma masuri, Jaldubi, Vikram, Zinc rice, CG devbhog, CG sugandhit, Bamleshwari and Unnat samma masuri and ten genotype recorded as susceptible like Shyamala, Chandrhasini, Bastar Dhan, Poornima, Chinor, Swarna sub-1, MTU1010, Rajeshwari while five genotypes like R-1919, TN-1, IR-64, HMT and Swarna recorded high severity and were classified as highly susceptible (score 9).

The 1000-grain weight, a direct indicator of grain quality and development, was significantly affected by BLB in susceptible genotypes. For instance, TN-1 experienced a 30.27% reduction in grain weight due to infection (from 23.25g to 16.21g), while Kala Namak showed only a 1.96% loss, maintaining almost stable grain weight even under disease pressure. Grain weight loss was highest in TN-1 (30.27%), Swarna (27.73%), IR-64 (27.51%), HMT (26.60%). These losses are closely aligned with high disease severity, confirming the impact of BLB on grain development. Minimal losses were observed in Kala Namak (1.96%), Maheshwari (6.16%), CG Sugandhit (8.18%).

Yield loss due to BLB infection ranged from 12.50% in Kala Namak to 35.68% in Swarna. High yield losses were observed in Swarna (35.68%), TN-1 (33.10%), R-1919 (30.45%) and Mahamaya (30.21%). These losses closely mirrored their disease severity and grain weight reductions. On the other hand, genotypes such as Rajeshwari (12.57%), Kala Namak (12.5%), and Maheshwari (16.40%) exhibited minimal yield loss despite varying degrees of infection, suggesting either effective resistance or tolerance.

The present findings are supported by earlier studies. Kumar *et al.*, (2018) ^[10] reported that local rice varieties in Chhattisgarh were more susceptible to BLB than improved ones, with H.M.T., Pant-4, and Safri-17 being most susceptible, while Maheshwari showed resistance. This suggests that resistance genes react differently to various *Xoo* isolates. Khan *et al.*, (2015) ^[16] observed significant yield losses due to BLB in Upper Dir, Pakistan, with Barawal Bandi showing the highest disease severity and grain loss. Chaudhary *et al.*, (2012) ^[3] highlighted that BLB can cause up to 80% yield loss in severe cases.

Table 4: Screening of rice genotypes for bacterial leaf blight under natural condition and yield losses

S. No	Genotypes	Disease severity	Score	Disease reaction	1000 g Grain Weight (Healthy Plants)	1000 g Grain Weight (Disease Plants)	Loss in Weight (%)	Healthy plot Yield in kg	Diseased plot yield in kg	Yield loss%
1	R-1919	61.25	9	HS	28.50	20.34	28.63	27.21	20.54	30.45
2	CG Tejasvi Dhan	60.22	7	S	27.00	23.98	11.18	26.00	20.24	22.15
3	Maheshwari	23.21	3	R	18.34	17.21	6.16	16.28	13.61	16.40
4	Karma masuri	38.11	5	MR	28.11	25.32	9.92	23.26	14.17	26.18
5	Jaldubi	45.21	5	MR	15.60	13.98	10.38	8.39	6.95	17.16
6	Mahamaya	58.65	7	S	29.99	25.68	14.37	27.34	20.70	30.21
7	Shyamala	52.54	7	S	25.30	22.19	12.29	10.78	8.10	23.86
8	Chandrhasini	61.27	7	S	25.20	21.69	13.92	16.48	13.47	18.26
9	Vikram	42.14	5	MR	27.40	24.75	9.67	21.78	17.62	19.10
10	Zinc rice	40.71	5	MR	22.40	20.21	9.77	19.21	15.69	18.32
11	Bastar Dhan	59.44	7	S	24.76	20.10	18.82	25.29	18.98	24.95
12	Poornima	55.59	7	S	15.45	12.23	20.84	19.31	13.43	20.10
13	CG devbhog	38.67	5	MR	18.32	16.20	11.57	23.21	17.73	23.61
14	CG sugandhit	35.52	5	MR	14.41	13.23	8.18	15.21	13.41	18.40
15	Kala namak	27.21	3	R	10.20	10.00	1.96	7.36	6.44	12.5
16	TN-1	68.54	9	HS	23.25	16.21	30.27	29.21	19.54	33.10
17	Bamleshwari	42.01	5	MR	25.50	21.91	14.07	25.76	17.03	21.18
18	IR-64	60.19	9	HS	26.35	19.10	27.51	28.21	20.11	28.71
19	Chinor	60.21	7	S	9.50	8.27	12.94	10.98	9.57	22.21
20	HMT	61.47	9	HS	28.49	20.91	26.60	13.18	10.89	18.21
21	ISM	35.24	5	MR	13.40	11.87	11.41	18.92	14.99	20.77
22	Swarna	65.21	9	HS	25.20	18.21	27.73	30.71	19.75	35.68
23	Swarna sub-1	50.51	7	S	28.90	24.21	16.22	28.89	21.88	29.21
24	MTU1010	57.46	7	S	27.26	22.46	17.60	19.21	15.38	25.14
25	Rajeshwari	55.36	7	S	25.60	21.26	16.95	20.28	17.73	12.57

4. Summary

During *Kharif* 2023-24, 112 hybrid rice entries were screened under artificial inoculation, recording a high Location Severity Index (LSI) of 7.78. Among these, 1 entry was resistant, 6 moderately resistant, 47 susceptible, and 58 highly susceptible. In *Kharif* 2024-25, screening was expanded to 120 entries, with an LSI of 7.19, again indicating high disease pressure. Here, 3 entries were resistant, 24 moderately resistant, 56 susceptible, and 38 highly susceptible. Under natural conditions, 25 rice genotypes were evaluated for BLB resistance and yield impact. Disease severity ranged from 23.21% (Maheshwari) to 68.54% (TN-1). Genotypes Maheshwari and Kala Namak showed resistance with minimal disease and yield loss,

while TN-1, Swarna, IR-64, and HMT were highly susceptible, experiencing up to 30.27% reduction in 1000-grain weight and 35.68% yield loss.

5. Conclusion

Screening under artificial inoculation revealed high BLB pressure. A few hybrid entries showed resistance, while most were susceptible to highly susceptible. Under natural conditions, Maheshwari and Kala Namak were resistant with minimal yield loss, whereas TN-1, Swarna, IR-64, and HMT were highly susceptible. These findings highlight the need to promote resistant genotypes for effective BLB management.

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