Society of Krishi Vigyan
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J Krishi Vigyan 2025, 13(1) : 171-179

DOI : 10.5958/2349-4433.2024.00128.X

ISSN 2319-6432 (Print)
ISSN 2349-6433 (Online)

Status and Screening of Brown Leaf Spot of Rice in Districts of Madhya Pradesh

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ABSTRACT

Rice (*Oryza sativa* L.) is a staple food for nearly half of the world's population. Its production is significantly affected by various biotic stresses, with fungal diseases causing major economic losses. One such disease is brown spot, caused by the Deuteromycetes fungus *Bipolaris oryzae* (teleomorph *Cochliobolus miyabeanus*), which is a significant challenge in all rice-growing regions. Given the significance of brown spot disease in rice, the current investigations aimed to: know the status of the disease and screen various rice varieties for their resistance to brown spot. A roving survey was conducted to determine the incidence and severity of brown leaf spot disease of Madhya Pradesh. The survey studied revealed that the disease was present in most of the areas, with incidences ranging from 6.52 to 32.51 per cent and severity from 7.14 to 39.54 per cent. One hundred rice varieties were screened to determine their response to the brown spot pathogen. The results indicated that only one variety, JRH-19, was highly resistant. Sixty varieties were moderately resistant, with 5.1 to 25 percent of the leaf area affected. One variety, Kranti, was found to be highly susceptible to brown leaf spot disease.

Key Words: Brown leaf spot, Incidence, Rice, Severity, Screening.

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INTRODUCTION

Rice (*Oryza sativa* L.) is a second most staple food cereal crop that feeds approximately half of the global population. India is the world's second largest producer of rice in terms of both area and production, after China. (Gharde *et al,*2018). Rice has a significant role in both life support and economic development around the world. The year 2004 was declared as the "International Year of Rice," with the theme of "Rice is Life," which demonstrates the importance of rice to be the main source of food and results from a recognition that rice-based structures are required for food safety, alleviation of poverty, and enhanced living.

Rice serves as a primary host for *Bipolaris oryzae*. Approximately 23 grass genera and 20 Oryza species have been identified as vulnerable to *B. oryzae* infection in controlled inoculation conditions. However, instances of natural infection in non-rice hosts are uncommon, with the exception of *Zizania aquatica* (wild rice) (Bean and Schwartz in 1961), *Leersia hexandra* (southern cut grass), and *Setaria italica* (German millet) (CPC, 2001). Brown leaf spot of rice caused by *Bipolaris oryzae* (*Breda de Haan*) Shoemaker (= *Helminthosporium oryzae* teleomorph = *Cochliobolus miyabeanus*) has been observed in Japan since 1900. Brown spot leads to reductions in both the quantity and quality of rice crop. The disease has been observed in all rice-growing countries, including Japan, China, Myanmar, Sri Lanka, Bangladesh, Iran, Africa, South America, Russia, North America, and the Philippines (Khalili *et al,* 2012).

In India, brown leaf spot of rice is prevalent in most of the rice-growing states. It was first discovered in Madras (1919) by Sundararaman (1922). This disease is widespread across rice-

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Table 1. Brown spot disease rating scale .

Disease Score	Affected leaf area
0	Spot are not present
1	Small brown speaks of pin point size on lower leaves.
3	Small roundish necrotic brown spots, about 1 -2 mm in diameter, with a distinct brown margin, significant numbers of spots on the upper leaves
5	Typical susceptible brown spot, 3 mm or larger infecting 4-25 percent of the leaf area.
7	Typical susceptible brown spot, 3 mm or larger infecting 26 -50 per cent of the leaf area.
9	Typical susceptible brown spot, 3 mm or larger infecting more than 75 percent of the leaf area.

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Samples were taken from the surveyed region, and the Percent Disease Index (PDI) was computed utilizing the formula of Wheeler (1969)

$$PDI = \frac{Sum\ of\ all\ disease\ ratting}{Total\ no.\ of\ leaves\ observed\ x\ Maximum\ grade} x100$$

growing regions worldwide. It tends to be particularly problematic in areas with heavy rainfall, such as Himachal Pradesh, Jammu and Kashmir, Uttarakhand, the coastal regions of Kerala and Karnataka, the Brahmaputra valley of Assam, and West Bengal. The disease tends to be more severe in regions where dry or direct-seeded rice cultivation practices are common, notably in the states of Bihar, Chhattisgarh, and Madhya Pradesh. The disease is critical in many places, resulting in significant grain output losses (up to 90%) when leaf spotting becomes epiphytic, as seen during the Great Bengal famine of 1942 (Ghose *et al,* 1960; Safdar and Rais 2024).

Bengal faced a devastating famine in 1943, killing 2 million people due to malnutrition, and many of them moved to other place as the rice crop was damaged by the fungus *Helminthosporium oryzae*, which caused brown spot (Padmanabham, 1973). This is also known as the disease of poor farmers, who are unable to supply all the requirements of crop. The disease arises especially when water availability is limited, and associated with nutritional imbalances, particularly a deficiency of nitrogen.

The pathogen, *Bipolaris oryzae*, infects various parts of the rice plant including the coleoptiles, leaf sheath, leaves, panicle, branches, glumes, and spikelets. This disease induces seedling blight characterized by small, circular lesions that are yellow or brown in colour. These lesions have the potential to encircle the coleoptiles, leading to distortion of primary and secondary leaves, (Webster and Gunnel in 1992). The current research aims to achieve the documentation and screening of different varieties of rice for their response against *Helminthosporium oryzae* causing brown leaf spot of rice in different districts of Madhya Pradesh.

MATERIALS AND METHODS

The study was carried out during 2023-24 for screening at Jawaharlal Nehru Krishi Vishwavidyalaya in Jabalpur, Madhya Pradesh, specifically at the Breeder Seed Production Unit, College of Agriculture, JNKVV, Jabalpur where rice germplasm was cultivated. The investigation details include the materials used and the methodology adopted, outlined under the following headings.

Survey of brown spot of rice in different districts of Madhya Pradesh

A survey was conducted during the 2022-23 kharif season in the primary rice-growing districts of Jabalpur division of Madhya Pradesh. The aim was to assess the severity of brown leaf spot disease in paddy fields. During the investigation, paddy plants displaying symptoms of brown spot disease were identified and selected

Table 2. Details of 0-9 scale used to determine the severity of brown spot disease.

Disease score	Disease severity (affected leaf area %)	Host reaction
0	No incidence	Immune (I)
1		Highly Resistant (HR)
3	1.1-5	Resistant (R)
5	5.1-25	Moderately Resistant (MR)
7	25.1-75	Susceptible (S)
9		Highly Susceptible (HS)

Table 3. Disease incidence and severity of brown spot of rice in Jabalpur division of Madhya Pradesh during *Kharif* 2023.

District	Tehsil/Taluk	Village	Variety	Disease incidence	Disease severity
Jabalpur	Jabalpur	Gwarighat	MTU-1010	18.64	15.63
		Bamhori	1121	11.69	10.94
	Panagar	Keolari	PS-4	12.59	14.63
		Pipariya	Mahamaya	21.64	17.51
	Sihora	Ghatsemirya	Kranti	27.51	21.89
		Majhgawan	Swarna	19.16	21.61
	Patan	Nunsar	Kranti	28.57	26.95
		Pakariya	MTU-1010	17.69	16.61
Mean				19.68	18.22
Katni	Badwara	Majhgawan	PS-5	12.13	13.12
		Bijori	PS-4	11.64	11.31
	Barhi	Kanwara	Kranti	14.51	13.16
		Karmore	MTU-1010	17.67	16.74
	Murwara	Pipraundh	Chatri	13.51	18.94
		Banda	Chatri	12.89	14.53
	Rithi	Kharkhari	MTU-1010	17.14	18.61
		Barkheda	PS-4	19.76	18.16
				14.90	15.57
Narsinghpur	Gadarwara	Sahpur	PS-5	9.54	11.51
		Vijanpur	PS-5	11.14	9.64
	Gotegaon	Karakbel	MTU-1010	10.16	9.52
		Belkheda	MTU-1010	9.19	8.63
	Kareli	Gobargaon	PS-4	8.74	10.97
		Manegaon	PS-4	13.73	11.89
	Narsimhapur	Jhirikala	Swarna	12.54	12.79
		Bhesapala	Mahamaya	11.33	13.84

for sampling. The severity of the disease was assessed using the Standard Evaluation System (SES) for rice, which utilizes a scale ranging from 0 to 9 as given table-1.

Screening of different varieties of rice for their response against pathogen

The investigation aimed to identify resistant sources against brown spot disease at the Experimental Breeder Seed Production, Unit, JNKVV, Jabalpur during the Kharif season of 2023-24.

One hundred different varieties of rice were collected from the Breeder Seed production unit, JNKVV-Jabalpur. These rice varieties were screened using the Standard Evaluation System (SES) scale for brown spot disease of rice**.** The

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District	Tehsil/Taluk	Village	Variety	Disease incidence	Disease severity
		Vijanpur	PS-5	11.14	9.64
	Gotegaon	Karakbel	MTU-1010	10.16	9.52
		Belkheda	MTU-1010	9.19	8.63
	Kareli	Gobargaon	PS-4	8.74	10.97
		Manegaon	PS-4	13.73	11.89
	Narsimhapur	Jhirikala	Swarna	12.54	12.79
		Bhesapala	Mahamaya	11.33	13.84
Mean				10.79	11.09
Seoni	Seoni	Alonia	Kranti	6.52	7.14
		Bamodhi	PS-4	8.92	10.57
	Barghat	Kasmi	PS-4	11.74	10.64
		Dhapara	Swarna	13.14	11.51
	Kurai	Arjuni	Mahamaya	9.53	10.13
		Dungariya	PS-5	10.11	10.74
	Dhanora	Amoli	Swarna	11.59	12.59
		Balpura	Kranti	13.79	12.78
Mean				10.66	10.76
Chhindwara	Amarwara	Badegaon	PS-5	13.74	12.84
		Kekda	PS-5	16.19	15.64
	Bichhua	Chicholi	MTU-1010	18.59	17.12
		Jaitpur	MTU-1010	17.71	16.56
	Chaurai	Bari	PS-4	12.54	18.74
		Dhaulpur	PS-4	18.14	16.63
	Chindwara	Gadhmari	Swarna	17.32	16.13
		Dewardha	Mahamaya	15.15	16.68
Mean				16.17	16.29
Mandla	Nainpur	Hirapur	Kranti	29.16	30.54
		Dithori	PS-4	27.84	32.64
	Niwas	Harduli	PS-4	19.99	38.74
		Kohani	Swarna	20.87	39.54
	Mandla	Amangaon	Mahamaya	26.74	19.98
		Dehra	PS-5	28.64	25.64
	Bichhiya	Dilwara	Swarna	27.54	31.59
		Khamtipur	Kranti	30.64	33.63
Mean				26.42	31.53
Balaghat	Katangi	Nandora	MTU-1010	25.44	30.71
		Khamariya	Swarna	27.84	31.52
	Kiranpur	Amagaon	PS-4	29.54	30.74
		Hatta	MTU-1010	28.74	33.39
	Balaghat	Rajegaon	Kranti	25.94	30.13
		Changotola	MTU-1010	28.14	31.59
	Lanji	Chicholi	Swarna	30.74	36.96
		Biranpur	Swarna	28.56	33.74
Mean				28.11	32.34
Dindori	Dindori	Deopada	MTU-1010	22.14	30.61
		Chandikapur	Swarna	12.94	16.16
	Amarpur	Karanpura	PS-4	30.64	28.94
		Lalpur	MTU-1010	28.59	30.14
	Samnapur	Atariya	Kranti	26.43	31.59
Mean				26.05	28.64

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Table 4. District wise data of incidence and severity of brown leaf spot of rice in Madhya Pradesh (Jabalpur division).

Districts	Disease incidence (DI)	Disease severity (DS)
Jabalpur	19.68	18.22
Katni	14.90	15.57
Narsinghpur	10.79	11.09
Seoni	**10.66**	**10.76**
Chhindwara	16.17	16.29
Mandla	26.42	31.53
Balaghat	**28.11**	**32.34**
Dindori	26.05	28.64

Table 5. Field evaluation of rice varieties against brown spot caused by *H. oryzae*

Sr. No.	Rice varieties	Disease severity % (65 Days after transplanting)	Host reaction	Score
1	JRH-19	1.00	HR	1
2	NPT-83	4.44	R	3
3	PB-1121	2.22	R	3
4	JRH-8	2.22	R	3
5	JRH-5	3.33	R	3
6	JR-81	2.22	R	3
7	PUSA JRH -56	2.22	R	3
8	PB-5	4.44	R	3
9	JR-21	3.33	R	3
10	JR-4	2.22	R	3
11	JNPT-10-17	2.22	R	3
12	JRB-1	2.22	R	3
13	JNPT-581-64	3.33	R	3
14	JR-10	6.66	MR	5
15	Kalli Mooch	7.77	MR	5
16	Londi	12.22	MR	5
17	JRH-141	10.00	MR	5
18	JNPT-14-7	8.88	MR	5
19	JR-206	17.17	MR	5
20	Naveen	13.13	MR	5
21	MTU-1010	14.14	MR	5
22	Kalli Kumol	8.88	MR	5
23	PB-1637	23.33	MR	5
24	IR-64	16.66	MR	5
25	Assam Koti	12.12	MR	5
26	PS-4	16.16	MR	5
27	JNPT-1058	12.12	MR	5
28	JRH-139	10.00	MR	5
29	JNPT-19	16.66	MR	5
30	Sonam	14.44	MR	5
31	JNPT-828	18.88	MR	5
32	JNPT-124-64	8.88	MR	5
33	JNPT-822	15.55	MR	5
34	Dubraj	20.00	MR	5

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Sr. No.	Rice varieties	Disease severity % (65 Days after transplanting)	Host reaction	Score
35	PB-1509	22.22	MR	5
36	JNPT-827	15.55	MR	5
37	JNPT-505-53	6.66	MR	5
38	JNPT-831	14.44	MR	5
39	DR-199-5	16.16	MR	5
40	JNPT-517-85	17.17	MR	5
41	Pusa Sambha-1853	15.55	MR	5
42	JRH-142	8.88	MR	5
43	Kalli Namak	6.66	MR	5
44	PB-1460	23.33	MR	5
45	Bhaisan	13.33	MR	5
46	DRR-45	7.77	MR	5
47	PB-1718	23.33	MR	5
48	JNPT-105	17.17	MR	5
49	JNPT-14-5	13.33	MR	5
50	Sonam Surbhi	14.44	MR	5
51	JR-33	10.00	MR	5
52	JNPT-832	15.55	MR	5
53	Kshatriya	16.66	MR	5
54	PRH-60	22.22	MR	5
55	Mahamaya	8.64	MR	5
56	Dhanteswari	17.17	MR	5
57	DRR-48	10.10	MR	5
58	MTU-1080	14.14	MR	5
59	PB-1	21.11	MR	5
60	JGL-1928	18.18	MR	5
61	JNPT-570-64	11.11	MR	5
62	BJR-11	15.55	MR	5
63	JRH-138	12.22	MR	5
64	PB-1847	7.77	MR	5
65	PB-1885	11.11	MR	5
66	WGL-14	30.00	MR	5
67	PB-1886	48.48	MR	5
68	JR-201	16.16	MR	5
69	JR-81	7.77	MR	5
70	JNPT-829	17.77	MR	5
71	Pusa Sambha-1850	20.00	MR	5
72	JNPT-8116	22.22	MR	5
73	JNPT-14-6	10.00	MR	5
74	Madurai	16.66	MR	5
75	JNPT-10-17	23.33	MR	5
76	DRR-49	54.44	S	7
77	MR-219	41.11	S	7
78	MTU-1081	44.44	S	7
79	JGL-3228	42.22	S	7
80	PUSA-4	51.11	S	7
81	JNPT-14-4	31.11	S	7
82	OR-1985	51.11	S	7
83	JR-137	28.88	S	7

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Sr. No.	Rice varieties	Disease severity % (65 Days after transplanting)	Host reaction	Score
84	PB-7	46.46	S	7
85	Swarna	55.55	S	7
86	Pusa-1460	48.88	S	7
87	PB-1692	27.77	S	7
88	JRH-140	30.00	S	7
89	JNPT-1059-9	26.66	S	7
90	JRH-143	31.11	S	7
91	WGL-32183	31.11	S	7
92	Falguni	38.88	S	7
93	PB 1121	42.32	S	7
94	MR-220	51.11	S	7
95	PB-1401	37.77	S	7
96	Chatri	46.66	S	7
97	WGL-32100	30.00	S	7
98	JNPT-14-3	35.55	S	7
99	WGL-23985	37.77	S	7
100	Kranti	77.77	HS	9

Table 6. Field evaluation of rice varieties against brown spot caused by *H. oryzae*

Disease Score	Affected leaf area	Host Response	Varieties	Total no. of varieties/host response
0	0	Immune (I)	0	0
1	Less than 1%	Highly Resistant (HR)	JRH-19	1
3	1.1-5%	Resistant (R)	NPT-83, PB -1121, JR21, JR -4, PB -5, JRH -5, JRH -8, JR -21, JRB-1, PUSA JRH-56, JNPT-581-64, JNPT-10-17	12
5	5.1-25%	Moderately Resistant (MR)	JR-206, MTU -1010, Naveen, PB -1885, PB -1847, JR -10, PS -4, JRH-138, Kalli kumol, PB -1718, Londi, JR -201, JNPT -505-53, JRH-141, Kshatriya, JNPT -1017, JNPT -822, JNPT -124-64, Sonam, Dubraj, JNPT-14-7, PB-1509, IR-64, JNPT-14-6, JNPT-828, JNPT -827, Assam kot i, PB -1637, JNPT -15-5, Sonam, Surbhi, JNPT -831, JNPT -832, Kalli -namak, Mahamaya, JNPT -8116, JNPT -1058, JR81, Pusasambha1850, Madu rai, JNPT -19, JR-33, JNPT-829, JRH-142, Pusasambha-1853, JRH-139, JNPT-105, PB -1, PRH -60, PB -1460, BJR -11, JGL -1928, DRR -45, Bhaisan, DR199 -5, JNPT -570-64, Dhanteswari, JNPT -517-85, MTU-1080, DRR-48, Kalli mooch.	60
7	25.1-75%	Susceptible (S)	MTU-108, JR -137, Chatri, PB -1692, JNPT -14-3, WGL -14, JNPT-1059-9, PB -1886, JGL -3228, JRH -140, Pusa -4, DRR -49, PB-7, MR -219, Falguni, PB -1121, Swarna, JR H -143, MR -220, PB-1401, WGL-32100, Pusa-1460, OR-1985, JNPT-14-4, WGL-23 985, WGL-32183.	26
9	>75%	Highly Susceptible (HS)	Kranti	1

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screening was conducted under field conditions at 65 days after transplanting at the BSP Unit, JNKVV Jabalpur (Table 2).

RESULTS AND DISCUSSION

An survey was carried out in the major rice-growing areas of Madhya Pradesh. The survey covered thirty-two taluks across eight districts: Jabalpur, Katni, Narsinghpur, Seoni, Chhindwara, Balaghat, Mandla, and Dindori, during the Kharif season of 2023. During the survey scoring of the leaves was done as per 0-9 scale (table 1) mentioned in material and methods and data presented in table 3 disease incidence (DI) and disease severity (DS).

The perusal of the data (Table 3) revealed that the brown leaf spot was observed in all areas of the Jabalpur division of Madhya Pradesh. Disease incidence ranged from 6.52 to 32.51 per cent and disease severity ranged from 7.14 to 39.54 per cent.

Scenario of the disease at village level

Among the different villages surveyed, the maximum mean disease incidence (32.51%) was recorded in Amadongri village of Dindori district while the minimum (6.52%) was recorded in Alonia village of Seoni district. Whereas the maximum mean disease severity (39.54%) was recorded in Kohani village of Mandla district while the minimum severity (7.14%) was recorded in Alonia village of Seoni district.

Scenario of the disease at district level

Among the different districts surveyed, the maximum mean disease incidence (28.11%) was recorded in Balaghat district, followed by Mandla (26.42%), Dindori (26.05%), Jabalpur (19.68%), Chhindwara (16.17%), Katni (14.90%) and Narsinghpur (10.79%) in descending order. The minimum disease incidence (10.66) was recorded in Seoni district (Table 4). Further, similar trend was observed for disease severity which was maximum (32.34%) in Balaghat district, followed by Mandla (31.53%), Dindori (28.64%), Jabalpur (18.22%), Chhindwara (16.29%), Katni (15.57%) and Narsinghpur (11.09%). The minimum disease severity (10.76%) was recorded in Seoni district (Table 4).

Screening of different varieties of rice for their response against *Helminthosporium oryzae*

Out of 100 varieties evaluated, one variety (JRH-19) was shown to be highly resistant to brown leaf spot disease, with less than 1% of the leaf area affected, and twelve varieties (NPT-83, PB-1121, JR21, JR-4, PB-5, JRH-5, JRH-8, JR-21, JRB-1, PUSA JRH-56, JNPT-581-64, and JNPT-10-17) were resistant having 1.1 to 5% leaf area affected, (Table 5 & 6).

Sixty varieties were found to be moderately resistant with 5.1 to 25 percent of the leaf area affected whereas One variety (Kranti) was shown to be found highly susceptible to brown leaf spot disease, with more than 75% of the leaf area affected, Table 06.

CONCLUSION

Given the significance of brown spot disease in rice, the current investigations aimed to screen various rice varieties for their resistance to brown spot. A survey of farmers' fields in the major rice-growing regions of the Jabalpur division of Madhya Pradesh revealed that brown leaf spot incidence and severity varied from one location to the next due to varying environmental conditions, cropping patterns, and inoculum buildup. During the survey, disease incidences ranged from 6.52% to 32.51%, and disease severity ranged from 7.14% to 39.54%. Screening of 100 rice varieties indicated that only one variety, JRH-19, was highly resistant to brown leaf spot disease. Sixty varieties were moderately resistant, with 5.1 to 25 percent of the leaf area affected. One variety, Kranti, was found to be highly susceptible to brown leaf spot disease.

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Received on 10/11/2024 Accepted on 18/02/2025

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