The Bioscan
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
21(2): S.I (2), 1977-1987, 2026 www.thebioscan.com

Evaluation of disease progress and resistance levels among wheat genotypes against spot blotch (*Bipolaris sorokiniana*)

Shashi Kumari, V.P. Chaudhary, Ankita Bharti and Sanjay Kumar Yadav
Department of Plant Pathology, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya 224229
Email id: shashi510k@gmail.com

DOI:https://doi.org/10.63001/tbs.2026.v21.i02.S.I(2).pp1977-1987

Keywords:
Wheat, spot blotch, AUDPC, Screening, Bipolaris sorokiniana

Received on:
18-05-2026

Accepted on:
06-06-2026

Published on:
16-06-2026

Abstract

Spot blotch, caused by *Bipolaris sorokiniana* (Sacc.) Shoem, is one of the most important foliar diseases of wheat worldwide, occurring in nearly all wheat-growing areas and causing significant annual yield losses. A field study was conducted during the Rabi seasons of 2023–24 and 2024–25 at the Main Experiment Station, NDUA&T, Kumarganj, Ayodhya, to evaluate the resistance of 89 wheat genotypes under artificial epiphytotic conditions. Each genotype was sown as a single 1 m row in mid-December. The susceptible variety Raj 4015 was used as a check and was sown after every 20 genotypes. A pure culture of the pathogen was sprayed on the genotypes in the evening using a cleaned sprayer. Disease assessments were made on the flag leaf and the leaf immediately below it using the double-digit scale (percent blighted area). For both seasons, scores were recorded three times at ten-day intervals. Disease severity and the area under the disease progress curve (AUDPC) were calculated for each genotype. Disease severity and AUDPC varied considerably among genotypes in both seasons. None of the 89 genotypes was immune (score 00–01) and six were classified as resistant (score 12–24). Forty six genotypes were rated as moderately resistant, thirty genotypes were moderately susceptible, seven were susceptible and none of the were highly susceptible. These results indicate that, planting fully resistant genotypes and moderately resistant varieties can help reduce yield losses from spot blotch.

INTRODUCTION

Wheat is one of the most widely produced and consumed grains in the world. Generally, wheat is a self-pollinated and hexaploid plant, belongs to family Poaceae (Graminae). It provides 20% of the world's population's total calories and protein (Poudel and Bhatta, 2017). For a sizable portion of the world's population, wheat (*Triticum aestivum* L.) serves as their main source of nutrition. Globally, wheat occupies an area of 220.7 million hectares, with a total production of 793.0 million tonnes and an average productivity of 3,424 kg/ha. India ranks as the second largest wheat producer after China, with 23.4 million hectares under cultivation with a production of 140.1 million tonnes and a productivity of 5,939.6 kg/ha, contributing almost 18% of global wheat production (FAO Statistics Division, 2024). The major wheat-growing states – Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar and Maharashtra – account for about 80% of the country’s wheat area and production. India is currently a wheat-surplus country and is positioned to export wheat, earning valuable foreign exchange. Wheat is nutritionally rich compared with many other cereals, containing 71.2 g carbohydrates, 11.8 g protein, 1.5 g fat, 1.2 g crude fiber, 306 mg phosphorus, and 41 mg calcium per 100 g grain (Rai and Mauria, 1999). *Cochliobolus sativus* (Ito & Kurib.) *Drechsler* ex Dastur (anamorph: *Bipolaris sorokiniana* (Sacc.) Shoem.) causes spot blotch, a major constraint on wheat production that can lead to substantial yield losses (Joshi *et al*., 2007). Effective management strategies include crop rotation, chemical control, optimized planting time, and the use of resistant varieties. Because genetic resistance is among the most sustainable control measures, researchers have focused on identifying and developing resistant genotypes to reduce losses from spot blotch (Singh *et al*., 2006).

Materials and Methods

Evaluation of wheat genotypes for disease resistance

The experiment was conducted at the Acharya Narendra Deva University of Agriculture and Technology's Main Experimental Station in Kumarganj, Ayodhya (U.P.) between Rabi 2023– 24 and 2024–25. Seeds of 89 genotypes from the All India Coordinated Wheat and Barley Improvement Project were collected and sent to the Department of Genetics and Plant Breeding, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.).Two rows of border rows were planted with Raj 4015 and Agra local, a plant vulnerable to foliar blight, throughout the whole perimeter of the experiment. The experiment was conducted at main experiment station of Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during crop season Rabi, 2023-24 and 2024-25. Each genotype was sown (Mid-week of December) in single row of one meter length at a distance of 25 cm row to row and 5 cm plant to plant. The ten-day-old pure culture of *Bipolaris sorokiniana*, multiplied on potato dextrose agar, and sorghum seeds were used for inoculation of the entries. The spore suspension was prepared in sterilized distilled water at a spore count of 50-75 per microscopic field (10x). This suspension was sprayed at the 3-4 leaf stage using a manual atomizer. The second field inoculation was again done in the same manner after 15 days of the first inoculation. After inoculation, recordings were regularly observed disease severity. The first observation was made after 10 days of incubation on 10 randomly selected plants. The disease score of each selected plant was recorded by using Kumar *et al.* (1998) a two-digit scale (Table 1) based on the percentage of damaged area on the flag and one leaf on the ground. The maximum infection score for each genotype was listed at the end. All recommended agronomic and cultural techniques were used to produce a high quality crop.

Table 1: The double digit scale, based on per cent blighted area on the flag leaf and one leaf just below given by Kumar *et al.* (1998).

A double digit* scale for appraising blight severity				
S. No.	Severity**		Rating	
	Flag leaf	Flag-1 leaf	Disease response	Range of value
1.	0	0-1	Immune (I)	00-01
2.	1-2	2-4	Resistant (R)	12-24
3.	3-4	4-6	Moderately Resistant(MR)	34-46
4.	5-6	6-8	Moderately susceptible (MS)	56-68
5.	7-8	8-9	Susceptible (S)	78-89
6.	9	9	Highly susceptible (HS)	99

* First and second value respectively, represents per cent blighted area on the flag leaf and flag-1 leaves. ** Values 1,2,3,4,5,6,7,8, and 9, respectively correspond to 10,20,30,40,50,60,70,80 and 90 per cent blighted area.

Observations recorded

Disease severity after Based on the percentage of blighted areas on the flag and flag-1 leaf at the blooming, soft dough, and hard dough phases. Each chosen plant's disease score was twice recorded.

Spot blotches during the dough stage were counted using a double-digit, 0-9 scale. The leaf under the flag leaf and the leaf above it were used to grade the disease's prevalence. The flag leaf's score is provided by the first of two digits, while the following (flag-1) leaf's score is provided by the second digit. The disease severity was calculated as a percentage of leaf area damaged at the dough stage using the Directorate of Wheat Research (DWR), Karnal, double-digit score. An average answer was calculated by subtracting the means of the two digits separately. The percent disease index (PDI) was calculated using the formula shown below:

$$PDI = \frac{Sum\ of\ all\ numerical\ ratings}{total\ number\ of\ plants\ X\ maximum\ grade} X100$$

In each plot 10 randomly selected plants were scored.

Result and Discussion

Since resistant varieties represent the most economical and sustainable approach to disease management. The present study screened 89 wheat genotypes to identify sources of resistance to spot blotch, caused by *Bipolaris sorokiniana*. Screening was conducted under artificial epiphytotic field conditions, and disease severity was assessed at the hard dough stage using the double-digit scale based on percent blighted area on the flag and flag-1 leaves. Results of varietal screening have been presented in Tables No. 2 and 3. A perusal of data showed that out of eighty nine genotypes tested, none genotypes have been found immune in both years (score 00-01). Six genotypes were found resistant in year 2023-24 and 2024-25 (score 12-24). Some of these were IPPSN-22, IPPSN-29, IPPSN-44, IPPSN-45, IPPSN-73, and IPPSN-82. Forty six genotypes were found moderately resistant (score 34-46) against spot blotch in year 2023-24 and 2024-25. Some of these were IPPSN-21, IPPSN-23, IPPSN-24, IPPSN-25, IPPSN-26, IPPSN-27, IPPSN-28, IPPSN-31, IPPSN-32, IPPSN-33, IPPSN-35, IPPSN-38, IPPSN-41, IPPSN-43, IPPSN-46, IPPSN-47, IPPSN-49, IPPSN-50, IPPSN-54, IPPSN-56, IPPSN-57, IPPSN-58, IPPSN-59, IPPSN-60, IPPSN-64, IPPSN-65, IPPSN-66, IPPSN-67, IPPSN-69, IPPSN-71, IPPSN-72, IPPSN-74, IPPSN-76, IPPSN-77, IPPSN-78, IPPSN-79, IPPSN-81, IPPSN-83, IPPSN-84, IPPSN-85, IPPSN-87, IPPSN-89, IPPSN-92, IPPSN-95, IPPSN-98, IPPSN-101. Thirty genotypes were found moderately susceptible (score 56-68) against spot blotch in both 2023-24 and 2024-25 year. Some of these were IPPSN-30, IPPSN-34, IPPSN-36, IPPSN-37, IPPSN-39, IPPSN-40, IPPSN-42, IPPSN-48, IPPSN-51, IPPSN-52, IPPSN-53, IPPSN-55, , IPPSN-61, IPPSN-62, IPPSN-63, IPPSN-68, IPPSN-70, IPPSN-75, IPPSN-80, IPPSN-86, IPPSN-88, IPPSN-90, IPPSN-91, IPPSN-93, IPPSN-96, IPPSN-99, IPPSN-100, IPPSN-102, IPPSN-103, IPPSN-105. And seven genotypes were found susceptible (score 78-89) against spot blotch in year 2023-24 and 2024-25. Some of these were IPPSN-40A, IPPSN-60A, IPPSN-80A, IPPSN-94, IPPSN-97, IPPSN-100A and IPPSN-104. None of the genotypes were found highly susceptible (score 99) in both year i.e., 2023-24 and 2024-25.

Table 2: List of wheat genotypes evaluated against spot blotch disease and their AUDPC Rate during 2023-2024 & 2024-25

Entry no.	Genotypes	Foliar blight score(0-9 DD)							
		2023-2024			2024-2025			AUDPC	
		Flowering stage	Soft dough stage	Hard dough stage	Flowering stage	Soft dough stage	Hard dough stage	2023-24	2024-25
1.	IPPSN-21	12	24	46	12	23	45	531	516
2.	IPPSN-22	1	12	24	1	12	23	240	235.5
3.	IPPSN-23	12	25	47	12	24	45	546	526.5
4.	IPPSN-24	12	24	36	12	23	35	486	471
5.	IPPSN-25	4	25	37	3	24	36	447	432
6.	IPPSN-26	3	15	47	3	14	36	481.5	327
7.	IPPSN-27	12	23	35	12	23	34	471	466.5
8.	IPPSN-28	2	14	27	2	13	25	280.5	261
9.	IPPSN-29	2	14	24	1	12	24	267	240
10.	IPPSN-30	23	35	57	13	26	56	762	687
11.	IPPSN-31	15	26	38	12	23	35	534	471
12.	IPPSN-32	13	24	46	14	25	37	537	513
13.	IPPSN-33	12	24	37	12	23	35	490.5	471
14.	IPPSN-34	25	36	57	23	34	56	784.5	747
15.	IPPSN-35	12	24	37	12	23	35	486	411
16.	IPPSN-36	14	25	57	2	23	56	603	505.5
17.	IPPSN-37	15	27	58	13	25	56	634.5	592.5
18.	IPPSN-38	12	24	46	2	23	37	531	420
19.	IPPSN-39	23	35	57	15	27	56	762	625.5
20.	IPPSN-40	14	26	58	13	25	56	618	592.5

21.	IPPSN-40A (Check)	24	45	78	12	35	78	978	877.5
22.	IPPSN-41	12	24	47	12	23	45	535.5	516
23.	IPPSN-42	23	35	57	23	34	56	762	747
24.	IPPSN-43	13	23	35	12	24	36	477	486
25.	IPPSN-44	1	12	24	2	12	24	94	300
26.	IPPSN-45	2	13	24	1	12	24	256.5	294
27.	IPPSN-46	13	24	35	12	23	34	487.5	466.5
28.	IPPSN-47	23	35	37	13	24	35	672	487.5
29.	IPPSN-48	12	34	57	13	34	56	685.5	687
30.	IPPSN-49	13	26	37	12	25	36	517.5	496.5
31.	IPPSN-50	13	25	47	12	24	45	552	526.5
32.	IPPSN-51	12	35	56	13	35	47	691.5	657
33.	IPPSN-52	13	35	57	12	24	45	702	526.5
34.	IPPSN-53	14	35	58	4	25	47	712.5	498
35.	IPPSN-54	13	25	37	5	17	28	507	334.5
36.	IPPSN-55	14	35	57	13	25	47	708	552
37.	IPPSN-56	12	23	37	3	15	28	480	301.5
38.	IPPSN-57	13	25	47	2	24	37	552	430.5
39.	IPPSN-58	14	27	48	12	23	45	583.5	516
40.	IPPSN-59	13	25	47	12	24	46	552	531
41.	IPPSN-60	3	14	37	12	23	36	178.5	475.5
42.	IPPSN-60A (Check)	25	47	79	23	45	78	999	961.5
43.	IPPSN-61	23	37	58	13	25	56	787.5	592.5
44.	IPPSN-62	23	35	56	15	27	49	757.5	594
45.	IPPSN-63	23	35	57	12	25	56	762	586.5
46.	IPPSN-64	3	15	49	2	14	47	396	370.5
47.	IPPSN-65	12	24	46	12	23	37	531	480
48.	IPPSN-66	13	25	37	2	23	35	507	411
49.	IPPSN-67	13	25	38	2	12	36	511.5	300
50.	IPPSN-68	23	35	57	14	26	47	762	568.5
51.	IPPSN-69	14	25	37	12	24	36	513	486
52.	IPPSN-70	23	35	57	12	34	56	702	681
53.	IPPSN-71	4	26	47	3	25	46	508.5	487.5

54.	IPPSN-72	12	24	37	2	15	36	490.5	331.5
55.	IPPSN-73	1	13	24	2	12	24	250.5	165
56.	IPPSN-74	3	15	37	4	14	35	342	385.5
57.	IPPSN-75	24	35	57	23	34	56	768	747
58.	IPPSN-76	13	25	47	12	24	45	552	526.5
59.	IPPSN-77	12	23	35	2	15	28	471	322.5
60.	IPPSN-78	15	36	57	13	35	56	718.5	697.5
61.	IPPSN-79	12	24	47	2	23	37	535.5	420
62.	IPPSN-80	23	35	58	12	23	56	904.5	565.5
63.	IPPSN-80A(Check)	25	47	79	23	35	78	999	856.5
64.	IPPSN-81	13	25	37	12	24	35	507	481.5
65.	IPPSN-82	2	13	24	1	12	24	256.5	294
66.	IPPSN-83	12	23	37	3	14	35	480	322.5
67.	IPPSN-84	4	25	37	3	23	35	453	417
68.	IPPSN-85	12	23	36	12	24	35	475.5	481.5
69.	IPPSN-86	23	35	57	12	23	56	762	565.5
70.	IPPSN-87	13	25	37	12	23	35	507	471
71.	IPPSN-88	23	35	57	13	25	56	762	592.5
72.	IPPSN-89	13	34	47	12	25	46	646.5	541.5
73.	IPPSN-90	23	35	57	13	25	56	762	586.5
74.	IPPSN-91	23	35	58	23	34	47	766.5	747
75.	IPPSN-92	12	24	37	12	23	35	490.5	471
76.	IPPSN-93	23	47	69	23	45	67	942	912
77.	IPPSN-94	24	47	78	23	45	79	988.5	966
78.	IPPSN-95	12	24	48	13	25	47	540	552
79.	IPPSN-96	24	47	68	23	45	59	943.5	876
80.	IPPSN-97	25	48	79	24	47	78	1009.5	988.5
81.	IPPSN-98	13	25	58	12	24	56	601.5	576
82.	IPPSN-99	25	37	59	23	35	57	804	762
83.	IPPSN-100	12	35	57	13	34	56	696	687
84.	IPPSN-100A(Check)	23	47	79	24	46	78	987	978
85.	IPPSN-101	12	24	37	12	23	35	490.5	471
86.	IPPSN-102	12	24	56	12	24	57	576	580.5

87.	IPPSN-103	24	37	57	23	35	58	778.5	766.5
88.	IPPSN-104	25	47	78	23	35	69	994.5	816
89.	IPPSN-105	13	35	58	12	34	57	706.5	685.5

The area under disease progress curve (AUDPC)

The Area Under Disease Progress Curve (AUDPC), derived from plant disease intensity observations for 89 wheat genotypes, ranged from **94** to **1009.5** in the first year and from **165** to **988.5** in the second year, reflecting rapid disease progression across all genotypes. Under artificial epiphytotic field conditions, the wheat genotypes displayed a wide range of disease responses to *Bipolaris sorokiniana*.

Table 3: Categorization of wheat genotypes against the response of spot blotch disease under artificial disease pressure (2023-24 & 2024-25).

S.no.	Disease reaction	Score	No. of genotypes	genotypes
1.	Immune(I)	00-01	NIL	NIL
2.	Resistant(R)	12-24	6	IPPSN-22, IPPSN-29, IPPSN-44, IPPSN-45, IPPSN-73, IPPSN-82
3.	Moderately Resistant (MR)	34-46	46	IPPSN-21, IPPSN-23, IPPSN-24, IPPSN-25, IPPSN-26, IPPSN-27, IPPSN-28, IPPSN-31, IPPSN-32, IPPSN-33, IPPSN-35, IPPSN-38, IPPSN-41, IPPSN-43, IPPSN-46, IPPSN-47, IPPSN-49, IPPSN-50, IPPSN-54, IPPSN-56, IPPSN-57, IPPSN-58, IPPSN-59, IPPSN-60, IPPSN-64, IPPSN-65, IPPSN-66, IPPSN-67, IPPSN-69, IPPSN-71, IPPSN-72, IPPSN-74, IPPSN-76, IPPSN-77, IPPSN-78, IPPSN-79, IPPSN-81, IPPSN-83, IPPSN-84, IPPSN-85, IPPSN-87, IPPSN-89,

				IPPSN-92, IPPSN-95, IPPSN-98, IPPSN-101.
4.	Moderately Susceptible (MS)	56-68	30	IPPSN-30, IPPSN-34, IPPSN-36, IPPSN-37, IPPSN-39, IPPSN-40, IPPSN-42, IPPSN-48, IPPSN-51, IPPSN-52, IPPSN-53, IPPSN-55, IPPSN-61, IPPSN-62, IPPSN-63, IPPSN-68, IPPSN-70, IPPSN-75, IPPSN-80, IPPSN-86, IPPSN-88, IPPSN-90, IPPSN-91, IPPSN-93, IPPSN-96, IPPSN-99, IPPSN-100, IPPSN-102, IPPSN-103, IPPSN-105
5.	Susceptible(S)	78-89	7	IPPSN-40A, IPPSN-60A, IPPSN-80A, IPPSN-94, IPPSN-97, IPPSN-100A, IPPSN-104,
6.	Highly susceptible	99	Nil	Nil

Similar findings have been reported by other researchers. Kenganal *et al.* (2008) screened 15 wheat cultivars against *Helminthosporium sativum* [*Cochliobolus sativus*] and identified varying levels of resistance: NIDW-295 and MACS-2496 were immune; DDK-1013, DWR-185, DWR-225, RAJ-4037, and MACS-2846 were highly resistant; GW-344 and DWR-195 were resistant; GW-322, DDK-1001, and DWR-162 were moderately resistant; DWR-2006 and DWR-1006 were susceptible; and DDK-1009 was highly susceptible. Earlier, Singh et al. (1995) conducted field inoculation trials with 257 genotypes and found that only 15 were consistently resistant to *H. sativum* (*C. sativus*) across three test years. Of these, 47 were moderately resistant, 158 moderately susceptible, 33 susceptible, and 4 highly susceptible. Notably, no genotype was completely free from infection during the evaluation period.

Iftikhar *et al.* (2012) screened 56 commercial wheat varieties for spot blotch resistance under both controlled and field conditions. Among these, 12 varieties exhibited moderate resistance (MR) under both *in vitro* and *in vivo* conditions, while 2 varieties showed MR at two scale levels under both conditions. Thirty-two varieties displayed moderate susceptibility (MS) to susceptibility (S) under controlled conditions but expressed MR under field conditions. Nine varieties—Faisalabad-83, Faisalabad-85, Inqilab-91, Kaghan-93, Kirin-95, Kohinoor-83, MH-97, Rohtas-90, and Zarlashta—consistently showed MR under both controlled and field conditions at one scale level. Singh *et al.* (2002) evaluated 325 genotypes against spot blotch, of which 3 genotypes (NW-2043, MACS-2942, and HUWL-99003) exhibited resistant reactions, 75 showed moderately resistant reactions, and the remaining 256 genotypes displayed varying levels of susceptibility. Ojha *et al*. (2016) evaluated 100 screened entries, among which 20 genotypes exhibited highly resistant reactions or immunity to the disease. Additionally, 28 genotypes were resistant, 22 were moderately resistant, 15 were moderately susceptible, and 15 were susceptible.

Conclusion

The evaluation of 89 wheat genotypes against spot blotch caused by *Bipolaris sorokiniana* under artificial epiphytotic conditions revealed significant variability in disease response. None of the genotypes exhibited complete immunity, but six were classified as resistant and fifty-one as moderately resistant, indicating valuable sources of resistance within the tested material. The presence of moderately susceptible and susceptible genotypes highlights the importance of careful selection in breeding programs. Overall, the study demonstrates that deploying resistant and moderately resistant genotypes can substantially reduce yield losses due to spot blotch. These findings provide a strong foundation for wheat improvement programs, emphasizing the need to incorporate resistant lines into breeding strategies to enhance durable resistance and ensure stable wheat production in spot blotch-prone regions.

Acknowledgments

The authors would like to express their sincere gratitude to all those who contributed to the successful completion of this research. We are thankful to our institution NDUA&T, Ayodhya for providing the necessary facilities and resources. We also appreciate the valuable guidance and support provided by our mentors, colleagues, and reviewers throughout this work.

References

FAOSTAT. 2024. Food and Agriculture Organization of the United Nations. Food Outlook.

Iftikhar, S., Shahzad, A., Munir, A., Rattu, A.R. and Fayyaz, M. 2012. Screening of commercial wheat varieties to spot blotch under controlled and field conditions. *Pakistan J. Botany*. **44(1)**: 361-363.

Joshi, A.K., Kumari, M., Singh, V.P., Reddy, C.M., Kumar, S. and Rane, J. 2007. Stay green trait: variation, inheritance and its association with spot blotch resistance in spring wheat (*Triticum aestivum* L.). Euphytica. **153**: 59-71.

Kenganal, M.Y., Hanchinal, R.R. and Nadaf, H.L. 2008. *In vitro* screening of wheat genotypes against *Helminthosporium sativum*. Res. Crops. **9(2)**: 450-455.

Kumar, J., Singh, G. and Nagarajan, S. 1998. A field scale for leaf blight recording. Indian Wheat Newsletter. **4**: 3.

Ojha, A., Singh, G., Singh, T.B., Singh, V. and Rajita. 2016. Screening of resistance source against spot blotch disease caused by *Bipolaris sorokiniana* in *Triticum aestivum* L. *International J. Advanced Research*. **5(1)**: 23-28.

Poudel, R and Bhatta, M. 2017. Review of nutraceuticals and functional properties of whole wheat. *J. Nutrition & Food Sciences*.**7**: 1-7.

Rai, M. and Mauria, S. 1999. Coarse cereals, not for poor alone. The Hindu Survey of Indian Agriculture. 55-59.

Singh, A.K., Singh, R.N., Kumar, S. and Singh, B.N. 2002. Bread Wheat genotypes resistant to spot blotch of wheat. Indian Phytopathology. **55(3)**: 378.

Singh, P.K., Mergoum, M., Ali, S., Adhikari, T.B., Elias, E.M. and Hughes, G.R. 2006. Identification of new sources of resistance to tan spot, *stagonospora nodorum* blotch, and *septoria tritici* blotch of wheat Crop Science. **46**: 2047-2053.