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Disease indexing of Indian mustard genotypes against alternaria blight disease

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Abstract
Mustard is an important oilseed crop in India and affected by various biotic factors including Alternaria blight. Alternaria blight not only degrades seed quality but also significantly lowers its oil content. As it is notable that, among various disease management approaches, use of resistant varieties is the best option owing to cost effective and environment friendly approach. However, till now only few resistant sources against this disease has been reported. Therefore, in the present investigation 75 Indian mustard genotypes have been evaluated under field conditions during *Rabi* 2021-22. Some of the genotypes showed resistance against this disease. These resistance sources will be helpful in developing superior cultivar (s) for managing Alternaria blight where Indian mustard cultivation is prevalent.

Keywords: Resistance, alternaria blight, disease indexing, biotic stress

Introduction
Indian mustard (*Brassica juncea* L. Czern. & Coss) is the most pre-dominant crop of oilseed Brassica group, which is a natural amphidiploid (2n = 36, AABB genome), often cross-pollinated and with genome size of 920 Mb (Barfa *et al*., 2017; Shyam *et al*., 2019; Baghel *et al*., 2020; Verma *et al*., 2021a; Rajpoot *et al*., 2020; Sharma *et al*., 2022; Yadava *et al*., 2022; Shrivastava *et al*., 2023) [7, 17, 3, 30, 10, 12, 33, 13]. It is being grown around the globe for its oil, condiment as well as for leafy vegetable in some parts of the world (Shyam *et al*., 2020; Shyam *et al*., 2021a; Sharma *et al*., 2022) [18, 19, 12]. It is the most important oilseed crop of India having significant economic, nutritional, and industrial applications (Tripathi *et al*., 2015; Thakur *et al*., 2020) [29, 27]. It is the most significant and widely cultivated species of rapeseed mustard crops in India, accounting for 90% of the crop's area (9.168 million ha) and production (11.75 MT), with a productivity of 1178 $kgha^{-1}$ in 2021–2022 (Ministry of Agriculture and Farmers Welfare, GoI, 2022) [8].
The vulnerability of Indian mustard to various biotic (Verma *et al*., 2021a; Verma *et al*., 2021b; Tripathi *et al*., 2022; Yadav *et al*., 2023) [30, 31, 23, 28, 36] abiotic stresses (Asati *et al*., 2022; Yadav *et al*., 2022) [2, 33], nutritional quality (Shyam *et al*., 2021b; Shyam *et al*., 2021c; Shyam *et al*., 2022a; Shyam *et al*., 2022b; Shyam *et al*., 2022c) [20, 21, 23, 24, 25] and presence of low levels of genetic diversity in the population (Rajpoot *et al*., 2022; Shyam *et al*., 2021d; Shyam *et al*., 2022d) [11, 22, 26] are the major bottlenecks for its improvement. This is a serious concern for breeding as higher genetic variability ensures better selections and aids in achieving genetic gains. Further, the identification and selection of genetically diverse parents are the most vital criteria for hybrid breeding programmes (Banga *et al.*, 2015) [5].
Alternaria leaf spot caused by *Alternaria brassicae and A. brassicola* is one of the most widespread and destructive disease of rapeseed-mustard causing yield losses as well oil content losses up to 15% -71% and 14.6%- 36% respectively (Meena *et al.*, 2016) [7]. This disease occurs regularly in moderate to severe form. As a common disease management practice, use of fungicides has been followed by most of the mustard growers, which ultimately affects the environment. However, it is of a well-known fact that the availability of resistant varieties is one of the cheapest and environmentally friendly options. Therefore, the present investigation was carried out with the objectives to screen Indian mustard genotypes by means of disease indexing under field conditions against Alternaria blight diseases.

Materials and Method

The current investigation was undertaken on a total of 75 Indian mustard genotypes (Table 1) acquired from the Zonal Agricultural Research Station, Morena, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya (RVSKVV), Gwalior, India (AICRP on Rapeseed and Mustard). All the genotypes were grown in randomized block design with two replications in Rabi 2021at the experimental field of Department of Genetics & Plant Breeding, College of Agriculture, RVSKVV, Gwalior, India. Each genotype was planted in a plot of one row of 2-meter length with an arrangement of 30 cm apart between rows and 15 cm plant to plant. The observation on incidence of this disease was monitored and documented. Modified 0-9 scale for rating of disease severity of Alternaria blight adopted as recommended by AICRP on Rapeseed & Mustard, 2011 as following Table 1.

Table 1: Scale (0-9) for rating of disease severity of Alternaria blight in mustard

Rating	Disease severity	Reaction
0	0	Immune/highly resistant (I)
1	<5	Resistant
3	5-10	Moderately Resistant
5	11-25	Moderately Susceptible (MS
7	26-50	Susceptible (S
9	>50	Highly Susceptible (HS)

The intensity was calculated witht the help of formulae

$$\text{PDI} = \frac{\text{Sumoftotalnumericalrating}}{\text{Totalno. ofobservation}} \text{x} \frac{100}{\text{Max. grade}}$$

Visual estimation of disease on all the 75 genotypes were made by randomly selecting five plants from each genotype and tagged for recording the appearance of disease symptoms and per cent disease severity at 7-days interval.

Result and Discussion

During *Kharif* 2021-22, screening of 75 mustard genotypes was carried out against Alternaria blight disease. After screening against Alternaria blight it was observed that, out of 75 genotypes screened in natural field condition, none of the Indian mustard genotypes included in the study showed immune and highly resistant reaction (HR) against Alternaria leaf spot (Table 2; Table 3; Fig.1). Similarly, in a study conducted by Yadav *et al*. (2014) [35] none of the 31 mustard lines were found immune or highly resistant against Alternaria blight. In the present study, eight genotypes including Pusa Bold, Kranti, Maya, Kiran, JM-2, China, GSL-1 and RP-9 found to be resistant (R) from Alternaria blight and 25 genotypes *viz*., RB-50, Varuna, Rohini, Vardan, Vasundhara, Swarn Jyoti, Pusa Jagannath, Shraddha, DMH1, JMWR-908-1, NRC-HB-101, NRC-HB-506, RVM-3, RH-749, NRCDR-2, DRMR IJ-31, PC-5, JM-1, JM-3, RMM-10-01-01, RMM-12-01-18, WRR-5, L-4, GSC-7 and PC-6 showed moderate resistant (MR) reaction. Moreover, total 39 genotypes *i.e*.., RH- 725, Pusa JaiKisan, Albeli, Sej-2, RGN-73, JTC-1, RVM-1, RVM-2, PM-26, PM-27, PM-28, Pusa Vijay, JMM-927, RMM-12-03-18, WRR-6, WRR-7, WRR-8, WRR-9, WRR-10, WRR-11, WRR-12, WRR-13, WRR-14, WRR-15, WRR-16, WRR-17, WRR-18, WRR-19, WRR-20, WRR-21, WRR-22, WRR-25, WRR-26, WRR-27, WRR-28, WRR-29, WRR-30, WRR-31 and WRR-32 were found susceptible (S) against the disease. While, three genotypes *viz;* PM-25, PM-30, JMM-991 were found highly susceptible (HS) against Alternaria blight disease of Indian mustard. The result is in accordance with previous findings in mustard (Ali *et al.*, 2016) [1]. The symptom of the Alternaria disease first appeared on the lower leaves in the month of November-December and reached at its peak towards the upper leaves. The reaction of different genotypes of Indian mustard differed significantly. This may be due to the genetic background of the genotypes. Most of the genotypes were found susceptible to Alternaria blight as weather conditions were favorable for the disease development. Knowing when the blight will attack in connection to meteorological elements may enable forecast of its occurrence, allowing growers to take prompt action in an effective way for crop management. This will result in efficient, economical, and environmentally friendly treatment of the blight.

The severity of the Alternaria blight of oilseed Brassicas is significantly influenced by the weather conditions. Among all, three genotypes found resistant to Alternaria blight disease. The results are in resemblance with Singh *et al.* (2018) [14], Chakrabarty *et al*. (2018) [6], Singh *et al*. (2020) [16] and Muhammad *et al*. (2022) [9]. Host resistance is a crucial aspect of integrated disease management. Given that this disease consistently manifests in newly released varieties of Indian mustard with no discernible variation, it urgently must be controlled. In mustard, resistance to Alternaria blight has been reported linked to leaf enzymes involved in the phenolic pathway, such as polyphenol oxidase, peroxidase, and catalase, higher leaf sugar contents, and high deposits of leaf epicuticular wax that form a hydrophobic coating to inhibit the adhesion of water-borne inoculum, conidia germination, and germ tube formation (Meena *et al*. 2016) [7]. So, it is important to focus on these parameters while searching for Alternaria blight resistant mustard genotype (s).

Table 2: Genotypic response against Alternaria blight disease in Indian mustard

S. No.	Genotypes	Alternaria Blight	
		PDI	Reaction
1.	RB-50	11.111111	MR
2.	Pusa Bold	5.5555556	R
3.	Varuna	22.222222	MR
4.	Rohini	11.111111	MR
5.	Kranti	5.5555556	R
6.	RH- 725	33.333333	MR
7.	Maya	5.5555556	R
8.	Vardan	16.666667	MR
9.	Vasundhara	22.222222	MR
10.	Swarn Jyoti	16.666667	MR
11.	Pusa Jagannath	11.111111	MR
12.	Pusa Jai Kisan	38.888889	S
13.	Albeli	44.444444	S
14.	Sej-2	44.444444	S
15.	Shraddha	22.222222	MR
16.	DMH 1	22.222222	MR
17.	L-4	16.666667	MR
18.	JMWR-908-1	16.666667	MR
19.	RGN-73	33.333333	S
20.	NRC-HB-101	22.222222	MR
21.	NRC-HB-506	11.111111	MR
22.	RVM-3	22.222222	MR
23.	RH-749	22.222222	MR
24.	NRC DR-2	11.111111	MR
25.	DRMR IJ-31	22.222222	MR
26.	CHINA	5.5555556	R
27.	GSL-1	5.5555556	R
28.	GSC-7	16.666667	MR
29.	PC-5	11.111111	MR
30.	PC-6	22.222222	MR
31.	RP-9	5.5555556	R
32.	KIRAN	5.5555556	R
33.	JTC-1	33.333333	S
34.	JM-1	22.222222	MR
35.	JM-2	5.5555556	R
36.	JM-3	11.111111	MR
37.	RVM-1	33.333333	S
38.	RVM-2	44.444444	S
39.	PM-25	66.666667	HS
40.	PM-26	44.444444	S
41.	PM-27	44.444444	S
42.	PM-28	33.333333	S
43.	PM-30	55.555556	HS
44.	Pusa Vijay	33.333333	S
45.	JMM-927	33.333333	S
46.	JMM-991	55.555556	HS
47.	RMM-10-01-01	11.111111	MR
48.	RMM-12-01-18	16.666667	MR
49.	RMM-12-03-18	33.333333	S
50.	WRR-5	22.222222	MR
51.	WRR-6	33.333333	S
52.	WRR-7	38.888889	S
53.	WRR-8	27.777778	S
54.	WRR-9	33.333333	S
55.	WRR-10	44.444444	S
56.	WRR-11	38.888889	S
57.	WRR-12	44.444444	S
58.	WRR-13	27.777778	S
59.	WRR-14	33.333333	S
60.	WRR-15	44.444444	S
61.	WRR-16	38.888889	S
62.	WRR-17	27.777778	S
63.	WRR-18	38.888889	S
64.	WRR-19	33.333333	S
65.	WRR-20	44.444444	S
66.	WRR-21	27.777778	S
67.	WRR-22	38.888889	S
68.	WRR-25	33.333333	S
69.	WRR-26	44.444444	S
70.	WRR-27	27.777778	S
71.	WRR-28	44.444444	S
72.	WRR-29	38.888889	S
73.	WRR-30	33.333333	S
74.	WRR-31	44.444444	S
75.	WRR-32	27.777778	S

Table 3: Categorizations of reactions of Indian mustard genotypes against Alternaria leaf spot

Severity (%) category	Disease reaction	Number of genotypes	Name of genotypes
0	Immune	-	-
<5	Highly Resistant	-	-
5.0 – 10	Resistant	8	Pusa Bold, Kranti, Maya, Kiran, JM-2, China, GSL-1, RP-9
10.1 - 25	Moderately Resistant	25	RB-50, Varuna, Rohini, Vardan, Vasundhara, Swarn Jyoti, Pusa Jagannath, Shraddha, DMH 1, JMWR-908-1, NRC-HB-101, NRC-HB-506, RVM-3, RH-749, NRCDR-2, DRMR IJ-31, PC-5, JM-1, JM-3, RMM-10-01-01, RMM-12-01-18, WRR-5 L-4, GSC-7, PC-6
25.1 - 50	Susceptible	39	RH-725, PusaJaiKisan, Albeli, Sej-2, RGN-73, JTC-1, RVM-1, RVM-2, PM-26, PM-27, PM-28, Pusa Vijay, JMM-927, RMM-12-03-18, WRR-6, WRR-7, WRR-8, WRR-9, WRR-10, WRR-11, WRR-12, WRR-13, WRR-14, WRR-15, WRR-16, WRR-17, WRR-18, WRR-19, WRR-20, WRR-21, WRR-22, WRR-25, WRR-26, WRR-27, WRR-28, WRR-29, WRR-30, WRR-31, WRR-32
>50.1	Highly Susceptible	3	PM-25, PM-30, JMM-991

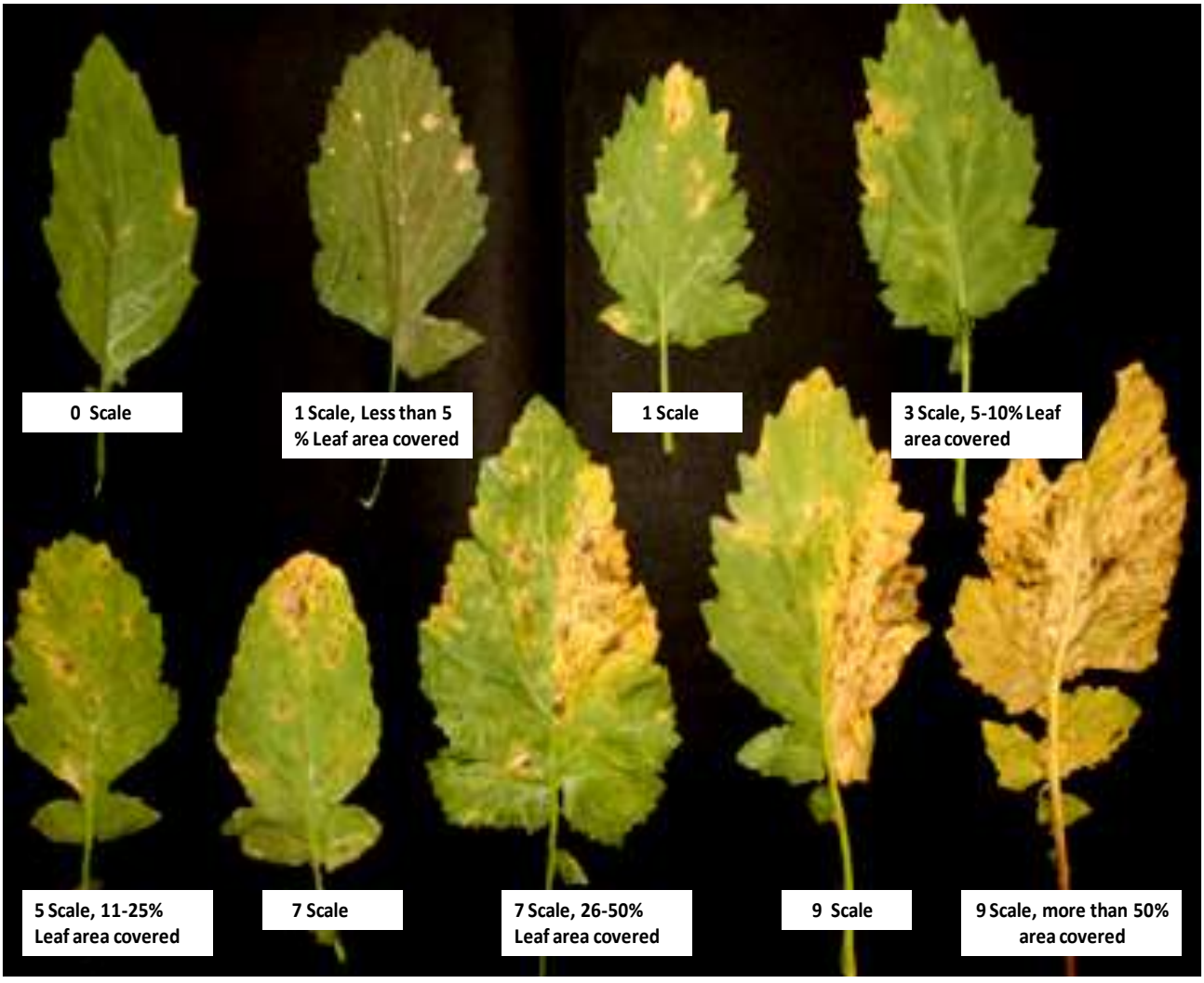

Fig 1: Categorizations of reactions of Indian mustard genotypes against Alternaria disease

Conclusion

In order to combat the constantly changing diseases, it is crucial to identify a variety of resistance genes in any crop species. It has been determined that the germplasm lines of Indian mustard exhibited resistant to moderately resistant response under field screening trial against Alternaria leaf disease. It is possible that these resistant genotype (s) identified in present investigation could be employed in future breeding programs to develop resistant cultivar (s), which could then be commercialized for cultivation in farmer's fields. Moreover, it is required that resistance must be confirmed in glasshouse under controlled artificial inoculation conditions and gene-specific molecular markers as some times disease escaped and plant showed resistant reactions.

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