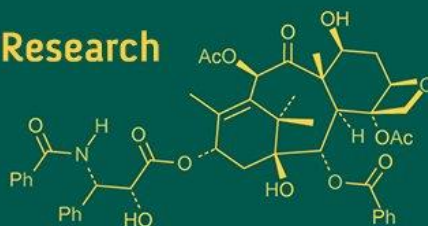


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Reaction of different maize varieties against Curvularia leaf spot disease caused by *Curvularia lunata*

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Abstract

In this study forty entries of maize were screened under inoculated field condition against *Curvularia* leaf spot disease and found that among these, four varieties exhibited a resistant reaction, characterized by the lowest percent disease index. These included DMRH 1410 (12.34%), DHM 121 (17.37%), LMH 616 (19.33%) and DKC 7074 (29.11%). Seventeen varieties were classified as moderately resistant, with disease ratings ranged from 3.1 to 5.0. Furthermore, eleven varieties were categorized as moderately susceptible, showed disease ratings between 5.1 to 7.0. These included Aravali Makka-1 (52.67%), Bio 9544 (57.00%), Gold 21 (57.33%), Yamanotri 888 (56.33%), CMH 18030 (58.10%), Bio 207 (62.10%), PMC-6 (62.33%), NMH 4790 (65.56%), White Gold (65.67%), Navjot (67.33%) and NMH-51 (69.67%). The remaining eight varieties were found to be susceptible, with disease ratings more than 7.0. Statistical analysis confirmed significant differences among genotypes, with critical difference and low coefficient of variation values indicating reliable results. These findings provide important insights for breeding disease-resistant varieties.

Keywords: *Curvularia* leaf spot, varieties, screening, maize, disease index

Introduction

Maize (*Zea mays* L.) commonly known as corn, is a globally significant cereal crop belonging to the family Poaceae (Gramineae), characterized by a diploid chromosome number of $2n = 20$.

In India, maize has covered about 12.09 million ha area with the annual production 43.41 MT and productivity of 3590 kg/ha in *Kharif*, 2024-25. Madhya Pradesh is the largest producer of maize with 6.64 million tonnes production followed by other major maize producing states *i.e.* Karnataka (6.19 million tonnes), Bihar (5.47 million tonnes), Maharashtra (4.75 million tonnes), Telangana (3.39 million tonnes), West Bengal (2.84 million tonnes), Rajasthan (2.68 million tonnes), Tamil Nadu (2.66 million tonnes), Andhra Pradesh (2.15 million tonnes) and Uttar Pradesh (1.96 million tonnes) (Anonymous, 2024-25a) ^[1, 3]. In Rajasthan, maize grown over an area 949.38 thousand ha and production 2344.47 thousand tonnes with productivity 2469 kg/ha. The major maize growing division in Rajasthan are Udaipur, Banswara, Chittorgarh, Bhilwara, Rajsamand, Jhalawar, Bundi, Kota and Sirohi divisions (Anonymous, 2024-25b) ^[1, 3].

Productivity of maize in India remains low due to both abiotic (drought, cold/frost, low N input, waterlogging) and biotic stress. In which biotic factors is the prevalence of several diseases caused by fungi, bacteria and viruses. *Curvularia lunata* as a pathogen causing leaf spot of maize was first identified in China by Wakker Boedijn in 1970 (Wang *et al.*, 2022) ^[10]. Maize is affected by as many as 112 diseases globally, while in India, approximately 35 diseases have been reported. Among these, foliar diseases are major concern and *Curvularia* leaf spot (CLS) of maize has become increasingly severe across all state of India in recent years, largely due to changing climatic conditions. In last few years, *Curvularia* leaf spot disease of maize become a major disease in Rajasthan. The estimated yield loss in maize due to *Curvularia* leaf is 22.29 percent (Garhwal *et al.* (2022) ^[6]

The pathogen causing *Curvularia* leaf spot exhibited common symptoms on maize include small, tan-colored lesions measuring about 0.5-2.0 mm long with brown margins that may be surrounded by a yellowish halo. Lesions can be scattered across the leaf or in dense groups and can join together into larger necrotic areas in early stage and then expand to round, oval, spindle shaped (Kumari *et al.*, 2022) [8] *Curvularia lunata* is soil and seed borne necrotrophic fungus. It is characterized by production of brown geniculate conidiophores with smooth oval type of clavate, septate and curved conidia in host tissue and culture media (Aroca *et al.*, 2018) [4].

Therefore, the identification and screening of resistant maize varieties is a crucial step in any integrated disease management program. Varietal screening involves the evaluation of different genotypes under artificial inoculation conditions to determine their relative resistance or susceptibility to *Curvularia* leaf spot disease. This process helps plant breeders and pathologists to identify promising lines that can be used directly in cultivation or as donors in breeding programs. Moreover, the knowledge gained from screening can assist in understanding the genetic basis of resistance, facilitating the development of improved cultivars through conventional and molecular breeding approaches. This ensures that newly released varieties retain effective resistance in the field. It also contributes to a sustainable crop protection strategy that minimizes dependence on fungicides and supports eco-friendly

agriculture.

Materials and Methods

The experiments were conducted in the Instructional farm of Agronomy, Rajasthan College of Agriculture, Udaipur. Forty maize varieties were screened during *Kharif* season 2023 and 2024 under field condition for their relative resistance and susceptibility against *Curvularia* leaf spot pathogen caused by *Curvularia lunata* under inoculated condition. Seed of each varieties were sown in “paired plot technique” having 3 m length of rows by maintaining row to row and plant to plant distance as 60 and 20 cm respectively, with three replications in RBD design. For inoculation the virulent resident local isolate of *C. lunata* (CLSRCA) was multiplied on autoclaved sorghum grains. All test entries were spray inoculated with spore suspension of 1×10^6 conidia ml^{-1} on 25-days-old maize plants with the help of hand held sprayer to the run off level. High humidity (>90 percent) was maintained throughout the disease development period by frequent sprinkler irrigations. Observations for disease severity (disease rating) was recorded two times at 30 and 60 days after inoculations on a 1-9 disease rating scale (Anonymous, 2017) [2]. Based on the percent disease index, the different varieties of maize were categorized into various reaction grades to determine their relative degree of resistance reaction to the disease as mention in Table-1. Percent disease index was calculated using following formula (Wheeler, 1969) [12].

$$\text{Percent disease index} = \frac{\text{Sum of all individual disease ratings}}{\text{Total No. of plant assessed} \times \text{Maximum rating}} \times 100$$

Table 1: Disease rating scale (1-9) for assessing resistance reaction against *Curvularia* leaf spot of maize, (Anon., 2017) [2].

Score	Percent infection	Disease reaction
1	Nil to very slight infection ($\leq 10\%$).	Resistant (score ≤ 3.0)
2	Slight infection, a few lesions scattered on two lower leaves (10.1-20%)	
3	Light infection, moderate number of lesions scattered on four lower leaves (20.1-30%)	
4	Light infection, moderate number of lesions scattered on lower leaves, a few lesion scattered on middle leaves below the cob (30.1-40%).	Moderately resistant (score 3.1-5.0)
5	Moderate infection, abundant number of lesions scattered on lower leaves, moderate number of lesion scattered on middle leaves below the cob (40.1-50%).	
6	Heavy infection, abundant number of lesions scattered on lower leaves, moderate infection on middle leaves and a few lesions on two leaves above the cob (50.1-60%).	Moderately susceptible (score 5.1-7.0)
7	Heavy infection, abundant number of lesions scattered on lower and middle leaves and moderate number of lesions on two to four leaves above the cob (60.1-70%).	
8	Very heavy infection, lesions abundant scattered on lower and middle leaves and spreading up to the flag leaf (70.1-80%)	Susceptible (score >7.0)
9	Very heavy infection, lesions abundant scattered on all most all leaves, plant prematurely dried and killed ($> 80\%$).	

Results and Discussion

Host plant resistance is an ultimate tool to keep away the diseases. A simple and low cost method to know the source of resistance in varieties is screening under artificial epiphytotic field conditions. The evaluation of 40 different varieties for percent disease index (PDI) revealed significant variation across the two years, 2023 and 2024. Among the tested varieties of maize exhibited considerable variation in their response to percent disease index. Eight varieties, namely LMH 1223 (71.80%), Partap Makka-9 (72.67%), Bio-4043 (74.80%), NAH-1137 (75.50%), CM 501 (76.69%), Bio 274 (80.37%), GPMH-1101 (80.20%) and Surya (81.50%), recorded higher percent disease index and were therefore categorized as susceptible (S). A total of eleven varieties, including Aravali Makka-1 (53.00%), Bio

9544 (56.73%), Yamanotri 888 (57.00%), Gold 21 (57.67%), CMH 18030 (58.11%), Bio 207 (62.40%), PMC-6 (62.67%), NMH 4790 (65.01%), White Gold (66.07%), Navjot (67.62%) and NMH-51 (69.83%), exhibited percent disease index (PDI) values ranged from 53.00% to 69.83% and were classified as moderately susceptible (MS). Seventeen varieties, namely Partap Hybrid Maize 3 (32.28%), Shriram 9701 (37.96%), ACH 5794 (34.95%), P1844 (35.00%), Partap Makka-4 (36.00%), Partap Hybrid-1 (38.72%), Partap Makka-5 (46.94%), NMWH-27 (39.80%), Bio 605 (40.67%), Rasi 4794 (41.93%), Partap Makka-3 (43.00%), Rasi Sx38 (40.97%), DMH 8255 (44.50%), PEHM-2 (45.65%), Makka 57794 (48.50%), RMH 1818 (49.67%) and CMH 19015 (46.81%), showed percent disease index between 32.28% to 49.67% and were

grouped as moderately resistant (MR). Only four varieties, DMRH 1410 (12.69%), DHM 121 (17.74%), LMH 616 (19.57%) and DKC 7074 (29.49%), recorded the lowest percent disease index and were thus categorized as resistant (R). None of the tested varieties exhibited complete immune to the disease under the prevailing conditions. The summarized results are presented in (Table 2.) The present investigation revealed that maize varieties GPMH 1101 and CM 501 exhibited a susceptible reaction under the tested conditions. These findings are in close agreement with the results reported by Palaki and Patil *et al.* (2018) ^[9] who also categorized both varieties as susceptible. The consistency between the present study and earlier reports indicates the stable susceptibility behavior of these genotypes across different environments and experimental conditions. Choudhary *et al.* (2011) ^[5] evaluated 35 maize inbred lines against *C. lunata* and identified five lines viz., EI 460, EI

585, EI 582, EI 586-1 and LM 10 as resistant, six as moderately resistant, 14 as susceptible and remaining ten lines as highly susceptible. Hooda *et al.* (2012) ^[7] screened two hundred maize entries of different maturity groups and specialty types for their response to *Curvularia* leaf spot and found that only 77 entries were resistant. Some of these resistant lines also exhibited multiple-disease resistance, whereas the remaining entries showed reactions ranging from susceptible to highly susceptible to other maize pathogens. Similarly, Wang *et al.* (2014) ^[11] evaluated 152 maize inbred lines for their response to *Curvularia* leaf spot and reported that 97.4% of the lines were either susceptible or highly susceptible. Among these, 85 lines were highly susceptible and 63 were susceptible, while only four lines (Shen 137, Qi 318, 77, and Nan 60-1) showed a moderately resistant reaction.

Table 2: Evaluation of maize varieties for resistance to *Curvularia* leaf spot under artificial inoculation

S. No.	Varieties	Percent disease index (PDI)*			Mean disease rating	Disease reaction
		2023	2024	Pooled		
1.	LMH 616	19.33 (26.08)	19.80 (26.42)	19.57 (26.25)	1.96	R
2.	White Gold	65.67 (64.13)	66.46 (54.61)	66.07 (54.37)	6.61	MS
3.	Partap hybrid Maize 3	32.00 (34.45)	32.56 (34.79)	32.28 (34.62)	3.23	MR
4.	Yamanotri 888	56.33 (48.64)	57.67 (49.41)	57.00 (49.02)	5.70	MS
5.	Shriram 9701	37.67 (37.86)	38.25 (38.20)	37.96 (38.03)	3.80	MR
6.	DKC 7074	29.11 (32.65)	29.87 (33.13)	29.49 (32.89)	2.95	R
7.	DMRH 1410	12.34 (20.57)	13.04 (21.17)	12.69 (20.87)	1.27	R
8.	Makka 57794	48.00 (43.85)	49.00 (44.43)	48.50 (44.14)	4.85	MR
9.	P1844	34.67 (36.07)	35.33 (36.47)	35.00 (36.27)	3.50	MR
10.	GPMH-1101	79.67 (63.20)	80.73 (63.96)	80.20 (63.58)	8.02	S
11.	Bio 207	62.10 (52.00)	62.70 (52.36)	62.40 (52.18)	6.24	MS
12.	CMH 18030	58.10 (49.66)	58.11 (49.67)	58.11 (49.66)	5.81	MS
13.	Bio 605	40.33 (39.42)	41.00 (39.82)	40.67 (39.62)	4.07	MR
14.	NMH 4790	65.56 (54.07)	64.45 (53.40)	65.01 (53.73)	6.50	MS
15.	CMH 19015	47.12 (43.35)	46.49 (42.99)	46.81 (43.17)	4.68	MR
16.	RMH 1818	49.33 (44.62)	50.00 (45.00)	49.67 (44.81)	4.97	MR
17.	Aravali makka-1	52.67 (46.53)	53.33 (46.91)	53.00 (46.72)	5.30	MS
18.	Bio 274	80.00 (63.43)	80.73 (63.96)	80.37 (63.70)	8.04	S
19.	ACH 5794	34.70 (36.09)	35.20 (36.39)	34.95 (36.24)	3.50	MR
20.	Rasi 4794	41.77 (40.26)	42.10 (40.45)	41.93 (40.36)	4.19	MR
21.	LMH 1223	72.00 (58.05)	71.60 (57.80)	71.80 (57.92)	7.18	S
22.	Partap Makka-3	42.67 (40.78)	43.33 (41.17)	43.00 (40.98)	4.30	MR
23.	DMH 8255	44.00 (41.55)	45.00 (42.13)	44.50 (41.84)	4.45	MR
24.	PEHM-2	45.33	45.97	45.65	4.57	MR

		(42.32)	(42.69)	(42.50)		
25.	Partap hybrid-1	38.10 (39.12)	39.33 (38.84)	38.72 (38.48)	3.87	MR
26.	Partap Makka-4	35.33 (36.47)	36.67 (37.27)	36.00 (36.87)	3.60	MR
27.	Rasi Sx38	40.67 (39.62)	41.27 (39.97)	40.97 (39.80)	4.10	MR
28.	Partap Maka-9	72.00 (58.05)	73.33 (58.91)	72.67 (58.48)	7.27	S
29.	PMC-6	62.33 (52.14)	63.00 (52.54)	62.67 (52.34)	6.27	MS
30.	Bio 4043	74.47 (59.65)	75.13 (60.09)	74.80 (59.87)	7.48	S
31.	Gold 21	57.33 (49.22)	58.00 (49.60)	57.67 (49.41)	5.77	MS
32.	Navjot	67.33 (55.08)	68.00 (55.55)	67.62 (55.31)	6.76	MS
33.	Surya	81.00 (64.16)	82.00 (64.90)	81.50 (64.53)	8.15	S
34.	NMH-51	69.67 (56.8)	70.00 (56.79)	69.83 (56.68)	6.98	MS
35.	DHM 121	17.37 (24.63)	18.10 (25.18)	17.74 (24.91)	1.77	R
36.	Bio 9544	57.00 (49.02)	56.45 (48.71)	56.73 (48.86)	5.67	MS
37.	Partap Makka-5	46.33 (42.90)	47.54 (43.59)	46.94 (43.24)	4.69	MR
38.	CM 501	76.17 (60.78)	77.20 (61.48)	76.69 (61.13)	7.67	S
39.	NMWH-27	39.53 (38.96)	40.07 (39.27)	39.80 (39.12)	3.98	MR
40.	NAH-1137	75.00 (60.00)	76.00 (60.67)	75.50 (60.33)	7.55	S
SEm±		2.13	2.41	1.83		
CD (p = 0.05)		6.00	6.79	5.16		
CV (%)		7.79	8.91	6.73		

*Average of three replications, Figures in parentheses is $\sqrt{\text{arcsine}}$ percent angular transformed value, R-Resistant, MR-Moderately Resistant, MS-Moderately Susceptible, S-Susceptible

Table 3: Category wise disease reaction of different maize varieties against CLS under field conditions

S. No.	Disease rating	Disease reaction	Maize varieties
1.	<3.0	R	DMRH 1410, DHM 121, LMH 616 and DKC 7074
2.	3.1-5.0	MR	Shriram 9701, Partap hybrid Maize 3, P1844, ACH 5794, Partap Makka-4, Partap hybrid-1, NMWH-27, Bio 605, Partap Makka-5, Rasi Sx38, Rasi 4794, Partap Makka-3, DMH 8255, PEHM-2, Makka 57794, RMH 1818 and CMH 19015
3.	5.1-7.0	MS	Aravali makka-1, Bio 9544, Gold 21, Yamanotri 888, CMH 18030, Bio 207, PMC-6, NMH 4790, White Gold, Navjot and NMH-51
4.	>7.0	S	Partap Maka-9, LMH 1223, Bio 4043, NAH-1137, CM 501, Bio 274, Surya and GPMH-1101

Conclusion

Based on percent disease index, maize varieties were categorized into the four classes during the observation of *Kharif* season 2023 and 2024. Forty varieties of maize were screened under artificial inoculation field conditions. Four maize varieties (DMRH 1410, DHM 121, LMH 616 and DKC 7074) was found to be resistant, seventeen varieties to be moderately resistant, eleven varieties to be moderately susceptible, and rest eight found susceptible to the disease.

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Competing Interests

Authors have declared that no competing interests exist.

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