

Screening of Maize Genotypes under Different Maturity Group against Maydis Leaf Blight Disease of Maize Caused by *Helminthosporium maydis*

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation on was undertaken for the management of Maydis leaf blight disease of maize. In the Screening trial, 84 maize genotypes of the maturity group (NIVT-Late) were tested against Maydis leaf blight under artificial inoculated condition, according to Disease Severity scale (1-9), No any entry was found resistant, 7 entries were found as moderately resistant to Maydis leaf blight, 34 entries rated as moderately susceptible and 44 entries found susceptible to Maydis leaf blight. Hundred maize genotypes of the maturity group (NIVT-Medium) were tested against Maydis leaf blight under field condition, No any entry was found resistant, 20 entries were found as moderately resistant to Maydis leaf blight, 31 entries rated as moderately susceptible and 50 entries found susceptible to Maydis leaf blight. Out of 40 maize genotypes of the maturity group (NIVT-Early + Extra Early) one entry was found resistant, 10 entries were moderately resistant to Maydis leaf blight, 22 entries rated as moderately susceptible and 8 entries found susceptible to Maydis leaf blight. Susceptible check CML-186 rated as a susceptible reaction to Maydis leaf blight.

Keywords: CML-186; disease severity scale; *Helminthosporium maydis*; maize; Maydis leaf blight; moderately resistant; moderately susceptible; NIVT-Late; NIVT-Medium; NIVT-(Early + Extra Early); resistant; screening; susceptible.

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1. INTRODUCTION

Maize is the most versatile crop adapted to different agro-ecological and climatic conditions. In India maize is an important cereal crop next to rice, wheat and sorghum. Maize is one of the largest (49.33t) consumable cereals in the world. In India, area under maize was 9.80 mha in 2016-17 and 9.60 mha in 2017-18(April) as forecasted, with production of 25.90 mt in 2016-17 and 27.15 mt in 2017-18(April) as forecasted, and yield 2.62 t/ha in 2016-17 and 2.83 t/ha in 2017-18 (April) as forecasted. (FAS), USDA [1]. It is known as the queen of cereals because of its high genetic yield potential. Maize is an important cereal crop after rice and wheat contributing almost 9 per cent to India's food basket and 5 per cent to World's dietary energy supply [2].

Southern Corn Leaf Blight (SCLB) or Maydis Leaf Blight (MLB) caused by *Helminthosporium maydis* (Syn. *Bipolaris maydis* (Nisik.) Shoemaker), (teleomorph: *Cochliobolus heterostrophus*) is a serious fungal disease of maize throughout the world where maize is grown under warm, humid conditions (White, 1999). The disease has a potential to reduce grain yield up to the extent of 41% in susceptible cultivar (Sharma and Rai, 2000). Three races of *Cochliobolus heterostrophus* known as O, T and C which have been described by (Smith et al., 1970 and Wei et al., 1988). Currently predominantly form of *Cochliobolus heterostrophus* race O, which can cause yield losses of up to 40 percent (Fischer et al., 1976, Gregory et al., 1979; Byrnes et al., 1989). In 1970s an epidemic was caused by T race in maize with Texas male sterile cytoplasm in USA but maize with normal cytoplasm was resistant to the pathogen [3]. The previous record of T race from India is from non-maize hosts from Pusa and Delhi. The disease is prevalent in warm humid temperate to the tropical region, where during the cropping period temperature ranges from 20-30°C (Singh and Srivastava, 2012). As the pathogen is able to overwinter in infected crop debris, management of crop debris between growing seasons can be helpful in reducing the initial amount of inoculums [3]. Little efforts have been made so far to find out the sources of resistance against such important disease. Breeding resistant varieties to the Maydis leaf blight is the most economical, efficient, and sustainable way than chemical control for the long run [3]. Moreover, it also ensures environment safety standards [4]. A study involving 119 maize genotypes to identify the

new resistance sources for 'Maydis Leaf Blight' under artificial epiphytotic condition at three locations viz., Almora, Nagenahalli and Varanasi for 12 years (1999-2011) was carried out. Three experiments helped for the identification of 41 resistant, 41 moderately resistant, 24 susceptible and 13 highly susceptible maize genotypes, Singh et al. [5].

Keeping in view of the above facts the study has been proposed to work out on the topic "Screening of Maize genotypes under different Maturity group against Maydis Leaf Blight Disease of Maize Caused by *Helminthosporium maydis*" at RPCAU, Pusa, Samastipur, Bihar.

2. MATERIALS AND METHODS

2.1 Sources of Resistance against Maydis Leaf Blight of Maize

Screening trial was conducted at Research farm of Tirhut College of Agriculture, Dholi, Muzaffarpur, Bihar, to identify resistant lines and genotypes against Maydis leaf blight under artificial inoculated condition. Eighty four entries with one susceptible check (CML 186) of the maturity group (NIVT-Late), 100 entries with one susceptible check (CML 186) of the maturity group (NIVT-Medium) and 40 entries with one susceptible check (CML 186) of the maturity group (NIVT-Early + Extra Early) were screened against the disease under artificial inoculated conditions.

The Experiment was conducted for Screening of the 84 entries under the maturity group (NIVT-Late), 100 entries under the maturity group (NIVT-Medium) and 40 entries under the maturity group (NIVT- Early+ Extra Early) against Maydis leaf blight under artificial inoculated conditions in a randomised block design with 2 replications. There were 2 rows of 4 m length per plot spaced 60 cm apart. Plant to plant spacing was 20 cm. The susceptible check variety "CML186" was sown in to provide a uniform source of inoculums. The inoculation for Maydis leaf blight was performed by culturing *Helminthosporium maydis* on sorghum seed. The plants were inoculated on 35 days old plants with a fine powder of these sorghum grains by putting a pinch of these powdered inoculums in the leaf whorl in the late afternoon to avoid the maximum day temperature during the incubation period and the second inoculation was done after a week of the first inoculation.

Table 1. Disease rating scale for Maydis leaf blight of maize

Rating scale	Degree of infection (Per cent DLA*)	PDI**	Disease reaction
1.0	Nil to very slight infection ($\leq 10\%$).	≤ 11.11	Resistant (R)
2.0	Slight infection, a few lesions scattered on two lower leaves (10.1-20%).	22.22	(Score: ≤ 3.0) (DLA: $\leq 30\%$)
3.0	Light infection, moderate number of lesions scattered on four lower leaves (20.1-30%).	33.33	PDI: ≤ 33.33)
4.0	Light infection, moderate number of lesions scattered on lower leaves, a few lesions scattered on middle leaves below the cob (30.1-40%).	44.44	Moderately resistant (MR)
5.0	Moderate infection, an abundant number of lesions scattered on lower leaves, a moderate number of lesions scattered on middle leaves below the cob (40.1-50%).	55.55	(Score: 3.1- 5.0) (DLA: $\leq 30.1-50\%$) PDI: 33.34 -55.55)
6.0	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%).	66.66	Moderately susceptible (MS)
7.0	Heavy infection, sufficient number of lesions scattered on lower and middle leaves and a moderate number of lesions on two to four leaves above the cob (60.1-70%).	77.77	(Score: 5.1- 7.0) (DLA: $\leq 50.1-70\%$) PDI: 55.56 -77.77)
8.0	Very heavy infection, lesions abundant scattered on lower and middle leaves and spreading up to the flag leaves (70.1-80%).	88.88	Susceptible (S)
9.0	Very heavy infection, lesions abundant scattered on almost all the leaves, plants prematurely dried and killed ($>80\%$).	99.99	(Score: > 7.0) (DLA: $>70\%$) PDI: >77.77)

* DLA- Diseased leaf area;**Per cent disease index (PDI)

First appearance of disease and further progress of disease was recorded at 10 days interval according to Disease rating scale assessment key of Maydis leaf blight given by Balint-Kurti et al., (2006), Chung et al., (2010) and Mitiku et al., (2014) that is shown in Table 1.

2.2 Disease Incidence (DI)

The incidence of Maydis leaf blight was visually assessed in all the plots at a weekly interval from the first appearance of disease for each treatment. For each plot, the number of infected maize plants was counted and expressed as a percentage of the total number of maize plants in that plot. The mean percentage disease incidence for each treatment was obtained from the three replications. The data was further statistically analysed. Disease incidence was calculated by the following formula (Wheeler, 1969).

$$\text{Disease incidence} = (\text{No. of diseased plant} / \text{total no. of planed examined}) \times 100$$

2.3 Per Cent Disease Index

Observations on the severity of the disease were recorded on 1-5 scale (Payak and Sharma, 1983). Plants were selected randomly and assessed in each plot for disease rating and the percent disease index was recorded. Percent disease index was calculated by using the following formula (Wheeler, 1969).

$$\text{Disease index} = (\text{the Sum total of numerical ratings} / \text{Number of plant examined} \times \text{Maximum grade}) \times 100$$

3. RESULTS

3.1 Sources of Resistance against Maydis Leaf Blight

Maize disease resistance screening work was conducted at Tirhut College of Agriculture, Dholi, Muzaffarpur, Bihar, to identify resistant lines and genotypes against Maydis leaf blight under artificial inoculated conditions during Kharif 2017. Maydis leaf blight, considered as the most

devastating disease of maize, causes a noticeable crop loss. Inbred lines are useful as they are genotyped, multiple time phenotyping is possible, and genetic uniformity, genetic stability and its vigour make inbred lines suitable to study in a diversified environment [3].

3.2 NIVT-Late

In this investigation, 84 maize genotypes were tested against Maydis leaf blight under field condition.

Table 2. Reaction of the maturity group (NIVT-Late) against Maydis leaf blight under artificial inoculated condition

Sl. no.	Hybrids name	Av. disease score	Disease reaction	Sl. no.	Hybrids name	Av. disease score	Disease reaction
1	CP 777	7.5	S	44	JH 13346	6.5	MS
2	OMH16-3	7.0	MS	45	SVMH-66	8.0	S
3	AH-1608	7.0	MS	46	Rasi-2432	7.5	S
4	MFH 16-22	9.0	S	47	IMHBG-17K-20	6.0	MS
5	JH 16081	7.0	MS	48	REH 2015-7	9.0	S
6	JH 16118	4.5	MR	49	JH 16040	8.0	S
7	JKMH 150375	6.5	MS	50	HT 17169	6.5	MS
8	CP 858	6.0	MS	51	CMH 15-005	7.0	MS
9	14561-010-04-01-03-3-2	8.5	S	52	Rasi-3499	8.0	S
10	KH-2193	6.5	MS	53	KNMH-4410	7.0	MS
11	BH 415017	5.5	MS	54	IIMRNH 1705	5.5	MS
12	NS 8282	8.5	S	55	QMH-1353	6.0	MS
13	GIN-04	6.5	MS	56	MAH-2014-3	5.0	MR
14	JH 16041	7.0	MS	57	Super-1818	6.0	MS
15	KNMH-4513	6.0	MS	58	DKC 9182 (IR8513)	7.5	S
16	AH-8183	9.0	S	59	PM17104L	7.5	S
17	JH 16209	5.0	MR	60	GH-1301	8.0	S
18	JH 16054	6.0	MS	61	TMMH 2840	9.0	S
19	VEH-17-1	9.0	S	62	AH-1645	8.5	S
20	MAH-2014-19	8.5	S	63	VNR-35379	7.5	S
21	PM17105L	7.0	MS	64	IIMRNH 1703	9.0	S
22	IMHBG-17K-25	5.0	MR	65	AMH-15119	7.5	S
23	GH 160131	9.0	S	66	ADV 1390164	7.5	S
24	OMH16-2	8.0	S	67	TS 2505	7.0	MS
25	JH 16046	7.0	MS	68	NMH-4530	8.0	S
26	ADV 1390064	9.0	S	69	CMH 14-714	7.0	MS
27	DKC 9185 (IR8449)	8.0	S	70	PM17106L	6.5	MS
28	DAS-MH-115	6.5	MS	71	JH 16034	6.5	MS
29	IMHBG-17K-24	8.5	S	72	IMHBG-17K-23	7.5	S
30	16402-008-03-03	8.0	S	73	B-57	7.5	S
31	AYN716443	6.5	MS	74	MFH 16-21	7.5	S
32	DKC9189 (IR8545)	7.5	S	75	CCH 2829	9.0	S
33	OMH16-1	8.5	S	76	QMH-1347	7.5	S
34	IIMRNH 1701	7.0	MS	77	JH 13336	4.5	MR
35	QMH-1420	9.0	S	78	CMH 14-721	8.0	S
36	BIO 218	8.5	S	79	20637-009-03-02	9.0	S
37	DAS-MH-114	6.0	MS	80	PM17101L	8.0	S
38	TA 5084	6.0	MS	81	IIMRNH 1704	6.5	MS
39	JH 16031	6.0	MS	82	BIO 9682 (C)	8.5	S
40	GH 160224	8.5	S	83	CMH 08-287 (C)	4.0	MR
41	KMH 463	9.0	S	84	CMH 08-282 (C)	5.0	MR
42	GK 3211	6.5	MS		CML 186 (S.C.)	8.5	S
43	CMH 14-720	5.5	MS				

Table 3. Reaction of the maturity group (NIVT-Medium) against Maydis leaf blight under artificial inoculated condition

Sl. no.	Hybrids name	Av. disease score	Disease reaction	Sl. no.	Hybrids name	Av. disease score	Disease reaction
1	IMHBG-17K-7	3.5	MR	51	GK 3215	8.0	S
2	HKH 364	8.5	S	52	MMH 16-12	8.0	S
3	KMH 16-2	8.5	S	53	KMH 16-42	8.0	S
4	BLH 122	8.5	S	54	IMHBG-17K-13	7.5	S
5	AH 6017	6.5	MS	55	PM17102M	6.5	MS
6	BLH 121	6.0	MS	56	KMH 16-29	8.5	S
7	LMH 1017	3.5	MR	57	BLH 119	7.0	MS
8	KMH 16-1	8.5	S	58	DH-314	4.5	MR
9	IIMRNH 1702	7.0	MS	59	GK 3213	8.0	S
10	RCRMH3(CAH156)	4.5	MR	60	IMHBG-17K-21	7.5	S
11	BLH 120	8.5	S	61	PM17103M	7.5	S
12	VaMH 15036	7.0	MS	62	IMHBG-17K-22	6.5	MS
13	ADV 140235	8.0	S	63	IMHBG-17K-6	6.5	MS
14	SYN716725	8.5	S	64	JKMH 15303	7.5	S
15	IMHBG-17K-19	6.0	MS	65	NMH-4053	8.0	S
16	JH 16029	9.0	S	66	CCH 1818	7.5	S
17	AH-7067R	5.5	MS	67	HKH 362	7.5	S
18	IMHBG-17K-18	4.0	MR	68	16402-008-01-01-03-5-2	5.5	MS
19	BH 415158	4.0	MR	69	BLH 118	5.5	MS
20	HKH 361	8.5	S	70	BH 415012	7.0	MS
21	UDMH-132	7.5	S	71	STAR-X-14	7.0	MS
22	KH 103	4.0	MR	72	NMH-4139	7.0	MS
23	IMHBG-17K-3	7.0	S	73	WH-1094	8.0	S
24	LMH 817	7.5	S	74	VaMH 15005	4.5	MR
25	JASL-2033	8.0	S	75	AH 6009	7.5	S
26	IMHBG-17K-2	6.0	MS	76	IMHBG-17K-11	9.0	S
27	LMH 917	5.5	MS	77	JH 32055	5.0	MR
28	IMHBG-17K-10	4.0	MR	78	IMHBG-17K-17	6.5	MS
29	IMHBG-17K-12	7.0	MS	79	IMHBG-17K-1	5.0	MR
30	UDMH-131	8.5	S	80	DKC7181 (IR8003)	7.5	S
31	IMHBG-17K-4	8.0	S	81	AH 6007	7.5	S
32	IMHBG-17K-16	3.5	MR	82	REH 2013-21	7.0	MS
33	JH 16045	5.5	MS	83	GH 160295	5.0	MR
34	LMH1117	4.5	MR	84	IMHBG-17K-9	7.0	MS
35	IMHBG-17K-14	7.5	S	85	RCRMH 4-1	8.0	S
36	AH 6008	7.0	MS	86	BH 415100	7.0	MS
37	KMH 16-40	8.0	S	87	GIN-03	8.5	S
38	MMH 16-11	7.0	MS	88	ADV 140187	8.5	S
39	K-27	7.0	MS	89	KMH 16-25	8.0	S
40	IMHBG-17K-8	5.0	MR	90	AH-1606	3.5	MR
41	STAR-X-16	8.0	S	91	DKC8181(IR8004)	6.5	MS
42	EH 2870	5.0	MR	92	IMHBG-17K-5	7.5	S
43	STAR-X-20	8.0	S	93	IMHBG-17K-15	4.0	MR
44	EH 2898	6.0	MS	94	BLH 117	5.0	MR
45	DAS-MH-311	8.0	S	95	STAR-X-18	8.5	S
46	BRMH-10 (CAH-1566)	8.0	S	96	REH 2013-15	8.5	S
47	AMH-14258	8.0	S	97	OMH16-4	6.0	MS
48	HKH 363	9.0	S	98	CMH 08-292 (C)	4.5	MR
49	WH-1010	6.0	MS	99	BIO 9544 (C)	7.5	S
50	NMH-51+	8.0	S	100	DHM 121 (C)	8.0	S
					CML 186 (S..C.)	8.5	S

Table 4. Reaction of the maturity group (NIVT-Early + Extra Early) against Maydis leaf blight under artificial inoculated condition

Sl. no.	Hybrids name	Av. disease score	Disease reaction	Sl. no.	Hybrids name	Av. disease score	Disease reaction
1	DH-312	8.0	S	22	FH 3823	4.5	MR
2	JH 32010	6.0	MS	23	MEH 16-2	8.0	S
3	JH 31968	5.0	MR	24	KMH 16-23	3.5	MR
4	KMH 16-21	6.0	MS	25	LMH 1115	7.0	MS
5	FH 3816	6.0	MS	26	AH-7080	6.0	MS
6	Filler	6.0	MS	27	REH 2013-19	5.5	MS
7	LMH 717	9.0	S	28	VNR-32943	3.5	MR
8	Syngenta EXIM	6.5	MS	29	AH 9003	5.5	MS
9	IH-1002	8.0	S	30	REH 2013-17	6.5	MS
10	IH-1404	4.5	MR	31	IH-0652	6.5	MS
11	AH-7188	7.0	MS	32	FH 3837	6.5	MS
12	KMH 16-9	8.0	S	33	EH 2891	5.5	MS
13	MEH 16-1	6.0	MS	34	JH 31983	7.0	MS
14	DH-313	7.5	S	35	JH 32013	6.5	MS
15	WH-2212	2.5	R	36	PMH5 (C)	5.5	MS
16	IH-1201	4.5	MR	37	BIO605 (C)	3.5	MR
17	EH 2878	8.0	S	38	DKC 7074 (C)	5.5	MS
18	Azad Kanti	5.0	MR	39	Vivek Hybrid 51 (C)	6.0	MS
19	DH-311	6.0	MS	40	Vivek Hybrid 45 (C)	4.5	MR
20	JH 31947	4.5	MR		CML 186 (S.C.)	8.5	S
21	KMH 16-19	6.5	MS				

According to disease severity scale (1-9), No any entries were found resistant followed by 7 entries viz. JH 16118, JH 16209, IMHBG-17K-25, MAH-2014-3, JH 13336, CMH 08-287 (C), CMH 08-282 (C) as moderately resistant to Maydis leaf blight, 34 entries rated as moderately susceptible and 44 entries found susceptible to Maydis leaf blight [3].

Susceptible check CML-186 rated as a susceptible reaction to Maydis leaf blight.

3.3 NIVT- Medium

In this investigation, 100 maize genotypes were tested against Maydis leaf blight under field condition.

According to disease severity scale (1-9), No any entry was found resistant followed by 20 entries viz. IMHBG-17K-7, LMH 1017, RCRMH3(CAH156), IMHBG-17K-18, BH 415158, KH 103, IMHBG-17K-10, IMHBG-17K-16, LMH1117, IMHBG-17K-8, EH 2870, DH-314, VaMH 15005, JH 32055, IMHBG-17K-1, GH 160295, AH-1606, IMHBG-17K-15, BLH 117, CMH 08-292(C) as moderately resistant to maydis leaf blight. 31 entries rated as moderately susceptible and 50 entries found susceptible to maydis leaf blight. Susceptible check CML-186

rated as a susceptible reaction to maydis leaf blight [3].

3.4 NIVT (Early +Extra Early)

In this investigation, 40 maize genotypes were tested against Maydis leaf blight under field condition.

According to disease severity scale (1-9), one entry was found resistant followed by 10 entries viz. JH 31968, IH-1404, IH-1201, Azad Kanti, JH 31947, FH 3823, KMH 16-23, VNR-32943, BIO605 (C), Vivek Hybrid 45 (C) as moderately resistant to Maydis leaf blight. 22 entries rated as moderately susceptible and 8 entries found susceptible to Maydis leaf blight. Susceptible check CML- 186 rated as a susceptible reaction to Maydis leaf blight [3].

4. DISCUSSION

4.1 Sources of Resistance against Maydis Leaf Blight

Use of resistance source is the most efficient, economical and sustainable method for disease control as it also ensures environment safety standards. Following observations were recorded in the present investigation.

In the present investigation, 84 maize genotypes of the maturity group (NIVT-Late) were tested against Maydis leaf blight under field condition. According to disease severity scale (1-9), No any entry was found resistant followed by 7 entries viz. JH 16118, JH 16209, IMHBG-17K-25, MAH-2014-3, JH 13336, CMH 08-287 (C), CMH 08-282 (C) as moderately resistant to Maydis leaf blight, 34 entries rated as moderately susceptible and 44 entries found susceptible to Maydis leaf blight. (According to disease rating scale 1-9) [3].

100 maize genotypes of the maturity group (NIVT-Medium) were tested against Maydis leaf blight under field condition. According to disease severity scale (1-9), No any entry was found resistant followed by 20 entries viz. IMHBG-17K-7, LMH 1017, RCRMH3(CAH156), IMHBG-17K-18, BH 415158, KH 103, IMHBG-17K-10, IMHBG-17K-16, LMH1117, IMHBG-17K-8, EH 2870, DH-314, VaMH 15005, JH 32055, IMHBG-17K-1, GH 160295, AH-1606, IMHBG-17K-15, BLH 117, CMH 08-292 (C) as moderately resistant to Maydis leaf blight, 31 entries rated as moderately susceptible and 50 entries found susceptible to Maydis leaf blight.

40 maize genotypes of the maturity group (NIVT-Early + Extra Early) were tested against Maydis leaf blight under field condition. According to disease severity scale (1-9), one entry was found resistant followed by 10 entries viz. JH 31968, IH-1404, IH-1201, Azad Kanti, JH 31947, FH 3823, KMH 16-23, VNR-32943, BIO605 (C), Vivek Hybrid 45 (C) as moderately resistant to Maydis leaf blight, 22 entries rated as moderately susceptible and 8 entries found susceptible to Maydis leaf blight. Susceptible check CML- 186 rated as a susceptible reaction to Maydis leaf blight [3].

Similar results were found in investigations of Singh et al. [5], Mubeen et al. [6], Kaur et al. [7], Rai et al. [8], Kumar and Saxena [9].

5. CONCLUSION

The present investigation on was undertaken for the management of Maydis leaf blight disease of maize. In the Screening trial, 84 maize genotypes of the maturity group (NIVT-Late) were tested against Maydis leaf blight under artificial inoculated condition, according to Disease Severity scale (1-9), No any entry was

found resistant, 7 entries were found as moderately resistant to Maydis leaf blight, 34 entries rated as moderately susceptible and 44 entries found susceptible to Maydis leaf blight.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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