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Short Communication

Identification of new resistance against turcicum leaf blight and maydis leaf blight in maize (*Zea mays* L.)

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Abstract

Turcicum leaf blight (TLB) and Maydis leaf blight (MLB) are amongst the important diseases of maize grown in the North-Western Himalayas. The experimental material was evaluated at two environments (natural E_1 & inoculated E_2) representing different agroclimatic and ecological conditions of North-Western Himalayas (SAREC, Kangra E_1 and HAREC, Bajaura E_2) to identify new resistance sources and to establish durability of known resistance sources of 8 parental genotypes, their 28 crosses and four checks *viz*., Palam Sankar Makka-2, Vivek Hybrid-45, Bio-9544 and DKC 7074 and were evaluated in RBD during *Kharif*, 2019 under natural conditions in E_1, whereas, under both natural as well as artificial epiphytotic conditions in E_2. The present study indicated the identification of 3 parental lines *viz*., P_3, P_6, P_8, 4 cross combinations *viz*., $P_3 \times P_4$, $P_3 \times P_5$, $P_3 \times P_6$, $P_7 \times P_8$ and 3 checks *viz*., Palam Sankar Makka-2, Vivek Hybrid-45 and DKC 7074 exhibiting resistant reaction against TLB in both environments under natural conditions and under artificial condition in E_2, whereas, against MLB under both natural as well as artificial epiphytotic condition in E_2. The new sources of resistance in the present study will be helpful for their deployment in the breeding programmes. The identified lines against TLB and MLB would serve as valuable sources of resistance and can be utilized in resistance breeding programmes. The cross combinations can be further evaluated for yield and other characters and can be released as promising hybrid varieties resistant to TLB and MLB.

Key words: Maize, TLB, MLB, natural conditions, artificial conditions.

Maize (*Zea mays* L.) is the most versatile crop with the highest yield potential and wider adaptability among cereals. It is cultivated in all climates such as tropics, subtropics and temperate conditions. Diseases caused by pathogens are one among the major causes of yield losses in maize. These diseases not only affect its yield but can greatly impair the quality and stability of production. Out of 112 diseases of maize reported so far from different parts of the globe, 65 are known to occur in India (Kaur *et al*., 2014). Among the various diseases of maize, Turcicum Leaf Blight (TLB)/Northern Corn Leaf Blight (NCLB) caused by *Exserohilum turcicum* and Maydis Leaf Blight (MLB)/Southern Corn Leaf Blight (SCLB) caused by *Bipolaris maydis* are widely prevalent in different maize growing areas of Himachal Pradesh. TLB initially exhibit elliptical spots on the leaves, greyish green in colour and water soaked lesions. The spots turn greenish with age and get bigger in size and finally attaining a spindle shape. These lesions appear first on the lower leaves and as the season progresses, the lesion number increases and all the leaves are covered. MLB spreads from the basal leaves to the developing ear and then flag leaf of maize plant. Though diseases can be managed through chemicals, these are neither farmer- nor environment-friendly. Further use of chemicals makes maize cultivation costly and reduces profit margin. Therefore, identification of disease

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resistance source is the primary and essential pre-requisite of any breeding programme.

The experimental material consisted of 8 parental genotypes, their 28 crosses and two checks *viz*., Palam Sankar Makka-2, Vivek Hybrid-45, Bio-9544 and DKC 7074 and were evaluated in RBD during *Kharif*, 2019 against TLB and MLB under natural conditions at SAREC, Kangra (E_1), whereas, both under natural as well as artificial epiphytotic conditions at HAREC, Bajaura (E_2). The disease rating of TLB is done at dough stage following 1-9 scale (Chung *et al*., 2010; Mitiku *et al*., 2014) and rating scale for recording MLB reaction consists of 9 broad categories designated by numerals 1 to 9 (Balint-Kurti *et al*., 2006; Chung *et al*., 2010 and Mitiku *et al*., 2014). On the basis of rating scale, the maize lines were classified into four groups namely, resistant (R) genotypes with a score $\leq$ 3.0; moderately resistant (MR) 3.1-5.0; moderately susceptible (MS) 5.1-7.0 and susceptible (S) > 7.0-9.0. The details of inbred lines used as parents along with checks used in the study is presented in the Table 1.

Inoculum was prepared by using heavily infected leaves collected in the previous year before the leaves became fully mature. Infected leaves were stored in large gunny bags in dry conditions protected from moisture and rodents. To prepare the inoculum, the dry leaves were ground into a meal about the coarseness of wheat bran.

Screening of the disease

a. Screening of the material for the diseases (TLB & MLB) under natural condition was done in the main experimental trial.

b. For the screening of material against TLB & MLB diseases under the artificial conditions, a separate single row trial in RBD with two replications in a plot size of 2.0 × 0.60 m (1.2 m^2) at a spacing of 60 × 20 cm was conducted during *Kharif*, 2019. The inoculation was done by dropping a pinch of inoculum by hand inside the whorl of the leaves when the crop was around 35 to 45 days old. This was followed by a spray of water from a knapsack sprayer directed in the whorl. The artificial inoculation was done three times at a weekly interval in the late afternoon.

Under natural conditions, all the 28 crosses and checks exhibited resistant reaction against TLB in both the locations. All the parents, except B73 in E_1 and BAJIM-1811 in E_2 showed resistance against TLB. B73 in E_1 and BAJIM-1811 in E_2 showed moderate resistance against TLB as also reported earlier by Chandrashekara *et al*. (2014); Mir *et al*. (2015) and Kumar *et al*. (2017).

Two crosses ($P_4 \times P_5$ & $P_4 \times P_8$) were found moderately resistant, 25 crosses were found moderately susceptible and one cross ($P_1 \times P_5$) was found susceptible against MLB under natural conditions in E_1. Among the parents, BAJIM-1811 was found moderately resistant, five parents (B73, BAJIM-1522, BAJIM-2010, 40318 & CML141) were found moderately susceptible and two parents (LM16 & LM 14) were found susceptible against Maydis leaf blight. All the checks were found moderately susceptible against MLB. Earlier workers *viz*., Rai (2009) and Chandrashekara *et al*. (2012) also reported similar disease reaction against MLB in maize. In E_2, fifteen crosses were found resistant and 13 crosses were found moderately resistant against MLB. Among the parents, five parents (BAJIM-1522, BAJIM-2010, BAJIM-1811, LM14 & CML141) were found resistant, whereas, three parents (B73, LM16 & 40318) were found moderately resistant against Maydis leaf blight. All the checks were found resistant except Bio-9544 which was found moderately resistant against MLB under natural conditions (Table 2).

Under artificial inoculated conditions in E_2, 23 crosses observed resistant and five crosses exhibited moderately resistant against Turcicum leaf blight. All the parents showed resistance against Turcicum leaf blight, except BAJIM-1811. All the checks were also found resistant against TLB. None of the crosses and checks were found moderately susceptible and susceptible against TLB, whereas, four crosses were found resistant, 23 crosses were found moderately resistant and one cross ($P_5 \times P_6$) was found moderately susceptible against Maydis leaf blight. Among the parents, four parents *viz*., BAJIM-2010, BAJIM-1811, LM14 & CML141 were resistant and four parents viz., B73, BAJIM-1522, LM16 & 40318 were found moderately resistant against Maydis leaf blight. All the checks were found resistant, except Bio-9544 which was found moderately resistant against MLB (Table 3).

Table 1. Details of inbred lines used as parents along with checks used in the study

Symbol/Code	Inbred line	Pedigree/Source
P_1	B73	PI 550473 (USDA)
P_2	BAJIM-1522	HKI488/HKI295-x-20-3-2-1-2-4-b-8- (HAREC, Bajaura)
P_3	BAJIM-2010	V336×3083-05-1 (HAREC, Bajaura)
P_4	BAJIM-1811	B52-x-1-1-5-4-b-x-x (HAREC, Bajaura)
P_5	LM16	PAU, Ludhiana
P_6	LM14	CA00310xbxb-1-1-1-1 (PAU, Ludhiana)
P_7	40318	DMR-155 (EC 447158) (IIMR, Winter Maize Nursery)
P_8	CML141	Pob62c3HC24-5-3-2-1-B-B-2-B-B-#
Symbol/Code	**Checks**	**Source**
Check 1	Palam Sankar Makka-2	CSKHPKV, Palampur (Himachal Pradesh)
Check 2	Vivek Hybrid-45	VPKAS, Almora (Uttrakhand)
Check 3	Bio-9544	Shriram Bioseed Genetics India Limited
Check 4	DKC 7074	Monsanto Company

Table 2. Disease reaction to Maydis leaf blight under natural conditions in E1 (Kangra) and E2 (Bajaura)

Disease Reaction Type	Environment	Parent (s)	Crosses	Check (s)
Resistant = 3.0	**E1**			
	E2	P_2, P_3, P_4, P_6, P_8 **[5]**	$P_1 \times P_5$, $P_1 \times P_6$, $P_1 \times P_8$, $P_2 \times P_3$, $P_2 \times P_4$, $P_2 \times P_5$, $P_3 \times P_4$, $P_3 \times P_5$, $P_3 \times P_6$, $P_3 \times P_7$, $P_4 \times P_5$, $P_4 \times P_6$, $P_4 \times P_7$, $P_4 \times P_8$, $P_7 \times P_8$ **[15]**	Palam Sankar Makka-2, Vivek Hybrid-45 and DKC 7074 **[3]**
Moderately Resistant 3.1-5.0	**E1**	P_4 **[1]**	$P_4 \times P_5$, $P_4 \times P_8$ **[2]**	
	E2	P_1, P_5, P_7 **[3]**	$P_1 \times P_2$, $P_1 \times P_3$, $P_1 \times P_4$, $P_1 \times P_7$, $P_2 \times P_6$, $P_2 \times P_7$, $P_2 \times P_8$, $P_3 \times P_8$, $P_5 \times P_6$, $P_5 \times P_7$, $P_5 \times P_8$, $P_6 \times P_7$, $P_6 \times P_8$ **[13]**	Bio-9544 **[1]**
Moderately Susceptible 5.1-7.0	**E1**	P_1, P_2, P_3, P_7, P_8 **[5]**	$P_1 \times P_2$, $P_1 \times P_3$, $P_1 \times P_4$, $P_1 \times P_6$, $P_1 \times P_7$, $P_1 \times P_8$, $P_2 \times P_3$, $P_2 \times P_4$, $P_2 \times P_5$, $P_2 \times P_6$, $P_2 \times P_7$, $P_2 \times P_8$, $P_3 \times P_4$, $P_3 \times P_5$, $P_3 \times P_6$, $P_3 \times P_7$, $P_3 \times P_8$, $P_4 \times P_6$, $P_4 \times P_7$, $P_5 \times P_6$, $P_5 \times P_7$, $P_5 \times P_8$, $P_6 \times P_7$, $P_6 \times P_8$, $P_7 \times P_8$ **[25]**	Palam Sankar Makka-2, Vivek Hybrid-45, Bio-9544 and DKC 7074 **[4]**
	E2			
Susceptible >7.0-9.0	**E1**	P_5, P_6 **[2]**	$P_1 \times P_5$ **[1]**	
	E2			

3 parental lines viz., BAJIM-2010, LM14 & CML141, 4 cross combinations viz., $P_3 \times P_4$, $P_3 \times P_5$, $P_3 \times P_6$, $P_7 \times P_8$ and 3 checks *viz*., Palam Sankar Makka-2, Vivek Hybrid-45 and DKC 7074 exhibited resistant reaction against TLB in both E_1, E_2 under natural condition and in E_2 under artificial condition, whereas, against MLB in E_2 under both natural as well as artificial epiphytotic conditions. The resistant lines against TLB and MLB are a valuable source and can be utilized in resistance breeding programmes. The cross combinations can be further evaluated for yield and other characters and can be released as promising hybrid varieties resistant to TLB and MLB.

Conflict of interest: The authors declare that they have no conflict of interest among them in this research paper.

Table 3. Disease reaction to Turcicum leaf blight and Maydis leaf blight under artificial inoculated conditions in E_2 (Bajaura)

Disease Reaction Type	Disease	Parent (s)	Crosses	Check(s)
Resistant ≤ 3.0	**TLB**	P_1, P_2, P_3, P_5, P_6, P_7, P_8 [7]	$P_1 \times P_3$, $P_1 \times P_4$, $P_1 \times P_5$, $P_1 \times P_7$, $P_1 \times P_8$, $P_2 \times P_3$, $P_2 \times P_4$, $P_2 \times P_5$, $P_2 \times P_6$, $P_2 \times P_8$, $P_3 \times P_4$, $P_3 \times P_5$, $P_3 \times P_6$, $P_3 \times P_7$, $P_3 \times P_8$, $P_4 \times P_5$, $P_4 \times P_6$, $P_4 \times P_7$, $P_4 \times P_8$, $P_5 \times P_7$, $P_5 \times P_8$, $P_6 \times P_8$, $P_7 \times P_8$ [23]	Palam Sankar Makka-2, Vivek Hybrid-45, Bio-9544 and DKC 7074 [4]
	MLB	P_3, P_4, P_6, P_8 [4]	$P_3 \times P_4$, $P_3 \times P_5$, $P_3 \times P_6$, $P_7 \times P_8$ [4]	Palam Sankar Makka-2, Vivek Hybrid-45 and DKC 7074 [3]
Moderately Resistant 3.1-5.0	**TLB**	P_4 [1]	$P_1 \times P_2$, $P_1 \times P_6$, $P_2 \times P_7$, $P_5 \times P_6$, $P_6 \times P_7$ [5]	
	MLB	P_1, P_2, P_5, P_7 [4]	$P_1 \times P_2$, $P_1 \times P_3$, $P_1 \times P_4$, $P_1 \times P_5$, $P_1 \times P_6$, $P_1 \times P_7$, $P_1 \times P_8$, $P_2 \times P_3$, $P_2 \times P_4$, $P_2 \times P_5$, $P_2 \times P_6$, $P_2 \times P_7$, $P_2 \times P_8$, $P_3 \times P_7$, $P_3 \times P_8$, $P_4 \times P_5$, $P_4 \times P_6$, $P_4 \times P_7$, $P_4 \times P_8$, $P_5 \times P_7$, $P_5 \times P_8$, $P_6 \times P_7$, $P_6 \times P_8$ [23]	Bio-9544
[1]				
Moderately Susceptible 5.1-7.0	**TLB**			
	MLB		$P_5 \times P_6$ [1]	
Susceptible >7.0-9.0	**TLB**			
	MLB			

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