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Evaluations of maize genotypes against banded leaf and sheath blight under natural and artificial epiphytotic conditions

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Abstract

***Rhizoctonia solani,* causal agent of banded leaf and sheath blight (BLSB) is widely distributed in the India in maize causing severe yield losses. In this study, a set was obtained by crossing ten QPM inbred lines in 10 × 10 diallel fashion (excluding reciprocals). In total sixty lines including parents, *F_1's, procured hybrids* and standard check (HQPM-1 and Vivek QPM-9) were evaluated against banded leaf and sheath blight of maize under field conditions and artificial conditions during *kharif* 2016 and 2017, respectively. Data on reaction of maize genotypes to banded leaf and sheath blight under natural epiphytotic conditions revealed that the six parents *viz.,* CML161, CML189, BAJIMQ-08-27, CML193, CML162 and CML171, one hybrid HQPM-7, one QPM check Vivek QPM-9 and forty one crosses were found to be moderately resistant. Under artificial epiphytotic condition thirteen crosses *viz.,* BAJIMQ-08-27 × CML162, BAJIMQ-08-27 × CML161, CML162 × CML161, CML163 × CML161, CML170 × CML163, BAJIMQ-08-26 × CML171, CML193 × BAJIMQ-08-27, BAJIMQ-08-26 × CML161, CML193 × CML161, BAJIMQ-08-26 × CML163, BAJIMQ-08-27 × CML171, CML180 × CML161 and CML189 × CML163 showed moderately resistant reaction to BLSB; however, one cross was found susceptible (CML180 × BAJIMQ-08-27). These lines identified to possess low disease incidence score against BLSB in the present study could be used successfully in developing genotypes having desirable level of resistance in disease endemic areas to aim for sustainable productivity.**

Key words: Banded leaf and sheath blight, artificial, natural, epiphytotic, QPM.

Globally maize (*Zea mays* L.) is the first and most important cereal crop grown under diverse environments unmatched by any other crop, as expansion of maize to new areas and environment still continues due to its range of plasticity. Maize was introduced to India in the beginning of 17^{th} century. In India maize is the third important cereals crop after rice and wheat that provides food, feed and fodder and serve as a source of raw material for developing hundreds of industrial products *viz*., starch, protein, oil, alcoholic beverages, food sweeteners, pharma, cosmetics, bio-fuel etc. Almost all parts of the maize plant are susceptible to numerous diseases that considerably reduce the yield and quality of the crop (Shurtleff 1980).

About sixty pathogens belonging to fungi, bacteria, nematodes and viruses groups have been reported in India to cause various diseases like rots, seedling blight, stalk rots, downy mildews, leaf spots, blights, ear and kernel rots etc. (Payak and Sharma 1980). Losses due to maize diseases have been estimated to the tune of 9.4 per cent, annually, for the countries of Asia, the figure is 12 per cent, while for African countries the estimate is as high as 14 per cent (Cramer 1967; James 1981). Even for the developed countries like USA, 12 per cent of the produce is lost due to diseases, annually. For India a percent loss of 13.2 has been estimated (Payak and Sharma 1985). Considering the losses caused by diseases in India, sixteen out of sixty two diseases has been identify as major constraint. Among various diseases of maize, banded leaf and sheath blight incited by the fungus

Rhizoctonia solani f.sp. *sasakii* Exner [*Thanetophorus sasakii* (shirai) Tu & Kimbro] has attained the status of an economically important disease.

The disease was first reported from Srilanka (Bertus 1927) under the name 'Sclerotial' disease. Subsequently, it was recorded from Malaysia under the name of 'Banded sheath rot', in the Philippines as 'Banded sclerotial disease' and as 'Summer sheath blight' in Japan. In India, in early sixties the disease was of minor importance in the western and central Himalayan foothill region. However, it became increasingly severe and assumed epidemic proportions in the next two decades. Presently, the disease is considered as a major constraint not only in India but in several countries of Tropical Asia, wherever maize is grown (Sharma *et al*. 1993). Banded leaf and sheath blight disease of maize was first reported in 1966 as a minor disease (Payak and Renfro 1966). This disease shot in prominence only in 1972 and caused an unprecedented epidemic in foot hills of Mandi district of Himachal Pradesh (Thakur *et al.* 1973). Now it is considered as one of the major diseases of maize in India and is known to be present in the states of Jammu Kashmir, Himachal Pardesh, Uttrakhand, Sikkim, Meghalaya, Assam, Nagaland, Punjab, Haryana, Rajasthan, Madhya Pardesh, Delhi, Uttar Pardesh and Bihar. The disease appears on leaves and sheath on 40-45 days old plant and later on spread to the ear. The characteristic lesions appear as concentric bands and rings on lower leaves and sheath. Affective plant produces large, grey, tars, or brown discolor areas alternating with dark brown bands. Later on sclerotia are formed in these areas. This disease causes direct loss due to premature death of early infected plants and stalk breakage and ear rot in the older plants. Losses in grain yield to the extent of 11 to 40 per cent under favourable conditions have been reported due to banded leaf and sheath blight (Singh and Sharma 1976). Pathogen and crop both are important, therefore, present investigation was undertaken to find out resistant genetic resources for its sustainable and ecofriendly management.

Materials and Methods

A total of sixty QPM maize genotypes (ten parents, forty five experimental hybrids, three procured hybrids along with two QPM checks) screened for BLSB under the natural conditions in the main experiment trial at experimental farm of Department of Crop Improvement, CSK HPKV Palampur situated at 1290.80 m amsl having 32°6' N latitude and 76°3' E longitude and 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* 2016 and 2017 at Research Sub Station, Akrot situated at 425 m amsl (above mean sea level) having 31°4' N latitude, 76°1' E longitude 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 inoculation was done in the late afternoon. The artificial inoculation was done three times at a weekly interval. The disease rating for BLSB was noted using scale given by Sharma *et al*. (2005) as below:

Disease severity (%)	Rating Scale	Reaction
0	0	Highly Resistant
1-10	1	Resistant
11-25	2	Moderately Resistant
26-50	3	Moderately Susceptible
51-75	4	Susceptible
> 75	5	Highly Susceptible

Results and Discussion

Disease reaction to banded leaf and sheath disease under natural epiphytotic condition

Data on reaction of maize genotypes to banded leaf and sheath blight under natural epiphytotic conditions is presented in the Table 1 and Table 2. None of the genotypes was found highly resistant to the disease. Six parents *viz.,* CML161, CML189, BAJIMQ-08-27, CML193, CML162 and CML171, one hybrid HQPM-7, one QPM check Vivek QPM-9 and forty one crosses were found to be moderately resistant. None of the genotypes and crosses was susceptible and highly susceptible for BLSB under natural epiphytotic condition. Several workers also found the similar results on reaction of banded leaf and sheath blight (Meena 2004; Sharma *et al*. 2005; Bhavna and Gadag 2011). Thakur (2014) evaluated forty eight genotypes for resistance to banded leaf and sheath blight and found that five lines was moderately resistant, eighteen were moderately susceptible, nineteen were susceptible, and two were highly susceptible to the disease. Palia (2013) and Rana (2016) while screening maize germplasm under field conditions found that twenty two lines were moderately resistant and thirty five were moderately susceptible to banded leaf and sheath blight which is in confirmation with the present investigation.

Disease reaction to banded leaf and sheath disease under artificial epiphytotic condition

Under artificial epiphytotic condition thirteen crosses *viz.,* BAJIMQ-08-27 × CML162, BAJIMQ-08-27× CML161, CML162 × CML161, CML163 × CML161, CML170×CML163, BAJIMQ-08-26×CML171, CML193×BAJIMQ-08-27, BAJIMQ-08-26× CML161, CML193 × CML161, BAJIMQ-08-26 × CML163, BAJIMQ-08-27 × CML171, CML180 × CML161 and CML189×CML163 showed moderately resistant reaction to BLSB; however, one cross was found susceptible (CML180 × BAJIMQ-08-27). Among the parents, hybrids and QPM checks none of them showed highly resistant and resistant reaction (Table 1 and Table 3). Two parent's *viz.,* CML180, CML161 and two hybrids namely HQPM-7 and Pratap QPM-1 showed moderately resistant reaction. Six parents *viz.,* CML189, BAJIMQ-08-27, CML193, CML163, CML170, CML171 and two QPM checks *viz.,* HQPM-1, Vivek QPM-9 were found to be moderately susceptible; whereas, two parents namely; CML162, BAJIMQ-08-26 were found to be susceptible. One parent; CML170 and one hybrid HQPM-4 exhibited highly susceptible reaction against banded leaf and sheath blight. Similar results were obtained by Sharma *et al.* (2003), Biswas *et al.* (2007) and Garg *et al.* (2007), Madhvi *et al.* (2011) and Asif and Mall (2017). Germplasm evaluation was extensively carried out in the past using a large number of maize varieties, hybrids and inbred lines in order to find out source materials resistant to BLSB but the success in achieving the absolute resistance seems to be of distant possibility. As of now, the genetic variability for resistance to BLSB has been found to be limited (Sharma *et al.* 2002) which is a bottleneck for an effective resistance breeding programme. However, the lines reported in this study as moderately resistant can be utilized as such or their resistance can be transferred into commercial varieties using cyclic breeding scheme to meet the immediate challenges posed by BLSB.

Table 1. Disease score of maize genotypes to banded leaf and sheath blight (BLSB) under natural and artificial inoculation under field conditions during *kharif* 2016 and 2017

		BLSB (Natural epiphytotic conditions)		BLSB (Artificial inoculation under field conditions)	
		Palampur		Akrot	
Sr. No.	Genotypes	2016	2017	2016	2017
1.	CML162 × CML161	2.00	2.00	2.00	2.00
2.	CML163 × CML161	2.00	2.00	2.00	2.00
3.	CML170 × CML161	2.00	2.00	2.50	3.50
4.	CML171 × CML161	2.00	2.00	3.00	3.00
5.	CML189 × CML161	2.50	1.50	3.00	3.00
6.	BAJIMQ-08-26 × CML161	2.00	2.00	2.00	2.00
7.	BAJIMQ-08-27 × CML161	2.50	3.50	2.00	2.00
8.	CML193 × CML161	2.00	2.00	2.00	2.00
9.	CML180 × CML161	2.00	2.00	2.00	2.00
10.	CML163 × CML162	2.00	2.00	3.00	3.00
11.	CML170 × CML162	2.00	2.00	2.50	3.50
12.	CML171 × CML162	2.00	2.00	3.50	4.50
13.	CML189 × CML162	1.50	2.50	3.00	3.00
14.	BAJIMQ-08-26 × CML162	2.00	2.00	3.00	3.00
15.	BAJIMQ-08-27 × CML162	2.50	3.50	2.00	2.00
16.	CML193 × CML162	2.00	2.00	3.00	3.00
17.	CML180 × CML162	2.00	2.00	3.00	3.00
18.	CML170 × CML163	2.00	2.00	2.00	2.00
19.	CML171 × CML163	2.00	2.00	3.00	3.00
20.	CML189 × CML163	2.00	2.00	2.00	2.00
21.	BAJIMQ-08-26 × CML163	2.00	2.00	2.00	2.00
22.	BAJIMQ-08-27 × CML163	2.00	2.00	3.00	3.00
23.	CML193 × CML163	2.00	2.00	3.00	3.00
24.	CML180 × CML163	2.00	2.00	3.50	4.00
25.	CML171 × CML170	2.00	2.00	3.00	3.00
26.	CML189 × CML170	2.00	2.00	3.00	3.00
27.	BAJIMQ-08-26 × CML170	2.00	2.00	3.00	3.00
28.	BAJIMQ-08-27 × CML170	2.00	2.50	3.00	3.00

29.	CML193 × CML170	2.00	2.00	2.50	3.50
30.	CML180 × CML170	2.00	2.00	3.00	3.00
31.	CML189 × CML171	2.00	2.00	3.00	3.00
32.	BAJIMQ-08-26 × CML171	2.00	2.00	2.00	2.00
33.	BAJIMQ-08-27 × CML171	2.00	2.00	2.00	2.00
34.	CML193 × CML171	2.00	2.00	3.00	3.00
35.	CML180 × CML171	3.00	3.00	3.00	3.00
36.	BAJIMQ-08-26 × CML189	3.00	3.00	3.00	3.00
37.	BAJIMQ-08-27 × CML189	2.00	2.00	4.00	4.00
38.	CML193 × CML189	2.00	2.00	3.00	3.00
39.	CML180 × CML189	2.00	2.00	4.00	4.00
40.	BAJIMQ-08-27 × BAJIMQ-08-26	1.50	2.50	4.00	4.00
41.	CML193 × BAJIMQ-08-26	2.00	2.00	3.50	3.50
42.	CML180 × BAJIMQ-08-26	2.00	2.00	3.00	3.00
43.	CML193 × BAJIMQ-08-27	2.00	2.00	2.00	2.00
44.	CML180 × BAJIMQ-08-27	2.00	2.00	5.00	5.00
45.	CML180 × CML193	2.00	2.00	2.50	3.50
46.	HQPM-4	3.00	3.00	5.00	5.00
47.	HQPM-7	2.00	2.00	2.00	2.00
48.	Pratap QPM-1	2.50	3.50	2.00	2.00
49	CML161	2.00	2.00	2.00	2.00
50.	CML162	2.00	2.00	4.00	4.00
51.	CML163	3.00	3.00	3.00	3.00
52.	CML170	3.00	3.00	5.00	5.00
53.	CML171	2.00	2.00	3.00	3.00
54.	CML189	2.00	2.00	3.00	3.00
55.	BAJIMQ-08-26	3.00	3.00	4.00	4.00
56.	BAJIMQ-08-27	2.00	2.00	3.00	3.00
57.	CML193	2.00	2.00	3.00	3.00
58.	CML180	3.00	3.00	2.00	2.00
59.	HQPM-1 (SC-1)	3.00	3.00	3.00	3.00
60.	Vivek QPM-9 (SC-2)	2.50	1.50	3.00	3.00

Table 2.Reaction of QPM maize genotypes to banded leaf and sheath blight (BLSB) during *kharif* 2016 and 2017 under natural epiphytotic conditions

Disease severity (%)	Rating scale	Reaction	Parents/hybrids/ QPM checks	Crosses
0	0	Highly resistant	-	-
1-10	1	Resistant	-	-
11-25	2	Moderately resistant	CML161, CML189, BAJIMQ-08-27, CML193, CML162, CML171, HQPM-7, **Vivek QPM-9**	CML162 × CML161, BAJIMQ-08-26 × CML163, CML193 × BAJIMQ-08-26, CML163 × CML161, CML171 × CML162, BAJIMQ-08-26 × CML171, CML170 × CML161, CML189 × CML162, CML193 × CML163, BAJIMQ-08-27 × CML171, BAJIMQ-08-26 × CML162, CML180 × CML163, CML193 × CML171, CML180 × BAJIMQ-08-27, CML189 × CML161, CML193 × CML162, CML189 × CML170, CML180 × CML162, BAJIMQ-08-26 × CML170, BAJIMQ-08-27 × CML189, CML193 × CML189, CML193 × CML170, CML180 × CML189, CML163 × CML162, CML180 × CML170, CML170 × CML162, CML189 × CML171, BAJIMQ-08-27 × CML163, CML180 × BAJIMQ-08-26, CML193 × BAJIMQ-08-27, CML171 × CML170, CML180 × CML193, BAJIMQ-08-26 × CML161, CML193 × CML161 CML170 × CML163, BAJIMQ-08-27 × CML170, BAJIMQ-08-27 × BAJIMQ-08-26, CML161 × CML163, CML180 × CML161
26-50	3	Moderately susceptible	Pratap QPM-1, CML163, CML170, BAJIMQ-08-26, CML180, **HQPM-1**, HQPM-4	BAJIMQ-08-27 × CML162, CML180 × CML171, BAJIMQ-08-27 × CML161, BAJIMQ-08-26 × CML189
51-75	4	Susceptible	-	-
>75	5	Highly susceptible	-	-

Table 3.Reaction of QPM maize genotypes to banded leaf and sheath blight (BLSB) during *kharif* 2016 and 2017 under artificial epiphytotic conditions

Disease severity (%)	Rating scale	Reaction	Parents/hybrids/QPM checks	Crosses
0	0	Highly resistant	-	-
1-10	1	Resistant	-	-
11-25	2	Moderately resistant	CML180, CML161, HQPM-7, Pratap QPM-1	BAJIMQ-08-27 × CML162, BAJIMQ-08-27 × CML161, CML162 × CML161, CML163 × CML161, CML170 × CML163, BAJIMQ-08-26 × CML171, CML193 × BAJIMQ-08-27, BAJIMQ-08-26 × CML161, CML193 × CML161, BAJIMQ-08-26 × CML163, BAJIMQ-08-27 × CML171, CML180 × CML161, CML189 × CML163
26-50	3	Moderately susceptible	CML189, BAJIMQ-08-27, CML193, CML163, CML171, **HQPM-1, Vivek QPM-9**	CML170 × CML162, CML189 × CML171, CML193 × BAJIMQ-08-26, CML180 × BAJIMQ-08-26, CML189 × CML162, CML193 × CML163, CML171 × CML161, BAJIMQ-08-26 × CML162, CML193 × CML171, CML189 × CML161, CML171 × CML170, CML180 × CML171, CML180 × CML193, CML189 × CML170, CML180 × CML162, BAJIMQ-08-26 × CML170, BAJIMQ-08-27 × CML170, CML193 × CML161, BAJIMQ-08-26 × CML189, CML193 × CML189, CML171 × CML163, CML193 × CML170, CML170 × CML161
51-75	4	Susceptible	CML162, BAJIMQ-08-26	BAJIMQ-08-27 × BAJIMQ-08-26, BAJIMQ-08-27 × CML189, CML180 × CML189, CML180 × CML163, CML171 × CML162, BAJIMQ-08-26 × CML171, CML193 × BAJIMQ-08-27
>75	5	Highly susceptible	CML170, HQPM-4	CML180 × BAJIMQ-08-27

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