Evaluation of maize genotypes against banded leaf and sheath blight incited by *Rhizoctonia solani* f. sp. *sasakii* under artificial epiphytotic conditions

ABSTRACT

Maize (*Zea mays* L.) is one of the most important cereal crops belongs to *Poaceae* family with very high potential for yield. Production of maize is hampered by a major constraint and devastating disease banded leaf and sheath blight caused by *Rhizoctonia solani* f. sp. *sasakii*. The experiment was conducted to evaluate the maize genotypes under field conditions at CCS Haryana Agricultural University, Regional Research Station, Karnal. A set of fifty seven genotypes (hybrids/inbred lines) were screened against banded leaf and sheath blight during *kharif* 2020 and 2021 under artificial epiphytotic conditions. The severity of banded leaf and sheath blight was recorded following 1-9 scale and genotypes evaluated categorized into four groups *viz*., resistant, moderately resistant, moderately susceptible and susceptible based on their disease reaction. Out of fifty seven genotypes screened against BLSB, eight inbred lines *viz*.,HKI 161, HKI-163, HKI-193-2, HKI-288-2, HKI-295, HKI-488, HKI-1344 and HKI 1352 (58-9-2)-2 found reistant and seventeen maize inbred lines were moderately resistant, whereas two hybrids (HQPM-4 and HKI-1040-7 x HKI 659-3) showed resistant reaction and ten maize hybrids were moderately resistant. Thus, these resistant/ moderately resistant maize genotypes can be further use in maize breeding program to develop durable BLSB resistant varieties.

Keywords: Maize, banded leaf and sheath blight, *Rhizoctonia solani* f. sp. *sasakii*, genotypes

1. INTRODUCTION

Maize (*Zea mays* L.) is a member of *Poaceae* family, originated in the Mexico, Central America and the most important cereal crops of the tropical and sub-tropical regions of the world agricultural ecosystem. Maize is known as 'Queen of the Cereals' or 'Miracle C4 crop' because of its genetic makeup conserve highest yield potentiality comparable to the other cereals and gaining popularity as evidenced by its large scale consumption as food, feed, fodder for animals and as source of industrial raw materials *viz*., starch, syrup, dextrose, gelatin, protein, alcoholic beverages, oil, pharmacy, cosmetics, bio-fuel (ethanol), food sweeteners etc. Globally maize area of about 193.7 million hectors is being produced together by over 170 countries with annual production of approximately 1147.7 million MT and average productivity is about 5.75 t/ha [5]. It occupies an area about 9.89 million hectares having production of 31.65 million tones with average productivity of 3.20 t/ha in India during 2020-21 [4].In Haryana, *kharif* maize is cultivated over an area of 6.63 thousand hectares with average production of 20.06 thousand tones achieving productivity of 3.02 t/ha [4].

Despite its high yield potential, maize is affected by several biotic and abiotic stresses that affect the tropical and subtropical maize yield production. Globally, about one hundred and twelve diseases of maize has been reported form different locations, of these sixty five diseases to occur in India incited by pathogens

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Comment [U2]: check again the writing unit ton/ha

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Comment [U4]: check again the writing unit ton/ha belonging to fungi, bacteria, viruses and nematodes groups. Out of these, banded leaf and sheath blight disease of maize caused by fungus, *Rhizoctonia solani* f. sp. *sasakii*Exner, (Tel: *Thanatephorussasakii*(Shirai) Tu and Kimbro) belonging to anastomosis group(AG1-IA) is considered as the major constraint responsible for yield losses. The disease causes severe huge impact on yield in several Asian countries [17]. In India, the disease was first reported from Tarai region of Uttar Pradesh and was recognized as a minor disease [15], later on disease was appeared in the epidemic form in humid and warm foot hill regions of Mandi district in Himachal Pradesh in early 1970 [22].

Now, the banded leaf and sheath blight is known as highly destructive disease in Himachal Pradesh, Assam, Meghalaya, Uttar Pradesh, Bihar, Nagaland, Jammu Kashmir, Haryana, Uttarakhand, Punjab, Sikkam, Madhya Pradesh, Delhi, Rajasthan, Orissa, Andhra Pradesh and West Bengal [19], [2], [16]. The magnitude of grain yield losses may vary between 11-40 per cent with 71 percent disease index in India, up to 100 per cent at the ear rot phase in Indonesia and 44-66 per cent in Myanmar depending upon prevailing agro climatic conditions [19], [20], [13].In India, annually one percent of the total maize yield is reduced by BLSB, the losses in terms of grain yield may estimate to the range of 11-40 per cent, even to 100 per cent specially in Haryana due to continue rains in the months of July and August[12].

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2. MATERIALS AND METHODS

2.1 Experimental setup and field preparation

In the present investigation, fifty seven maize genotypes (Hybrids/inbred lines) were screened against banded leaf and sheath blight (BLSB) at research area of Chaudhary Charan Singh Haryana Agricultural University, Regional Research Station, Karnal during *kharif* 2020 and 2021 under artificial epiphytotic conditions. Two lines of each genotype consist of 3 m length with a row to row and plant to plant spacing of 75 cm and 20 cm, respectively were sown during both the *kharif* seasons. Experiments were laid out in randomized complete block design with three replications and all the recommended packages and practices of CCSHAU, Hisar were followed [3].

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2.2 Preparation of mass culture of *R. solani* f. sp. *sasakii*

Barley grains were soaked in water for 24 hours and dispensed 40 g seeds in 250 ml Erlenmeyer flask after removing excess of water and autoclaved at 121.6°C at 15 lbs for 20 minutes.Each flask was inoculated with 5 mm mycelium disc of *R. solani* isolates, derived from the actively growing cultures on the PDA plates and incubated at 25 ±2°C in BOD incubator for ten days. The fully grown fungal mycelium on barley grains were dispensed out from flask on a paper for drying at 15°C. The impregnated grains were utilized for inoculation and stored in paper bags or in the flasks for later use [1].

2.3 Artificial inoculation method

Inoculation on 30-35 days old maize plants was performed during evening hours and the moist conditions prevailed either due to rain or through irrigation. The grain inoculums were inserted between the leaf sheath and stalk at lower second or third internodes level of plant [1].

2.4 Observations recorded

The observations were recorded using 1-9 scale (Table 1) [7] and categorized them into different disease reaction on the basis of average disease score as follows:

Table 1: Disease rating scale for assessment of banded leaf and sheath blight of maize

Rating scale	Disease reaction	PDI
1.0-3.0	Resistant (R)	0.00-33.33%
4.0-5.0	Moderately resistant (MR)	44.44-55.55%
6.0-7.0	Moderately susceptible (MS)	66.66-77.77%
8.0-9.0	Susceptible (S)	88.88-99.99%

3. RESULTS AND DISCUSSION

3.1 Screening of maize genotypes(hybrids/inbred lines) against banded leaf and sheath blight

Host plant resistance is considered as one of the outstanding ways for managing the diseases to a sustainable agriculture with cost effective and eco-friendly approach.All the genotypes (hybrids/inbred lines) were showed significant variations in disease reaction during both the *kharif*seasons. Data indicated that all the genotypes showed resistant to susceptible reaction against banded leaf and sheath blight of maize. During *kharif* 2020 and 2021 the mean of disease score of banded leaf and sheath blight of maize varied from 2.2 to 8.4 (Table 2).

A total of forty four state inbred lines of maize were screened against banded leaf and sheath blight (BLSB). Out of which eight maize inbred lines namely HKI 161, HKI-163, HKI-193-2, HKI-288-2, HKI-295, HKI-488, HKI-1344 and HKI 1352 (58-9-2)-2 were found resistant (disease score ≤ 3.0) to banded leaf and sheath blight disease and seventeen maize inbred lines *viz.*,MBR-139, HKI-164-7-6, HKI-191-2-5, HKI-193-1, HKI-323, HKI-335, HKI-488-1RG, HKI-536C, HKI-1105, HKI-1128, HKI-1332, HKI-1345, HKI-1354-7, HKIL-287, HKI-1042-NP 19-ER-1 and PC-1 ER-4 were moderately resistant (disease score 3.1-5.0). Eighteen maize inbred lines (HKI-488T-3, HKI-536YN, BC- 570 ER-1, HKI-1011, HKI-1015-6, HKI-1025, HKI-1040-4, HKI-1105-ER-5, HKI-1348-8-2, HKI-1352, HKI-1651 (14-3-1), HKI-1657, HKI-1659, HKI-1664, NP-80ER-2, PC-3 ER-1, PC4-6 and PC 1221-4) were moderately susceptible (disease score 5.1-7.0) whereas, one inbred line PC 1473-5 exhibited susceptible reaction (disease score ≥7.0) against BLSB(Table 3).

Similarly, thirteen maize hybrids were screened against banded leaf and sheath blight (BLSB) during *kharif* 2020 and 2021. Among them, two hybrids *viz.*,HQPM-4 and HKI-1040-7 x HKI 659-3 were found resistant (disease score ≤ 3.0) to banded leaf and sheath blight disease and ten maize hybrids *viz.*,HQPM-1, HM-8, HM-11, HKI288-2x HKI 323, HKI 193-2x L-287, HKI 327 Tx L-287, HKI-1105-

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6x LM-17, HKI-1354-7x HKI-1344, HKI-1105 x IMR 307 and HKI-184 x HKI-1105 were moderately resistant (disease score 3.1-5.0). One maize hybrid (HKI 288-2x LM-17) showed moderately susceptible reaction against BLSB whereas, none of maize hybrid exhibited susceptible reaction (Table 4).The variable response of the genotypes for *R. solani* f. sp. *sasakii* has also been observed by earlier researches. However, there have been limited reports on genetics of resistance to banded leaf and sheath blight in maize [18]. The developments of resistant hybrids through classical plant breeding have been slow because unavailability of banded leaf and sheath blight resistance source [14, [6].Lal [8] screened one hundred inbred lines and sixty hybrids of maize against banded leaf and sheath blight during *kharif* 2011, out of which eighteen inbred and fourteen hybrids were resistant. Malik et al. [10] also evaluated thirty inbred lines and seven hybrids during *kharif* 2013-14. Out of thirty, only four inbreed lines (HKI-488WG, HKI-C-141, HKI-1040-5 and HKI-1347-4LT) were resistant, whereas (HKI-139, HKI-1352, HKI- 1378, HKI-150, HKI-766RG, HKI-MBR-139, HKI-323 and HKI-325-17A) were found moderately resistant. In case of hybrids, HM 11 was resistant whereas HQPM 1, HQPM 7, HM 6 and HKI 1040-7 x HKI 1128 were found moderately resistant. Similarly, Madhavi et al. [9] also screened twenty two maize genotypes out of which one inbred line PFSR9-2 was resistant against BLSB, whereas PFSR6-1, PFSR6-2 and PFSR18 were moderately resistant. In case of hybrids, one hybrid DHM 117 showed resistant reaction while DKC9145, DKC9133 and KMH3110 were found moderately resistant. Thakur et al. [22] and Meena et al. [11] also corresponds the variable pathological response in maize inbred lines and hybrid against BLSB pathogen under artificial epiphytotic conditions.

Table 2: **Disease rating and disease reaction of maize genotypes against banded leaf and sheath blight (*R. solani* f. sp. *sasakii*) under field conditions during *kharif* 2020 and 2021**

Sr. No	Inbred lines	*Kharif* 2020	*Kharif* 2021	Average	Reaction
1	HKI-161	2.8	2.6	2.7	R
2	HKI-163	2.5	2.4	2.5	R
3	HKI-193-1	4.6	4.9	4.8	MR
4	HKI-193-2	2.6	2.5	2.6	R
5	HKI-488-1RG	3.9	4.6	4.3	MR
6	HKI-1025	5.4	6.5	6.0	MS
7	HKI-1128	4.8	4.6	4.7	MR
8	HKI-1344	2.4	2.7	2.6	R
9	HKI-191-2-5	4.2	4.4	4.3	MR
10	HKI-288-2	2.3	3.6	3.0	R
11	HKI-323	3.5	4.5	4.0	MR
12	HKI-335	4.6	4.8	4.7	MR
13	HKI-488	2.7	2.4	2.6	R
14	BC-570ER-1	6.3	6.9	6.6	MS
15	HKI-1105	3.5	3.8	3.7	MR
16	HKI-1345	4.1	4.5	4.3	MR
17	HKI-1352	6.4	6.8	6.6	MS
18	HKI-1354-2	4.8	4.6	4.7	MR
19	HKI-1354-7	3.5	4.2	3.9	MR
20	HKI-1651 (14-3-1)	5.9	6.8	6.4	MS
21	HKI-1657	6.4	6.6	6.5	MS
22	HKI-1664	6.6	5.9	6.3	MS
23	HKIL-287	4.2	4.6	4.4	MR
24	HKI-1042-NP 19-ER-1	3.8	3.4	3.6	MR
25	NP-80ER-2	6.7	6.4	6.6	MS
26	PC 1473-5	7.6	8.4	8.0	S
27	MBR-139	4.3	4.8	4.6	MR
28	HKI-164-7-6	3.9	4.5	4.2	MR
29	HKI-295	2.4	2.6	2.5	R
30	HKI-488T-3	6.8	6.4	6.6	MS
31	HKI-536C	3.6	3.8	3.7	MR
32	HKI-536YN	5.6	6.2	5.9	MS
33	HKI-1015-6	6.4	6.7	6.6	MS
34	HKI-1040-4	5.6	5.9	5.8	MS
35	HKI-1105-ER-5	6.8	6.5	6.7	MS
36	HKI-1332	4.2	4.7	4.5	MR
37	HKI-1348-8-2	5.3	6.4	5.9	MS
38	HKI 1352 (58-9-2)-2	2.8	2.6	2.7	R
39	HKI-1659	6.4	6.9	6.7	MS
40	PC-1 ER-4	3.8	4.6	4.2	MR
41	PC-3 ER-1	5.4	6.8	6.1	MS
42	PC 1221-4	6.5	5.8	6.2	MS
43	HKI-1011	6.8	6.4	6.6	MS
44	PC 4-6	5.9	6.4	6.2	MS

Sr. No	Hybrids	*Kharif* 2020	*Kharif* 2021	Average	Reaction
1	HQPM-1	3.6	3.9	3.8	MR
2	HQPM-4	2.4	2.2	2.3	R
3	HM-8	3.5	3.8	3.7	MR
4	HM-11	4.1	4.5	4.3	MR
5	HKI 288-2x HKI 323	4.8	4.6	4.7	MR
6	HKI 193-2x L-287	4.5	4.8	4.7	MR
7	HKI 288-2x LM-17	5.6	6.2	5.9	MS
8	HKI 327 T x L-287	3.7	4.2	4.0	MR
9	HKI-1105-6 x LM-17	4.5	5.3	4.9	MR
10	HKI-1040-7 x HKI 659-3	2.4	2.7	2.6	R
11	HKI-1354-7 x HKI-1344	4.3	4.5	4.4	MR
12	HKI-1105 x IMR 307	3.8	4.1	4.0	MR
13	HKI-184 x HKI-1105	4.1	4.6	4.4	MR

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Table 3: Screening of inbredlines against banded leaf and sheath blight (*R. solani* f. sp. *sasakii*) under field conditions during *kharif* 2020 and 2021

Disease score	Disease reaction	No. of inbreds	Inbreds
< 3.0	Resistant	8	HKI 161, HKI-163, HKI-193-2, HKI-288-2, HKI-295, HKI-488, HKI-1344, HKI 1352 (58-9-2)-2
3.1-5.0	Moderately Resistant	17	MBR-139, HKI-164-7-6, HKI-191-2-5, HKI-193-1, HKI-323, HKI-335, HKI-488-1RG,HKI-536C,HKI-1105,HKI-1128, HKI-1332, HKI-1345, HKI-1354-7, HKIL-287, HKI-1042-NP 19-ER-1, PC-1 ER-4
5.1-7.0	Moderately Susceptible	18	HKI-488T-3, HKI-536YN, BC- 570 ER-1, HKI-1011, HKI-1015-6, HKI-1025, HKI-1040-4,HKI-1105-ER-5, HKI-1348-8-2, HKI-1352, HKI-1651 (14-3-1), HKI-1657, HKI-1659, HKI-1664, NP-80ER-2, PC-3 ER-1, PC4-6, PC 1221-4
7.1-9.0	Susceptible	1	PC 1473-5

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Table 4: Screening of hybrids against banded leaf and sheath blight (*R. solani* f. sp. *sasakii*) under field conditions during *kharif* 2021 and 2021

Disease score	Disease reaction	No. of hybrids	Hybrids
< 3.0	Resistant	2	HQPM-4, HKI-1040-7 x HKI 659-3
3.1-5.0	Moderately Resistant	10	HQPM-1, HM-8, HM-11, HKI288-2x HKI 323, HKI 193-2x L-287, HKI 327 Tx L-287, HKI-1105-6x LM-17, HKI-1354-7x HKI-1344, HKI-1105 x IMR 307, HKI-184 x HKI-1105
5.1-7.0	Moderately Susceptible	1	HKI 288-2x LM-17
7.1-9.0	Susceptible	0	NIL

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4. CONCLUSION

This study emphasized the identification of resistance source among maize genotypes (hybrids /inbred lines) against banded leaf and sheath blight disease. This study revealed eight inbred lines *viz.*,HKI 161, HKI-163, HKI-193-2, HKI-288-2, HKI-295, HKI-488, HKI-1344 and HKI 1352 (58-9-2)-2 and two hybrids (HQPM-4 and HKI-1040-7 x HKI 659-3)of maize found resistant against banded leaf and sheath blight can be further utilize for developing resistant maize varieties and help to develop management strategies for the control of banded leaf and sheath blight. These resistant /moderately resistant genotypes of maize could be used for identifying durable resistance, QTL analysis/as donor parents in breeding programs.

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Comment [U12]: The reference hasn't used the Medeley or Zatero applications

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