Plant Archives Vol. 26, Supplement 2, 2026 pp. 2329-2334 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-2.292

FIELD ASSESSMENT OF CERTAIN MAIZE INBREDS FOR RESISTANCE TO BANDED LEAF AND SHEATH BLIGHT (*Rhizoctonia solani* F. Sp. *Sesakii*)

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(Date of Receiving : 17-04-2026; Date of Revision : 03-06-2026; Date of Acceptance : 26-06-2026)

ABSTRACT

Maize (Zea mays L.) is one of the most widely cultivated cereal crops and plays a vital role in food, feed and industrial sectors. However, its productivity is severely affected by several diseases, among which Banded leaf and sheath blight caused by *Rhizoctonia solani f. sp. sasakii* is an economically important disease in tropical and subtropical maize-growing regions. The present study was conducted to evaluate 51 maize inbred lines for resistance to banded leaf and sheath blight under artificial epiphytotic conditions. The trial was conducted at Agricultural Research Station, Peddapuram, Andhra Pradesh (ANGRAU) for three consecutive years, during kharif 2023, 2024 and 2025. The experiment was laid out in an alpha lattice design with two replications, and artificial inoculation was carried out using sorghum grain culture of the pathogen. Disease severity was assessed using the standard 1–9 disease rating scale, and pooled analysis over three years was performed. Majority of the inbred lines under study belonged to the moderately susceptible category (78.47% of the inbreds), whereas, 5.88% of inbreds showed susceptible reaction. The results revealed significant variation among the inbred lines for their reaction to the disease, indicating the presence of genetic variability among the inbreds. Among the maize inbreds, PI 15 recorded consistently recorded moderately resistant reaction to BLSB. Susceptible inbred line, CM 600 recorded a mean disease severity score of 7.5 against mean disease score of 5.8 for the location during 3-year period. Inbred lines, PL 23352, PL 23364 and PL 23371 exhibited significant levels of resistance under field conditions. Promising maize inbreds lines identified in the present study with stable resistance to BLSB could be incorporated in the breeding programme for developing BLSB disease-resistant maize hybrids.

***Keywords*:** Banded leaf and sheath blight, inbred lines, Maize, *Rhizoctonia solani* f. sp. *sasakii*, Resistance

Introduction

Maize (*Zea mays* L.) is one of the world's most important cereal crops, serving as a staple food, animal feed, and industrial raw material. Being a C4 plant, it exhibits high photosynthetic efficiency and possesses the greatest yield potential among cereals. Globally, maize is cultivated over approximately 193 million hectares with production exceeding 1.14 billion tonnes (ANGRAU, 2024). India ranks among the leading maize-producing countries, contributing more than 40 million tonnes annually with an average productivity of about 3.5 t ha^{-1} (Agricultural and Processed Food Products Export Development Authority [APEDA], 2025). The total maize production in India during 2024–25 is estimated at 43.41 million tonnes, with the crop cultivated over an area of nearly 12 million hectares (APEDA, 2025). Despite its yield potential and versatile uses the crop is frequently subjected to various abiotic and biotic stresses that hampers its productivity. Among the major biotic constraints affecting maize production, banded leaf and sheath blight (BLSB) caused by *Rhizoctonia solani f. sp. sasakii* Exner is one of the most destructive diseases in tropical and subtropical maize-growing regions. The pathogen has a broad host range infecting plants across 32 families and 188 genera, including cereals, millets, pulses, oilseeds, grasses, and weeds (Devi and Thakur, 2018). In cereals, the AG 1-1A anastomosis group of *R. solani* causes banded leaf and sheath blight (Wang *et al.*, 2013). Severe infections can cause cob sterility and sclerotia formation, with yield losses ranging from 11–40% and reaching up to 100% under favourable conditions (Hooda *et al.*, 2015; Singh *et al.*, 2020). The persistence of soil-borne inoculum complicates management, necessitating strategies such as machinery sterilization, fungicide use, and soil fumigation (Singh *et al.*, 2020). Although cultural, chemical, and biological practices can partially manage BLSB, integrated disease management (IDM) remains the most sustainable approach. Host plant resistance is crucial but limited genetic variability constrains breeding progress. However, Sharma *et al.* (2002) observed limited genetic variability for BLSB resistance in Indian maize germplasm. Therefore, identification of resistant inbred lines is essential for developing disease-resistant hybrids through breeding programmes. Efforts in India, China, Indonesia, and the Philippines have identified a few moderately resistant genotypes (Hooda *et al.*, 2015). Keeping this in view, the present investigation was undertaken to evaluate fifty maize inbred lines for their reaction against banded leaf and sheath blight under artificial epiphytotic field conditions.

Materials and Methods

Experimental site

The field experiment was conducted at Agricultural Research Station, Peddapuram (ANGRAU) situated at 17.06306 North latitude and 82.13804 East longitude and at 35 m MSL. The trial was conducted for three consecutive years, i.e., during *Kharif* 2023, 2024 and 2025. Fifty-one maize inbred lines from existing breeding germplasm were evaluated for their resistance to banded leaf and sheath blight (BLSB) of maize caused by *Rhizoctonia solani* f. sp. *sasakii* under artificial inoculated conditions. The experiment was laid out in alpha lattice design with two replications, with each entry sown in 2.0 m row adopting a spacing of 60 x 20 cm. All the recommended agronomic practices given under vyavasaya panchangam of ANGRAU were followed.

Pathogen multiplication and inoculation technique

The pathogen *Rhizoctonia solani* f. sp. *sasakii* was isolated from infected maize leaf sheaths of Peddapuram location. Pure culture was obtained by using the hyphal tip method and maintained under mineral oil at 4 °C for further use. The pathogen was mass multiplied on double sterilised sorghum grains for two weeks under laboratory conditions to create artificial epiphytotics (Ahuja and Payak, 1978). Artificial inoculation was carried out at 30 days after sowing (DAS**)** during evening hours, by inserting pathogen colonized maize grains (3 no's) at second leaf sheath uniformly in all the entries to ensure disease development. Sprinkler irrigation was provided for 3-4 days following inoculation with the pathogen to facilitate effective pathogen establishment. Typical symptoms of banded leaf and sheath blight appeared on the leaf sheath within 3–4 days of inoculation. Disease observations were recorded 30 days after inoculation using the modified 1–9 rating scale (table 1) as per Ahuja and Payak (1983) and Hooda *et al.* (2018). Mean disease score from 2 replications was presented in the results. Data from the three years was pooled and analyzed as per standard statistical procedures and presented.

Results

Fifty one maize inbred lines were evaluated under artificial epiphytotic conditions for their reaction to banded leaf and sheath blight during kharif seasons of 2023, 2024 and 2025. Disease severity was recorded using the standard 1–9 rating scale at 30 days after inoculation and mean disease scores were used for grouping of inbreds. Results (Table 2) suggests significant variation among maize inbred lines with respect to disease reaction across three years of evaluation, indicating the presence of differential levels of resistance among maize genotypes to *Rhizoctonia solani* f. sp. *sasakii*. From the 3 year study, 9 inbreds (including checks) out of 51 inbreds screened for BLSB resistance showed consistent moderately resistant reaction, seven inbreds from the station *viz*., PI 15 (4.5), PL 23352 (4.9), PL 23364 (4.9), PL 23371 (4.9), PL 23357 (5.0), PL 23362 (5.0) and PL 23363 (5.0), were found to possess promising levels of resistance to BLSB. Inbred lines, LM 14 (4.8) and BML 6 (5.0) were found consistent in their reaction to the disease under local conditions. Majority of the inbred lines under study belonged to the moderately susceptible category (78.47% of the inbreds), whereas, 5.88% of inbreds showed susceptible reaction. Local weather conditions (tropical climate) might have contributed to consistently higher disease scores recorded in the study (Garg *et al.*, 2007). Highly susceptible reaction was observed in PI 342 (7.2), CML 451 (7.2) and CM 600 (7.5). These genotypes consistently recorded higher disease severity across seasons, indicating poor resistance under artificial inoculation conditions.

Stable disease reaction observed in the select maize inbred lines suggests the presence of durable field resistance, making these genotypes promising candidates for resistance breeding programmes. Mean disease score from the three year study indicates influence of slight environmental variation in disease development. The overall mean disease severity was highest during 2023 (6.0), followed by 2025 (5.8), and 2024 (5.6). Reactions of maize inbreds used in the study remained relatively consistent across the three years, suggesting stability in genotype response. The pooled mean BLSB severity across all entries was 5.8.

Discussion

The pooled analysis of disease scores over three years (2023–2025) revealed considerable variability among the evaluated genotypes, with mean values ranging from 4.5 to 7.5 demonstrating significant differences among the genotypes for disease reaction. The coefficient of variation (C.V) values ranged from 11.51% to 13.62%, indicating acceptable experimental precision and reliability of the screening procedure. In the present study, PI 15 emerged as the most resistant genotype, followed by LM 14, PL 23352, PL 23364 and PL 23371. These genotypes consistently recorded lower disease scores across years, suggesting stable resistance and their potential utility as donor parents in resistance breeding programmes.

The findings of the present investigation are in close agreement with earlier reports indicating the existence of limited but useful sources of resistance against banded leaf and sheath blight in maize. Several workers have identified resistant or moderately resistant maize genotypes against *Rhizoctonia solani* under artificial epiphytotic conditions (Sharma *et al.*, 2005, Subrata Biswas *et al.*, 2007, Garg *et al.*, 2007, Thakur *et al.*, 2018, Bindu Madavi *et al.*, 2018) The identification of moderately resistant maize genotypes to BLSB in the present study, particularly PI 15 and LM 14, further supports the existence of genetic variability for BLSB resistance in maize germplasm. The intermediate disease scores observed in genotypes such as PI 10, QIL 4-2306, CML 563 and several PL series entries in the present study may be indicative of partial resistance or tolerance mechanisms, which could be effectively utilized in breeding programmes aimed at developing durable resistance. Earlier study of Kumar *et al.* (2022) indicate that resistant sources against BLSB are relatively scarce, thereby emphasizing the importance of the resistant genotypes identified in the present investigation. Conversely, genotypes *viz*., CM 600 (7.5), CML 451 (7.2) and PI 342 (7.2) were identified as the most susceptible, followed by PI 327 (6.9) and CAL 1812 (6.8) indicating poor resistance under the tested conditions, making them less suitable for use in resistance breeding. Meena *et al.* (2021) also reported resistance in maize inbreds EV1417 and moderate resistance in CML-323 against *Rhizoctonia solani*, which was associated with enhanced defense enzyme activity and stable electrolyte leakage following infection. Such findings suggest that physiological and biochemical defense mechanisms may contribute to stable resistance expression in resistant genotypes identified in the present study as well. Overall, the study demonstrates the presence of substantial genetic variability for disease resistance among the tested genotypes. Genotypes with lower disease scores, particularly PI 15 can be effectively utilized in resistance breeding programmes.

Conclusion

Banded leaf and sheath blight (BLSB) of maize is one of the major biotic constraints in kharif maize under tropical climate conditions, the causal organism, *Rhizoctonia solani* f. sp. *sesaki* is a necrotroph having a broad host range and capable of infecting maize at all crop growth stages resulting in significant crop losses. Availability of inbreds with good source of resistance to BLSB could help develop hybrids with resistance or tolerance to BLSB thereby helping avoid yield losses in problematic areas. In the present study, maize inbreds at ARS, Peddapuram were screened against BLSB under artificial inoculated conditions for three consecutive years (2023-25). Among the fifty-one inbreds screened against BLSB, PI 15 was found promising showing consistent moderate resistant reaction. In addition, PI 15, PL 23352, PL 23364, PL 23371, PL 23357, PL 23362 and PL 23363 also recorded moderate resistant reaction, making them ideal material for use in breeding programme for developing BLSB tolerant hybrids.

Table 1 : Disease Rating Scale by Hooda *et al.* (2018).

<table>
<tr><th>Rating Scale</th><th>Degree of infection(percent DLA)</th><th>PDI</th><th>Disease reaction</th></tr>
<tr><td>1.0</td><td>Disease on one leaf sheath only; few small, non-coalescent lesions present (≤10%).</td><td>≤11.11</td><td rowspan="2">Resistant (R) (Score:≤3.0) (DLA:≤3%) (PDI:≤33.33)</td></tr>
<tr><td>2.0</td><td>Disease on two sheaths; lesions large and coalescent (10.1-20%).</td><td>22.22</td></tr>
<tr><td>3.0</td><td>Disease up to four sheaths; lesions many and always coalescent (20.1-30%).</td><td>33.33</td><td>Moderately</td></tr>
</table>

4.0	As in disease rating symptoms of 3.0, + rind discolored with small lesions (30.1-40%).	44.44	Resistant(MR) (Score:3.1-5.0) (DLA:30.1-00%) (PDI:33.34-55.55)
5.0	Disease on all sheaths except two internodes below the ear (40.1-50%).	55.55	
6.0	Disease up to one internode below ear shoot; rind discoloration on many internodes with large depressed lesions (50.1-60%).	66.66	Moderately susceptible(MS) (Score:5.1-7.0) (DLA:50.1-70%) (PDI:55.56-77.77)
7.0	Disease up to the internodes bearing the ear shoot but shank not affected (60.1-70%).	77.77	
8.0	Disease on the ear; husk leaves show bleaching, bands and cracking among themselves as also silk fibers; abundant fungal growth between and on kernels; kernels formation normal except being lusterless; ear size less than normal; some plants prematurely dead (70.1-80%).	88.88	Susceptible(S) (Score:≥7.0) (DLA:70%) (PDI:≥77.77)
9.0	In addition to disease rating symptoms of 8.0, shrinkage of stalk; reduced ear dimension; wet rot and disorganization of ear; kernel formation absent or rudimentary; prematurely dead plants common; abundant sclerotia production on husk leaves, kernels ear tips and silk fibres (≥80%).	99.99	

Table 2 : Disease reaction of maize inbred lines against BLSB under artificial epiphytotic conditions during 2023–2025 and pooled analysis.

S.No.	Treatment	2023	2024	2025	Pooled mean	Reaction
1	PI 9	6.5	5.5	6.6	6.2	MS
2	PI 10	6.0	4.9	5.5	5.5	MS
3	PI 15	4.0	4.4	5.2	4.5	MR
4	PI 26	6.0	5.3	6.8	6.0	MS
5	PI 26(1)	6.0	6.0	6.6	6.2	MS
6	PI 38	6.0	6.6	5.1	5.9	MS
7	PI 327	7.5	7.2	6.0	6.9	MS
8	PI 329	7.0	6.8	6.2	6.7	MS
9	PI 332	5.5	6.0	5.1	5.6	MS
10	PI 339	7.0	6.3	5.8	6.3	MS
11	PI 340	6.5	5.8	6.2	6.2	MS
12	PI 342	7.5	8.0	6.1	7.2	S
13	PI 344	5.5	6.5	6.7	6.2	MS
14	PI 345	5.5	6.0	6.5	6.0	MS
15	PL 23348	6.0	6.7	5.8	6.2	MS
16	PL 23349	5.5	6.0	6.5	6.0	MS
17	PL 23350	6.0	5.3	6.7	6.0	MS
18	PL 23351	6.5	5.3	5.5	5.8	MS
19	PL 23352	4.0	5.5	5.3	4.9	MR
20	PL 23353	6.0	6.0	5.1	5.7	MS
21	PL 23354	5.0	6.1	6.0	5.7	MS
22	PL 23355	6.5	5.6	5.9	6.0	MS
23	PL 23356	4.5	5.7	5.9	5.4	MS
24	PL 23357	5.0	5.3	4.7	5.0	MR
25	PL 23358	7.0	5.0	5.5	5.8	MS
26	PL 23359	7.0	6.0	4.6	5.9	MS
27	PL 23360	6.0	5.1	5.9	5.7	MS
28	PL 23361	5.5	5.0	6.3	5.6	MS
29	PL 23362	5.0	4.5	5.4	5.0	MR
30	PL 23363	4.5	5.3	5.3	5.0	MR
31	PL 23364	6.0	4.0	4.8	4.9	MR
32	PL 23365	7.5	5.0	6.4	6.3	MS
33	PL 23366	7.5	5.2	5.7	6.1	MS
34	PL 23367	6.0	4.6	6.4	5.6	MS
35	PL 23368	6.5	5.1	5.9	5.9	MS

36	PL 23369	5.5	5.4	4.4	5.1	MS
37	PL 23370	6.0	5.0	7.0	6.0	MS
38	PL 23371	4.5	4.8	5.5	4.9	MR
39	PL 23372	6.5	6.7	5.9	6.4	MS
40	CAL 1812	7.5	6.3	6.5	6.8	MS
41	CLO 2450	5.0	5.6	5.2	5.3	MS
42	CML 451	7.5	7.0	7.1	7.2	S
43	CML 563	6.0	5.5	4.8	5.4	MS
44	CML 581	5.5	6.5	6.5	6.2	MS
45	CML 582	6.0	4.3	6.5	5.6	MS
46	IML 187	7.0	5.8	6.6	6.4	MS
47	QIL 4-2306	6.0	4.9	5.6	5.5	MS
48	QIL 4-2124	7.5	6.0	5.4	6.3	MS
49	CM 600	7.7	7.3	7.6	7.5	S
50	BML 6	5.0	5.0	5.1	5.0	MR
51	LM 14	5.5	4.3	4.5	4.8	MR
	Mean	6.0	5.6	5.8	5.8	
	C.D.	1.66	1.55	1.52	1.09	
	SE(m)	0.58	0.54	0.53	0.39	
	SE(d)	0.82	0.77	0.76	0.55	
	C.V. (%)	13.62	13.58	12.92	11.51	

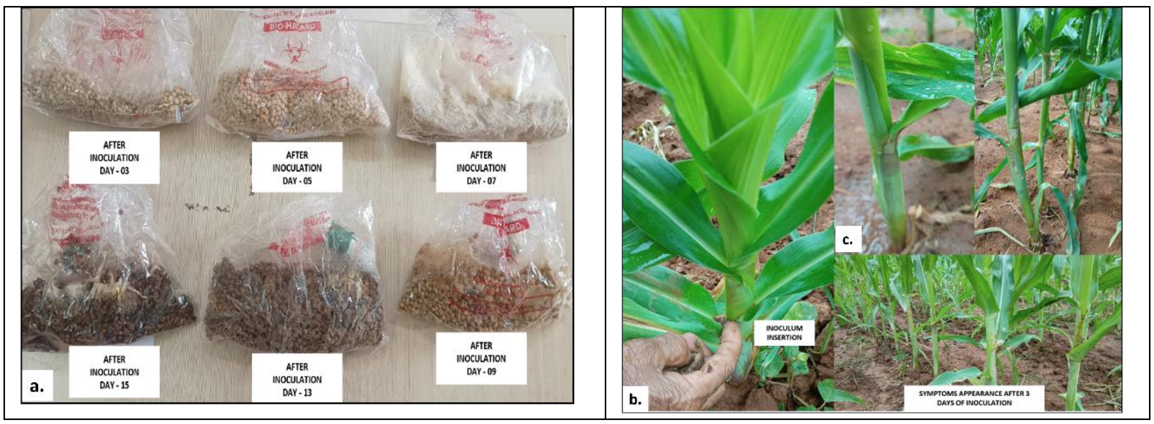

Fig. 1 : Sorghum grain culture technique for inducing bacterial leaf and sheath blight on maize epiphytotics under controlled conditions from left, a) Progressive growth of *Rhizoctonia solani* f. sp. *sesakii* on sorghum grain (up to 15 days of inoculation) b) artificial inoculation of BLSB sorghum grain onto basal 2-3 lower leaf at 30 DAS c) Development of water-soaked lesions (early BLSB symptoms) at 3 days post artificial inoculation

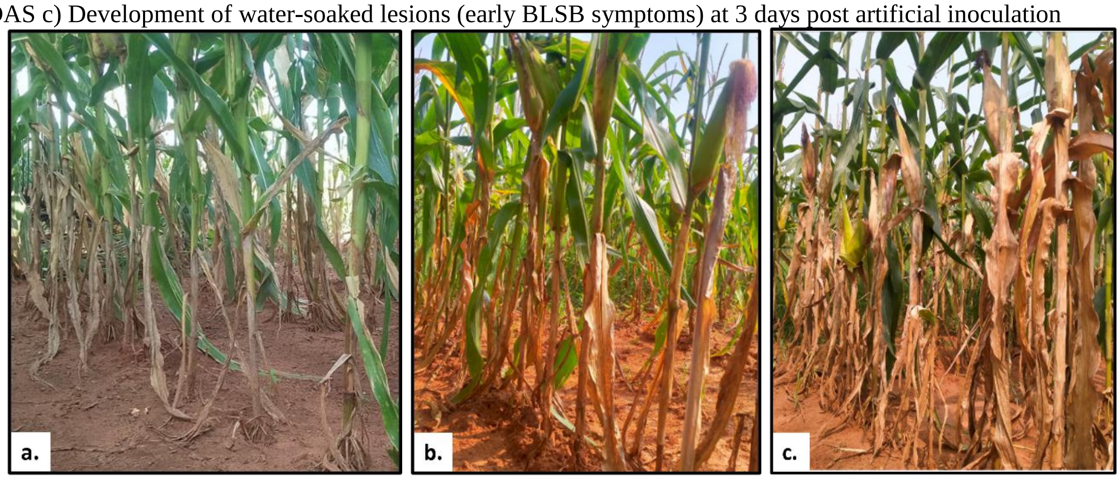

Fig. 2 : Disease reaction of maize inbreds to banded leaf and sheath blight pathogen (*Rhizoctonia solani* f. sp. *sesakii*) under artificial inoculation conditions. From left a: moderate resistant reaction, symptom development up to 2 nodes below the ear; b: moderate susceptible reaction, disease on all sheaths up to the internodes bearing the ear, but shank not affected; c: susceptible reaction, disease on ear, husk leaves show bleaching, shrinkage of stalk, reduced ear dimensions, wet rot, disorganization of ear and in some instances premature death of plant.

Acknowledgement: Authors sincerely thank Acharya N G Ranga, Agricultural University, Lam, Guntur, Andhra Pradesh and AICRP (Maize), IIMR, Ludhiana for extending funding and facilities during undertaking of research work at ARS, Peddapuram.

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