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Reaction of Maize Inbred Lines to Banded Leaf and Sheath Blight Incited by *Rhizoctonia solani* f.sp. *sasakii* Exner

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A B S T R A C T

An Experiment was conducted in the field at Agricultural Research Station, Peddapuram, Andhra Pradesh, India with the objective of evaluating 10 maize inbred lines against Banded Leaf And Sheath Blight disease caused by *Rhizoctonia solani* f.sp. *sasakii* during Rainy season under Natural Conditions consequently for three years 2018, 2019 and 2020. The trial has been conducted to find out the occurrence of disease and/or any new disease on a set of maize inbred lines (10 lines) susceptible to different diseases. Disease score was taken at weekly intervals starts from 37 DAS to 93 DAS by using Standard disease Rating Scale of 1to 9. Among these ten inbreeds (CM 400, CM 500, CM 501, CM 600, BML 6, BML 7, SURYA, Early Composite, LM 14 and IIMRSBTPOOL) CM 500 showed moderately resistant reaction and BML 7 showed susceptible reaction to the BLSB, none of the inbred showed resistant reaction and remaining inbred lines expressed moderately susceptible reaction to the disease.

Introduction

Maize (*Zea mays* L.) is one of the most important cereal crops of the world grown in the irrigated and rainfed areas which ranks third after wheat and rice. Due to its high potentiality than any other cereals, it is also called as a versatile and miracle crop so it is popularly known as 'Queen of Cereals' (Singh, 2002). It is the world leading and staple cereal crop belongs to tribe *maydaea* and grass family, Poaceae and also provides raw materials for the livestock and many agro-allied industries in the world (Ali *et al.*, 2011; Randjelovic *et al.*, 2011).

Despite very high yield potential of maize, one of the major deterrents to high grain yield is its sensitivity to several diseases. From different parts of the world, about112 diseases of maize have been reported, of these, 65 are known to occur in India (Saxena, 2002). Seed rot and seedling blight, leaf spots and blights, downy mildews, stalk rots, banded leaf and sheath blight, and smut and rots are the most important diseases of maize crop (Hafiz,

1986). Among different fungal diseases affecting maize production, banded leaf and sheath blight (BLSB) induced by *Rhizoctonia solani* f. sp. *sasakii* causes significant gain yield loss from 11% to 40%, even to 100% on some cultivars in some warm and humid regions, where the conditions are favourable for the pathogen (Madhavi *et al.*, 2011; Izhar and Chakraborty, 2013; Gao *et al.*, 2014). Since the pathogen is soil borne, the disease starts from first leaf sheath to upward and even up to the ears to cause maximum damage. The pathogen is characterized by formation of dull brown Sclerotia on the host. High relative humidity and rain fall significantly favors development and spread of this disease. An optimum temperature about 28°C and high relative humidity (88 to 90%) in the first week of infection favor rapid disease progress. If the relative humidity goes below 70%, disease development and spread becomes slow (Sharma, 2005). Additionally, high crop densities impact disease severity.

The use of fungicides is costly and environment unfriendly and it is simple, effective, safe and economical to use resistant varieties for controlling these disease. In such contest, identification of resistant genotypes/varieties would be good alternatives to manage the diseases. Development of resistant hybrids is dependent on selection of suitable resistant Inbred Lines. The trial has been conducted to find out the occurrence of disease and/or any new disease on a set of maize inbred lines (10 lines) susceptible to different diseases.

Materials and Methods

The basic materials screened in the present study comprised 10 diverse maize inbred (*Z. mays*) lines. All 10 inbred lines are CM 400, CM 500, CM 600, CM 501, BML 6, BML 7, SURYA, Early Composite, LM 14, IIMRSBTPOOL were received from the Winter Nursery Center, Indian Institute of Maize Research, Hyderabad during *kharif* season of three consecutive years of 2018, 2019 & 2020. The work of disease screening and determination of resistance was done under AICRP on maize, in an experimental plot maintained at ANGRAU-Agricultural Research Station, Peddapuram, Andhra Pradesh. Diseased leaf samples were collected from maize growing areas of RARS Chintapalle. The Inbred Lines were sown in a single row of 4m length spaced at 70 x 20 cm. Recommended agronomic practices and insect pest control measures were followed as per schedule. The disease severity on test entries was scored at weekly intervals using 1-9 disease rating scale (Hooda *et al.*, 2018). The reaction of various lines was recorded. The Inbred Lines were grouped into the different reaction categories viz., Resistant, Moderately Resistant, Moderately Susceptible and Susceptible.

Disease assessment

Disease scoring was started 37 days after sowing. The disease incidence was measured on individual plant visually at 7 days intervals. A total of 9 scorings were done from August to October, in two consecutive years 2019 & 2020, i.e. 37DAS, 44DAS, 51DAS, 58DAS, 65DAS, 72DAS, 79DAS, 86DAS and 93DAS. Disease assessment on basis of modified 1-9 rating scale of AICMIP (1983); Muis and Quimio (2006) and Hooda *et al.*, (2018). The genotypes showing disease score between 1.0–3.0 were considered as resistant (R), 3.1 – 5.0 as moderately resistant (MR), 5.1 – 7.0 as moderately susceptible (MS) and 8.0 – 9.0 as susceptible (S).

Results and Discussion

Efforts for location of Resistant source and their utilization in Resistant breeding Programme are very much important to

manage the disease in the long run. The present trial revealed that none of the tested inbred lines was completely free from banded leaf and sheath blight (BLSB) disease infection caused by *Rhizoctonia solani* f. sp. *sasakii*. However, significant variations in disease score and severity for BSLB was observed in inbred lines. The present study revealed that out of 10 inbred lines tested, only one line CM 500 (Score – 5.0) showed moderately resistant reaction against BLSB disease. BML 7 showed disease score of 7.3 exhibited Susceptible. Eight lines CM 400, CM 501, CM 600, BML 6, SURYA, Early Composite, LM 14 and IIMRSBTPOOL recorded disease score of 6.0, 5.9, 6.5, 6.8, 6.3, 6.4, 5.9& 6.0 respectively and were found Moderately Susceptible (MS). Disease reaction indicating satisfactory level of disease development and the categorization of materials into different classes was appropriate (Table 1). These results are in confirmative with the Thakur *et al.,* (2018) who have reported such types of resistance in Maize inbred lines under Natural Epiphytotic conditions viz., in six inbred lines CML161, CML189, BAJIMQ-08-27, CML193, CML162 and CML171 were moderately resistant to BLSB. Among the 29 inbreeds of maize analyzed, only a single genotype CA00106, recorded moderate resistance to BLSB at all the three locations and the remaining were found highly susceptible (Anshu *et al.,* 2007). Out of 22 inbred lines, PFSR9-2 had shown resistant reaction whereas PFSR6-1, PFSR6-2 and PFSR18 were found to be moderately resistant to BLSB disease. In case of hybrids, DHM 117 is the only hybrid which had shown resistant reaction, DKC9145, DKC9133 and KMH3110 were found moderately resistant and the remaining have shown susceptible reaction based on disease rating scale 0-30-resistant; >30- 60-moderately resistant; >60-90-susceptible; and >90-100-highly susceptible. (Bindu Madavi *et al.,* 2018).

Weekly disease prevalence data of trap nursery of most susceptible lines are used in development of disease forecasting model. Mean Temperature of 25 – 30^0C coupled with an average relative humidity of 90 -100% is most suitable for development of BLSB disease in maize. Similarly rainfall over 100mm in the first two weeks favors severe infection and further disease development (Anshuman and Shahi, 2012). If the relative humidity goes below 70%, disease development and spread becomes very slow.

Additionally, high crop densities at pre flowering stage in 40-50 days old plants favor higher disease severity (Hooda *et al.,* 2015). In the present study (table 2) disease pressure was increased progressively from year to year in the same inbred lines due to favorable epidemiological conditions under natural conditions. The progressive development of disease with advancement of crop growth of highly susceptible lines BML 7 reveals that, the conditions for development of disease were highly congenial under such circumstances the reactions exhibited by the line CM 500 confirmed as a moderately resistant.

The trial is helpful for their deployment in breeding Programmme and as donors for different research Programmes and could be used to develop lines for banded leaf and sheath blight disease endemic areas to aim at sustainable productivity. And also alarm the farmers to give forecast and manage the disease based on epidemiological factors.

Table.1 Rating scale (1-9) for assessment of BLSB (*R. solani* f. sp. *sasakii*)

Rating scale	Degree of infection (Per cent DLA*)	PDI**	Disease reaction
1.0	Disease on one leaf sheath only; few small, non-coalescent lesions present (≤10%)	≤11.11	Resistant (R) (Score: ≤3.0) (DLA:< 30%) (PDI: ≤33.33)
2.0	Disease on two sheaths; lesions large and coalescent (10.1-20%).	22.22	
3.0	Disease up to four sheaths; lesions many and always coalescent (20.1-30%).	33.33	
4.0	As in disease rating symptoms of 3.0, + rind discolored with small lesions (30.1-40%).	44.44	Moderately Resistant (MR) (Score: 3.1–5.0) (DLA: 30.1-50%) (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 fibers (>80%).	99.99	

Table.2 BLSB disease severity in trap nursery

S. No.	Inbred	Time of observation DAS	Disease severity 1-9 scale		Terminal Disease severity	Reaction
			Kharif 2019	*Kharif* 2020		
1	CM 400	65	2.0	8.3		
		72	3.0	8.7		
		79	3.0	8.9	6.0	MS
		86	3.0	9.0		
		93	3.0	9.0		
2	CM 500	65	1.0	4.9		
		72	1.0	5.6		
		79	1.0	7.1	5.0	MR
		86	1.0	8.7		
		93	1.0	9.0		
3	CM 501	65	3.0	5.9		
		72	3.0	6.1		
		79	3.0	7.6	5.95	MS
		86	3.0	8.8		
		93	3.0	8.9		
4	CM 600	65	4.0	6.5		
		72	4.0	7.7		
		79	4.0	8.5	6.5	MS
		86	4.0	9.0		
		93	4.0	9.0		
5	BML 6	65	4.0	3.2		
		72	5.0	3.9		
		79	5.0	4.2	6.8	MS
		86	5.0	8.6		
		93	5.0	8.6		
6	BML 7	65	6.0	3.2		
		72	6.0	3.9		
		79	6.0	6.0	7.3	S
		86	6.0	8.5		
		93	6.0	8.6		
7	Surya	65	4.0	4.2		
		72	4.0	5.4		
		79	4.0	6.5	6.35	MS
		86	4.0	8.4		
		93	4.0	8.7		

8	Early Composite	65	3.0	3.9		
		72	3.0	5.0		
		79	3.0	6.4	6.45	MS
		86	4.0	8.8		
		93	4.0	8.9		
9	LM 14	65	3.0	5.3		
		72	3.0	7.2		
		79	3.0	7.5	5.9	MS
		86	3.0	8.7		
		93	3.0	8.8		
10	IIMR SBT POOL	65	2.0	8.6		
		72	2.0	8.9		
		79	3.0	9.0	6.0	MS
		86	3.0	9.0		
		93	3.0	9.0		

Table.3 Weather factors at the time of observation

Time of observation DAS	Period		Temperature (^{o}C)		Rainfall (mm)	Rainy days	Relative humidity	
	From	To	Min.	Max.			From	To
2019								
65	24-Sep	30-Sep	24.8	31.8	80.0	4	74.0	94.7
72	1-Oct	7-Oct	24.7	33.3	27.0	1	68.2	93.7
79	8-Oct	14-Oct	24.5	32.6	27.8	2	69.5	93.7
86	15-Oct	21-Oct	24.6	30.8	15.3	2	73.8	92.8
93	22-Oct	28-Oct	24.0	29.6	138.5	3	78.4	94.6
Mean			24.52	31.62	288.6	12	72.78	93.9
2020								
65	21-Sep	27-Sep	24.5	28.7	124.5	3	84.1	97.1
72	28-Sep	4-Oct	25.1	32.6	19.2	1	65.1	95.0
79	5-Oct	11-Oct	25.4	31.7	85.7	3	73.0	99.4
86	12-Oct	18-Oct	24.6	29.5	297.2	5	82.6	99.9
93	19-Oct	25-Oct	24.9	32.2	22.5	2	68.5	99.4
Mean			24.9	30.94	549.1	14	74.66	98.16

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