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SCREENING OF GENOTYPES FOR MULTIPLE DISEASE RESISTANCE IN MAIZE IN PEDDAPURAM, ANDHRA PRADESH, INDIA

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ABSTRACT

The Research included field screening of maize genotypes for Resistance to Banded Leaf and Sheath Blight (BLSB) caused by *Rhizoctonia solani* f.sp. *sasakii* (Kuhn) Exner and Maydis Leaf Blight (MLB) caused by *Bipolaris maydis*. The field screening experiment was done in a experimental plot maintained at All India Coordinated Research Project on Maize-ANGRAU-Agricultural Research Station, Peddapuram, Andhra Pradesh. Fifty genotypes were evaluated in the field, under Leaf inoculated conditions and replicated three times in a randomized complete block design (RCBD). First disease incidence was observed on 60 days after sowing (DAS). Among fifty genotypes tested against BLSB, according to disease rating scale (1-9), 23 genotypes had shown resistant reaction with disease scoring of ≤3.0, 21 genotypes had shown moderately resistant reaction and remaining 6 genotypes had shown moderately susceptible reaction. Out of these fifty genotypes tested against MLB, 43 genotypes were found resistant with disease scoring of ≤3.0 and remaining 7 genotypes had shown moderately resistant reaction.

Keywords: Screening, genotypes, disease score.

Introduction

Maize (*Zea mays* L.) is an important staple food crop and provides raw materials for the livestock and many agro-allied industries in the world (Bello *et al*., 2010). The area, production and productivity of maize has increased significantly in last few decades. India registered a growth rate of more than 7% in production and more than 6% in productivity in last 5 years. Maize production in India is 21.73 million tones with 8.55 million ha with productivity of 2.6 t/ha (Annual report, DMR, 2012-13). Approximately 65 pathogens including fungi, bacteria and viruses cause economically important diseases in maize with annual losses amounting to 9.4% (Singh and Gilbreath, 2002). Among fungal diseases, leaf blights, smuts and stalk rots cause significant damage (Rahman *et al*., 1986). Banded leaf and sheath blight (BLSB) caused by *Rhizoctonia solani* f.sp. *sasakii* (Kuhn) Exner is an important disease in South and South-East Asian countries. In India, the disease is prevalent during kharif season and favours temperature of 25-30^{o}C and relative humidity of 100% (Ahuja and Payak, 1981). It causes considerable amount (23.9 to 31.9% or more) of crop yield loss at favorable condition. Further, it is estimated that 1% of total grain yield of India is lost by the disease (Payak and Sharma, 1981). Maydis leaf blight (MLB) or Southern corn leaf blight (SCLB) caused by *Bipolars maydis*, also called *Drechslera maydis,* is a serious fungal disease of maize throughout the world, with characteristic angular tan lesions on leaves. The disease causes significant losses both in quality and quantity of the crop, resulting in the loss of chlorophylic area, small chaffy kernels if more leaf area is affected (Payak and Renfro, 1968). Due to lower nutritional value, the leaves are also not suitable for fodder (Harlapur, 2012). Perusal of literature indicates that considerable amount of work has been done on management of these diseases using chemicals, biological agents, modified cultural practices and host resistance (Sharma and Hembram, 1990; Ali and Shabeer, 1992; Sharma and Rai, 1999; Williams (2000); Sharma *et al*., 2003). Since the mechanical control through stripping of lower leaves is labour- intensive, and is also not cost and time effective and chemical control is expensive and less environment friendly, increasing emphasis is currently being laid on host- controlled resistance to BLSB and MLB. However, information on resistant material towards these diseases reported was scarce in the published literature. Hence, present investigation was undertaken to identify the sources of resistance against BLSB and MLB of maize.

Materials and Methods

Field experiment was performed at Agricultural Research Station, Peddapuram. The experiment was carried out in a randomized complete block design (RCBD) with three replications. Maize seeds were planted in a six rows of 4mts length. The seeds were spaced at 20 cm in 70 cm wide rows. Half dose of urea (at the rate of 150 kg ha^{-1}) and full dose of phosphatic fertilizer (at the rate of 75 kg ha^{-1}) were applied at the time of planting. Herbicides used were Atrazine (pre-planting) and an insecticide Emamectin Benzoate was applied at the rate of 80 gms acre^{-1} when the crop was at 5–6 leaf stage. Field experiment was carried out for screening of fifty maize genotypes against *R. solani* causing banded leaf and sheath blight and *Bipolaris maydis* causing Maydis leaf blight. Disease assessment of BLSB was

made at an interval of 10 days, after 65 days after sowing on the basis of 1 to 9 disease scoring scale of AICMIP (1983) and Muis and Quimio (2006) and MLB disease assessment was made at 35 days after sowing on the basis of 1-9 scale (BalintKurti *et al*., 2006; Chung *et al*., 2010 and Mitiku *et al*., 2014).

Method of inoculation

Inoculum is prepared by gathering, in the previous year, leaves heavily infected with Banded leaf and sheath blight and Maydis leaf blight. This should be done before leaves become fully mature, but not too green that spoilage would occur in storage. It is best to store leaves in large gunny bags in some dry room protected from moisture and rodents. Just before inoculation, the dry leaves are ground a meal of about the coarseness of wheat bran. This may be done in a mill, or, if not available, the leaves may be placed in tightly woven sacks and beaten with sticks of stamped on to break up the leaves. By sifting through a screen, fragments of the right size can be obtained. About 30 kg of such leaf meal is sufficient to inoculate twice 20,000 to 22,000 plants. This requires the collection of 25 to 30 bags of infected leaves in the previous season. Inoculation is done by placing a pinch of leaf meal (a heaped thimbleful) into the whorl of each plant when the latter are about 30-45 cm high. A second inoculation may be made five to ten days later. This method of inoculation will be ineffective if dry weather prevails following application of the leaf meal. To avoid this and to facilitate infection during dry weather, water (10-12 ml) can be applied in the whorls by means of an 8-10 litre sprayer. Second inoculation can be followed if the symptoms do not appear even after a week of first inoculation. If there is some rain or heavy dew soon after application of inoculum, the addition of water is not necessary. High humidity (>90%) was maintained throughout the disease development period by frequent irrigations. The disease severity was studied on 10 plants in the middle row of each plot for each entry according to 1–9 severity scale (Hooda *et al*., 2018).

Disease assessment

Disease scoring of BLSB and MLB was recorded by using 1 to 9 scale (Table 1 & Table 2) of Indian Institute of Maize Research, Ludhiana (Anonymous a, 2014) commenced from 45 days after planting and assessment of disease severity was continued on weekly basis for 6 weeks. The genotypes showing disease score between 1.0–3.0 were considered as resistant (R), 4-5 as moderately resistant (MR), 6-7 as moderately susceptible (MS) and 8-9 as susceptible (S).

Table 1 : Rating scale for assessment of BLSB (*R. solani* f. sp. *sasakii*) severity on maize plants

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 fibres (>80%).	99.99	

*DLA- Diseased leaf area; **Per cent disease index (PDI)

Table 2 : Rating scale for assessment of MLB (*Bipolaris maydis*) severity on maize plants

Rating scale	Degree of infection (Per cent DLA*)	PDI**	Disease reaction
1.0	Nil to very slight infection (≤10%).	≤11.11	Resistant (R) (Score: ≤ 3.0) (DLA:< 30%) (PDI: ≤ 33.33)0
2.0	Slight infection, a few lesions scattered on two lower leaves (10.1-20%).	22.22	
3.0	Light infection, moderate number of lesions scattered on four lower leaves (20.1-30%).	33.33	
4.0	Light infection, moderate number of lesions scattered on lower leaves, a few lesions scattered on middle leaves below the cob (30.1-40%).	44.44	Moderately resistant (MR) (Score: 3.1–5.0) (DLA: 30.1-50%) (PDI: 33.34-55.55)
5.0	Moderate infection, abundant number of lesions scattered on lower leaves, moderate number of lesions scattered on middle leaves below the cob (40.1-50%).	55.55	

6.0	Heavy infection, abundant number of lesions scattered on lower leaves, moderate infection on middle leaves and a few lesions on two leaves above the cob (50.1-60%).	66.66	Moderately susceptible (MS) (Score: 5.1-7.0) (DLA: 50.1-70%) (PDI: 55.56-77.77)
7.0	Heavy infection, abundant number of lesions scattered on lower and middle leaves and moderate number of lesions on two to four leaves above the cob (60.1-70%).	77.77	
8.0	Very heavy infection, lesions abundant scattered on lower and middle leaves and spreading up to the flag leaf (70.1-80%).	88.88	usceptible (S) (Score: >7.0) (DLA:>70%) (PDI: >77.77)
9.0	Very heavy infection, lesions abundant scattered on almost all the leaves, plant prematurely dried and killed (>80%).	99.99	

*DLA- Diseased leaf area; **Per cent disease index (PDI)

Results and Discussion

Reactions of Maize genotypes against *R. solani* f. sp. *sasakii* are presented in Table.3. Screening of fifty maize genotypes for resistance to BLSB disease, during kharif-2018, under leaf inoculated conditions, according to disease rating scale (1-9), revealed that out of fifty entries tested against BLSB, 23 entries (30015, 30030, 30024, 30011, 30007, 30010, 30006, 32005, 32025, 36048 etc. Refer Table No.3 for remaining lines.) were found resistant with disease scoring of ≤3.0, 21 entries (30027, 30034, 30032, 32032, 32040, 32063, 32039, 32054, 32059, 36045 etc. Refer Table No.3 for remaining lines) were found moderately resistant with disease scoring of 4.0-5.0 and 6 entries *viz*., 32007, 32024, 36049, 36019, 12406 and 13406 were found moderately susceptible to the disease with disease scoring of 6.0-7.0. No entry was found susceptible to BLSB.

Reactions of Maize genotypes against *Bipolaris maydis* are presented in Table.4. Out of fifty entries tested against MLB, during kharif-2018, under leaf inoculated conditions, according to disease rating scale (1-9), 43 entries (30015, 30030, 30024, 30011, 30007, 30010, 30027, 30034, 30032, 32005 etc. Refer Table No.3 for remaining lines) were found resistant with disease scoring of ≤3.0 and 7 entries *viz*., 30006, 12406, 12402, 12403, 11601, 11609 and 13410 were found moderately resistant with disease scoring of 4.0-5.0. No entries were showed moderately susceptible or susceptible reaction against MLB.

Anshu *et al*. (2007) analyzed 29 inbreds of maize and only one genotype CA00106, recorded moderate resistance to BLSB at all the three locations *i.e* at Udaipur (Rajasthan, Western India), Pantnagar (Uttarakhand, North-Eastern India), and New Delhi (North India) and the remaining were highly susceptible. The pooled data of three years (2003 - 2005) revealed that the genotypes, DRLT-180 IC324207, G-RS-7, RKU-193 IC309233 and MZ-80 IC339731 of National Bureau of Plant Genetic Resource Station, Shillong were resistant (with disease rating 10. to 2.0), while, RS-9 and RKU-113 IC309153 were susceptible (4.1 to 5.0) and the rest were intermediate (2.1 to 4.0) in disease reaction of BLSB (Subrata *et al*., 2007). Maize inbred lines, CA003134, CA00396 and CA00310 (CML 465) showing intermediate reaction were also found to have higher degree of tolerance against BLSB than other lines. It has also been found that inbred lines CA14510 (CML 428), CA14524 (CML 474) and Suwan 1 (S) C# f-f possessed high degree of tolerance to BLSB (Sharma *et al*., 2005). Five inbred lines of maize (15648, 15649, 15650, 15651 and 15653) and full season maturity genotypes, ganga-11, prabhat and x-1266 were found resistant to BLSB disease, under field conditions by Sharma *et al*. (2002). Remaining hundred entries showed moderate resistant, susceptible and highly susceptible reactions to the banded leaf and sheath blight disease of maize. Sharma *et al*. (2002) reported the presence of limited genetic variability for resistance to maize sheath blight disease in India. Azra and Hussain (2019) evaluated thirty-six maize genotypes against MLB under artificial epiphytotic conditions during kharif season 2015 and 2016 and found that 14 genotypes were moderately resistant, 14 genotypes were moderately susceptible and the remaining eight genotypes were grouped as highly susceptible. Kumar *et al*. (2018) screened 85 genotypes of maturity group NIVT-Late against MLB along with check and reported that no entry was found resistant to the disease, 7 entires were found as moderately resistant, 34 entries rated as moderately susceptible and 44 entries susceptible to the disease.

Conclusion

Screening of maize landraces leading to the identification of BLSB and MLB resistant sources that holds a great promise in resistance breeding in areas prone to BLSB and MLB. The determination of genetic basis of these sources and incorporation of their resistant genes into susceptible commercial cultivars is prerequisite in the development of high yielding BLSB and MLB resistant maize cultivars. 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 material resistant to BLSB and MLB but the success in achieving the absolute resistance seems to be of distant possibility. As of now, the genetic variability for resistance to BLSB and MLB has been found to be limited which is a bottleneck for an effective resistance breeding programme. However, the lines reported in this study as promising can be utilized as such or their resistance can be transferred into commercial varieties using cyclic breeding scheme to meet the challenges posed by BLSB and MLB. Entries identified as promising in this study need to be evaluated against more number of isolates at one location and also in multi-location trials to find out sources of stable resistance against most isolates prevalent in different areas.

Table 3 : Promising entries for BLSB (*R. solani* f. sp. *sasakii*) under leaf inoculated conditions, according to disease rating scale 1-9 given by Hooda *et al.*

S.No.	NIVT&AVT Groups	BLSB Score	Disease Reaction	S.No.	NIVT&AVT Groups	BLSB Score	Disease Reaction
1	30015	1.0	R	26	36043	2.0	R
2	30030	1.0	R	27	36007	2.0	R
3	30024	2.0	R	28	36021	1.0	R
4	30011	1.0	R	29	36012	1.0	R
5	30007	1.0	R	30	36059	1.0	R
6	30010	2.0	R	31	12407	5.0	MR
7	30027	5.0	MR	32	12406	6.0	MS
8	30034	5.0	MR	33	12401	5.0	MR
9	30032	4.0	MR	34	12402	5.0	MR
10	30006	3.0	R	35	12404	5.0	MR
11	32005	2.0	R	36	12403	3.0	R
12	32025	2.0	R	37	12405	5.0	MR
13	32032	5.0	MR	38	11603	3.0	R
14	32040	5.0	MR	39	11604	5.0	MR
15	32063	5.0	MR	40	11605	3.0	R
16	32039	5.0	MR	41	11601	4.0	MR
17	32054	5.0	MR	42	11607	5.0	MR
18	32059	5.0	MR	43	11610	5.0	MR
19	32007	6.0	MS	44	11602	2.0	R
20	32024	6.0	MS	45	11608	3.0	R
21	36045	5.0	MR	46	11609	3.0	R
22	36048	2.0	R	47	11606	3.0	R
23	36025	1.0	R	48	13404	5.0	MR
24	36049	6.0	MS	49	13410	4.0	MR
25	36019	6.0	MS	50	13406	6.0	MS

R-Resistant MR-Moderately Resistant MS-Moderately Susceptible S-Susceptible

Table 4 : Promising entries for MLB (*Bipolaris maydis*) disease under leaf inoculated conditions, according to disease rating scale 1-9 given by Hooda *et al.*

S. No.	NIVT&AVT Groups	MLB Score	Disease Reaction	S.No.	NIVT Group	MLB Score	Disease Reaction
1	30015	1.0	R	26	36043	1.0	R
2	30030	1.0	R	27	36007	2.0	R
3	30024	3.0	R	28	36021	1.0	R
4	30011	1.0	R	29	36012	1.0	R
5	30007	1.0	R	30	36059	1.0	R
6	30010	3.0	R	31	12407	3.0	R
7	30027	1.0	R	32	12406	4.0	MR
8	30034	1.0	R	33	12401	3.0	R
9	30032	3.0	R	34	12402	4.0	MR
10	30006	4.0	MR	35	12404	3.0	R
11	32005	2.0	R	36	12403	4.0	MR
12	32025	2.0	R	37	12405	3.0	R
13	32032	2.0	R	38	11603	1.0	R
14	32040	2.0	R	39	11604	2.0	R
15	32063	2.0	R	40	11605	2.0	R
16	32039	2.0	R	41	11601	4.0	MR
17	32054	2.0	R	42	11607	2.0	R
18	32059	2.0	R	43	11610	1.0	R
19	32007	2.0	R	44	11602	1.0	R
20	32024	2.0	R	45	11608	1.0	R
21	36045	1.0	R	46	11609	4.0	MR
22	36048	1.0	R	47	11606	3.0	R
23	36025	1.0	R	48	13404	2.0	R
24	36049	1.0	R	49	13410	4.0	MR
25	36019	1.0	R	50	13406	3.0	R

R-Resistant MR-Moderately Resistant MS-Moderately Susceptible S-Susceptible

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