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Research Article

Evaluation of Maize Inbred and Hybrids against Fusarium Stalk Rot Caused by *Fusarium verticillioides*

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ABSTRACT

Maize crop is being suffering from many biotic and abiotic stresses and among the biotic stresses diseases causes the major loss of the crop. Among the diseases Fusarium stalk rot caused by Fusarium verticillioides is one of the important disease has to be managed in order to reduce the yield losses. The main objective of this study is to find out the resistant sources of maize which can be used for resistant breeding programme. In our study 50 inbred lines and 50 hybrids were screened against F. verticillioides during Kharif 2018 at college of agriculture V C Farm Mandya. Out of 50 maize inbred lines only 5 lines were scored as resistant and 19 lines were moderately resistant. Out of 50 maize hybrids none of them were resistant and 10 hybrids were moderately resistance. The checks CM 202 (Resistant check) and 30-B07 (Susceptible check) showed resistant and susceptible reaction against F. verticillioides.

Keywords: *Maize, Fusarium stalk rot, Fusarium verticillioides, Inbred lines, Hybrids.*

INTRODUCTION

Maize has amazing properties like bulky (as fodder), nutritionally rich as compensating demand of other cereals deficit. Maize (*Zea mays* L.) is an important cereal crop belonging to the grass family, Poaceae and is a native to South America. It is the third most important cereal crop in India after Wheat and Rice. Maize is considered as the "Queen of cereals". Being a C4 plant, it is capable of utilizing solar radiation more efficiently even at higher radiation intensity and more stress tolerant than other crops (Anita, 2016).

Globally, India ranks 4th in area and 6th in production of Maize. In India, it is grown on 9.23 m ha with the production and productivity of 23.67 m tonnes and 2564 kg ha-1 respectively (Kokar, 2014). Karnataka state produces around 17 percent of the total maize production in the country.

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The average area under Maize cultivation in the State during 2009-10 was 1.2 million hectares with a production of 3.17 million tonnes. Haveri is the second major Maize producing district in Karnataka, accounting for 28 percent of the State's production. It is also grown in a major area of Davanagere, Shimoga and Chitradurga districts (Ravikumar, 2011).

Sustainable maize cultivation is continuously challenged by diseases that cause quantitative and qualitative losses in yield. Many fungal, viral and bacterial pathogens have been reported on maize apart from abiotic stresses. Based on the research efforts for the last few years under the aegis of All India Coordinated Maize Improvement Project, 16 out of 61 diseases found to be adversely affecting this crop and have been identified as major ones (Payak & Sharma, 1985).

Stalk rot is one of the most destructive maize diseases throughout the world. Stalk rot reduces yield directly by affecting the physiological activity of the plants and finally results in lodging, which is the main cause of economic losses. Different stress conditions such as drought, heavy cloudiness, high plant density, leaf diseases and corn borer attack favour stalk rot because of decreased photosynthesis (Dodd, 1979). The wide range of environments, pathogens and plants affects the occurrence and expression of stalk rot symptoms, making screening for resistance difficult.

Host plant resistance is considered as the most economic, eco-friendly and sustainable strategy for disease control, hence screening of germplasm through artificial inoculation technique against PFSR is helpful in finding out the source of resistance, which can be used in breeding programme. Cultivation of resistant varieties is the effective and feasible method to combat the disease as compared to chemical control. Hence, several available germplasm of potential under different maturity groups and specialty corn are required to be screened to identify resistant varieties. Though, scanty information is available on it but so far concerted investigations have not been done (Gopal, 2014).

To develop disease resistant varieties, screening of available genotypes against the pathogens was done under artificial epiphytotic condition and it yielded a set of stalk rot resistant germplasm in India (Shekhar et al, 2010), (Hooda, 2012) & abroad (Clark & Foley, 1985). In India, artificial epiphytotic condition for PFSR disease is created by inoculating the plants in the field just after flowering mainly by toothpick method of inoculation (Anonymous, 1983) & (Anonymous, 2012). But this method requires longer time for disease development and rotting symptoms in the inoculated stalks become prominent only at harvesting stage.

MATERIALS AND METHODS

During *Kharif* 2018, a total of 50 maize inbred lines and 50 maize hybrids were planted at College of Agriculture, V.C. Farm, Mandya, in single row replicated plot of 2m row length along with one susceptible check 30-B07 and one resistant check CM 202 with a spacing of 60 x 20 cm and replicated twice. Recommended agronomic practices were followed to establish good crop stand.50 maize inbred lines received from CIMMYT Mexico and 50 hybrid maize lines collected from ZARS Mandya were used for screening.

Collection of diseased samples and Pathogen isolation

The Maize stalks which are showing typical Fusarium stalk rot symptoms were collected from Fusarium stalk rot screening plot at Zonal Agricultural Research Station (ZARS), V.C. Farm, Mandya. The pathogen *Fusarium verticillioides* was isolated by standard tissue isolation technique.

The fungus was isolated following standard tissue isolation technique, as mentioned below. In the symptom showing stem, the discolored stem bits taken and surface sterilized by using 5% Sodium hypo chlorite for 30 seconds, followed by 70% of ethanol for 30 seconds and washed thoroughly thrice in sterile distilled water to remove the

traces of treated chemical, if any. Then these surface sterilized bits were aseptically transferred to each Petri dish, containing potato dextrose agar (PDA). The Petri dishes were incubated at room temperature (25±1°C) for a week and observed periodically for fungal growth. The growth of the fungus was conspicuous, after 24 hours of incubation. The pure colonies which developed from the bits were transferred to PDA slants and incubated at room temperature.

Maintenance of the culture

The cultures of the fungus were sub-cultured on potato dextrose agar slants and kept in laboratory at 28±1° C for 15 days. Such mother culture slants were preserved at 5°C in refrigerator. Further, these cultures were sub-cultured once in a month and used for future studies.

Mass multiplication of the pathogen and inoculum preparation

The mass multiplication of the pathogen *F. verticillioides* was done by broth culturing on 0.2% YESB (Yeast Extract Sucrose Broth). In a round bottom flask of 2 liter capacity 1 liter of distilled water was taken and added with 20g of sucrose and 2g of Yeast Extract and the flask was autoclaved at 121^0C temperature and 15 K pa pressure for 20 minutes. After cooling in aseptic conditions the media was inoculated with one week old pure culture of *F. verticillioides* and kept at room temperature for 10 days.

The 10 days old broth taken the mycelial mat was ground by using grinder and checked for spore load by using Haemocytometer. The minimum spore load of about 2×10^6 was adjusted by diluting the grinded product with distill water. This culture was used for stem inoculation to the maize plants.

Artificial inoculation by Syringe method

The inoculum suspension containing 2×10^6 conidia/ml of *F. verticillioides* was injected diagonally using a syringe after pricking and making a hole of 2.0 cm with the help of the jabber in the second internode of 45-50 days old maize plants above the soil level and after 25-35 days of inoculation, each inoculated stalk was observed for the Fusarium stalk rot symptom and disease scoring was done following 1-9 disease rating scale (Anita, 2016).

Disease scoring

Disease severity was recorded based on percentage discoloration of the maize stem by destructive sampling (stem splitting) method and scoring by 1-9 scale (Anita, 2016). The genotypes were grouped as Highly resistant (1-2), Resistant (2-3), Moderately resistant (3-4), Moderately susceptible (4-5), Susceptible (5-6) and highly susceptible (6-9) as in table1.

RESULTS AND DISCUSSION

Spore suspension of Mandya isolate was able to produce Fusarium stalk rot symptoms in maize lines. Out of 50 maize inbred lines none of the maize inbred showed highly resistant reaction, 5 inbred lines showed resistant reaction *viz.*, C298, SNL153296, VL1010764, VL05616 and VL1O36 with a mean disease score of 2.7, 19 maize inbred lines showed moderately resistant reaction with a mean disease score of 3.52, 14 maize inbred lines recorded a moderately susceptible reaction with a mean disease score of 4.45, 4 maize inbred lines recorded susceptible reaction with a mean disease score of 5.5 and 8 maize inbred lines showed highly susceptible reaction with a mean disease score of 6.85 (Table 2). Small et al. (2012) also reported 5 maize inbred lines showed resistance to Fusarium stalk rot *viz.*, CML 390, CML 444, CML 182, VO617Y-2 and RO549W and 19 expressed moderately resistant reaction. Two lines *viz.*, CM 202 and MAI 766 were moderately resistant to Fusarium stalk rot (Archana, 2017).

Out of 50 maize hybrids none of the maize hybrids showed highly resistant and resistant reaction, 10 hybrids *viz*., VH152961, VH151797, 33554×104, VH152573, VH152809, VH152809,MAH 14-5, MAH 14-733, 267×40421, 10×729 and 40310×305 showed moderately resistant reaction with a mean disease score of 3.96, 13 hybrids recorded a moderately susceptible reaction with a mean disease score of 4.56, 15 hybrids recorded susceptible reaction with a mean

disease score of 5.56 and 12 hybrids showed highly susceptible reaction with a mean disease score of 6.64 (Figure 1). 30-B07 recorded a susceptible reaction (5.7) while CM202 recorded a moderately resistant reaction with disease score of 3.6. Anita[1] identified 6 moderately resistant maize hybrids viz., MPC-1-15, FSCH 55, ADVSW-1, Madhuri-C, ABH9001 and HKH 425. Out of 135, none of the genotypes showed resistant, 34 genotypes expressed moderately resistant reaction, 73 showed moderately susceptible reaction and 29 genotypes exhibited susceptibility reaction to TLB disease (Mallikarjuna, 2018).

Since, the Fusarium stalk rot appears during post flowering stage and causing high yield loss, use of resistant varieties is the best management strategy which is feasible and economical to reduce the yield loss. Hence, the inbreds screened for *Kharif* season and found resistant against Fusarium stalk rot, can be used as breeding material for the development of resistant maize cultivar. The maize hybrids found resistant could be validated and used for cultivation.

Table 1: Rating scale for maize Fusarium stalk rot disease

Rating scale	Degree of infection	Disease reaction
1	No discoloration or discoloration only at the point of inoculation	Highly resistant
2	<25% of the inoculated internode discolored	Resistant
3	25 to <50 % of the inoculated internode discoloured	Moderately resistant
4	50 to <100 % of the inoculated internode discolored	Moderately Susceptible
5	25% of adjacent internode discolored	Susceptible
6	½ discoloration of the adjacent internode	Highly susceptible
7	Discoloration of three internodes	Highly susceptible
8	Discoloration of four internodes	Highly susceptible
9	Discolorations of five internodes or plants prematurely killed	Highly susceptible

Table 2: Reaction of maize inbred lines and hybrids for Fusarium stalk rot

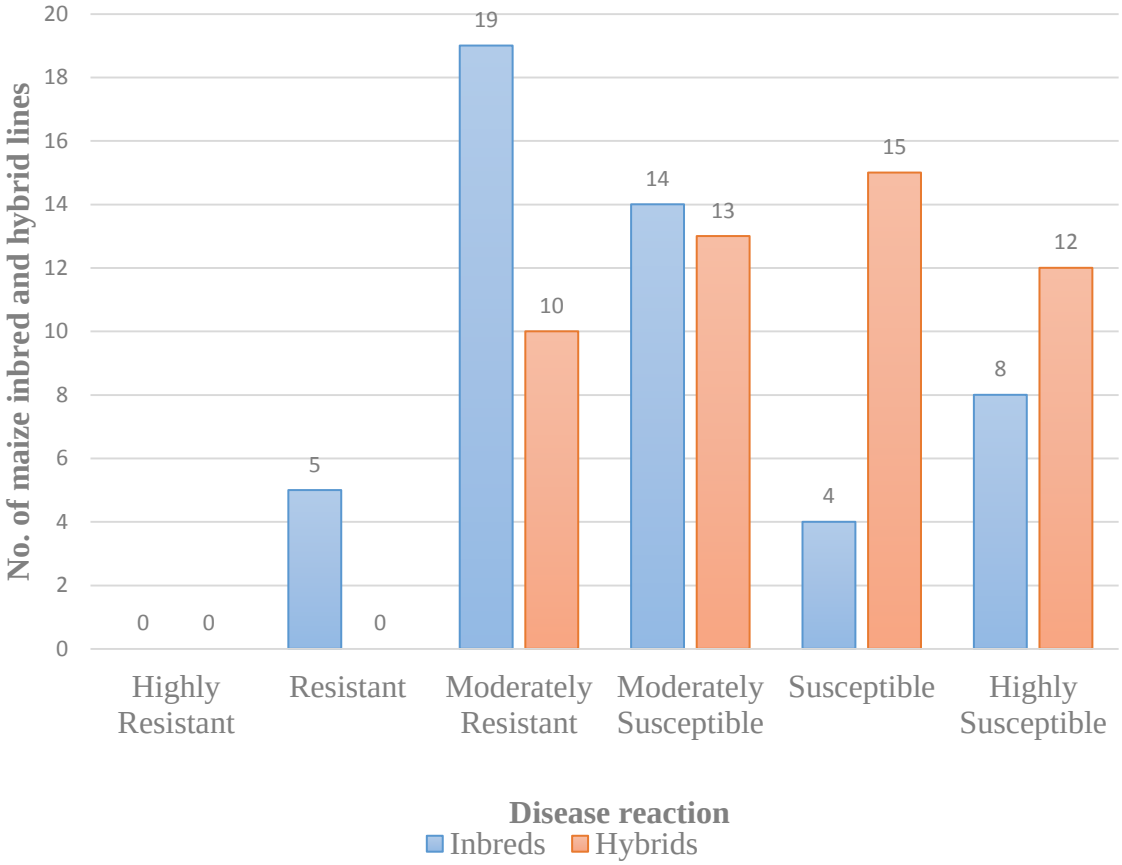
Sl. No	Inbred lines	DS(1- 9 scale) mean	DR **	Hybrids	DS(1- 9 scale) mean	DR **
1	SNL142663	4.5	MS	VH171300	7.15	HS
2	CM504	3	MR	40058×276	5	S
3	VL1217	3	MR	1298×729	5.5	S
4	C298	2.675	R	VH151137	4.1	MS
5	CML151	4	MS	33118×264	4.6	MS
6	VL1012903	3.6	MR	VH151806	6.1	HS
7	VL1033	3.3	MR	VH152961	3.8	MR
8	VL057982	4.875	MS	VH16919	5.5	S
9	CML538	6.5	HS	VH15775	6.1	HS
10	VL1242	3.6	MR	VH16937	4	MS
11	SNL153296	2.6	R	VH151797	3.9	MR
12	VL1010764	2.65	R	33554×104	3.55	MR
13	VL05616	2.9	R	AH113948	5.2	S
14	VL1244	4.7	MS	VH151051	6.83	HS
15	VL1053	3.41	MR	KH15425	5.875	S

16	VL107730	4.9	MS	VH1691	7.5	HS
17	VL1043	3.7	MR	215×264	4.375	MS
18	VL1050	3.5	MR	KH151966	4.9	MS
19	VL109480	3.2	MR	VH152573	3.5	MR
20	VL1018807	3.9	MR	VH152760	5.5	S
21	VL1018419	3.7	MR	VH16939	6.1	HS
22	VL1018640	4	MS	VH112651	5.5	S
23	VL1051611	5.7	S	VH152809	3.625	MR
24	VL1219	5.5	S	VH153028	4.8	MS
25	VL058727	4.1	MS	VH152661	6.3	HS
26	VL105611	6.1	HS	MAH 14-5	3.5	MR
27	VL0511321	4.1	MS	MAH 14-733	3.8	MR
28	VL1047	5.2	S	267×40421	3.8	MR
29	VL1017256	6.4	HS	10×729	3.8	MR
30	VL1249	4.3	MS	40013×105	7	HS
31	VL1O36	2.7	R	31188×264	5.7	S
32	VL1055	3.7	MR	33554×729	5.6	S
33	VL058454	6.5	HS	40058×40421	3.5	HS
34	VL108880	4.6	MS	33118×40421	4.9	MS
35	VL109293	7	HS	7×40421	6.4	HS
36	VL0512388	7.9	HS	338×276	4.9	MS
37	VL0512423	3.7	MR	40013×105	5.9	S
38	VL1012756	5.6	S	215×40421	6.1	HS
39	VL1016173	3.6	MR	261×105	4.8	MS
40	VL1030	6.2	HS	33554×264	5.1	S
41	VL1031	4.9	MS	729×40421	5.8	S
42	VL109452	3.5	MR	215×729	4.8	MS
43	VL123	4.3	MS	13×264	5.9	S
44	VL109287	3.8	MR	1298×40422	5.9	S
45	VL1223	8.2	HS	31188×729	7.1	HS
46	VL108496	4.5	MS	224×105	4.5	MS
47	VL1018393	4.7	MS	40013×264	4.2	MS
48	VL108750	3.7	MR	1298×276	5.5	S
49	VL1012849	3.6	MR	40310×305	3.7	MR
50	VL108849	3.5	MR	729×264	7.125	HS
SEm±	0.155402			0.256011		
CD@5%	0.312292			0.514473		
CV	4.998974			6.999366		

Mean of two replications. 5 plant/ replication

DS- Disease Score, DR- Disease Reaction, R- Resistance, MR- Moderately Resistance, MS- Moderately Susceptible, S- Susceptible, HS-Highly Susceptible.

Fig 1: The disease reaction of the maize inbred lines and hybrids screened artificially against Fusarium stalk rot



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