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Field screening of maize (*Zea mays* L.) landraces for resistance against turcicum leaf blight (TLB) under temperate conditions

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Abstract
Maize is the leading cereal worldwide with wide adaptability and higher productivity potential. It has notable productive potential among the cereals and is the third most important grain crop after wheat and rice. Turcicum leaf blight (TLB) affects the maize crop from the seedling stage to maturity. The present study involved field evaluation of seventy maize landraces for resistance against TLB disease under artificially inoculated field conditions in an augmented design using 3 checks at Mountain Crop Research Station, Larnoo during *kharif*, 2017. Among seventy landraces, forty-three lines were categorised as resistant, eighteen moderately resistant, five moderately susceptible and landrace Tral 3 recorded highest percent disease index (PDI) as 78.91 per cent and rated as susceptible. Thus the genotypes identified to possess low disease severity score against TLB would be helpful for their deployment in future breeding programs and eventually could be used in developing promising genotypes having desirable level of resistance in disease endemic areas to aim for sustainable productivity.

Keywords: maize, landrace, turcicum leaf blight, screening, resistance

Introduction
Maize (*Zea mays L.*, 2n=20) is the leading cereal worldwide, originated in Central America and Mexico but because of its wide adaptability and higher productivity potential, it is grown over a wide range of environments around the world. It belongs to the tribe *Maydeae*, of the grass family, *Poaceae.* Maize with a notable productive potential among the cereals, is the third most important grain crop after wheat and rice. At global level maize is cultivated over an area of 177.4 million hectares with an annual production of about 960.2 million tonnes and average productivity of 5.5 tonnes ha^{-1} (Anonymous, 2013-14) [2]. Due to existing biotic and abiotic stresses, the sustainability of the maize production to meet the future demand remains to be debatable. Among the biotic stresses affecting maize, TLB also called Northern corn leaf blight caused by *Exserohilum turcicum* (syn. *Heliminthosporium turcicum* Pass.) is of worldwide importance. Maize grain yield loss varies from 25 to 90 per cent in different parts of India depending upon the severity of Turcicum Leaf Blight epiphytotics (Chenula and Hora, 1962; Jha, 1993) [10]. Yield losses have approached 50%, when the disease is severe at 2-3 weeks after pollination (Shurtleff, 1980) [15]. Turcicum leaf blight is considered a serious disease under mountain agro ecologies of Jammu and Kashmir.

Turcicum leaf blight affects the maize crop from the seedling stage to maturity. The symptoms first appear as grayish green small elliptical spots on the leaves with water soaked lesions parallel to leaf margins, finally attaining a spindle shape with long elliptical grayish or tan lesions. If the disease starts at an early stage, it causes premature death of blighted leaves. As a result, the crop loses their nutritive value as fodder, have reduced germination capacity, vigor, grain yield and total sugar content (Payak and Renfro, 1968, Ferguson *et al*., 2004) [13, 8], has restricted starch formation, chaffy kernels and infected plants are liable to infection with stalk rots (Cuq *et al*., 1993) [7]. The fungus has a wide host range and a high pathogenic variability with several races already reported in different parts of the world (Pratt R.G., 2003; Agrios, 2005) [14, 1].

Genetic resistance of crop plants against pathogen is economical and eco-friendly disease management strategy. The resistant varieties are not only environmental friendly but also suitable to adopt at farmer's level. Since new races of pathogens will be emerging

continuously and some available resistant sources may become susceptible; there is a need to identify new sources of resistance through artificial epiphytotics to cater to the resistance breeding programmes. Keeping in view the above points, the present study was carried out to screen the seventy maize landraces for identification of resistant sources against Turcicum leaf blight disease under artificially inoculated field conditions, which would be further useful in improvement of maize populations through population improvement programmes.

Material and Methods

Collection of diseased samples and Pathogen isolation

The diseased leaf samples of affected maize plants showing typical symptoms of Turcicum leaf blight having necrotic lesions were collected in paper poly bags from different maize growing areas of Kashmir valley during survey in *Kharif* season of 2016-17 and stored for isolation of pathogen. The pathogen *Exserohilum turcicum* was isolated from infected leaves using single spore isolation technique (Tuite, 1969). Total eight single spore cultures of *E. turcicum* isolated from diseased samples of different locations representing different maize cultivars and local land races were maintained on potato dextrose agar slants.

Layout of Maize Trial for field screening

For the identification of source of resistance to *E. turcicum*, a set of 70 maize landraces were evaluated in an augmented design along with 3 checks KG-2 for high altitude (susceptible check), SM- C4 (moderately susceptible) for low altitude and SM-C7 (resistant) for mid altitude areas under field conditions at Mountain Crop Research Station, Larnoo, a hot spot of Turcicum leaf blight in Kashmir during *kharif* season 2017 (Ahangar, M.A. *et al.*, 2016) [4], using 1 to 9 disease rating scale (Anonymous a, 2014) [3]. The test genotypes were planted in 2 row plots of 3m length with plant spacing of 60×20 cm.

Inoculum preparation and inoculation

Spore suspension of the *E. Turcicum* from each isolate of 20 days old cultures was prepared by washing the conidia with distilled water. The spore concentration was measured by haemocytometer and maintained at 3×10^5 spore ml^{-1}. Equal volume of spore suspension of 8 isolates was mixed and sprayed in evening by using atomizer at three to four leaf stage of maize plants on and humidity was maintained by spraying water. Control plants were treated similarly with distilled water in which spore suspension was made (Ahangar, M.A. *et al.*, 2016) [4].

Disease assessment

Disease reaction was recorded by using 1 to 9 scale (Table 1) of Indian Institute of Maize Research, Ludhiana (Anonymous a, 2014) [3] 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), 8-9 as susceptible (S).

Table 1: Disease Scale

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) (PDI: ≤ 33.33)
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) (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	Mod. susceptible (MS) (Score: 5.1-7.0) (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	Susceptible (S) (Score: >7.0) (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; **Percent disease index (PDI)

Results and Discussion

The Turcicum leaf blight disease of maize was widespread in all the surveyed areas of Kashmir province. Eight single spore cultures of *E. turcicum* isolates of diverse locations were maintained on potato dextrose agar medium. The isolates were designated as ET-1 to ET-8. Among seventy landraces along with resistant, moderately resistant and susceptible checks on the basis of disease reaction and 1-9 disease scale, the performance of all the maize genotypes were classified into four groups (Table 2, Figure 1). Three lines with a disease score 1, twenty-one lines with a score 2 and nineteen lines with a score 3 were categorised as resistant (Figure2), showed per cent disease intensity (PDI) ranged from 8.1 per cent for Shopian-11 to 32.1 per cent for Pulwama-3 for resistant lines. Seventeen landraces with disease score 4 and one line with score 5 indicated moderate resistance and shows PDI between 33.5 per cent for Shopian-3 to 45.7 per cent for Tral-K. Five landraces with disease score of 6 were rated moderately susceptible as their PDI ranged from 56.8 per cent for Pulwama-7 to 65.3 per cent for Kupwara-6. Landrace Tral 3 recorded PDI as 78.91 per cent was severely affected by TLB and rated as susceptible (Figure 2).

Babita and Mani (2011) [5] screened the temperate maize lines against northern corn leaf blight and found five inbreds resistant to disease. Singh *et al.*, (2014) [16] evaluated 118 maize genotypes to identify, the new sources of resistance to TLB under artificial epiphytotic conditions and identified 26 resistant, 56 moderately resistant, 26 susceptible and 10 highly susceptible maize genotypes. Ishfaq *et al.*, (2014) [9] carried out a disease reaction studies against turcicum leaf blight were done with two crosses viz., 15C (A) x I-318 (R) and I-401(A) x I-318(R) for all six generations with P_1, P_2, F_1,

F_2, BC_1 and BC_2 and results revealed significant variability has been exhibited by fungus to infect different generations of a particular cross. In I-15C (A) x I-318(R) cross, F_1 was moderately resistant to turcicum leaf blight but F1 of I-401(A) x I-318(R) cross was moderately susceptible to the disease. Mitiku *et al.*, (2014) [9] results revealed that the variety BH660 was highly resistant with the incidence of 13.7% and a grain yield of 3.7kg/plot while as the variety BH543 was susceptible with the incidence of 52.3% and grain yield of 3.4kg/plot. Mir *et al.*, (2015) [11] confirmed that among 10 inbred lines evaluated, three were found moderately resistant, five lines moderately susceptible and the rest two, were severely affected by TLB and rated as susceptible. In the present study among 26 maize genotypes which were initially screened for resistance. Ahanger etal in 2016 confirmed that against *E. turcicum* under field conditions, 8 genotypes were found resistant when screened against twelve isolates of *E. turcicum* under artificial epiphytotic conditions, eight genotypes were found moderately resistant with disease grade ranged from 2.1-2.5.

Conclusion

Screening of maize landraces leading to the identification of TLB resistant sources that holds a great promise in resistance breeding in areas prone to TLB. 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 TLB resistant maize cultivars.

Table 2: Reaction of maize genotypes to *E. Turcicum* under artificially inoculated field conditions

S. No	Entry	% Disease intensity	Score	Response
1	Tral-4	23.3	3	R
2	Kishtawar-1	30.1	3	R
3	Pulwama-3	32.1	3	R
4	Pulwama-8	15.9	2	R
5	Shopin-6	34.2	4	MR
6	Shopian-II-3	28.4	3	R
7	Pulwama-2	31.3	3	R
8	Kishtawar-4	24.2	3	R
9	Tral-5	40.0	4	MR
10	Srinagar-1	11.5	2	R
11	Shopian-3	33.5	4	MR
12	Sidar kapran	23.8	3	R
13	Tral-2	9.3	1	R
14	Hail kapran	33.5	4	MR
15	Kupwara-13	57.4	6	MS
16	Poonch-1	58.2	6	MS
17	Kishtawar-9	13.0	2	R
18	Kulgam-7	24.4	3	R
19	Kishtawar-3	36.9	4	MR
20	Shopian-II-6	27.6	3	R
21	New kishtawar	17.7	2	R
22	Pulwama-5	38.8	4	MR
23	Kupwara-10	10.2	1	R
24	Kishtawar-2	20.5	2	R
25	Tral-6	14.1	2	R
26	Pulwama-6	16.6	2	R
27	Shopian-5	18.2	2	R
28	Kulgam-11	13.0	2	R
29	Kupwara-3	34.7	4	MR
30	Kupwara-15	59.3	6	MS
31	Kishtawar-7	41.2	4	MR
32	Kupwara-5	14.4	2	R
33	Kulgam-3	29.0	3	R
34	Shopian-II-4	21.8	2	R
35	Tral K	45.7	5	MR
36	Pulwama-10	25.3	3	R
37	Kulgam-10	12.2	2	R
38	Srinagar-2	24.8	3	R
39	Shopian-11	8.2	1	R
40	Shopian-8	-	-	-
41	Kulgam-9	23.1	3	R
42	Pulwama-7	-	-	-
43	Pulwama-1	30.5	3	R
44	Kulgam-6	27.3	3	R
45	Tral-7	19.6	2	R
46	Shopian-9	13.1	2	R
47	Kupwara-1	28.6	3	R
48	Tral-1	12.7	2	R
49	Tral-9	43.0	4	MR
50	Pulwama-4	60.65	6	MS

51	Kupwara-6	65.23	6	MS
52	Kupwara-12	39.6	4	MR
53	Pulwama-11	25.3	3	R
54	Kulgam-2	37.1	4	MR
55	Shopian-2	-	-	-
56	Shopian-10	28.0	3	R
57	Kupwara-2	21.4	2	R
58	Pulwama-9	19.7	2	R
59	Kulgam-4	38.0	4	MR
60	Shopian-1	40.2	4	MR
61	Tral-3	78.91	8	S
62	Kulgam-5	39.7	4	MR
63	Shopian-4	13.9	2	R
64	Kishtawar-8	16.7	2	R
65	Tral-8	34.6	4	MR
l66	Shopian-7	20.4	2	R
67	Kupwara-2	36.2	4	MR
68	Kupwara-14	19.4	2	R
69	Shopian-II-1	25.0	3	R
70	Kishtawar-6	37.0	4	MR
1-9 scale was used:- 1,2,3= Resistant (R), Score: ≤ 3.0, PDI: ≤ 33.33; 4,5= Moderately resistant (MR), Score: 3.1–5.0, PDI: 33.34-55.55; 6,7=Moderately susceptible (MS), Score: 5.1-7.0, PDI: 55.56-77.77; 8,9=Susceptible (S); Score: >7.0, PDI: >77.77.				

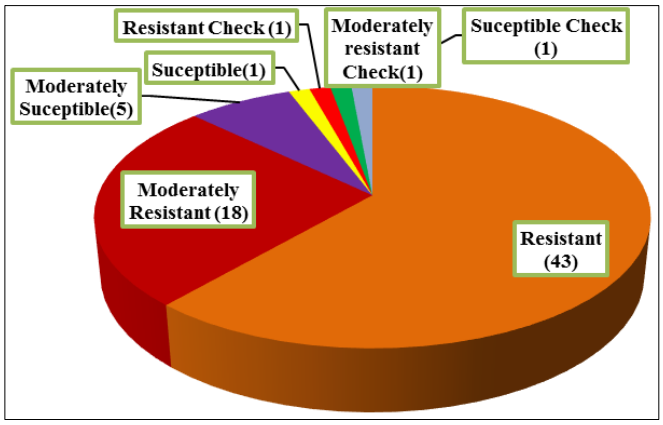

Fig 1: Number of resistant, moderately resistant, moderately susceptible and susceptible lines

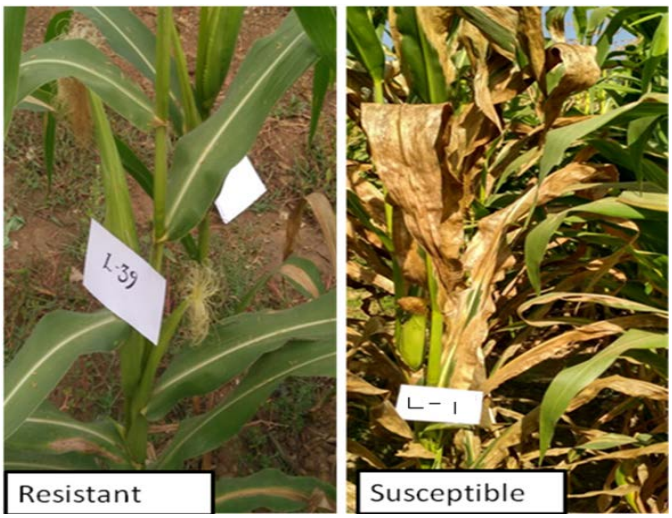

Fig 2: Symptoms on resistant and susceptible lines

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