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Evaluation of maize genotypes for Turcicum leaf blight (*Exserohilum turcicum*) in Terai and inner terai of Nepal

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ABSTRACT

Thirty maize genotypes in 2014-2015 at Dumarwana, Nijgadh, Keureni and Rampur and ten genotypes in 2015-2016 at Anandpur, Shitalnagar, Dumarwana, Nijgadh and Rampur were evaluated for resistance to Turcicum leaf blight (*Exserohilum turcicum*) under farmers field conditions. The scale used for disease severity ranged from 1-5 scale based on the proportionate leaf area affected by the disease. The combined analysis over locations in 2014-2015 showed that among the 30 genotypes 25 genotypes were resistant (1.0-2.0 scale), and 5 genotypes were moderately resistant (2.1-3.0 scale). Similarly the pooled analysis over locations in 2015-2016 showed that 7 genotypes were resistant (1.0-2.0 scale) and 3 genotypes were moderately resistant (2.1-3.0 scale). The maize genotypes namely Z376-26, Z478-3, Z433-99, Z464-5, Z478-2, Z466-1, CAH1513, RML-95/RML-96, CAH1515, CAH1521, CAH1515, CAH151, CAH153, ZH114228 , Z376-9, Z466-3, Z376-5, RML-32/RML-17, RML-86/RML-96 and 900MGold were resistant with disease severity scale of 1.5 and with higher grain yield in both the years. Thus above genotypes were identified as promising sources of resistance against *E. turcicum* and they can be used to develop disease resistant and high yielding varieties to enhance maize productivity in terai and inner terai of Nepal.

Key words: resistant, susceptible, genotypes, severity

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INTRODUCTION

Maize (*Zea mays* L.) is the second most important staple food crop in Nepal in terms of both area and production after rice. It is the principle food crop in the hills of Nepal. Both abiotic and biotic stresses contribute to lower maize yields in Nepal. The most devastating diseases of

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maize in the context of Nepal are leaf blights (northern and southern), ear rot, stalk rot, rust, downy mildews, etc. (Khadka & Shah, 1967; Shah, 1968; Thapa, 1977; Manandhar, 1983; Batsa et al., 1989; Paudel et al., 1989). Among the major global issues, food and nutrition security, especially in developing and under developed countries are the biggest challenges of the present agricultural scenario (Ulrich, 2011). For the livestock maize serves as important fodder crop, for human staple food crop and for many agro-allied industries as source of raw materials in the world (Bello et al., 2010; Randjelovic et al., 2011). Turcicum Leaf blight (TLB) of maize caused by *Exserohilum turcicum* (Pass.) K.J. Leonard and E.G. Suggs (teleomorph *Setosphaeria turcica* Luttrell) was first observed by Passerini on corn in Italy in 1876, and has been reported from all maize growing areas of the world wherever maize is cultivated (Atac. 1984; Leonard et al., 1985). The pathogen was formerly known as *Helminthosporium turcicum* (Khedekar et al., 2010; Muiru et al., 2007). Khadka and Shah (1967) reported this disease for the first time in Nepal. TLB, also known as Northern corn leaf blight (NCLB), is more prevalent in the hills during summer and winter to early spring in Terai and Inner terai. The disease occurs in maize from the seedling to maturity stages. The epidemic of the disease is increasing every year in all maize growing areas because of intensive maize cultivation where three maize crops are harvested each year from the same land. TLB reported in 1966 for the first time in Nepal (DAER, 1966) and was not considered as the major disease of maize crop 1985. Temperatures between 20 and 25 ^{0}C, relative humidity from 90 to 100%, and low luminosity favor the disease development (Bentolila et al., 1991). In mid-altitude regions where there is high humidity, low temperature and cloudy weather TLB can be severe during the maize growing season (Singh et al., 2004; Harlapur, 2005). Although many maize genotypes have been released from breeding programmes, their reactions to the turcicum leaf blight are largely unknown. This experiment was carried out in order to identify the reaction of maize genotypes to turcicum leaf blight pathogen under field conditions.

MATERIALS AND METHODS

Experimental site

The followings locations were selected for the experiments. The geographical details of these sites are as below;

Table 1. Geographic description of experimental locations

Location	Longitude	Latitude	Elevation (m)
Dumarwana (Bara)	85° 1' 8.5"E	27° 7' 55.7"N	124
Nijgadh (Bara)	85° 10' 32.5"E	27° 12' 11.8"N	169
Keureni (Nawalparasi)	84°12'31.44" E	27°40'22.77" N	178
Shitalnagar (Nawalparasi)	84° 23' 21.1"E	27° 41' 42.5"N	193
Anandpur (Chitwan)	84° 23' 13.7"E	27° 40' 12.1" N	194
Rampur (Chitwan)	84° 20' 20.9"E	27° 39' 0.3"N	182

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Field experiments

All field experiments were conducted during winter seasons in 2014-2015 and 2015-2016 using randomized complete block design (RCBD) with 2 replications at 6 locations of 3 districts namely; Bara (Dumarwana and Nijgadh), Chitwan (Rampur and Anandpur) and Nawalparasi (Keureni and Shitalnagar). The row to row and plant to plant spacing were 60 cm and 25 cm respectively. The plot area was 24 m^2 in 2014-2015 and 30 m^2 in 2015-2016. The fertilizer used was 200:60:40 kg NPK ha^{-1} for all experiments. The recommended package of practices was followed during crop growth according to recommendations given by National Maize Research Program (NMRP), Rampur, Chitwan. Disease severity was measured using scale of 1–5 rating as per CIMMYT protocol (CIMMYT, 1985; Singh et al. 2004).

Data collection and analysis

Each maize genotype was screened using standard 1-5 scale. According to Payak and Sharma, (1982), 1 scale for complete resistant and 5 for the complete susceptible. Based on this rating scale, the maize lines were categorized into four groups namely, resistant (R) genotypes with a score < 2.0; moderately resistant (MR) 2.1-3.0; moderately susceptible (MS) 3.1-3.5 and highly susceptible (S) > 3.5. Grain yields were adjusted to 80% shelling recovery. Grain yield was estimated using formula adopted by Carangal et al. (1971) and Shrestha et al. (2015) by adjusting the grain moisture at 15% and converted to the grain yield kg per hectare. Data were analyzed through GENSTAT packages applying 5% significance level.

RESULTS AND DISCUSSION

Results from individual locations (Table 2) in 2014-2015 showed that at Dumarwana genotypes Z376-9, Z466-3, Z376-5 were resistant with disease severity scale of 1.5 and with grain yield of >10.5 t ha^{-1}. Similarly at Nijgadh RML-32/RML-17, Z376-26 and Z478-3 were resistant with 1.5 disease severity scale and >9 t ha^{-1}grain yield. Likewise at Kuereni Z433-99 and Z464-5 showed resistant reaction having disease severity scale of 1.5 and with grain yield >11 t ha^{-1}. At Rampur genotypes Z478-2, Z466-1 and 900MGold were resistant (with 1.5 disease severity scale) and grain yield of >8.5 t ha^{-1}.

Table 2. Response of maize genotypes for turcicum leaf blight and grain yield (t ha^{-1}) in 2014-2015 winter

SN	Genotypes	Dumarwana		Nijgadh		Keureni		Rampur		Combined	
		TLB. (1-5)	GY	TLB. (1-5)	GY	TLB (1-5)	GY	TLB (1-5)	GY	TLB (1-5)	GY
1	Z478-2	1.5	10.65	1.5	8.98	1.5	8.02	1.5	9	1.5	9.2
2	Z478-3	1.5	9.49	1.5	9.38	1.5	10.06	1.5	8.64	1.5	9.4
3	Z478-5	1.5	9.99	1.5	8.74	1.5	8.87	1.5	8.12	1.5	8.9
4	Z478-4	2	9.57	2	9.86	1.5	10.09	2	7.74	1.9	9.3
5	Z478-8	1.5	9.92	3	6.65	1.5	8.01	2	5.95	2	7.6
6	Z480-1	2	11.37	3	7.41	2.5	4.09	2.5	5.71	2.5	7.1
7	Z478-9	2.5	6	3.5	10.59	2.5	5.13	1.5	5.17	2.5	6.7
8	Z480-2	1.5	6.81	4.5	6.47	2	6.91	2.5	5.32	2.6	6.4

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9	Z478-10	2.5	7.13	4.5	6.32	1.5	8.41	2	5.51	2.6	6.8
10	Z433-11	1.5	10.44	1.5	6.76	1	12.29	1.5	2.89	1.4	8.1
11	Z433-99	1.5	10.27	2.5	5.77	1.5	11.42	1.5	6.27	1.8	8.4
12	Z464-5	1.5	8.81	2	6.07	1.5	11.27	1.5	6.24	1.6	8.1
13	Z376-30	1.5	8.41	2	3.67	1.5	9.68	1.5	5.38	1.6	6.8
14	Z466-4	1.5	7.95	3	7.64	1.5	6.24	1.5	6.34	1.9	7
15	Z466-3	1.5	11.21	2	6.83	1.5	9.03	1.5	7.11	1.6	8.5
16	Z466-1	1.5	10.61	3.5	7.39	1.5	7.73	1.5	8.91	2	8.7
17	Z376-2	1.5	9.86	2.5	6.36	1.5	9.38	1.5	7.97	1.8	8.4
18	Z376-5	1.5	10.62	2.5	7.84	1.5	5.41	1.5	7.25	1.8	7.8
19	Z376-6	1.5	10.07	1.5	7.96	2	7.63	1.5	8.56	1.6	8.6
20	Z376-8	1.5	10.16	1.5	7.33	1.5	9.04	1.5	7.55	1.5	8.5
21	Z376-9	1.5	11.38	1.5	7.9	1.5	8.79	2	7.92	1.6	9
22	Z376-26	1	10.11	1.5	9.47	1.5	8.5	1.5	8.54	1.4	9.2
23	Z376-34	1.5	8.45	2.5	9.67	1.5	7.1	1.5	8.45	1.8	8.4
24	Z376-51	1.5	8.25	1.5	8.72	1.5	10.47	1.5	7.05	1.5	8.6
25	900M Gold	1.5	9.35	2	7.69	1.5	7.71	1.5	8.79	1.6	8.4
26	30V92	2.5	8.57	2	10.42	3	9.09	4.5	4.95	3	8.3
27	RML-32/RML-17	2	10.64	1.5	11.37	2	7.65	2.5	8.27	2	9.5
28	RML-95/RML-96	1.5	11.15	2	11.04	1.5	9.04	2	7.46	1.8	9.7
29	RML-86/RML-96	1.5	9.74	2.5	7.63	1.5	10.94	2	7.43	1.9	8.9
30	Rampur Hybrid-2	1.5	10.71	1.5	8.74	2	9.17	2.5	6.32	1.9	8.7
	Mean	1.6	9.59	2.3	8.02	1.7	8.57	1.8	7.03	1.9	8.3
	F-test									**	ns
	CV%									27	18.9
	$LSD_{0.05}$									0.7	2.2

GY: Grain yield

In 2015-2016 (Table 3) at Nijgadh genotypes CAH1513 and CAH1515 were resistant with disease severity scale of 1.5 and with grain yield of >7 t ha^{-1}. Similarly at Dumarwana RML-95/RML-96, CAH1515 and CAH1521 were resistant with 1.5 disease severity scale and >7 t ha^{-1}grain yield. Likewise at Shitalnagar CAH1521, CAH1515, CAH151 and CAH153 showed resistant reaction having disease severity scale of 1.5 and with grain yield >11 t ha^{-1}. At Rampur genotypes ZH114228 and CAH153 were resistant (with 1.5 disease severity scale) and grain yield of >5 t $ha^{-1}$and at Anandapur genotypes CAH1515, ZH114228 and RML-86/RML-96 were resistant with grain yield of > 8 t ha^{-1}.

The maize germplasm with resistance to *E. turcicum* was previously reported (Muriithi and Mutinda, 2001; Pandurangegowda *et al*., 2002; Dharanendraswamy, 2003; Harlapur, 2005). Maize susceptibility, cropping practices, and weather conditions strongly influence disease development. The quantitative and qualitative mechanisms control maize resistance to TLB (Hooker, 1981; Ogliari *et a*l., 2007). Quantitative resistance is described by low lesion number, small lesion area having typical necrotic lesion types, along with reduced severity and area under disease progress curve (AUDPC) values; whereas the qualitative resistance is characterized by small lesions surrounded by chlorotic halo also referred to as Ht (*Helminthosporium turcicum*)-lesions type. The results of these experiments showed that resistance reactions for TLB varied with locations and these findings were similar to findings obtained by Welz and Geiger (2000) who reported differential expression of resistance by some varieties when tested at different

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places. The variation in reactions with different climatic conditions was due to environmental factors such as temperature and light that can modify resistance based on Ht genes and also disease pressure varies in different areas.

Table 3. Response of maize genotypes for turcicum leaf blight and grain yield (t ha^{-1}) during winter season of 2015-2016.

SN	Genotypes	Nijgadh		Dumarwana		Shitalnagar		Rampur		Anandapur		Combined	
		TLB (1-5)	GY	TLB (1-5)	GY	TLB (1-5)	GY	TLB (1-5)	GY	TLB (1-5)	GY	TLB (1-5)	GY
1	CAH158	1	4.6	1.5	6.5	2	11.7	2.5	4.8	2	7.6	1.8	7.03
2	CAH1521	2	2.9	1.5	7.1	1.5	12.3	2	4.3	1.5	11	1.7	7.51
3	CAH1513	1.5	8.4	2	7.5	2	11.3	3.5	2	2	9.5	2.2	7.74
4	CAH1515	1.5	7	1.5	7.5	1.5	12.8	2	3.5	1.5	9.4	1.6	8.02
5	CAH151	2	6.8	2	7.1	1.5	11.1	1	3.9	1	8	1.5	7.39
6	CAH153	2.5	7.7	2	8.1	1.5	11.9	1.5	6.4	1.5	7	1.8	8.22
7	ZH114228	3	8.5	1.5	6.2	2	13.4	1.5	5.6	1.5	9	1.9	8.56
8	CAH1511	2.5	8	2	8.1	2.5	12.1	2	5.1	1.5	6.8	2.1	8.02
9	RML-95/RML-96	3	5.1	1.5	7.7	2	9.5	2	3.5	2	8.7	2.1	6.88
10	RML-86/RML-96	2.5	5.5	2	7.4	1.5	9.1	1.5	3.5	1.5	9.7	1.8	7.04
	Mean	2.15	6.45	1.75	7.32	1.8	11.52	1.95	4.26	1.6	8.67	1.9	7.64
	F-test											*	*
	CV%											26.3	17.9
	$LSD_{0.05}$											0.6	1.76

GY: Grain yield

Table 4. Pooled reaction (over locations) to TLB of maize genotypes in 2014-2015 and 2015-2016

2014/15				2015/16	
Genotypes	Reaction	Genotypes	Reaction	Genotypes	Reaction
Z478-2	R	Z466-1	R	CAH158	R
Z478-3	R	Z376-2	R	CAH1521	R
Z478-5	R	Z376-5	R	CAH1513	MR
Z478-4	R	Z376-6	R	CAH1515	R
Z478-8	R	Z376-8	R	CAH151	R
Z480-1	MR	Z376-9	R	CAH153	R
Z478-9	MR	Z376-26	R	ZH114228	R
Z480-2	MR	Z376-34	R	CAH1511	MR
Z478-10	MR	Z376-51	R	RML-95/RML-96	MR
Z433-11	R	900M Gold	R	RML-86/RML-96	R
Z433-99	R	30V92	MR		
Z464-5	R	RML-32/RML-17	R		
Z376-30	R	RML-95/RML-96	R		

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Z466-4	R	RML-86/RML-96	R
Z466-3	R	Rampur Hybrid-2	R

The combined analysis over locations in 2014/15 showed that among the 30 genotypes 25 genotypes were resistant (1-2.0 scale), and 5 genotypes were moderately resistant (2.1-3.0 scale). Similarly the pooled analysis over locations in 2015/16 showed that 7 genotypes were resistant (1-2.0 scale) and 3 genotype was moderately resistant (2.1-3.0 scale) (Table 4).

CONCLUSION

The maize genotypes namely Z376-26, Z478-3, Z433-99, Z464-5, Z478-2, Z466-1, CAH1513, RML-95/RML-96, CAH1515, CAH1521, CAH1515, CAH151, CAH153, ZH114228 , Z376-9, Z466-3, Z376-5, RML-32/RML-17, RML-86/RML-96 and 900MGold were resistant with higher grain yield. Therefore they can be used in breeding program as potential sources of resistance and can be grown to enhance maize productivity in terai and inner terai of Nepal.

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