Middle East Journal of Agriculture Research
Volume: 13 | Issue: 01| Jan. – Mar.| 2024

EISSN: 2706-7955 ISSN: 2077-4605
DOI: 10.36632/mejar/2024.13.1.3
Journal homepage: www.curresweb.com
Pages: 93-101

Screening the Resistance Reaction of Normal Maize Inbred Lines to Turciccum Leaf Blight and Grey Leaf Spot Diseases Resistance at Bako, Western Oromia

Debela Diro[1], Midekssa Dida[2] and Temesgen Deressa[1]

[1]Ethiopian Institute of Agricultural Research, Bako Agricultural Research Centre, P.O. Box 3, Bako, Ethiopia.
[2]Ethiopian Institute of Agricultural Research, Ambo Agricultural Research Centre, P.O. Box 37, Ambo, Ethiopia.

Received: 02 Jan. 2024 **Accepted:** 20 Jan. 2024 **Published:** 25 Jan. 2024

ABSTRACT

The most destructive foliar diseases that affect maize in the western region of Ethiopia are turcicum leaf blight and grey leaf spot. Bako National Maize Research Center conducted a study during the 2018/19 main cropping season with the objective of screening normal maize genotypes against turcicum leaf blight and grey leaf spot, which are caused by Exserohilum turcicum (Pass.) Leonard and Suggs and Cercospora zeae maydis, respectively. Two replications of the field experiment were set up in an alpha lattice design. Artificial inoculations of turcicum leaf blight and grey leaf spot were made twice at four to six leaf stages of genotypes by putting dry, ground-infected maize leaves into the whorls of younger maize plants in order to ensure the development of infection. At intervals of seven days from the time the disease first appeared until the maize reached physiological maturity, the disease severity (1–5) on 66 test entries was evaluated. During the season, all of the inbred lines exhibited symptoms of their respective diseases; nevertheless, there was a significant difference ($P<0.05$) in the intensity of the diseases among the lines. This study revealed that 20, 15, 20 and 11 inbred lines, were found resistant, moderately resistant, susceptible and highly susceptible, respectively to TLB disease. Likewise, 22, 10, 11 and 23 inbred lines, were found resistant, moderately resistant, susceptible and highly susceptible, respectively to GLS disease. The result implied that the genotypes identified to be resistant to GLS and TLB might be used in further breeding programs.

Keywords: Diseases, Genotypes, Grey leaf spot, Inbred lines, Resistant, Turciccum leaf blight

1. Introduction

Maize is one of the most important and widely grown crops in the world. While it is a key source of feed and industrial products in high-income countries, it also offers food, feed, and nutritional security in sub-Saharan Africa (SSA), Asia, and Latin America, which are the world's poorest regions. This crop provides at least 30% of the total calories that people consume, with intake ranging from 52 to 450 g/person/day. It accounts for 40% of the cereal production in Sub-Saharan Africa (SSA), where more than 80% is consumed as food (Prasanna *et al.,* 2021). The intake of maize per person per day in Latin America ranges from 50 to 267 g (Poole *et al.,* 2020). According to Abate *et al.* (2015), it is a significant cereal crop in many parts of the world, including Ethiopia. The most important cereal crop in the world after rice and wheat is maize, which is grown widely in Ethiopia's lowland to highland agro-ecologies (Gebre *et al.,* 2019). Its overall yearly production and productivity in the 2020 cropping season was 10.02 million tons and 4.24 t ha-1, respectively (FAOSTAT, 2021). Ethiopia's average yield of 4.179 t/ha is still less than the global average of 5.78 t/ha, despite the fact that maize is an essential commodity for food security (FAO, 2020).

Abiotic and biotic issues, improper management techniques, inadequate use of cultivars resistant or tolerant to biotic and abiotic stresses, and climate change are all major contributors to maize's low

Corresponding Author: Debela Diro, Ethiopian Institute of Agricultural Research, Bako Agricultural Research Centre, P.O. Box 3, Bako, Ethiopia. E-mail: - debeladiro@gmail.com yielding (Abate *et al.,* 2015). According to Berger *et al.* (2014) and Masuka *et al.* (2017), foliar diseases of maize are the primary cause of the global decline in maize productivity. Similarly, in Ethiopia's warm and humid growing zones, foliar diseases are the most significant danger to maize yields, according to Tewabech *et al.,* (2001). Turcicum leaf blight (TLB) and grey leaf spot (GLS), which are caused by Excerohillum turcicum and Cercospora zeae maydis, respectively, are the two most economically significant foliar diseases that threaten the yield of maize (Tewabech *et al.,* 2012; Keno *et al.,* 2018). Those diseases are the two most detrimental diseases that cause significant yield losses in Ethiopia's midaltitude sub-humid agro-ecology during the maize cropping season. This is because the diseases are favored by favorable environmental factors like relatively higher humidity, moderate to high temperature, and/or warm conditions. GLS has developed fast to areas where it was previously unknown due to the deployment of susceptible genotypes in highly favorable conditions in tropical regions that have little conservation tillage (Derera *et al.,* 2008). The quickly occurring endemicization of GLS was likely accelerated by the simultaneous production of several crops of maize in the same area in a single year, along with the widespread application of stover (dry stalks) as mulch for adjacent crops (like bananas) in the complex agro-ecosystems characteristic of sub-Saharan Africa (Gordon *et al.,* 2006; Worku *et al.,* 2012; Bekeko *et al.,* 2018). Turcicum leaf blight can induce leaf necrosis and premature foliage mortality if it infects a plant during its early stages of development. This lowers the crop's grain yield (Raymundo and Hooker, 981). Conversely, grey leaf spot indicates necrotic lesions that typically have a long duration. Individual lesions may coalesce to cause leaf senescence, which significantly reduces photosynthetic areas and results in poor grain filling (Derera *et al.,* 2008). Wegary *et al.* (2004) indicated that yield loss in Ethiopia was approximately 37%, whereas Ward *et al.* (1997) estimated that yield loss in South Africa was 60%. Similarly, in susceptible cultivars, TLB generated the maximum mean grain yield loss of 50% and thousand kernel weight loss of 16.4%, according to Assefa and Tilahun (1992). Cultural practices, chemical treatments, and host plant resistance are some of the management strategies for TLB and GLS infections (Pratt *et al.,* 2003). Chemical fungicide use is ineffective because of its high cost and environmental unpredictability. Using host plant resistance is the most economical and successful way to manage these diseases to increase genetic resistance to various foliar diseases, it is therefore desirable to find resistant inbred lines from a range of sources in the maize pre-breeding program. Despite early efforts to find maize germplasm resistant to these diseases and use it for a breeding program, further research should be conducted to find alternative sources of maize germplasm that can be screened under artificial inoculation in order to get new and stable resistance. So, the objective of the study was to evaluate locally created and adapted maize inbred lines and identify those that are resistant or tolerant to GLS and/or TLB for application in a breeding program.

2. Materials and Methods

2.1. Description of the study area

The experiments were conducted at Bako national maize research center (BNMRC) of maize disease nursery field during main season of 2018/19. Bako is located at 370 E, 090 060 N and receives the annual rain fall of about 1237 mm and situated at an altitude of 1650 m above sea level, which represent mid altitude subhumid agro-ecology zone of Ethiopia. It has minimum and maximum average temperature of 15.60C and 30.70C, respectively. Both experiments were conducted in the field under artificial epiphytotic conditions for evaluation against TLB and GLS.

2.2. Description of experimental materials and design

A total of sixty-six inbred lines of normal maize were employed, with two replications, arranged in a 6x11 alpha lattice design. Each inbred line was planted in a plot consisting of two rows of 3.6m long spaced at 25 and 75cm between plants within and between rows, respectively. CML-197 and SC-22, two inbred lines of maize, were employed as susceptible checks for TLB and GLS, respectively. All recommended agronomic management practices were implemented for the area.

2.3. Inoculum preparation and inoculation

One year before to trial, an inoculum of E. turcicum and C. zeae maydis had been produced by obtaining samples from extensively infected maize fields exhibiting characteristic symptoms of TLB and GLS, respectively. The infected leaves were allowed to dry in the shade, then they were crushed or ground into a texture similar to wheat bran and kept in paper bags at 4°C until the inoculation date. According to Dagne (2008), the ground leaves were then sprinkled into the plant whorls by placing a pinch of leaf mill into each whorl when the plant reaches stages 4–6 in moist environments, allowing the plant to hold onto the leaves long enough for spore germination. To make sure sufficient infection, a second inoculation took place ten days following the first.

2.4. Assessment of disease reaction

TLB and GLS were visually assessed in the field two weeks after artificial inoculation on a plot basis from the two rows. Date of first disease appearance, disease incidence, disease severity, and grain yield (t/ha) data were scored. Data collected included the progress of severity of foliar diseases on each inbred lines were quantified at seven days intervals starting from onset of disease until senescence. Disease incidence was measured as percent of infected plants per total plant per plot. Disease severity was rated based on 1-5 scoring scale (CIMMYT, 1985); where 1=no disease symptoms, 2=moderate lesion below the leaf subtending the ear,3=heavy infestation on and below the leaf subtending the ear with few lesions above it, 4=severe lesion on all but the uppermost leaves which may have a few lesions, 5=all leaves dead. The categorization on each disease reactions was made on the basis of disease severity ratings using a 1-5 scale (Roane *et al.,* 1974) with some modifications, where;1.0–2.0=Resistant (R); 2.1-2.5=Moderately Resistant (MR); 2.6 -3.0= Susceptible (S), and >3.0 Highly susceptible (HS).

2.5. Statistical data analysis

SAS version 9.2 (SAS Institute, 2004) PROC GLM was used to analyze the data. Applying the LSD-test at the 5% significance level, mean separation was carried out to compare treatment means.

3. Results and Discussion

Sixty-six maize inbred lines have been tested to determine their resistance to GLS and TLB. As can be shown in Tables 1 and 2, respectively, the mean disease severity and yield data showed significant ($P < 0.001$) variation for TLB and GLS resistance among the inbred lines. For TLB, the range of disease severity was 1.6 to 4.1, and for GLS, it was 1.3 to 4.5. Inbred lines with mean severity values of < 2 were categorized under resistant/tolerant to TLB and GLS. Whereas, inbred lines with mean severity values ranging from 2.1-2.5 considered as moderately resistant, 2.6-3.0 as susceptible and those with severity value > 3 were considered as highly susceptible to TLB and GLS diseases (Tables 1 and 2).

Table 1: Mean TLB severity, reaction categories and yield of 66 inbred lines evaluated under artificial inoculation during 2018 main cropping season at Bako.

S/N	Pedigree	Severity (scale1-5)	Reaction to TLB	Yield t ha^{-1}
1	TZMI719-#-#	2.3	MR	1.18
2	30G 19F2-43-1-1-1-1-1-1-#	1.8	R	0.86
3	SZSYNA99F2-3-6-3-1-#-#	2.3	MR	0.71
4	GIBE-1-178-2-1-2-1-#-#	2.9	S	0.23
5	(CML205/CML208//CML202)-X-2-1-2-B-B-B-#	2.9	S	3.02
6	[CML312/CML442//[CML390/CML206]-BB-2-4-BBB]-1-B-3-1-1-BBB-#-#-#	1.7	R	3.13
7	DE-38-Z-126-3-2-2-2-2-#	2.6	S	1.69
8	[[CML388/CML391]-BB-5-2/CML390]-2-1-2-1-1-BBB-#-#-#	2.5	MR	0.89
9	30H83-7-1-5-1-1-1-1-#	2.0	R	1.93
10	[CML312/CML445//[TUXPSEQ]C1F2/P49-SR] F2-45-3-2-1-BBB]-1-2-1-1-2-B*4-#-#	2.6	S	3.38
11	[CML444/DRB-F2-60-1-1-1-BBB//[LZ956441/LZ966205]-B-3-4-4-B-5-B*7-#-#-#	2.0	R	1.22
12	CKL05019-#	4.1	HS	3.53
13	SZSYNA99F2-133-2-1-1-1-#-#	1.7	R	1.89
14	TZMI741-#-#-#	2.9	S	0.95

15	CML197-#	4.1	HS	3.27
16	143-5-I-#	1.9	R	1.96
17	TZMI733 -#-#	3.0	S	2.07
18	TZMI750-#-#-#	2.1	MR	0.98
19	30H83-7-3-4-1-1-1-#-#	2.8	S	2.95
20	BH-660F2-31-1-1-2-1-1-1-1-#	2.8	S	0.60
21	30H83-7-1-2-1-1-1-#-#	2.5	MR	2.54
22	POOL9A-128-5-1-1-1-2-1-#	1.8	R	0.66
23	SZSYNA 99-F2-3-6-2-1-1-1-1-#	1.7	R	1.16
24	CIMCALI8843/S9243-BB-#-B-5-1-BB-2-3-4-B-#-#-#	1.7	R	1.76
25	ZM-605-C2F2-428-3-B-B-B-B-B-B-B/F7215)-2-2-2-2-1-1-#	1.8	R	1.37
26	CML-197 x 142-1-e(F2) 86-1-1-1-1-1-#	3.2	HS	3.52
27	DE-38-Z-126-3-2-2-2-1-1-#	2.9	S	1.39
28	139-5- j-#	2.2	MR	0.21
29	DE-147-Z-126-72-1-1-2-2-2-1-#	1.6	R	0.72
30	Gibe-1-54-3-6-1-2-1-#-#	1.9	R	0.86
31	CIMCALI8843/S9243-B-B-#-B-5-1-B-B-2-3-1-B-#-#-#	1.9	R	0.70
32	TZMI759-#-#-#	2.2	MR	1.30
33	TZMI407-short-#-#-#	1.8	R	0.93
34	POOL 9A-4-4-1-1-1-#-#	2.3	MR	1.16
35	[DTPWC8F31-4-2-1-6-B2/CML395//[CML445/ZM621B]-2-1-2-3-1-BB]-3-2-1-1-1-2-B*4-#	1.7	R	2.28
36	TZMI740 -#-#	1.8	R	1.68
37	30G 19F2-54-1-1-1-#-#	2.0	R	0.97
38	SC-715-154-1-1-#	2.1	MR	3.30
39	TZMI751-#-#-#	3.1	HS	1.05
40	Kulenic1-0080-4-2-4-1-2-#-#	1.9	R	1.24
41	MAS[MSR/312]-117-2-2-1-B*9-#-#-#	2.6	S	3.52
42	FH625-272-1-1-1-#-#	2.5	MR	0.89
43	(DRBF2-60-1-2)-B-1-B-B-B/F7215)-1-1-3-#	3.2	HS	3.03
44	POO'E 4-2-2-1-2-1-#	3.9	HS	2.16
45	(DRBF260-1-2)-B-1-B-B-B-#	2.9	S	2.87
46	GIBE-1-20-2-1-2-1-1-#-#	2.5	MR	2.34
47	SZSYNA99F2-3-6-4-1-1-1-1-#-#	2.0	R	0.52
48	35B-190-O-S-10-2-1-2-2-#	2.4	MR	1.68
49	GIBE1-265-5-4-1-1-1-#-#	1.9	R	1.31
50	KULENI 320-2-3-1-1-2-1-1-#-#	2.7	S	2.73
51	TZMI742-#-#-#	3.6	HS	1.85
52	TZMI754-#-#-#	3.1	HS	1.58
53	35B-190-O-S-10-2-1-1-1-#-#	3.1	HS	1.96
54	35B-190-O-S10-9-1-1-#-#	2.3	MR	1.57
55	ILOO'E 1-9-1-1-2-1-2-#	2.8	S	1.83
56	SC-22-430(63)-#	2.5	MR	1.58
57	TZMI746 -#-#	2.8	S	2.79
58	GIBE-1-158-1-1-1-1-#-#	2.6	S	1.34
59	30H83-56-1-1-3-1-1-#-#	2.2	MR	3.19
60	TZMI747-#-#-#	2.6	S	0.56
61	[LZ956441/LZ9662O5]-B-3-4-4-B-5-B*7-#-#-#	3.5	HS	1.28
62	SC 22	0.18	HS	0.18
63	FH625-272-1-2-1-#-#	2.6	S	1.97
64	SC-715-13-2-1-#	1.8	S	0.74
65	30V53F2-20-2-1-3-3-1-1-#	2.2	S	0.96
66	[INTB-F2-90-2-1-1-BBB/CML395]-B-1-1-1-1-B-B-#	2.4	S	1.97
LSD(0.05)		1.4		1.31
CV (%)		27.9		33.9

1.0–2.0=Resistant (R); 2.1-2.5=Moderately Resistant (MR); 2.6 -3.0= Susceptible (S), and >3.0=Highly susceptible (HS)

Table 2: Mean GLS severity, reaction categories and yield of 66 inbred lines evaluated under artificial inoculation during 2018 main cropping season at Bako.

S/N	Pedigree	Severity (scale1-5)	Reaction to GLS	Yield t ha^{-1}
1	TZMI719-#-#	1.5	R	1.03
2	30G 19F2-43-1-1-1-1-1-1-#	1.5	R	1.06
3	SZSYNA99F2-3-6-3-1-#-#	2	R	0.68
4	GIBE-1-178-2-1-2-1-#-#	3.3	HS	0.15
5	(CML205/CML208//CML202)-X-2-1-2-B-B-B-#	1.5	R	0.86
6	[CML312/CML442//[CML390/CML206]-BB-2-4-BBB]-1-B-3-1-1-BBB-#-#-#	1.5	R	1.47
7	DE-38-Z-126-3-2-2-2-2-#	1.5	R	1.19
8	[[CML388/CML391]-BB-5-2/CML390]-2-1-2-1-1-BBB-#-#-#	2.8	S	0.65
9	30H83-7-1-5-1-1-1-1-#	3.5	HS	1.44
10	[CML312/CML445//[TUXPSEQ]C1F2/P49-SR] F2-45-3-2-1-BBB]-1-2-1-1-2-B*4-#-#	1.8	R	4.2
11	[CML444/DRB-F2-60-1-1-1-BBB//[LZ956441/LZ966205]-B-3-4-4-B-5-B*7-#-#-#	2	R	1.27
12	CKL05019-#	3.5	HS	2.04
13	SZSYNA99F2-133-2-1-1-1-#-#	2.3	MR	1.91
14	TZMI741-#-#-#	2	R	1.09
15	CML197-#	4.3	HS	3.31
16	143-5-I-#	3.3	HS	2.14
17	TZMI733 -#-#	1.8	R	0.89
18	TZMI750-#-#-#	1.5	R	0.53
19	30H83-7-3-4-1-1-1-#-#	1.5	R	5.32
20	BH-660F2-31-1-1-2-1-1-1-1-#	2.8	S	0.31
21	30H83-7-1-2-1-1-1-#-#	1.5	R	3.18
22	POOL9A-128-5-1-1-1-2-1-#	3	S	0.61
23	SZSYNA 99-F2-3-6-2-1-1-1-1-#	3.5	HS	0.77
24	CIMCALI8843/S9243-BB-#-B-5-1-BB-2-3-4-B-#-#-#	2.5	MR	0.67
25	ZM-605-C2F2-428-3-B-B-B-B-B-B-B/F7215)-2-2-2-2-1-1-#	2.3	MR	1.96
26	CML-197 x 142-1-e(F2) 86-1-1-1-1-1-#	1.5	R	1.51
27	DE-38-Z-126-3-2-2-2-1-1-#	2.8	S	1.06
28	139-5- j-#	1.5	R	0.34
29	DE-147-Z-126-72-1-1-2-2-2-1-#	1.8	R	0.99
30	Gibe-1-54-3-6-1-2-1-#-#	4	HS	0.9
31	CIMCALI8843/S9243-B-B-#-B-5-1-B-B-2-3-1-B-#-#-#	2.3	MR	0.8
32	TZMI759-#-#-#	1.8	R	1.18
33	TZMI407-short-#-#-#	2	R	1.1
34	POOL 9A-4-4-1-1-1-#-#	2.8	S	1.29
35	[DTPWC8F31-4-2-1-6-B2/CML395//[CML445/ZM621B]-2-1-2-3-1-BB]-3-2-1-1-1-2-B*4-#	1.8	R	1.94
36	TZMI740 -#-#	1.5	R	1.41
37	30G 19F2-54-1-1-1-#-#	2.5	MR	1.47
38	SC-715-154-1-1-#	2.8	S	1.76
39	TZMI751-#-#-#	3.5	HS	0.54
40	Kulenic1-0080-4-2-4-1-2-#-#	3.5	HS	1.21
41	MAS[MSR/312]-117-2-2-1-B*9-#-#-#	3.8	HS	4.02
42	FH625-272-1-1-1-#-#	3.8	HS	0.6
43	(DRBF2-60-1-2)-B-1-B-B-B/F7215)-1-1-3-#	2.5	MR	3.35
44	POO'E 4-2-2-1-2-1-#	3.8	HS	1.61
45	(DRBF260-1-2)-B-1-B-B-B-#	4.5	HS	2.89
46	GIBE-1-20-2-1-2-1-1-#-#	3.8	HS	1.7
47	SZSYNA99F2-3-6-4-1-1-1-1-#-#	2.8	S	0.46
48	35B-190-O-S-10-2-1-2-2-#	3.5	HS	1.28
49	GIBE1-265-5-4-1-1-1-#-#	3	S	0.96
50	KULENI 320-2-3-1-1-2-1-1-#-#	3.3	HS	2.87

51	TZMI742-#-#-#	3.8	HS	1.13
52	TZMI754-#-#-#	3.5	HS	0.43
53	35B-190-O-S-10-2-1-1-1-#-#	4.5	HS	2.46
54	35B-190-O-S10-9-1-1-#-#	2.3	MR	1.63
55	ILOO'E 1-9-1-1-2-1-2-#	2.3	MR	1.44
56	SC-22-430(63)-#	3.5	HS	1.05
57	TZMI746 -#-#	1.3	R	2.82
58	GIBE-1-158-1-1-1-1-#-#	2.3	MR	1.75
59	30H83-56-1-1-3-1-1-#-#	4.3	HS	7.76
60	TZMI747-#-#-#	3.3	HS	0.61
61	[LZ956441/LZ9662O5]-B-3-4-4-B-5-B*7-#-#-#	2.8	S	1.32
62	SC 22	3	S	0.38
63	FH625-272-1-2-1-#-#	4	HS	1.04
64	SC-715-13-2-1-#	2.5	MR	0.83
65	30V53F2-20-2-1-3-3-1-1-#	1.5	R	1.59
66	[INTB-F2-90-2-1-1-BBB/CML395]-B-1-1-1-1-B-B-#	2.8	S	1.48
LSD (0.05)		1.3		1.04
CV (%)		23.8		33.28

1.0–2.0=Resistant (R); 2.1-2.5=Moderately Resistant (MR); 2.6 -3.0= Susceptible (S), and >3.0 highly susceptible (HS)

Thus, twenty inbred lines were classified as resistant or tolerant, fifteen inbred lines as moderately resistant, twenty inbred lines as sensitive, and eleven inbred lines as highly susceptible to TLB (Table 1 The inbred lines 22, 10, 11, and 23 were also classified as resistant/tolerant, moderately resistant, susceptible, and highly susceptible to GLS, in that order (Table 2). For TLB and GLS, the susceptible checks CML197 and SC22, respectively, were compared to those inbred lines that had demonstrated resistance or tolerance. For use in resistance breeding programs, select inbred lines may serve as sources of GLS and TLB resistance.

Based on artificial inoculation, field screening experiments showed a distinct response difference between inbred lines to TLB and GLS (Figure 1). Chandrashekara *et al.* (2014) found that there was a significant difference in TLB and GLS severity amongst inbred lines based on related research conducted elsewhere. Among the inbred lines evaluated, 30.30% and 33.33%, respectively, showed resistance/tolerance responses to TLB and GLS. The data revealed that the highest number of the inbred lines tested have shown resistant reactions to TLB and GLS, where some inbred lines were showed resistant/tolerant reaction to both GLS and TLB. Inbred lines, namely 30G 19F2-43-1-1-1-1-1-1-#, [DTPWC8F31-4-2-1-6-B2/CML395//[CML445/ZM621B]-2-1-2-3-1-BB]-3-2-1-1-1-2-B*4-# [CML312/CML442//[CML390/CML206]-BB-2-4-BBB]-1-B-3-1-1-BBB-#-#-#, TZMI407-short-#-#-# were showed multiple disease resistance compared with the checks. A negative correlation has been shown between disease severity and yield, with the more susceptible inbred lines presumably losing their active leaf tissues and resulting in reduced photosynthetic leaf area. Eventually, the plant produces few kernels and/or may contribute to the overall yield loss. These results are consistent with the findings of Pandurangegowda *et al.* (1994), Muiru *et al.* (2007), Singh *et al.* (2004), and Patil *et al.* (2000), who showed differential reaction to diseases among the various maize germplasm. Inbred maize lines CM-104 and CM-105 exhibited durable resistance to E. turcicum, according to findings reported by Sharma and Payak (1990). Gordon *et al.* (2006) reported on the elements showing partial resistance to gray leaf spot in maize and their potential uses in resistant genotype selection and breeding. Two inbreds, Gibe-1-186-2-2-1 and 136-a, have been confirmed by Wende *et al.,* (2013) as TLB resistant lines. Dagne *et al.,* (2008) also reported on promising sources of resistance to maize disease. They found Gotto LMS5, SC-22, and CML-395 as moderately resistant, A-7016 and CML-197 susceptible to GLS, and 143- 5-I and CML-387 as resistant. For the examined maize diseases, different maize germiplasms exhibited varying resistance reactions (Deressa *et al.,* 2018). Researchers also claimed that the resistance genes included in the genotypes used in breeding programs influence how inbred lines respond to different diseases.

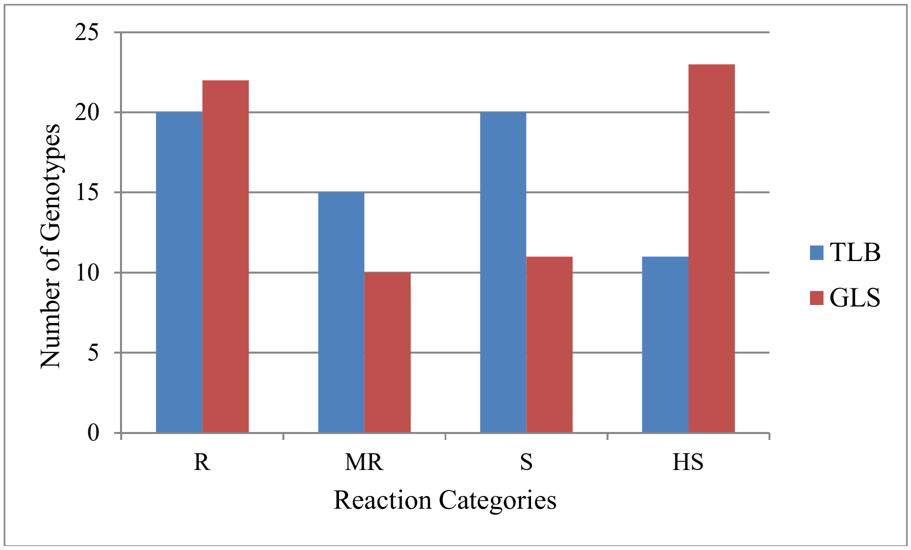

Fig. 1: Number of normal maize inbred lines with resistant (R), moderately resistant (MR) susceptible (S), and Highly susceptible (HS) reactions to GLS.

4. Conclusion and Recommendation

Twenty inbred lines were shown to be resistant to TLB and twenty-two to GLS under artificial epiphytotic conditions. The findings therefore demonstrate the resistance to TLB and GLS of maize, respectively, produced by E. turcicum and C. zeae maydis, that the chosen resistant lines may possess. It is recommended that maize inbred lines that were shown to be resistant or tolerant in this study conduct controlled environment screening in order to accurately confirm the extent of resistance to TLB and GLS. To identify the gene or genes causing the resistance and add them to cultivars with desirable agronomic traits, it would be preferable to employ molecular techniques. In addition, the investigation's promising lines with high yield and other agronomic traits can be used to sustainably increase the yield of maize in disease-endemic areas. As an alternative, the aforementioned promising genotypes could be employed as parents in hybridization to give current high yielding cultivars that have been adapted the gene for resistance to TLB and GLS.

5. Acknowledgements

The authors would like to thank EIAR for financial support provided to conduct the experiment. We are also grateful to Bako National Maize Research Center breeding program for delivering maize genotypes. It is also our pleasure to thank the National Maize Research plant protection division technical assistants; Geta Gelana, Abebech Yilma and Diriba Oljira for assistance they provided in field management and data collection.

References

Abate, T.S., S.H. Bekele, M. Abebe, W. Dagne, K. Yilma, *et al.,* 2015. Factors that transformed maize productivity in Ethiopia. Food science, 7: 965-981.

Assefa, T., and T. Tilahun, 1992. Review of maize diseases in Ethiopia, pp. 43-51. In The Proceeding of the first maize workshop of Ethiopia. 57 May, 1992. Addis Ababa, Ethiopia.

Bekeko, Z., C. Fininsa, S. Hussien, T. Hussien, D. Wegari, and B. Asalf, 2018. Resistanc e ofsome selected maize genotypes to gray leaf spot disease (Cercospora zeae maydis) in Ethiopia. Journal of Genetic and Environmental Resources Conservation, 6(1):1-13. https://doi.org/10.1016/j.cropro.2018.05.010

Berger, K., C. Maryke, N. Jeanne, M. Felix, J. Frederik, T. Pangirayi, and A. Alexander, 2014. Mapping QTL conferring resistance in maize to gray leaf spot disease caused by Cercospora zeina. BMC Genetics, 15:60.

Chandrashekara, C., S.K. Jha, P.K. Agrawal, N.K. Singh and J.C. Bhatt, 2012. Screening of Extra Early Maize Inbred under artificial epiphytotic condition for North-Western Himalayan region of India. Maize Genetics Cooperation Newsletter, 86.

CIMMYT. 1985. Managing trials and reporting data for CIMMYT's international maize testing program. Mexico (DF): CIMMYT.

Dagne, W., Z. Habtamu, A. Demissew, and S. Harjit, 2008. The Combining Ability of Maize Inbred Lines for Grain Yield and Reaction to Grey Leaf Spot Disease. East Afr. J. of Sci. 2 (2): 135-145.

Derera, J., P. Tongoona, K.V. Pixley, B. Vivek, M.D. Laing, and N.C. Rij, 2008. Gene action controlling grey leaf spot resistance in Southern Africa maize germplasm. Crop. Aci., 48: 93-98.

Deressa, T., M. Haile, M. Dida, B. Tilahun, T. Keno, G. Demissie, B. Garoma, and E. Hawassa, 2018. Evaluation of Resistance Reaction of Maize Inbred Lines to Major Foliar Diseases in Ethiopia. Evaluation, 8(3):30-40.

FAOSTAT. (Food and Agriculture Organization of United Nations) (2020). FAOSTAT [Online]. Available at http://www.fao.org/faostat., Accessed August.

FAOSTAT. (Food and Agriculture Organization of United Nations), 2021. FAOSTAT [Online]. Available at http://faostat3.fao.org, Accessed March, 2022.

Gebre, G., H. Isoda, B. Rahut, Y. Amekawa, and H. Nomura, 2019. Gender differences in the adoption of agricultural technology: The case of improved maize varieties in southern Ethiopia. Womens Stud Int. Forum 76: 102264.

Gordon, S.G., P.E. Lipps, and R.C. Pra, 2006. Heritability and components of resistance to Cercospora zeae-maydis derived from maize inbred VO613Y. Phytopathology 96:593–598.

Keno, T., G. Azmach, D. Wegary, M. Worku, B. Tadesse, L.Wolde, T. Deressa, B. Abebe, T. Chibsa, and L.M. Suresh, 2018. Major biotic maize production stresses in Ethiopia and their management through host resistance. Afr. J. Agric. Res. 13 (21): 1042–1052. https://doi.org/10.5897/ajar2018.13163 https://doi.org/10.5897/ajar2018.13163

Masuka, B., G.N. Atlin, M. Olsen, C. Magorokosho, M. Labuschagne, J. Crossa *et al.,* 2017. Gains in maize genetic improvement in eastern and southern Africa: I. CIMMYT hybrid breeding pipeline. Crop Science. 57:1–12.

Muiru, W.M., E.W. Mutitu, and J.W. Kimenju 2007. Reaction of some Kenean maize genotypes to Turcicum leaf blight under green house and field condition. Asian J. Plant Sci. 6(8): 11901196.

Pandurangegowda, K.T., M. Sangamlal, V.P. Mani, and W.W. Singh, 1994, Additional source of resistance in maize to Exserohilum turcicum. Indian J. of Agr. Sci., 64: 498-500.

Patil, S.J., M.C. Wali, S.I. Harlapur and M. Prashanth 2000, Maize Research in north Karnataka. Bulletin, University of Agricultural Sciences, Dharwad, 54.

Poole, N., J. Donovan, and O. Erenstein, 2021. Agri-nutrition research: Revisiting the contribution of maize and wheat to human nutrition and health. Food Policy, 100, 101976. https://doi.org/10. 1016/j.foodpol.2020.101976

Prasanna, B.M., J.E. Cairns, P.H. Zaidi, Y. Beyene, D. Makumbi, M. Gowda, ... and X. Zhang, 2021. Beat the stress: breeding for climate resilience in maize for the tropical rainfed environments. Theoretical and Applied Genetics, 134(6): 1729-1752. https://doi.org/10.1007/s00122-021-03773-7.

Pratt, R.C., K. Gordon, P. Lipps, G. Asea, G. Bigrawa, and K. Pixley, 2003. Use of IPM in the control of multiple disease of mazie. Afr. Crop. Sci. J., 11: 189-198.

Raymundo, A.D., and A.L. Hooker, 1981. Measuring the relationship between north corn leaf blight and yield losses. Plant. Dis., 65: 325-327.

Roane, C.W., R.L. Harison and C.F. Genter, 1974. Observations on grey leaf spot of maize in Virginia.Plant Disease Reporter, 58: 456-459.

SAS Institute Inc. 2004. SAS/STATA guide for personal computers. Version 9.2 edition. Carry (NC): SAS Institute.

Sharma, R.C. and M.M. Payak 1990. Durable resistance to two leaf blights in two maize inbred lines. Theoretical and Applied Genetics, 80: 542-544.

Singh, R., V.P. Mani, K.S. Koranga, G.S. Bisht, R.S. Khandelwal, P. Bhndari and S.K. Pant 2004. Identification of additional sources to Exserohilum turcicumin maize (*Zea mays* L.). Sabrao J. Breeding and Genetics. 36(1): 45-47.

Singh, R., V. Srivstava, R. Mani, S. Khandelwal, and R. Lekharam, 2014. Screening of maize genotype against northern corn leaf blight. Geneti. Plant. Breed., 9: 1689-1693.

Tewabech, T., A. Getachew, and W. Dagne 2001. Maize pathology research in Ethiopia. A review. In meeting the challenge of global climate change and food security through innovative maize research. Proc. the second national maize workshop of Ethiopia. 18-20 April 2011, EIAR/CIMMYT, Addis Ababa, Ethiopia. 104-112.

Tilahun, T., D. Wagary, G. Demissie, M. Negash, S. Admassu and H. Jifar, 2012. Maize pathology research in Ethiopia in the 2000s: A review. In Meeting the Challenges of Global Climate Change and Food Security through Innovative Maize Research (193).

USDA-FAS. 2017. United States Department of Agriculture, Foreign Agricultural Service. World Agricultural Production Circular Series WAP04 -17, April 2017.

Ward, J.M.J., M.D. Laing, and A.L.P. Cairs 1997. Management practices to reduce grey Leaf spot of maize. J. Crop. Sci., 37(4): 1257-1262.

Wegary, D., D. Kitaw, and G. Demissie 2004. Assessment of losses in yield and yield components of maize varieties due to grey leaf spot. Pest. Manag. J. Ethiop., 8: 59-69

Worku, M., S. Twumasi-Afriyie, L. Wolde, B. Tadesse, G. Demisie, G. Bogale, D. Wegary, and B.M. Prasanna, (Eds.). 2012. Meeting the Challenges of Global Climate Change and Food Security through Innovatie Maize Research. Proceedings of the Third Nati onal Maize Workshop of Ethiopia. Mexico, DF: CIMMYT.