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Research Article

EVALUATION OF MAIZE GENOTYPES FOR RESISTANCE AGAINST GRAY LEAF SPOT IN HILLS OF NEPAL

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Abstract

Maize crop is affected by several diseases, but Gray leaf spot (GLS), is the major disease that threat maize production in every year in mid-hills and high-hills of Nepal. To identify the source of resistant on gray leaf spot disease maize genotypes were screened/evaluated under hot spots during 2013 and 2014 summer seasons across the hill environment of Nepal. In the screening nursery both exotic(CIMMYT China) and NMRP developed genotypes were included and screened at Pakhribas, Dhungkharka, Supping and Salyan during 2013 & 2014 summer seasons under replicated conditions. The genotypes identified resistant and high yielding at Dhungkharka in 2013 were YML58/(CML226/CATETO//CML226/CATETO)F2-B-1-2-B,YML32/(P147-F2-108-S7/P45-C8-76-S5)-F2-B-30-1-3, YML32/Cel FSRYS9956-B-3-2-4-B and YML58/(G34/36/G33TSR)-F2-B-4-1-B. In case of Salyan none of the genotypes showed resistant reaction against GLS but eight genotypes namely; YML23/P502-C2-58-1-1-2-5-B, YML23/P502-C2-185-3-4-1-3-B-1-B, YML23/P502-C3-F2-10-8-1-1-B, YML23/GLSI01P502-B-25-2-B, YML23/MBR-C5W-F108-2-3-1-B, YS12Q-189, YS12Q-33 and YS12Q-189 reacted MR reaction. At Pakhribas two genotypes reacted resistant (R) reaction namely; YML23/GLS101HGA-B-4-1-B and YS12Q-189 and other ten genotypes responded MR reaction. None of the tested entries at Suping responded resistant reaction but four genotypes ZM-401, 07SADVI, ZM-627 and BGBYPOP responded MR reaction against GLS. During 2014 summer season a total of 20 genotypes both exotic (CIMMYT India) and NMRP developed were screened against GLS across the hill regions of Pakhribas, Dhungkharka and Salyan. From the result of Pakhribas the genotype P501SRCO/P502SRCO was recorded for resistant (1.3) reaction and three genotypes 05SADVI, Entry # 36 and Entry # 27 were responded for MR reaction. In case of Dhungkharka nine genotypes namely; ZM-401, ZM-627, 05SADVI, 07SADVI, TLBRSO7F16, ENTRY#33, ENTRY#24, ENTRY#32 and ENTRY#21 were recorded for MR reaction. The tested genotypes at Salyan revealed that six genotypes namely; 05SADVI, 07SADVI, ACROSS-9942/ACROSS-9944, BGBYPOP, ENTRY # 24 and ENTRY# 32 were reacted resistant reaction and the genotype 07SADVI produced significantly highest grain yield (8638 kg/ha).

Key words: Maize genotypes; resistant; susceptible; *Cercospora zeae maydis*; evaluation

Introduction

Maize is staple food of hill people and seventy percent of maize is produced in mid hills region (900-1500 masl) and a further eight percent is produced in high hills (1500-2200 masl) and remaining 22 % is produced in Terai and inner terai (<900 masl). Of the several maize diseases Gray leaf spot (GLS) caused by *Cercospora zea- maydis* Tehon and Daniels, on maize is recognized as one of the most yield-limiting diseases of maize in the mid hills and high hills of Nepal. It is estimated to be spreading at a rate of 80-160 km each year. It is an important new record disease in Nepal. The disease was recorded from hill districts like Lalitpur, Kavrepalanchowk, Tehrathum, Khotang Bhojpur and Dhankuta within the country. Grain loss of 80% was estimated in farmer's field due to this disease (Manandhar *et al.*, 2009). Since, the problem of the disease is realized in many districts there need of resistant variety to combat the disease. The disease was first identified and reported in Nepal in 2006 (Tiwari and Ferrara, 2007). The disease has been observed spreading over the years in 22 districts in the eastern, central and mid-western regions of the country (Manandhar *et al.*, 2009).

GLS is evident on plants as small spots first on lower leaves of plants at tassel initiation. The disease moves upwards and spots change into long characteristics lesions within a month turning plants into a diseased field. The disease is significant since it rapidly destroys foliage when the plant is near at grain maturity..The disease has been reported from America, Africa Europe and Asia. Gray leaf spot is becoming very economically important disease at the

present upper eight or nine leaves which contribute 75-90% of the photo syntheses for grain fill (Ward *et al.*, 1999).Leaves of susceptible varieties become severely blighted or killed as early as 30days prior to physiological maturity.

The impact of Grey leaf spot on yield production greatly realized. With objective to observe and measure reactions of maize to GLS, maize genotypes were screened across the hill environments of Nepal to identify the source of resistance for general cultivation for the resource poor farmers in the hills.

Materials and Methods

Study site Description

Field experiments were conducted to identify the sources of resistance for gray leaf spot in maize genotypes during 2013 and 2014 summer seasons across the mid hill environments. Maize genotypes requested from CIMMYT China and NMRP developed were evaluated in disease hot spots in hilly regions. The experimental site ware Pakhribas, Dhungkharka, Supping and Salyan.

Experimental Design and Crop Husbandry

Experiments were laid out in replicated conditions in randomized complete block design with natural epidemic condition. The plot size was 4.5 m^2 (2 rows of 3 m long) with spacing 75cm × 25cm. (row to row and plant to plant), respectively. Assessment of disease severity was done by using 1-5 disease rating scales (Maroof *et al*., 1993) in all genotypes as;

1. (Resistant)= Plants with one or two to few scattered lesions on lower leaves,
2. (Moderately resistant)= Moderate number of lesions on leaves, affecting less than 25 per cent of the area,
3. (Moderately susceptible)= Abundant lesions on lower leaves, few on other leaves affecting 26-50% leaf area,
4. (Susceptible)= Lesions abundant on lower and mid leaves, extending to upper leaves affecting 51-75% leaf area and
5. (Highly susceptible)= Lesions abundant on almost all leaves, plant prematurely dried or killed with 76-100% of the leaf area affected.

The severity of the disease was recorded in one time at the peak time of disease development correlate with maize grain filling stage or physiological maturity stage.

Data Analysis

Analysis of variance for grain yield and other ancillary characters of maize were analyzed using the statistical package MSTAT-C (Russel and Eisensmith, 1983). Treatments (genotypes) were compared using the "F-test" and any significant differences between treatments were compared by Least Significant Difference (LSD) at 5% level of probability.

Results and Discussion

The disease began to appear on plants in mid-July in most of the tested sites and first symptoms seen in farmer's variety and started infected in other tested genotypes. The result from Chinese genotypes screened at Dhungkharka during 2013 showed that the severity ranged from resistant to susceptible reaction. The resistant and high yielding genotypes were YML58/(CML226/CATETO//CML226/CATETO)F2-B-#1-2-B,YML32/(P147-F2-108-S7/P45-C8-76-S5)-F2-B-30-1-3, YML32/Cel FSRYS9956-B-3-2-4-B and YML58/(G34/36/G33TSR)-F2-B-4-1-B. Another set of Chinese genotypes were screened in the same year at Ginger Research Program (GRP), Salyan including 22 entries and none of the genotypes showed resistant reaction, however eight genotypes reacted MR reaction and produced good yield as compared to other tested genotypes and these genotypes were YML23/P502-C2-58-1-1-2-5-B, YML23/P502-C2-185-3-4-1-3-B-1-B, YML23/P502-C3-F2-10-8-1-1-B, YML23/GLSI01P502-B-25-2-B, YML23/MBR-C5W-F108-2-3-1-B, YS12Q-189, YS12Q-33 and YS12Q-189. At ARS, Pakhribas 22 exotic (Chinese) genotypes were screened against GLS during 2013 and the result showed that genotypes reacted resistant reactions were YML23/GLS101HGA-B-4-1-B and YS12Q-189 and the severity level of other ten genotypes were 2.0 which reacted MR level of disease reaction. The yield was significantly differences among the tested genotypes and highest yield was produced by YML23/P502-C2-185-3-4-1-3-B-1-B (7080 kg/ha) with MR reaction. At Suping, Makawanpur, one of the hot spot of GLS, NMRP set was screened including 11 genotypes in farmer's field with farmer as replications in three farmer's field. For favorable environmental conditions the farmers local (Suping local) is severely infected by GLS and yield reduction up to 50-60% in this location. Of the tested entries none of genotypes showed resistant reaction but four genotypes namely; ZM-401, 07SADVI, ZM-627 and BGBYPO reacted MR reaction against GLS. The yield of tested entries was found significantly difference. During 2014 summer season a total of 20 genotypes both exotic (CIMMYT India) and NMRP developed were screened against GLS across the hill regions of Pakhribas, Dhungkharka and Salyan. From the result of Pakhribas the genotype P501SRCO/P502SRCO was reacted for resistant reaction and three genotypes 05SADVI, Entry # 36 and Entry # 27 were reacted as MR reaction and rest of the genotypes were recorded as MS reaction. In case of yield non-significant difference was observed among the tested genotypes. In case of Dhungkharka nine genotypes namely; ZM-401, ZM-627, 05SADVI, 07SADVI, TLBRSO7F16, ENTRY#33, ENTRY#24, ENTRY#32 and ENTRY#21 were recorded for MR reaction. For grain yield production the genotype

ZM-627 produced significantly highest grain yield of 6932 kg/ha among the tested entries. The tested genotypes at Salyan revealed that six genotypes namely; 05SADVI, 07SADVI, ACROSS-9942/ACROSS-9944, BGBYPOP,ENTRY # 24 and ENTRY# 32 were reacted resistant reaction and the genotype 07SADVI produced significantly highest grain yield (8638 kg/ha). Host resistance for this worldwide important disease of maize has been reported on several hybrids and inbred lines (Hilty *et al.,* 1979; Ward *et al.,* 1999). Details of results are given in Table 2 - 8.

In general, resistant genotypes were smaller in number than moderately resistant and moderately susceptible whereas the susceptible genotypes were equal to resistant genotypes in number (Figure 1). The results of the overall experiments showed that the 13 genotypes were resistant, 53-moderately resistant, 62-moderately susceptible and 13-susceptible. The resistant genotypes were YML58/(CML226/CATETO//CML226/CATETO)F2-B-1-2-B, YML32/(P147-F2-108-S7/P45-C8-76-S5)-F2-B-30-1-3, YML32/Cel FSRYS9956-B-3-2-4-B, YML58/(G34/36/G33TSR)-F2-B-4-1-B, YML23/GLS101HGA-B-4-1-B, YS12Q-189, P501SRCO/P502SRCO, 05SADVI, 07SADVI, AC9942/AC9944, BGBYPOP, ENTRY#33, ENTRY#32. The YML32/(P147-F2-134-S7/P33-C3-64-S5)-F2-B-7-3-1,YML58/(G34/36/G33TSR)-F2-B-3-1-B, YML58/(SEY90-C1#/G34/36-B)-F2-B-2-1-B, Yunrui 505, Yunrui 544, YML23/P502-C2-58-1-1-2-5-B, YML23/P502-C2-185-3-4-1-3-B-1-B, YML23/P502-C3-F2-10-8-1-1-B, YML23/GLSI01P502-B-25-2-B, YML23/MBR-C5W-F108-2-3-1-B, YML23/GLSI01HGA-B-4-1-B, YS12Q-33, YS12Q-189, Manakamana-1, YML23/P502-C2-58-1-1-2-5-B, YML23/P502-C2-185-3-4-1-3-B-1-B, YML23/P502-C3-F2-10-8-1-1-B, YML23/GLS101P502-B-25-2-B, YML23/P44-C10-HS8-30-2-2-1-B, YML23/P44-C10-HS8-30-4-B-4-1-B, YML23/PSEWHGB-CO-F39-1-1-4-3-B, YS12Q-33, YS12Q-71, ZM-401, 07SADVI, ZM-627, BGBY-POP, 05SADVI, ENTRY#33, ENTRY#36, ENTRY#27, ZM-401, ZM-627, 05SADVI, 07SADVI, TLBRSO7F16, ENTRY#33, ENTRY#24, ENTRY#32 ENTRY#2,1 ZM-401, ZM-627, TLBRS07F16, P501SRCO/P502SRCO, ENTRY#24, ENTRY#36, ENTRY#27, RAMSO3F08, ENTRY#28, ENTRY#34, ENTRY #21, MANAKAMANA-3, FARMER'S VARIETY were found moderately resistant. The genotypes found moderately susceptible were YML58/(P147-F2-105-S7/P33-C3-64-S5)-F2-B-24-1-3, YML58/(P147-F2-107-S7/CML323)-F2-B-22-2-1,YML58/(P147-F2-134-S7/P33-C3-64-S5)-F2-B-7-2-1, YML58/(CML226/CATETO DC 1267/7619))F2-5-1-B, YML58/(P147-F2-107-S7/P45-C8-76-S9)-F2-B-3-3-1, Yunrui 999, Yunrui 47(R), Yunrui 89, YR88, YR9, Yunrui 105, Manakamana-3, Deuti, Farmer's Variety, YML23/P502-C2-185-3-4-1-3-B-1-B, YML23/GLSI01P502-B-23-2-B, YML23/P44-C10-HS8-30-2-2-1-B, YML102/P44-C10-HS8-30-4-B-4-1-B, YML23/P44-C10-HS8-30-4-B-4-1-B, YML23/PSEWHGB-C0-F39-1-1-4-3-B, YS12Q-70, YS12Q-71, YS12Q-108, Deuti, Farmer's Variety, YML23/P502-C2-185-3-4-1-3-B-1-B, YML102/P44-C10-HS8-30-4-B-4-1-B, YML23/MBR-C5W-F108-2-3-1-B, YML23/(MBR/MDR-C3W)-P44-2-2-1-B, Yunrui 21, YS12Q-108, 05SADVI, TLBRS07F16, TLBRS07F10, RML-32/RML-17, RML-4/RML-17, GLSY, ZM-401, ZM-627, 05SADVI, TLBRSO7F16, AC9942/AC9944, BGBYPOP, ENNTRY#24, RAMS03F08, ENTRY#28, ENRTY#34, ENRTY#32, ENTRY#21, RML-32/RML-17, Manakamana-3, Farmer's Variety, P501SRCO/P502SRCO, AC9942/AC9944, BGBYPOP, ENTRY#36, ENTRY#27, RAMSO3F08, ENTRY#28, ENTRY#34, RML-32/RML-17, RML-32/RML-17. Likewise the genotypes namely Rampur Hybrid-2, RML-32/RML-17, YML32/Cel FSRYS9952HGA-B-5-4-1-B, YML58/(GLSIY01/SPMAT)-B-34-1-1-B, Yunrui 10, Yunrui 407, YML23/(MBR/MDR-C3W)-F44-2-2-1-B, Yunrui 21, YML23/GLS101P502-B-23-2-B, YS12Q-70, Farmer's Variety, Manakamana-3, Dhungkhark Local were found susceptible to grey leaf spot disease (Table 1).

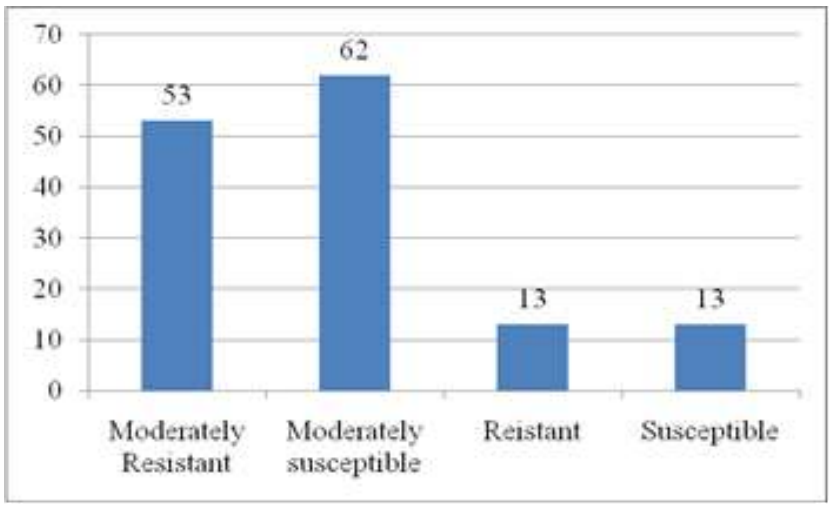

Fig. 1: No. of maize genotypes based disease reaction

Table 1: Classification of maize genotypes based on disease reaction and severity scale

Reaction	Maize Genotype
Resistant	YML58/(CML226/CATETO//CML226/CATETO)F2-B-1-2-B, YML32/(P147-F2-108-S7/P45-C8-76-S5)-F2-B-30-1-3, YML32/Cel FSRYS9956-B-3-2-4-B, YML58/(G34/36/G33TSR)-F2-B-4-1-B, YML23/GLS101HGA-B-4-1-B, YS12Q-189, P501SRCO/P502SRCO, 05SADVI, 07SADVI, AC9942/AC9944, BGBYPOP, ENTRY#33, ENTRY#32,
Moderately Resistant	YML32/(P147-F2-134-S7/P33-C3-64-S5)-F2-B-7-3-1,YML58/(G34/36/G33TSR)-F2-B-3-1-B, YML58/(SEY90-C1#/G34/36-B)-F2-B-2-1-B, Yunrui 505, Yunrui 544, YML23/P502-C2-58-1-1-2-5-B, YML23/P502-C2-185-3-4-1-3-B-1-B, YML23/P502-C3-F2-10-8-1-1-B, YML23/GLSI01P502-B-25-2-B, YML23/MBR-C5W-F108-2-3-1-B, YML23/GLSI01HGA-B-4-1-B, YS12Q-33, YS12Q-189, Manakamana-1, YML23/P502-C2-58-1-1-2-5-B, YML23/P502-C2-185-3-4-1-3-B-1-B, YML23/P502-C3-F2-10-8-1-1-B, YML23/GLS101P502-B-25-2-B, YML23/P44-C10-HS8-30-2-2-1-B, YML23/P44-C10-HS8-30-4-B-4-1-B, YML23/PSEWHGB-CO-F39-1-1-4-3-B, YS12Q-33, YS12Q-71, ZM-401, 07SADVI, ZM-627, BGBY-POP, 05SADVI, ENTRY#33, ENTRY#36, ENTRY#27, ZM-401, ZM-627, 05SADVI, 07SADVI, TLBRSO7F16, ENTRY#33, ENTRY#24, ENTRY#32 ENTRY#2,1 ZM-401, ZM-627, TLBRS07F16, P501SRCO/P502SRCO, ENTRY#24, ENTRY#36, ENTRY#27, RAMSO3F08, ENTRY#28, ENTRY#34, ENTRY #21, Manakamana-3, Farmer's Variety
Moderately Susceptible	YML58/(P147-F2-105-S7/P33-C3-64-S5)-F2-B-24-1-3, YML58/(P147-F2-107-S7/CML323)-F2-B-22-2-1, YML58/(P147-F2-134-S7/P33-C3-64-S5)-F2-B-7-2-1, YML58/(CML226/CATETO DC 1267/7619))F2-5-1-B, YML58/(P147-F2-107-S7/P45-C8-76-S9)-F2-B-3-3-1, Yunrui 999, Yunrui 47(R), Yunrui 89, YR88, YR9, Yunrui 105, Manakamana-3, Deuti, Farmer's Variety, YML23/P502-C2-185-3-4-1-3-B-1-B, YML23/GLSI01P502-B-23-2-B, YML23/P44-C10-HS8-30-2-2-1-B, YML102/P44-C10-HS8-30-4-B-4-1-B, YML23/P44-C10-HS8-30-4-B-4-1-B, YML23/PSEWHGB-C0-F39-1-1-4-3-B, YS12Q-70, YS12Q-71, YS12Q-108, Deuti, Farmer's Variety, YML23/P502-C2-185-3-4-1-3-B-1-B, YML102/P44-C10-HS8-30-4-B-4-1-B, YML23/MBR-C5W-F108-2-3-1-B, YML23/(MBR/MDR-C3W)-P44-2-2-1-B, Yunrui 21, YS12Q-108, 05SADVI, TLBRS07F16, TLBRS07F10, RML-32/RML-17, RML-4/RML-17, GLSY, ZM-401, ZM-627, 05SADVI, TLBRSO7F16, AC9942/AC9944, BGBYPOP, ENNTRY#24, RAMS03F08, ENTRY#28, ENRTY#34, ENRTY#32, ENTRY#21, RML-32/RML-17, MANAKAMANA-3, Farmer's Variety, P501SRCO/P502SRCO, AC9942/AC9944, BGBYPOP, ENTRY#36, ENTRY#27, RAMSO3F08, ENTRY#28, ENTRY#34, RML-32/RML-17, RML-32/RML-17
Susceptible	Rampur Hybrid-2, RML-32/RML-17, YML32/Cel FSRYS9952HGA-B-5-4-1-B, YML58/(GLSIY01/SPMAT)-B-34-1-1-B, Yunrui 10, Yunrui 407, YML23/(MBR/MDR-C3W)-F44-2-2-1-B, Yunrui 21, YML23/GLS101P502-B-23-2-B, YS12Q-70, Farmer's Variety, Manakamana-3, Dhungkhark Local

Table 2: Gray leaf spot disease reaction on maize genotypes from CIMMYT/China at 2013 summer

SN	Genotype	Grain yield (kg/ha)	Disease Severity (1-5)	Disease Reaction
1	Rampur Hybrid-2	4128	4	S
2	RML-32/RML-17	3369	4	S
3	YML58/(P147-F2-105-S7/P33-C3-64-S5)-F2-B-24-1-3	5983	3	MS
4	YML58/(P147-F2-107-S7/CML323)-F2-B-22-2-1	5898	3.5	MS
5	YML58/(P147-F2-134-S7/P33-C3-64-S5)-F2-B-7-2-1	4316	3	MS
6	YML32/(P147-F2-134-S7/P33-C3-64-S5)-F2-B-7-3-1	8604	2	MR
7	YML58/(CML226/CATETO DC 1267/7619))F2-5-1-B	5632	3.5	MS
8	YML58/(CML226/CATETO//CML226/CATETO)F2-B-1-2-B	8858	1.5	R
9	YML58/(P147-F2-107-S7/P45-C8-76-S9)-F2-B-3-3-1	4121	3	MS
10	YML32/(P147-F2-108-S7/P45-C8-76-S5)-F2-B-30-1-3	8752	1.5	R
11	YML32/Cel FSRYS9952HGA-B-5-4-1-B	3400	4	S
12	YML32/Cel FSRYS9956-B-3-2-4-B	9975	1.5	R
13	YML58/(GLSIY01/SPMAT)-B-34-1-1-B	4345	4.5	S
14	YML58/(G34/36/G33TSR)-F2-B-3-1-B	6232	2	MR
15	YML58/(G34/36/G33TSR)-F2-B-4-1-B	10983	1.5	R
16	YML58/(SEY90-C1#/G34/36-B)-F2-B-2-1-B	6706	1.8	MR
17	Yunrui 999	4680	3	MS
18	Yunrui 47(R)	5510	3.3	MS

SN	Genotype	Grain yield (kg/ha)	Disease Severity (1-5)	Disease Reaction
19	Yunrui 505	5722	2	MR
20	Yunrui 89	7789	2.8	MS
21	Yunrui 10	4302	4.3	S
22	YR88	5170	3.5	MS
23	YR9	7068	2.8	MS
24	Yunrui 105	6387	3.5	MS
25	Yunrui 544	8364	2.5	MR
26	Yunrui 407	4151	3.8	S
	Grand mean	6171	2.9	
	F-test	**	**	
	CV%	13.8	15	
	$LSD_{0.05}$	1754	0.9	

**, Significant at 0.01 probability level

Table 3: Grain yield, GLS disease severity and disease reaction for 22 maize genotypes from CIMMYT/China at Salyan in 2013 summer

SN	Genotype	Grain yield (kg/ha)	Disease Severity (1-5)	Disease Reaction
1	Manakamana-3	7191	3	MS
2	Deuti	6743	3.5	MS
3	Farmer's Variety	7940	3	MS
4	YML23/P502-C2-58-1-1-2-5-B	7132	2	MR
5	YML23/P502-C2-185-3-4-1-3-B-1-B	8978	3	MS
6	YML23/P502-C2-185-3-4-1-3-B-1-B	7944	2	MR
7	YML23/P502-C3-F2-10-8-1-1-B	9040	2	MR
8	YML23/GLSI01P502-B-23-2-B	6539	3	MS
9	YML23/GLSI01P502-B-25-2-B	7882	2	MR
10	YML23/P44-C10-HS8-30-2-2-1-B	7187	3	MS
11	YML102/P44-C10-HS8-30-4-B-4-1-B	5739	3	MS
12	YML23/P44-C10-HS8-30-4-B-4-1-B	8136	3	MS
13	YML23/MBR-C5W-F108-2-3-1-B	6335	2	MR
14	YML23/(MBR/MDR-C3W)-F44-2-2-1-B	8112	4	S
15	YML23/GLSI01HGA-B-4-1-B	8046	2	MR
16	YML23/PSEWHGB-C0-F39-1-1-4-3-B	5492	3	MS
17	Yunrui 21	7196	4	S
18	YS12Q-33	6779	2	MR
19	YS12Q-189	6016	2	MR
20	YS12Q-70	7002	3	MS
21	YS12Q-71	6011	3	MS
22	YS12Q-108	6008	3	MS
	Grand mean	7157	2.75	
	F-test	ns	**	
	CV%	15.1	12.5	
	$LSD_{0.05}$	2242	0.8	

**, Significant at 0.01 probability level. ns, Non-significant

Table 4: Grain yield, GLS disease severity and disease reaction for 22 maize genotypes from CIMMYT/China at Pakhribas in 2013 summer

SN	Genotype	Grain yield (kg/ha)	Disease Severity (1-5)	Disease Reaction
1	Manakamana-1	5057	2	MR
2	Deuti	4731	3	MS
3	Farmer's Variety	2855	3	MS
4	YML23/P502-C2-58-1-1-2-5-B	6036	2	MR
5	YML23/P502-C2-185-3-4-1-3-B-1-B	7080	2	MR
6	YML23/P502-C2-185-3-4-1-3-B-1-B	6199	3	MS
7	YML23/P502-C3-F2-10-8-1-1-B	5384	2	MR
8	YML23/GLS101P502-B-23-2-B	4568	4	S
9	YML23/GLS101P502-B-25-2-B	6362	2	MR
10	YML23/P44-C10-HS8-30-2-2-1-B	4078	2	MR
11	YML102/P44-C10-HS8-30-4-B-4-1-B	3589	3	MS
12	YML23/P44-C10-HS8-30-4-B-4-1-B	3263	2	MR
13	YML23/MBR-C5W-F108-2-3-1-B	4078	3	MS
14	YML23/(MBR/MDR-C3W)-P44-2-2-1-B	5710	3	MS
15	YML23/GLS101HGA-B-4-1-B	5302	1	R
16	YML23/PSEWHGB-CO-F39-1-1-4-3-B	4894	2	MR
17	Yunrui 21	4242	3	MS
18	YS12Q-33	5057	2	MR
19	YS12Q-189	4731	1	R
20	YS12Q-70	5384	4	S
21	YS12Q-71	5710	2	MR
22	YS12Q-108	2773	3	MS
	Grand mean	4867	2.5	
	F-test	*	*	
	CV%	19.6	26.9	
	$LSD_{0.05}$	1982	0.65	

*, Significant at 0.05 probability level

Table 5: Grain yield, GLS disease severity and disease reaction for 11 maize genotypes at Suping 2013 summer

SN	**Genotype**	**Grain yield (kg/ha)**	**Disease Severity (1-5)**	**Disease Reaction**
1	ZM-401	4415	2.5	MR
2	05SADVI	3882	3	MS
3	07SADVI	4000	2	MR
4	ZM-627	4283	2	MR
5	BGBY-POP	3958	2.5	MR
6	TLBRS07F16	3392	3.5	MS
7	TLBRS07F10	3576	3.5	MS
8	RML-32/RML-17	5123	3	MS
9	RML-4/RML-17	5159	3	MS
10	GLSY	4425	3.5	MS
11	Farmer's Variety	3263	4	S
	Grand mean	4134	3.0	

Table 5: Grain yield, GLS disease severity and disease reaction for 11 maize genotypes at Suping 2013 summer

SN	Genotype	Grain yield (kg/ha)	Disease Severity (1-5)	Disease Reaction
	F-test	*	ns	
	CV%	10.1	11.9	
	$LSD_{0.05}$	931	1.9	

*, Significant at 0.05 probability level . ns, Non-significant

Table 6: Grain yield, GLS disease severity and disease reaction for 20 maize genotypes at Pakhribas in 2014 summer

SN	Genotype	Grain yield (kg/ha)	Disease Severity (1-5)	Disease Reaction
1	ZM-401	1698	3.3	MS
2	ZM-627	2290	2.8	MS
3	05SADVI	74	3	MS
4	05SADVI	1007	2.3	MR
5	TLBRSO7F16	829	3	MS
6	P501SRCO/P502SRCO	1615	1.3	R
7	AC9942/AC9944	762	3	MS
8	BGBYPOP	632	3	MS
9	ENTRY#33	963	2	MR
10	ENNTRY#24	1392	3	MS
11	ENTRY#36	588	2.5	MR
12	ENTRY#27	306	1.3	MR
13	RAMS03F08	1937	2.8	MS
14	ENTRY#28	881	3	MS
15	ENRTY#34	1355	3.3	MS
16	ENRTY#32	1182	3	MS
17	ENTRY#21	1001	3	MS
18	RML-32/RML-17	587	3	MS
19	Manakamana-3	1136	3	MS
20	Farmer's Variety	1279	3.3	
	Grand mean	1076	2.7	
	F-test	ns	ns	
	CV%	62.8	26.8	
	$LSD_{0.05}$	1414	1.5	

ns, Non-significant at 0.05 probability level

Table 7: Grain yield, GLS disease severity and disease reaction for 20 maize genotypes at Dhungkharka in 2014 summer

SN	Genotype	Grain yield (kg/ha)	Disease Severity (1-5)	Disease Reaction
1	ZM-401	3760	2.5	MR
2	ZM-627	6932	2	MR
3	05SADVI	4075	2.5	MR
4	07SADVI	5266	2	MR
5	TLBRSO7F16	2268	2	MR
6	P501SRCO/P502SRCO	1979	3.5	MS
7	AC9942/AC9944	3798	2.8	MS
8	BGBYPOP	3188	2.8	MS
9	ENTRY#33	2327	2.5	MR
10	ENTRY#24	2423	2.5	MR

11	ENTRY#36	1903	3.5	MS
12	ENTRY#27	3091	3.3	MS
13	RAMSO3F08	3770	2.8	MS
14	ENTRY#28	2244	2.8	MS
15	ENTRY#34	2982	3.1	MS
16	ENTRY#32	2570	2.3	MR
17	ENTRY#21	2934	2.5	MR
18	RML-32/RML-17	2680	2.8	MS
19	Manakamana-3	2496	3.8	S
20	Dhungkhark Local	3608	4.5	S
	Grand mean	3215	2.8	
	F-test	**	**	
	CV%	23.9	10.3	
	$LSD_{0.05}$	1606	0.6	

**, Significant at 0.01 probability level

Table 8: Grain yield, GLS disease severity and disease reaction for 22 maize genotypes at Salyan in 2014 summer

SN	Genotype	Grain yield (kg/ha)	Disease Severity (1-5)	Disease Reaction
1	ZM-401	8015	1.8	MR
2	ZM-627	8745	1.8	MR
3	05SADVI	7995	1.3	R
4	07SADVI	8638	1.3	R
5	TLBRS07F16	5200	1.8	MR
6	P501SRCO/P502SRCO	5304	2.3	MR
7	AC9942/AC9944	7315	1.5	R
8	BGBYPOP	4753	1.5	R
9	ENTRY#33	7765	1.3	R
10	ENTRY#24	3628	1.8	MR
11	ENTRY#36	6446	2	MR
12	ENTRY#27	4876	2	MR
13	RAMSO3F08	5478	1.8	MR
14	ENTRY#28	4327	2	MR
15	ENTRY#34	5213	1.8	MR
16	ENTRY#32	8766	1.5	R
17	ENTRY #21	4472	1.8	MR
18	RML-32/RML-17	7175	2.8	MS
19	Manakamana-3	7260	1.8	MR
20	Farmer's Variety	7823	2	MR
	Grand mean	6460	1.8	
	F-test	**	ns	
	CV%	17.6	21.1	
	$LSD_{0.05}$	2383	0.8	

Conclusion

Genotypes of maize resistant to moderately resistant to GLS have been identified. The OPVs like Manakamana-3 and Deuti which are already released and recommended for mid hills are still tolerance to GLS which can reduce yield loss in GLS prone environments of the hills. Several resistant genotypes of maize can be useful for source of disease resistance in the national maize breeding program. Genotypes of maize including YML58/(CML226/CATETO//CML226/CATETO)F2-B-1-2-B,YML32/(P147-F2-108-S7/P45-C8-76-S5)-F2-B-30-1-3, YML32/Cel FSRYS9956-B-3-2-4-B,

YML23/GLS101HGA-B-4-1-B and YS12Q-189 from China, and ZM 627, 05 SADVI, 07 SADVI, ZM 401 and BGBYPOP from NMRP were identified as resistant/moderately resistant to GLS and these genotypes should be used in breeding program of national maize research for further verification in agronomical and other yield attributing traits in the hills of Nepal.

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