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-P2-108-S7(P45-C8-76-S5)-F2-B-30-1-3, YML32/Cel05SADVI/07SADVI/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/GLS101HG-A-4-1-1-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, 07SADV1, ZM-627 and BGYBPOP 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 P501SRC0/P502SRC0 was recorded for resistant (1.3) reaction and three genotypes 05SADV1, ENTRY # 36 and Entry # 27 were responded for MR reaction. In case of Dhungkharka nine genotypes namely; ZM-401, ZM-627, 05SADV1, 07SADV1, TLBLRSOTF16, ENTRY#33, ENTRY#24, ENTRY#32 and ENTRY#21 were recorded for MR reaction. The tested genotypes at Salyan revealed that six genotypes namely; 05SADV1, 07SADV1, ACROSS-9942/ACROSS-9944, BGYBPOP, ENTRY # 24 and ENTRY# 32 were reacted resistant reaction and the genotype 07SADV1 produced significantly highest grain yield (8638 kg/ha).

Key words: Maize genotypes; resistant; susceptible; Cercospora zea 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 30 days 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 were 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 m² (2 rows of 3 m long) with spacing 75 cm x 25 cm. (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, YML32(P147-108/P745-C8-76-55)F2-B-30-1-3, YML32/CELFSRSY9956-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-C2-58-1-2-5-3, YML23/P502-C2-185-3-4-1-3-1-B-1, YML23/P502-C3-F2-10-8-1-1-B, YML23/GLS101P502-25-2-5-2-B, YML23/MBR-C5W-FI08-2-3-1-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 different among the tested genotypes and highest yield was produced by YML23/P502-C2-185-3-4-1-3-1-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; ZM401, 07SADVI, ZM401 and YS12Q showed resistant reaction against GLS. The yield of tested entries was found significantly different. 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 05SADV1, 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; ZM401, ZM627, 05SADV1, 07SADVI, TLBRSO7F16, ENTRY#33, ENTRY#24, ENTRY#32 and ENTRY#21 were recorded for MR reaction. For grain yield production the genotype
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)F2B-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/GRS101HGA-B-4-1-B, YS12Q-189, P051SRCO/P052SRCO, 05SADV1, 07SADV1, 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, Yunru 505, Yunru 544, YML23/P052-C2-58-1-2-5-B, YML23/P052-C2-185-3-4-1-3-B-1-B, YML23/P052-C3-F2-B-10-8-1-1-B, YML23/GRS101P502B-25-2-B, YML23/MBR-C5W-F108-2-3-1-B, YML23/GRS101HGA-B-4-1-B, YS12Q-33, YS12Q-189, Manakama-1, YML23/P052-C2-58-1-2-5-B, YML23/P052-C2-185-3-4-1-3-B-1-B, YML23/P052-C3-F2-10-8-1-1-B, YML23/GRS101P502B-25-2-B, YML23/MBR-C5W-F108-2-3-1-B, YML23/GRS101HGA-B-4-1-B, YS12Q-33, YS12Q-189, Manakama-1, YML23/P052-C2-58-1-2-5-B, YML23/P052-C2-185-3-4-1-3-B-1-B, YML23/P052-C3-F2-10-8-1-1-B, YML23/GRS101P502B-25-2-B, YML23/P44-C10-HS8-30-2-2-1-B, YML23/P44-C10-HS8-30-4-4-1-B, YML23/P44-C10-HS8-30-4-4-1-B, YML23/MWR-C5W-F108-2-3-1-B, YML23/MWR-MDR-C3W)-P44-2-2-1-B, Yunru 21, YS12Q-108, 05SADV1, TLBRS07F16, TLBRS07F10, RML-32/RML-17, RML-4/RML-17, GLSY, ZM-401, ZM-627, 05SADV1, ENTRY#33, ENTRY#36, ENTRY#27, ZM-401, ZM-627, 05SADV1, 07SADV1, TLBRS07F16, ENTRY#33, ENTRY#24, ENTRY#32 ENTRY#2,1 ZM-401, ZM-627, TLBRS07F16, P051SRCO/P052SRCO, ENTRY#24, ENTRY#36, ENTRY#27, RAMSO3F08, ENTRY#28, ENTRY#34, ENTRY #21, MANAKAMA-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/CML232)-F2-B-22-2-1, YML58/(P147-F2-134-S7/P33-C3-64-S5)-F2-B-7-2-1, YML8/(CML226/CATETO DC 1267(7619))-F2-5-1-B, YML58/(P147-F2-107-S7/P45-C8-76-S9)-F2-B-3-3-1, Yunru 999, Yunru 47(R), Yunru 89, YR88, YR9, Yunru 105, Manakama-3, Deuti, Farmer’s Variety, YML23/P052-C2-185-3-4-1-3-B-1-B, YML23/GRS101P502B-23-2-B, YML23/P44-C10-HS8-30-2-2-1-B, YML102/P44-C10-HS8-30-4-4-1-B, YML23/P44-C10-HS8-30-4-4-1-B, YML23/P44-C10-HS8-30-4-4-1-B, YML23/MWR-C5W-F108-2-3-1-B, YML23/MWR-MDR-C3W)-P44-2-2-1-B, Yunru 21, YS12Q-108, 05SADV1, TLBRS07F16, TLBRS07F10, RML-32/RML-17, RML-4/RML-17, GLSY, ZM-401, ZM-627, 05SADV1, TLBRS07F16, AC9942/AC9944, BGBYPOP, ENNR#24, RAMSO3F08, ENENTRY#28, ENENTRY#34, ENENTRY#32, ENENTRY#21, RML-32/RML-17, Manakama-3, Farmer’s Variety, P051SRCO/P052SRCO, 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, YML23/Cel FSRYS9952HGA-B-5-4-1-B, YML58/(GLS101HGA-S5)-P44-2-2-1-B, Yunru 10, Yunru 407, YML23/MWR-MDR-C3W)-F44-2-2-1-B, Yunru 21, YML23/GRS101P502B-23-2-B, YS12Q-70, Farmer’s Variety, Manakama-3, Dungkhark Local were found susceptible to grey leaf spot disease (Table 1).

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

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### 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 FSRYS95956-B-3-2-4-B, YML58/(G34/36/G33TSR)-F2-B-4-1-B, YML23/GLS101HGA-B-4-1-B, YS12Q-189, P501SRCO/P502SRCO, 05SADV, 07SADV, 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-3-1-1-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/P302-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/MBR-CSW-F108-2-3-1-B, YML23/GLS101HGA-B-4-1-B, YS12Q-33, YS12Q-189, Manakamana-1, YML23/P502-C2-58-1-1-2-5-B, YML23/P302-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-HS8-30-4-4-1-B, YML23/PSEWHSB-CO-F39-1-1-4-3-B, YS12Q-33, YS12Q-71, ZM-401, 07SADV, ZM-627, BGBYPOP, 05SADV, ENTRY#33, ENTRY#36, ENTRY#27, ZM-401, 07SADV, 05SADV, TLBRS07F16, ENTRY#43, ENTRY#24, ENTRY#32 ENTRY#21 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/GLS101P502-B-23-2-B, YML23/P44-C10-HS8-30-2-2-1-B, YML23/P44-C10-HS8-30-4-4-1-B, YML23/P44-C10-HS8-30-4-4-1-B, YML23/PSEWHSB-CO-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, YML23/P44-C10-HS8-30-4-4-1-B, YML23/MBR-CSW-F108-2-3-1-B, YML23/(MBR/MDR-C3W)-F44-2-2-1-B, Yunrui 21, YS12Q-108, 05SADV, TLBRS07F16, TLBRS07F10, RML-32/RML-17, RML-4/RML-17, GLSY, ZM-401, ZM-627, 05SADV, TLBRS07F16, AC9942/AC9944, BGBYPOP, ENTRY#24, RAMSO3F08, ENTRY#28, ENTRY#34, ENTRY#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 FSRYS95952HGA-B-5-4-1-B, YML58/(GLS1Y01/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, Dhungkharg 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 DC 1267/7619))/(F2-5-1-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/(GLS1Y01/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 |
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/GLSII01P502-B-23-2-B| 6539                | 3                      | MS               |
| 9  | YML23/GLSII01P502-B-25-2-B| 7882                | 2                      | MR               |
| 10 | YML23/P44-C10-HS8-30-2-2-1-B| 7187                | 3                      | MS               |
| 11 | YML102/P44-C10-HS8-30-4-4-1-B| 5739                | 3                      | MS               |
| 12 | YML23/P44-C10-HS8-30-4-4-1-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/GLSII01HGA-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               |

| SN | Genotype                          | Grain yield (kg/ha) | Disease Severity (1-5) | Disease Reaction |
|----|-----------------------------------|---------------------|------------------------|------------------|
| 1  | ZM-401                            | 4415                | 2.5                    | MR               |
| 2  | 05SADV1                           | 3882                | 3                      | MS               |
| 3  | 07SADV1                           | 4000                | 2                      | MR               |
| 4  | ZM-627                            | 4283                | 2.5                    | MR               |
| 5  | BGBY-POP                          | 3958                | 2.5                    | MR               |
| 6  | TLBR07F16                         | 3392                | 3.5                    | MS               |
| 7  | TLBR07F10                         | 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: 4867, 2.5

*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  | 05SADV1                           | 3882                | 3                      | MS               |
| 3  | 07SADV1                           | 4000                | 2                      | MR               |
| 4  | ZM-627                            | 4283                | 2.5                    | MR               |
| 5  | BGBY-POP                          | 3958                | 2.5                    | MR               |
| 6  | TLBR07F16                         | 3392                | 3.5                    | MS               |
| 7  | TLBR07F10                         | 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

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               |
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   | TLBR507F16                     | 5200                | 1.8                    | MR               |
| 6   | P501SRCO/P502SRCO              | 5304                | 2.3                    | MR               |
| 7   | AC9942/AC9944                  | 7315                | 1.5                    | R                |
| 8   | GGBYPPOP                       | 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<sub>0.05</sub> 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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