Screening of Maize Genotypes/Hybrids for Identifying Resistant Sources against Banded Leaf and Sheath Blight (BLSB) in Rampur, Chitwan, Nepal

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The research included field screening of maize genotypes/hybrids for resistance to banded leaf and sheath blight (BLSB). The field screening experiment was done in a sick plot maintained at National Maize Research Program (NMRP) of Nepal Agricultural Research Council, Rampur, Chitwan. Fifteen maize genotypes/hybrids were evaluated in the field and replicated three times in randomized complete block design (RCBD). First disease incidence was observed on 60 days after sowing (DAS). Highest disease severity (81.33±1.67) was found in RL-36/RL-197. RML-76/RL-105 and RAMPUR HYBRID-2 had lowest disease severity (66.00±2.00). Also, lowest area under disease progress curve (AUDPC) value (631.67±18.33) was found in RML-76/RL-105, which was at par with P-3533 (660.00±26.67). Cob weight (r = 0.64), cob diameter (r = 0.51) and thousand grain weight (r = 0.50) were negatively correlated with total AUDPC. Total AUDPC value contributed 41.6 percent loss in cob weight, 26.2 percent loss in cob diameter and 25.5 percent loss in thousand grain weight.

Key words: screening, genotypes/hybrids, disease severity, AUDPC, Coorelation

INTRODUCTION

In Nepal maize (Zea mays L.) is the second most important crop grown in terms of production and area. The crop is grown for food, feed and fodder. It is a major traditional cereal crop in rain-fed ecosystem of the hills and mountain. In last ten years the demand of maize is constantly growing by 5 percent (Sapkota and Pokhrel, 2013). Banded leaf and sheath blight caused by Rhizoctonia solani (teleomorph: Corticium sasakii, syn. Thanatephorus cucumeris) is increasing in severity and prevalence in all environments and becoming one of the important diseases of maize throughout the country (Paudyal et al., 2001). This disease was first reported by Bertus in 1927 in Sri Lanka. In Nepal it was reported in 1977 for the first time and found mainly in inner terai causing 90 percent loss (Subedi, 2015). Presence of light brown mycelium which is cottony on the ear of the plant, presence of small and round black sclerotia, premature drying of ears and caking of the ear sheath are the characerized symptom of this disease (Rajput and Harlapur, 2014).

Under favourable climatic conditions loss in grain yield due to BLSB can be upto 40.4 percent (Singh and Sharma, 1977). Lal et al. (1980) reported 31.9 percent yield losses at severity level of 87.3 percent. Development of the resistant cultivar is more ideal for management of the disease but it has not been possible due to non-availability of host resistance. In this study, attempts have been made to identify the least affected genotypes/hybrids of maize in terms of disease severity and Area Under Disease Progressive Curve (AUDPC) against BLSB in field conditions at National Maize Research Program (NMRP) of Nepal agricultural Research Council, Rampur, Chitwan.

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MATERIALS AND METHODS

Field experiment

Field experiment for screening of fifteen maize genotypes/hybrids against *R. solani* causing banded leaf and sheath blight was conducted at the sick plot maintained at the National Maize Research Program (NMRP), Rampur, Chitwan. The size of each plot was 5 x 1.2 m² with plant spacing of 0.35 m and row spacing 0.6m. Two seeds per hill were planted. Ten genotypes and five hybrids altogether fifteen were taken as a treatment.

Disease assessment was made at an interval of 10 days after 65 days after sowing on the basis of 1 to 5 disease scoring scale (Sharma, Srinivas and Basta, 2001) and continued for four times.

Disease rating scale
1.0 Disease on one leaf sheath only; few small, non-coalescent lesions present.
1.5 Disease on two sheaths: lesions large and coalescent.
2.0 Disease on up to four sheaths; lesions many and always coalescent.
2.5 As in disease rating of 2.0 + rind discoloured with small lesions.
3.0 Disease on all sheaths except two internodes below the ear.
3.5 Disease up to one internode below ear shoot; rind discoloration on many internodes with large depressed lesions.
4.0 Disease up to the internodes bearing the ear shoot but shank not affected.

4.5 Disease on the ear; husk leaves show bleaching, bands and caking among themselves as also silk fibers; abundant fungal growth between and on kernels; kernel formation normal except being lusterless; ear size less than normal; some plants prematurely dead.
5.0 In addition to disease rating symptoms of 4.5, shrinkage of stalk; reduced ear dimensions; wet rot and disorganization of ear; kernel formation absent or rudimentary; prematurely dead plants common; abundant sclerotial production on husk leaves, kernels, ear tips and silk fibers.

Area under disease progress curve

Area under disease progress curve (AUDPC) was calculated by using the following formula (Das *et al.*, 1992).

\[ n-1 \]

\[ \text{AUDPC} = \sum_{i=1}^{n-1} \frac{(Y_{i}+Y_{i+1})/2 \times (t_{i+1}-t_{i})}{i} \]

Where, \( Y_{i} \) = disease severity on the \( i^{th} \) date \( Y_{i+1} \) = disease severity on the \( i+1^{th} \) date and \( n \) = number of dates

Disease severity (%)

\[ = \frac{\text{Sum of all numerical rating}}{\text{Total number of samples observed} \times \text{maximum rating}} \times 100 \]

Statistical data analysis

The agronomical, disease scoring were tabulated in excel data sheet. The data were processed to fit into R-studio and analyses were conducted using R 3.0.3 (Team R, 2013) and the agricolae version 1.1-8 package (De Mendiburu, 2014). The data entry was done to develop ANOVA table and different treatments were compared by Duncan’s multiple range test and correlation analysis was done by SPSS.

Figure 1: Sample plants being tagged in the field

Figure 2: A plant showing disease symptoms

Figure 3: Sclerotia in a stem of a maize plant
RESULTS AND DISCUSSION

Disease Severity

On 65 and 75 days after sowing (DAS) the test genotypes and hybrids did not vary for disease severity percentage but varied significantly on 85 and 95 DAS (Table 1). On 85 DAS, highest disease severity was found in genotype JM-8 (69.33±4.00) and hybrid RL-36/RL-197 (68.67±1.67) which were at par with RAMPUR HYBRID-2 (67.33±2.33). Lowest disease severity percentage was found in RML-76/RL-105 (60.33±1.67) which was at par with JM-7 (61.33±1.33), RL-180/RML-5 (61.67±1.00), P-3533 (61.67±4.00), RML-95/RL-105 (62.00±1.00). There was not much variation in disease severity among the genotypes on 65 DAS and 75 DAS. On 95 DAS highest disease severity percentage was found in RL-36/RL-197 (81.33±1.67) which was at par with JM-4 (77.67±0.67), JM-8 (77.00±1.33), RL-180/RML-5 (77.33±3.67). There was lowest disease severity percentage in RML-76/RL-105 (66.00±2.00) and RAMPUR HYBRID-2 (66.00±2.00) which were at par with genotype P-3533 (70.33±1.33). Disease severity on 95 DAS on RAMPUR HYBRID-2 (66.00±2.00) was found to be decreased than disease severity on 85 DAS (67.33±2.33), this may be due to RAMPUR HYBRID-2 developing resistance against this disease in the later days.

Table 1. Severity percentage of banded leaf and sheath blight (R. solani) on different maize genotypes/hybrids at NMRP research field, Rampur, Chitwan, Nepal, 2016

<table>
<thead>
<tr>
<th>Genotypes/Hybrids</th>
<th>65 DAS</th>
<th>75 DAS</th>
<th>85 DAS</th>
<th>95 DAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>RML-76/RL-105</td>
<td>22.00±1.67</td>
<td>42.00±7.33</td>
<td>60.33±1.67c</td>
<td>66.00±2.00d</td>
</tr>
<tr>
<td>RML-87/RL-105</td>
<td>22.00±2.00</td>
<td>39.33±2.33</td>
<td>65.00±1.00bc</td>
<td>73.67±1.67bc</td>
</tr>
<tr>
<td>RL-180/RML-5</td>
<td>21.33±1.00</td>
<td>41.33±0.67</td>
<td>61.67±1.00bc</td>
<td>77.33±3.67ab</td>
</tr>
<tr>
<td>RML-95/RL-105</td>
<td>26.67±2.00</td>
<td>46.67±5.67</td>
<td>62.00±1.00bc</td>
<td>75.67±2.00bc</td>
</tr>
<tr>
<td>RL-153/RL-105</td>
<td>25.33±1.33</td>
<td>47.67±9.00</td>
<td>63.00±3.00abc</td>
<td>71.67±4.33bc</td>
</tr>
<tr>
<td>RML-55/RL-105</td>
<td>21.67±1.33</td>
<td>41.33±3.33</td>
<td>63.67±3.00abc</td>
<td>73.33±1.67bc</td>
</tr>
<tr>
<td>RML-5/RL-105</td>
<td>23.33±1.33</td>
<td>37.33±3.67</td>
<td>63.67±3.00abc</td>
<td>73.33±1.67bc</td>
</tr>
<tr>
<td>RML-85/RL-105</td>
<td>24.67±1.67</td>
<td>50.00±7.33</td>
<td>63.00±6.70abc</td>
<td>73.67±2.33bc</td>
</tr>
<tr>
<td>RML-57/RL-174</td>
<td>23.00±2.33</td>
<td>40.00±1.33</td>
<td>65.67±2.67abc</td>
<td>73.67±0.67bc</td>
</tr>
<tr>
<td>RL-36/RL-197</td>
<td>25.33±0.67</td>
<td>41.33±5.53</td>
<td>68.67±1.67a</td>
<td>81.33±1.67a</td>
</tr>
<tr>
<td>JM-4</td>
<td>21.33±1.00</td>
<td>38.00±8.33</td>
<td>66.67±3.00abc</td>
<td>77.67±0.67ab</td>
</tr>
<tr>
<td>JM-7</td>
<td>24.00±0.67</td>
<td>42.67±1.33</td>
<td>61.33±1.33bc</td>
<td>74.33±1.67bc</td>
</tr>
<tr>
<td>JM-8</td>
<td>23.67±1.00</td>
<td>48.00±3.67</td>
<td>69.33±4.00ab</td>
<td>77.00±1.33ab</td>
</tr>
<tr>
<td>P-3533</td>
<td>23.67±2.00</td>
<td>37.67±2.33</td>
<td>61.67±4.00bc</td>
<td>70.33±1.33cd</td>
</tr>
<tr>
<td>RAMPUR HYBRID-2</td>
<td>25.00±1.67</td>
<td>46.67±5.00</td>
<td>67.33±2.33abc</td>
<td>66.00±2.00d</td>
</tr>
</tbody>
</table>

Means in a column having same letter(s) do not differ significantly at 5 percent probability by DMRT. DAS= Days after sowing

Area under disease progress curve (AUDPC)

The maize genotypes and hybrids did not differ significantly for AUDPC1 and AUDPC2 but differed for AUDPC3 (Table 2). RL-36/RL-197 had the highest AUDPC (750.00±16.67) followed by JM-8 (731.67±16.67) and RL-36/RL-197 (750.00±16.67). RML-76/RL-105 had the lowest AUDPC (631.67±18.33) followed by P-3533 (680.00±26.67).

There was not much significant variation in disease severity and AUDPC among the genotypes. From the results no such genotypes or hybrids were found resistant to BLSB which is also supported by the statement, out of several maize genotypes (inbreds/hybrids) screened against BLSB disease under artificially inoculated conditions, very few genotypes showed resistant to moderately resistant reaction (Rijal et al., 2007). Chaudhary et al., (2016) stated the unavailability of widely adaptable and resistance source to BLSB and necessity of biological or chemical management to reduce the loss from the disease. The fungus is controlled by the use of fungicides because of not having any resistant varieties against BLSB (Muis and Quimio, 2016).

Correlation between total AUDPC and yield attributing characters

Cob weight (r = 0.64), cob diameter (r = 0.51) and thousand grain weight (r = 0.50) were found negatively correlated with total AUDPC (Figure 4, 5 & 6). Total AUDPC value contributed 41.6 percent loss in cob weight, 26.2 percent loss in cob diameter and 25.5 percent loss in 1000 grain weight.
Table 2. AUDPC of banded leaf and sheath blight (*R. solani*) on different maize genotypes at NMRP research field, Rampur, Chitwan, Nepal, 2016

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>AUDPC1</th>
<th>AUDPC2</th>
<th>AUDPC3</th>
<th>Total AUDPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>RML-76/RL-105</td>
<td>320.00±38.33</td>
<td>511.67±40.00</td>
<td>631.67±18.33&lt;sup&gt;e&lt;/sup&gt;</td>
<td>1463.33±91.67</td>
</tr>
<tr>
<td>RML-87/RL-105</td>
<td>306.67±20.00</td>
<td>521.67±16.67</td>
<td>693.33±3.33&lt;sup&gt;bcd&lt;/sup&gt;</td>
<td>1521.67±26.67</td>
</tr>
<tr>
<td>RL-180/RML-5</td>
<td>313.33±8.33</td>
<td>515.00±6.67</td>
<td>695.00±21.67&lt;sup&gt;abcd&lt;/sup&gt;</td>
<td>1523.33±36.67</td>
</tr>
<tr>
<td>RML-95/RL-105</td>
<td>366.67±30.00</td>
<td>543.33±26.67</td>
<td>688.33±10.00&lt;sup&gt;bcd&lt;/sup&gt;</td>
<td>1598.33±65.00</td>
</tr>
<tr>
<td>RL-153/RL-105</td>
<td>365.00±51.67</td>
<td>553.33±55.00</td>
<td>673.33±36.67&lt;sup&gt;de&lt;/sup&gt;</td>
<td>1591.67±133.33</td>
</tr>
<tr>
<td>RML-55/RL-105</td>
<td>315.00±21.67</td>
<td>525.00±10.00</td>
<td>686.67±6.67&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1526.67±26.67</td>
</tr>
<tr>
<td>RML-5/RL-105</td>
<td>303.33±18.33</td>
<td>505.00±6.67</td>
<td>685.00±23.33&lt;sup&gt;bcd&lt;/sup&gt;</td>
<td>1493.33±16.67</td>
</tr>
<tr>
<td>RML-57/RL-174</td>
<td>315.00±8.33</td>
<td>528.33±16.67</td>
<td>696.67±16.67&lt;sup&gt;abcd&lt;/sup&gt;</td>
<td>1540.00±40.00</td>
</tr>
<tr>
<td>RL-36/RL-197</td>
<td>333.33±30.00</td>
<td>550.00±26.67</td>
<td>750.00±16.67&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1633.33±65.00</td>
</tr>
<tr>
<td>JM-4</td>
<td>296.67±46.67</td>
<td>523.33±53.33</td>
<td>721.67±18.33&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1541.67±115.00</td>
</tr>
<tr>
<td>JM-7</td>
<td>333.33±5.00</td>
<td>520.00±11.67</td>
<td>678.33±15.00&lt;sup&gt;bcde&lt;/sup&gt;</td>
<td>1531.67±26.67</td>
</tr>
<tr>
<td>JM-8</td>
<td>358.33±23.33</td>
<td>586.67±38.33</td>
<td>731.67±16.67&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1676.67±78.33</td>
</tr>
<tr>
<td>P-3533</td>
<td>306.67±13.33</td>
<td>496.67±13.33</td>
<td>660.00±26.67&lt;sup&gt;de&lt;/sup&gt;</td>
<td>1463.33±41.67</td>
</tr>
<tr>
<td>RAMPUR HYBRID-2</td>
<td>353.33±23.33</td>
<td>570.00±21.67</td>
<td>705.00±6.67&lt;sup&gt;abcd&lt;/sup&gt;</td>
<td>1628.33±51.67</td>
</tr>
</tbody>
</table>

Means in a column having same letter(s) do not differ significantly at 5 per cent probability by DMRT

Ns = Not significant

$P$-Value | 0.214  | 0.359  | 0.0104<sup>*</sup> | 0.306  |
LSD      | Ns     | Ns     | 49.568     | Ns     |
CV (%)   | 13.348 | 8.834  | 4.283      | 7.035  |
Grand mean | 332.67 | 502.133| 692.00     | 1561.001|

Figure 4. Correlation between total AUDPC and cob weight

Figure 5. Correlation between total AUDPC and cob diameter

Figure 6. Correlation between total AUDPC and 1000 grain weight
CONCLUSION

From these results it may be concluded that sources of host resistance to banded leaf and sheath blight disease may not be adequate because none of the genotypes/hybrids showed resistant against Banded leaf and sheath blight. However, the hybrid RML-76/RL-105 showed some level of resistance with least disease severity and AUDPC among the test genotypes/hybrids. Using RML-76/RL-105 for sowing in the field along with biological and chemical control can reduce the effect of this disease. RAMPUR HYBRID-2 also showed resistance to BLSB in the later days with least disease severity among other genotypes/hybrids but it has high disease severity during the grain filling period of the crop which plays a significant role in yield determination of the crop but need to be studied further more. This disease is found to contribute in different yield attributes like Cob weight, cob diameter and 1000 grain weight which are crucial for the production and productivity of the crop.

ACKNOWLEDGEMENTS

I would like to acknowledge Premier Publishers for providing full waiver during the publication process.

REFERENCES


Accepted 21 August 2019


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