Changes in susceptibility to soybean rust caused by *Phakopsora pachyrhizi* associated with plant age and leaf node position

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Justification

Understanding the effect of plant age and leaf node position on susceptibility to rust is important for determining optimum timing for fungicide sprays and designing the most reliable protocols for assessing resistance of soybean genotypes. Under field conditions, soybean rust is usually most severe after flowering and on the lower leaves, but it is not clear if this response is due plant physiological stages or due to a canopy environment effect. The goal of this work is to clarify if the effect of plant age and leaf node position on susceptibility to rust.

Objectives

- To determine the effect of plant age and leaf node position on soybean rust severity in outdoor and greenhouse conditions.
- To test the relationship between attached and detached leaf assays in assessing leaf susceptibility to rust.

Methodology

- Soybeans (cv Williams 82) were grown in Sept-Nov 2008 in 7" diameter pots maintained in greenhouse conditions (21±2°C) and outdoors (min. -2°C, max 32°C).
- Planting was staggered every 5 days to obtain plants of seven ages at the time of inoculation.

**Leaf Node**

<table>
<thead>
<tr>
<th>Leaf Node</th>
<th>Plant ages and growth stage at time of inoculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 d</td>
<td>44 d 49 d 54 d 59 d 65 d 70 d 75 d</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

- *Phakopsora pachyrhizi* suspension (4000 spores / ml) was sprayed homogeneously to leaves on the 2nd, 5th and 7th node of each plant ranging in age from 39 (V4) to 75 (R8) days old.
- After inoculation, one lateral leaf was detached and placed on water agar in petri plates in a growth chamber (72±2°C), or left attached to the plants.

Disease assessments

- Severity (% leaf area)
- Lesion density (8 lesions/cm²)
- Sporulation (1-5 rating)
- Pustule number per lesion

Effect of Plant Age

- Soybean leaves were susceptible to rust on plants inoculated at all ages tested.
- Rust severity, lesion density, sporulation, and pustule number per lesion were greater (P<0.05) on older plants compared to younger plants.
- However, the effect of plant age was more evident on outdoor plants than greenhouse plants possibly due to low disease severity in the greenhouse.
- The effect of plant age was most evident on leaves on node 2 and node 5, but was generally not significant on node 7 leaves.

Lesion density, sporulation and pustule number per lesion on leaves of outdoor plants in attached and detached leaf assays.

Comparison of Attached and Detached Leaf Assays

- Linear regressions showed a significant predictive relationship between detached and attached leaf assays on outdoor plants, but the coefficient of determination depended on leaf node.
- On greenhouse plants, the detached leaf assay was not a good predictor of rust severity or lesion density observed on attached leaves.

Coefficient of determination (R²) for the relationship between attached and detached leaf assays

<table>
<thead>
<tr>
<th>Leaf Node</th>
<th>Outdoor plants</th>
<th>Greenhouse Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity</td>
<td>Lesion density</td>
<td>Severity</td>
</tr>
<tr>
<td>R²</td>
<td>R²</td>
<td>R²</td>
</tr>
<tr>
<td>Node 2</td>
<td>0.34 0.22</td>
<td>0.5</td>
</tr>
<tr>
<td>Node 5</td>
<td>0.55 0.75</td>
<td>Not Significant</td>
</tr>
<tr>
<td>Node 7</td>
<td>0.70 0.42</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Results

Effect of Leaf Node

- Overall effects of leaf node, averaged over all plant ages, were significant (P<0.05) for most rust variables measured on outdoor plants, but the effect of node was generally not significant for greenhouse plants.
- In outdoor plants, leaves on node 2 (bottom canopy) generally showed greater severity, lesion density and sporulation than leaves on node 7 (upper canopy).
- On outdoor plants inoculated at R4, severity, lesion density and sporulation was greater (P<0.05) on node 2 than on node 7 in detached leaf assays. However, the effect of leaf node was not significant for any rust variable in the attached leaf assay.

Mean rust severity and sporulation for each leaf node on outdoor plants inoculated at R4

Conclusions

- This study confirms that soybean plants are susceptible to rust at all stages of development, but that plants in vegetative stages are less susceptible than those infected at reproductive growth stages.
- The fact that severity and sporulation was positively related to plant age when exposed to a constant environment and inoculum pressure suggests that susceptibility is associated with plant physiological maturity. However, in outdoor conditions, canopy environment and inoculum density will likely interact with plant physiology in the development of rust.
- Detached leaf assays are fast and practical to use, but their reliability in predicting soybean susceptibility to rust may depend on the physiological maturity of the leaves used and on the environment plant are exposed to in natural conditions.
- This information may be useful for determining the best times to rate rust for evaluations of soybean resistance.
- Microscopic observations of the infection process on leaves of different ages are being conducted to investigate the mechanisms behind the differences observed in susceptibility to rust.

Acknowledgment

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