ANTHRACNOSE RESISTANCE IN STEM AND LEAVES OF COMMON BEAN IS CONFERRED BY ASSOCIATION OF DOMINANT AND RECESSIVE GENES

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Anthracnose, caused by the ascomycete Colletotrichum lindemuthianum (Sacc. & Magn.) Lams-Scrib., is one of the most important diseases of the common bean (Phaseolus vulgaris L.) in Brazil and in other bean growing regions of the world. Typical symptoms of common bean anthracnose are observed in the leaf and in pods. However, if the environment favors the development of fungus, injuries in the stem can also be observed. This may weaken the stem and impair its capacity to support the plant. Differential symptoms in leaves and stem were observed in segregating populations derived from backcrosses involving common bean Brazilian cultivar AN 910408 (Carioca x [carioca (Rio Tibagi x Guanajuato 31)], resistant to races 64, 67, 73 and 83 of C. lindemuthianum, with susceptible recurrent parent cultivar Rudá. This led to the hypothesis that different genes might be involved in resistance in leaves and stem. Thus, this work aimed to study the genetic mechanisms of the resistance in the leaf and stem in segregating populations from backcrosses involving resistant cultivar AN 910408 and susceptible cultivar Rudá.

MATERIAL AND METHODS. BC4F2 plants derived from crosses between cultivars Rudá (recurrent) and AN 910408 (donor) were used. These crosses are part of a common bean backcross breeding program assisted by molecular markers conducted at the Universidade Federal de Viçosa, Viçosa, MG, Brazil. One hundred and sixty BC4F2 plants and twelve plants of each genitor were sown in the greenhouse. Fourteen days after sowing the first expanded trifoliate leaf of each plant was inoculated with spore suspensions of C. lindemuthianum race 83 (1.2 x 10^6 spores/ml). Spore suspensions were applied with a horse-hair paint brush according to Pio-Rivero and Chaves (1975). The plants were then incubated for seven days in a mist chamber, which was maintained at 20 - 22 °C and 100% relative humidity. After this period, each plant was scored visually for disease symptoms using a 1 - 9 scale (Rava et al., 1993) in which 1 (one) is attributed to plants with no visible symptoms and 9 (nine) to severely diseased or dead plants. For evaluation of anthracnose symptoms in the stem, plants with no symptoms or with very small dark brown lesions were evaluated as resistant. Plants with severe symptoms showing depressed and obscure cankers leading or not to stem breakage were considered susceptible. The observed values of resistant and susceptible plants were compared with the expected values, for each tested hypothesis, through the Chi-square test.

RESULTS AND DISCUSSION. Previous inheritance studies showed that AN 910408 possesses one resistance gene to C. lindemuthianum race 73 (Paula Jr. et al., 1997). Our results indicate that two genes which interact epistatically, one dominant and one recessive, are involved in the genetic control of leaf anthracnose resistance when this cultivar was inoculated with C.
lindeemuthianum race 83 (Table 1). As for stem anthracnose resistance, two genes also epistatic, one
dominant and one recessive, explain the resistance to C. lindeemuthianum race 83 (Table 1). The
combined analysis of anthracnose symptoms in leaves and stems in a BC4F2 population (Rudá x AN
910408) showed that 21 plants did not present any symptoms in leaves or stems, whereas 11 showed
symptoms only in stems, 3 showed symptoms only in leaves, and 125 showed symptoms in
both organs (Table 2). Although these two characteristics present the same genetic control when
analyzed separately (segregation 3:13, Table 1), the hypothesis that both are controlled by the same
genes was rejected, because there were individuals that presented leaf resistance but stem
susceptibility, and the opposite was also true. Our analyses indicate that the recessive gene is the
same for leaf and stem resistance, however, the dominant genes are distinct and independent from
each other (Hypothesis 2 - Table 2). These resistance genes could be part of a complex cluster that
confers resistance to other races of C. lindeemuthianum in cultivar AN 910408.

Table 1 – Separate analyses for common bean leaf and stem anthracnose resistance to C.
lindeemuthianum race 83

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Population</th>
<th>Organ</th>
<th>Observed ratio</th>
<th>Expected ratio</th>
<th>Expected Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:13 (R:S)</td>
<td>Rudá x AN 910408</td>
<td>Leaf</td>
<td>32 128</td>
<td>30 130</td>
<td>3/16 13/16</td>
</tr>
<tr>
<td>3:13 (R:S)</td>
<td>Rudá x AN 910408</td>
<td>Stem</td>
<td>24 136</td>
<td>30 130</td>
<td>3/16 13/16</td>
</tr>
</tbody>
</table>

*3:13 = Resistance is only conferred when one dominant and one recessive genes are present
* Chi-square value ($\chi^2$)

Table 2 – Hypothesis test for combined inheritance of common bean leaf and stem
anthracnose resistance in cultivar AN 910408

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Observed Number</th>
<th>Expected frequency</th>
<th>Expected number</th>
<th>$\chi^2$</th>
<th>P</th>
<th>Expected frequency</th>
<th>Expected number</th>
<th>$\chi^2$</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf</td>
<td>Stem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>S</td>
<td>125</td>
<td>43/64</td>
<td>107.5</td>
<td></td>
<td>49/64</td>
<td>122.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>S</td>
<td>11</td>
<td>9/64</td>
<td>22.5</td>
<td>49.93</td>
<td>0%</td>
<td>3/64</td>
<td>7.5</td>
<td>4.48</td>
</tr>
<tr>
<td>S</td>
<td>R</td>
<td>3</td>
<td>9/64</td>
<td>22.5</td>
<td></td>
<td>3/64</td>
<td>7.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>R</td>
<td>21</td>
<td>3/64</td>
<td>7.5</td>
<td></td>
<td>9/64</td>
<td>22.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Hypothesis 1: Anthracnose resistance in leaf and stem is given by $A_\_ bbcc$; leaf resistance is given by $A_\_ bb$ and stem resistance by $A_\_ cc$.
* Hypothesis 2: Anthracnose resistance in leaf and stem is given by $A_\_ bb C_\_ $; leaf resistance is given by $A_\_ bb$ and stem resistance by $bb C_\_ $.
* Chi-square value ($\chi^2$); * Probability; * Resistant, * Susceptible

References.


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