Research Notes: United States: Instability of virulence characters of soybean mosaic virus strains after seed transmission

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1) Instability of virulence characters of soybean mosaic virus strains after seed transmission

Soybean mosaic virus (SMV) is distributed worldwide. The primary mode of transmission is through seed (Goodman and Oard, 1980), although the virus is also nonpersistently transmitted by aphids (Irwin and Goodman, 1981). Cultivars have been identified which combine tolerance to SMV infection and low incidence of transmission through seed (Goodman and Oard, 1980).

Several reports exist of the variety in symptoms caused by various isolates of SMV observed in various soybean cultivars. In 1979, Cho and Goodman classified 98 isolates of SMV from seeds in the USDA soybean germplasm collection into seven strains (G1 - G7) based on disease reactions of soybean cultivars to these strains. The authors recommended that a range of SMV strains differing in virulence should be used in breeding programs in which SMV resistance is an objective. A few years later, Polston, Xu, and Goodman (unpublished) identified several additional strains of SMV from the People's Republic of China. These were more virulent than G1 - G7, and produced different reaction patterns on the differential soybean lines than did the seven classified strains.

Recent evidence suggests that even the seven characterized strains (G1 - G7) may possess unstable virulence characteristics when they are transmitted through seeds. Virus isolates recovered from seedlings of parents inoculated with a particular strain may not match the differential host reactions of the inoculated strain. Implications of this instability may be significant in breeding programs.

Materials and methods: Two strains of SMV, G2 and G4, were obtained from infected tissue dried and stored over silica gel or calcium sulfate at -20°C by Cho after his classification studies. These were inoculated onto soybean cultivar 'Williams' for increase. The soybean cultivar 'Midwest' was used for transmission experiments, since it is reported to transmit SMV through seed at a rate of 21.7% (Bowers, 1980). Midwest seedlings were used 24 days after planting, approximately two weeks prior to flowering, at the 3-trifoliolate stage. All seedlings showing symptoms of virus infection were removed. One primary leaf from each remaining plant was frozen for later analysis by enzyme-linked immunosorbent assay (ELISA) to insure that all test plants were initially virus-free. For inoculations, SMV-infected leaf tissue was ground in 0.01 M sodium phosphate, pH 7.2, and 600-mesh carborundum was added to the slurry. Inoculum was rubbed onto test-plant leaves with a cotton-tipped applicator. Leaves were rinsed with tap water. Twenty plants were inoculated with G2, 20 with G4, and 20 received treatment with G2 and G4 (G2 was inoculated onto the youngest trifoliolate, G4 onto the next youngest). Test plants were kept in a greenhouse with supplemental fluorescent lights at 70-80°F until they flowered, set seeds, and reached seed maturity, about 11 weeks after inoculation. Shortly before test plants dried, leaves were collected from four plants of the G2 group, four of the G4 group, four of the group with G2 and G4, and three of the buffer controls. These samples were used to inoculate the soybean differential lines used by Cho and Goodman (1979) to confirm
the identity of the virus strains. Seeds from test plants were collected and dried at room temperature for two weeks, treated with Captan, and planted in sand benches in the greenhouse. Five days later, one primary leaf from each plant was collected for testing by ELISA. Four weeks after planting, young tissue was collected from each of the seedlings shown by ELISA to be infected with SMV. This tissue was used to inoculate sets of differential soybean lines to identify the strain(s) of SMV in the seedlings.

Results and discussion: The results of these experiments are summarized in Table 1. The identity of the SMV strain recovered from inoculated test plants at the end of the growth period was, in all cases, the same as that with which the plants were inoculated at the beginning of the experiment. Some of the seeds produced by these plants contained SMV, through seed transmission. However, the identity of the virus strain in the offspring seedling was not always the same as that present in the parent plant. We also found that Midwest plants which arose from seeds in our seed lot previously infected with SMV also produced seeds carrying a different SMV strain. It was not always possible to pinpoint the identity of a strain absolutely. For example, according to Cho and Goodman's (1979) scheme, if a sample causes mosaic symptoms in Williams and necrosis in 'Ogden' and 'Marshall', it could be strain G3 alone or a combination of strains G2 and G3 (Table 2). Nonetheless, our results indicate that the virulence of SMV transmitted through soybean seeds may be altered. The mechanism by which this apparent selection for altered virulence via seed transmission occurs is unknown.

Table 1. Identification of strains of SMV from soybean cultivar Midwest before and after transmission through seeds

<table>
<thead>
<tr>
<th>Used to inoculate</th>
<th>Identified in previously infected virus-free parent plants (uninoculated) parent</th>
<th>Identified in parent plants at plant maturity</th>
<th>Identified in seedlings from seeds of parent plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>G2</td>
<td>G2</td>
<td>G3 alone, or G2 and G3</td>
<td></td>
</tr>
<tr>
<td>G4</td>
<td>G4</td>
<td>G2 and G3 and G4</td>
<td></td>
</tr>
<tr>
<td>G2 and G4</td>
<td>G2 and G4</td>
<td>G3 alone, or G2 and G3</td>
<td></td>
</tr>
<tr>
<td>Buffer</td>
<td>No virus</td>
<td>No virus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>G2</td>
<td>G3 alone, or G2</td>
<td></td>
</tr>
</tbody>
</table>

*Identification of SMV strains was done by inoculation onto differential soybean lines (Cho and Goodman, 1979).*
Table 2. Reactions of SMV strains G2, G3 and G4 on differential soybean lines of Cho and Goodman (1979)

<table>
<thead>
<tr>
<th>Virus strain</th>
<th>Soybean cultivar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Williams</td>
</tr>
<tr>
<td>G2</td>
<td>M(^a)</td>
</tr>
<tr>
<td>G3</td>
<td>M</td>
</tr>
<tr>
<td>G4</td>
<td>M</td>
</tr>
</tbody>
</table>

\(^a\)Symbols for symptoms: -- = symptomless, no virus detected by assay on bean; M = mosaic; N = necrosis.

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Literature Cited


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