SUGARCANE MOSAIC VIRUS IN TAIWAN

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ABSTRACT

Five Taiwan isolates of sugarcane mosaic virus (SCMV) were classified on the basis of symptoms on differential host varieties. The SCMV strains from Taiwan were as follows: the fine stripe type and the necrotic type = mixture of SCMV-A and -B; the short stripe type = SCMV-B; the yellow stripe type = SCMV-A, and a Badila cane isolate = SCMV-D. The data obtained on physical properties, serology, purification, and electron microscopy were consistent with these identifications, although these methods could not be used independently, without symptoms, as the identifying criteria.

INTRODUCTION

In 1950, Liu reported the presence of at least four strains of sugarcane mosaic virus (SCMV) in Taiwan. He listed a short stripe type, a necrotic type, a yellow stripe, type and a fine stripe type. These were collected on the commercial varieties of sugarcane present at that time. Sugarcane clones F 108, POJ 2883, Co 281, 35-119 and 34-1347 were found to be useful in strain differentiation. In 1953, Liu and reported that only three strains (fine stripe, short stripe, and yellow stripe) were present in Taiwan; they mentioned no necrotic symptoms. Leu and later also found only the three distinct strains, but they mentioned that the short stripe type produced a severe mottling, necrosis, and stunting when inoculated onto clones 40-1311, 41-667, 53-363 and 53-383.

Abbott and Stokes attempted to classify the Taiwan strains with the differential host system used by Summers et al and updated by Abbott and Tippitt. Abbott and Stokes identified the yellow stripe as SCMV strain A and suggested that the fine stripe might be SCMV-F.

In this paper, a description was done to the tests to classify five isolates of SCMV from Taiwan by symptomatology on differential varieties and by electron microscopy, serology, purification, and physical properties, so that the Taiwan strains may be related to those found in the USA and other cane-growing countries.
MATERIALS AND METHODS

The yellow stripe type (YST), fine stripe type (FST), and necrotic type (NT) mosaic isolates were collected on Saccharum interspecific hybrid 53-363 and the short stripe type (SST) was collected on hybrid 54-420. The FST, SST, and YST were thought to represent the types described by Leu and Bae. The NT was the type obtained by inoculation of 53-363 with SST and maintained in the field since 1966 (Leu and Bae). The Badila isolate (BdI) was collected on the S. officinarum clone Badila (a chewing cane). All isolates were collected in Taiwan.

Varieties with symptoms diagnostic for strain identification were used. These were Saccharum hybrids CP 31-294, CP 31-588, and Co 281; Sorghum bicolor cv. 'Rio'; and Sorghum halepense (Johnsongrass). These varieties were also inoculated with strain A, B, or D of SCMV. The Taiwan isolates were tested twice (in the fall of 1977 and the following winter). The NT and FST isolates were tested again in the spring of 1978. These tests were performed in the quarantine greenhouse at Beltsville, Maryland. Similar tests conducted in Taiwan during the winter and the spring did not have SCMV-A, -B, and -D available for comparison. Diagnostic varieties were inoculated with an artist’s airbrush. Assay plants (Rio sorghum) used for thermal inactivation point (TIP) and dilution end point (DEP) tests were inoculated by the finger rub method. The source plants for the DEP tests were Rio sorghum and those for the TIP test, 'Sart' sorghum.

All of these isolates were purified from Rio sorghum by the method of Gillaspie. Tissue was extracted by the ascorbic acid method, concentrated and purified by differential centrifugation followed by a rate-zonal centrifugation in sucrose density gradients. Samples for serology and electron microscopy were resuspended in 0.01 M borate buffer, pH 8. Microprecipitin tests were used to compare the serological reactions of the Taiwan isolates to antisera of SCMV strains A, B, D, H, and I. Samples were negatively stained with 2% phosphotungstic acid, pH 7, for electron microscopy. Only the general morphology of the virus particles was determined and not accurate normal length.

RESULTS

All of the Taiwan isolates and the known SCMV strains produced infectious bands in comparable areas of sucrose density gradients after rate zonal centrifugation and all were flexuous rods resembling those of the potyvirus group. All of the Taiwan isolates and SCMV-A, -B, and -D had a TIP between 54 and 57 C. The DEP varied from 1:00 to 100,000 from one test to another, but all of the isolates, except NT, and the known strains had average DEP’s of 1:1000 to 1:100,000. The NT isolate DEP was 1:10,000 to 1:100,000.

The diagnostic variety test results indicate that isolate YST was SCMV-A, BdI was SCMV-D, and SST was SCMV-B. All of the isolates produced mild mosaic symptoms on Co 281 and did not infect johnsongrass, eliminating the possibility of SCMV-C or maize dwarf mosaic virus. Isolates FST and NT differed somewhat from the described strains. The FST and NT isolates produced some symptoms of SCMV-A and some of SCMV-B. Symptoms of an artificially produced mixture of SCMV-A and -B were similar to the symptoms of FST on CP 31-294 and CP 31-588.
The NT symptoms were more variable than those of the other isolates. Some CP 31-294 plants infected with NT had symptoms very similar to those of SCMV-B alone and other plants had symptoms similar to those of a SCMV-A and -B mixture. As the symptoms produced by NT differ from those of FST even though both isolates appear to be mixtures of SCMV-A and -B, it is probable that the components of the mixture are maintained in different ratios (Gillaspie and Koike).

The microprecipitin test data, shown in Table 1, indicate that all of the Taiwan isolates are serologically related. All produced heterologous titers similar to or lower than the homologous titers with SCMV-A, -B, -D, and -H antisera and no reaction with SCMV-I antiserum. These results correlate well with the strain identification obtained from the differential variety tests described above.

**TABLE 1. Classification of Taiwan isolates of sugarcane mosaic virus**

<table>
<thead>
<tr>
<th>Taiwan Symptom Designation</th>
<th>Sugarcane Variety Source</th>
<th>SCMV Strains</th>
<th>Microprecipitin Reaction</th>
<th>Antiserum to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine Stripe type</td>
<td>53-363</td>
<td>A + B</td>
<td>++</td>
<td>+ -</td>
</tr>
<tr>
<td>Necrotic type</td>
<td>53-363</td>
<td>A + B</td>
<td>++</td>
<td>+ -</td>
</tr>
<tr>
<td>Short stripe type</td>
<td>54-420</td>
<td>B</td>
<td>++</td>
<td>+ -</td>
</tr>
<tr>
<td>Yellow Stripe type</td>
<td>53-363</td>
<td>A</td>
<td>++</td>
<td>+ -</td>
</tr>
<tr>
<td>Badila isolate</td>
<td>Badila</td>
<td>D</td>
<td>++</td>
<td>+ -</td>
</tr>
</tbody>
</table>

1 Classification of sugarcane mosaic strains according to Summers et al., and Abbott and Tippett.

2 Serological reactions: ++ = titer about the same as homologous titer of antiserum: + = titer lower than homologous of antiserum -- = no reaction.

**DISCUSSION**

Symptomatology, purification, serology, physical properties, and electron microscopy data are consistent with the identification of the Taiwan isolates as follows: Bd1 = SCMV-D, FST and NT = mixtures of SCMV-A and -B, SST = SST = SCMV-B, and YST = SCMV-A.

Our DEP and TIP results for SCMV-A, -B, and -D agree closely with those of Abbott and Tippett, Tocic and Ford, and Zummo except for the slightly lower TIP value obtained for SCMV-A (52-53 C) by Abbott and Tippett. This close agreement is gratifying because of the variety of source and assay plants used in obtaining these results by the different authors. The variation in TIP and DEP data among tests did not allow use of these data in strain identification.
There are indications that FST has taken on the characteristics of a new strain. Sugarcane clones 53-22, 53-29, and 53-32 are resistant to YST (SCMV-A) and SST (SCMV-B) but very susceptible to FST (SCMV-A and -B); and *Saccharum barberi* is susceptible to YST and SST, but immune to FST (Leu and Bau⁶, Liu and Li⁷).

Our results for the YST isolate are similar to those of Abbott and Stokes¹, but they found FST to be similar to SCMV-F. Strain F could be included in the FST mixture that we tested since the mild symptoms of SCMV-F could probably be masked by the more severe symptoms of SCMV-A and -B. The FST and NT isolates reacted with antiserum to a Pakistan isolate (4975) that has been tentatively identified as SCMV-F (Gillaspie *et al.*⁵) and BdI, SST, and YST failed to react significantly in microprecipitin tests with the 4975 antiserum (R. W. Harris, Unpublished data). However, the 4975 antiserum was of low titer, so that the significance of these data is unknown. Also, FST does not infect johnsongrass, and the 4975 isolate does. The NT isolate used had apparently become contaminated during the 12 years it was maintained under field conditions since NT and SST had very different symptoms on the diagnostic sugarcane clones.

REFERENCES


4. ———— and H. Koike (1973). Sugarcane mosaic virus and maize dwarf mosaic virus in mixed infections of sugarcane and other grasses. Phytopathology 63, 1300-1307


LAS CEPAS DEL VIRUS MOSAICO DE LA CAÑA EN TAIWAN

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RESUMEN

Se identificaron cinco aislados del virus del mosaico de la caña de azúcar de Taiwan a base de las síntomas en las variedades diferenciales. Las Cepas del virus mosaico de Taiwan fueron designadas como sigue: el tipo de raya fina y de necrotica de Taiwan = una mezcla de cepa A y B; el tipo raya corta = cepa B; el tipo raya amarilla = cepa A; y el aislado de la caña Badila = cepa D.

La data obtenida sobre la propiedad física, la serología, la purificación y la microscopía electrónica fueron consistente con las identificaciones, aunque los métodos no se usan independientemente como criterios de identificaciones sin síntomas.