# Use of a Set of Differential Sorghum Inbred Lines to Compare Isolates of Sugarcane Mosaic Virus from *Sorghum* and Maize in Nine Countries

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**ABSTRACT**

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Eleven inbred sorghum lines (OKY8, BTx3197, Atlas, Rio, BTx398, SA8735, NM31, SC0097-14E, Q7539, QL11, RTx430) were distributed to cooperators in nine countries. The reactions of selected johnsongrass-infecting isolates of sugarcane mosaic virus (SCMV-Jg) and maize dwarf mosaic virus (MDMV) on these sorghum lines indicated that the isolates could be grouped as follows: 1) the Australian SCMV-Jg, which alone produced a necrotic red stripe reaction on sorghums OKY8 and SA8735, which have the dominant *N* gene; 2) isolates of SCMV-Jg and MDMV-A from the United States and Europe that produced systemic mosaic symptoms in OKY8; and 3) the Venezuelan MDMV, which induced severe systemic necrosis in RTx430. QL11 with the Krish SCMV resistance source was highly resistant to all isolates within the three suggested groupings.

Strains of sugarcane mosaic virus (SCMV) infect sorghum (*Sorghum bicolor* (L.) Moench) in most countries where the crop is grown, including Argentina (2), Australia (17), France (15), India (10), Italy (5), United States (20), Venezuela (13), and Yugoslavia (9).

Among SCMV strains, two major groups can be distinguished: strains that readily infect sugarcane (*Saccharum officinarum* L. interspecific hybrids) but rarely infect johnsongrass (*Sorghum halepense* (L.) Pers.) and those that readily infect johnsongrass but not sugarcane. Strains in the first group, of which 12 have been described in the United States, have been principally recovered from sugarcane, whereas those in the latter group have usually been found infecting maize (*Zea mays* L.) and sorghum. Strains from sugarcane have been differentiated primarily on selected sugarcane cultivars (3), whereas the johnsongrass-infecting strains designated as maize dwarf mosaic virus (MDMV) have been separated into strains A, C, D, E, and F and distinguished from each other by symptomatology, differential responses of selected maize inbreds, and differential rates of transmission by two aphid species (8). Inoculation of selected sweet sorghum lines with johnsongrass-infecting isolates from various regions of the United States also revealed considerable variation in their effects on plant growth and severity of leaf symptoms (26).

Johnsongrass-infecting potyviruses from Australia and Europe have generally been designated johnsongrass-infecting strains of SCMV (SCMV-Jg)

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(5,18,22), whereas those from the United States and several South American countries have been described as MDMV-A (4,21). Several studies (16,22, 24,25) have concluded that MDMV-A in the United States is very closely related to several European SCMV-Jg isolates on the basis of host range and serological relationships and should be considered a strain of SCMV. Grass-infecting potyviruses that do not systemically infect johnsongrass and thus are not grouped with the above include MDMV-B in the United States and two strains from Australia that have *Urochloa mosambicensis* (Hack.) Dandy and *Digitaria didactyla* Willd. as their perennial hosts (17).

SCMV strains induce a wide range of symptoms on sorghum, including local and systemic necrosis, systemic mosaic,

**Table 1.** Reactions of seven differential sorghum lines to sugarcane mosaic virus isolates from sorghum and maize in nine countries

| Isolate<br>Original host | Cooperator, country | Max/min temp (C) | OKY8 | SA8735 | BTx3197 | Atlas | Rio | SC0097-14E | RTx430 |
|---|---|---|---|---|---|---|---|---|---|
| Australia<br>SCMV-Jg<br>Sorghum | D. Persley, Australia | 28/18 | *n* N(RS)[a] | *n* N(RS) | *n* M-N | M-N | *n* M | M | M,SRL |
| United States<br>MDMV-A<br>(ATCC PV55)<br>Maize | A. Gillaspie, R. Mock, United States | 23/13 | M | *n* Ch,N | *n* N | *n* N | Ch,Nfl | Nil | ··· |
| United States<br>MDMV-A<br>(Iowa 65-74)<br>Maize | M. Tosic, Yugoslavia | 30/15 | M | M(N) | *n* M-N | *n* M(N) | (*n*)M(N) | M | M |
| United States<br>MDMV-A<br>Sorghum (Texas) | R. Toler, United States | 29/18 | M | Ch,M | M-N | M-N | M(N) | M | M,SRL |
| United States<br>SCMV-Jg<br>(California)<br>Johnsongrass | M. Tosic, Yugoslavia | 30/15 | M | *n* M(N) | *n* M-N | *n* M(N) | (*n*)M(N) | M | M |
| Yugoslavia<br>SCMV-Jg<br>Maize | M. Tosic, Yugoslavia | 30/15 | M | *n* M(N) | *n* M-N | *n* M(N) | (*n*) M(N) | M | M |
| Italy<br>SCMV-Jg<br>Maize (Bergamo isolate) | M. Conti, Italy | 27/22 | M | *n* N | *n* N | *n* N | M | M(N) | ··· |
| Italy<br>SCMV (SRSV[b] isolate) | J. Dijkstra/ H. Rossel, Holland | 25/20 | M | *n* M | *n* M | *n* M | *n* M,Ch | *n* M | ··· |
| France<br>SCMV-Jg<br>Maize | P. Signoret, France | 27/17 | M | *n* M | *n* M-N | *n* M | *n* M | M | ··· |
| Bulgaria<br>SCMV-Jg<br>Maize (Krushovitsa isolate) | M. Markov, Bulgaria | 35/4 | M | M-N | M-N | M-N | M-N | M(N) | ··· |
| Argentina<br>MDMV<br>Sorghum | E. Teyssandier, Argentina | 37/4 | M | M-N | M-N | M-N | N | M-N | ··· |
| Venezuela<br>MDMV (Johnsongrass strain)<br>Sorghum | M. Riccelli, Venezuela | 30/21 | M | N | N | M-N | M | M | N |
| Nigeria<br>SCMV<br>Maize | H. Rossel, Nigeria | 35/25 | Nil | Nil | Ch,N | *n* Ch,N | *n* Ch,M | Nil | ··· |

[a] n = Necrotic lesions, inoculated leaves, (*n*) = necrotic lesions, inoculated leaves on some plants only or occurred in some tests only, N = systemic necrosis, (N) = necrosis on some plants only or occurred in some tests only, N(RS) = necrotic red stripe reaction, Nfl = necrotic fleck, M = mosaic, M-N = necrosis developed after appearance of mosaic symptoms, Ch = chlorosis, and SRL = slight red leaf.

[b] SRSV = sorghum red stripe virus.

mottling, leaf reddening, and stunting. The development of various symptom patterns depends on genotype, virus strain, temperature, and time of infection (1,7,12,18). The wide range of symptoms produced on sorghum genotypes after SCMV infection has been used to differentiate johnsongrass-infecting potyviruses (19).

Knowledge of the relationships among SCMV strains occurring in different areas of the world is important because of the widespread economic importance of SCMV in sorghum (19) and because resistance and tolerance in sorghum may be strain-specific. In response to recommendations made at the International Workshop on Sorghum Diseases held at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India, in December 1978, this work was initiated to examine the reactions of selected inbred sorghum lines to various SCMV isolates. The lines were selected by virologists and plant breeders in Queensland, Australia, and in Texas. In this paper, data from cooperators in nine countries are presented and discussed.

## MATERIALS AND METHODS

The fixed lines distributed to all cooperators were OKY8, BTx3197, Atlas, Rio, BTx398 (Martin), YEFxSSF WxSA8735-2-8-9-2 (SA8735), NM31, SC0097-14E, Q7539, and QL11. RTx430 was sent to some cooperators. The first seven lines listed were selected because of their characteristic reactions to SCMV in either Queensland or Texas (1,12,18). Q7539 and SC0097-14E are sources of resistance to natural infection (11,19), whereas QL11 incorporates the Krish resistance source (6). Seed of all lines was increased at and distributed from the Hermitage Research Station of the Queensland Department of Primary Industries, Australia.

Cooperators were sent recommended procedures for testing that included an outline of suitable methods of inoculation and advice on assessment of genotype reactions. Photographs of disease symptoms were requested from cooperators. The data presented in this paper were based on the reactions of plants that had been manually inoculated and maintained in a glasshouse, with the exception of data from Venezuela, which were based on manually inoculated plants growing in the field.

## RESULTS AND DISCUSSION

Ten cooperators in nine countries tested one or more SCMV isolates on the sorghum lines supplied. Table 1 presents data for 14 isolates on seven lines which had differential reactions with the isolates used. Four lines not included in Table 1 showed little variation between isolates, viz. NM31—systemic necrosis with all isolates; BTx398—systemic mosaic; Q7539—systemic mosaic with 11 isolates and no symptoms with MDMV-A (ATCC PV55) and SCMV-maize Nigeria; of QL11—no symptoms with any isolates.

The Australian SCMV-Jg isolate could be clearly distinguished from the other isolates tested by the development of the necrotic red stripe reaction (18) on OKY8. This line was either symptomless or developed mosaic symptoms only with all other isolates. The red stripe reaction consists of systemic necrosis within 7 days of inoculation and develops at both high and low temperatures. It is distinct from the necrotic red leaf reaction, which requires low temperatures (lower than 20 C) for expression (12). Lines developing this reaction include Atlas and BTx3197 (1,12). SA8735 can develop both the red stripe and red leaf reactions (12), and consequently for this line, the two reactions need to be distinguished on the basis of temperature dependence and symptomatology.

Only minor differences were evident in the reactions of lines to isolates of johnsongrass-infecting strains from the United States, which included two isolates of MDMV-A and an SCMV-Jg isolate originally obtained from johnsongrass in California (14). Previous work (23) had shown that two of the isolates used in this survey, MDMV-A isolate Iowa 65-74 and SCMV-Jg (California), were identical in antigenic properties and host range.

No major differences were detected between isolates from Europe (Bulgaria, France, Italy, and Yugoslavia). The minor variations in symptom expression on some lines may be attributed to such factors as temperature variations in different locations or minor differences between virus isolates. The European isolates were also similar in reactions to SCMV-Jg and the MDMV-A isolates from the United States. This is consistent with previous work (22,25) indicating a close relationship between johnsongrass-infecting isolates of SCMV from Yugoslavia and Italy and with MDMV-A and SCMV-Jg isolates from the United States.

The Venezuelan isolate can best be distinguished by the development of severe systemic necrosis in RTx430 compared with mosaic symptoms developed by the Australian, U.S., and Yugoslav isolates. This line has previously been found suitable for distinguishing between MDMV-A in the U.S. and Venezuelan isolates of MDMV from sorghum (21).

A sorghum isolate from Argentina induced severe necrosis on Rio and NM31, and occasionally, a temperature-dependent red leaf reaction in SC0097-14E. QL11 did not differentiate any isolate used in this work, but it has been used recently to differentiate a sugarcane-infecting isolate from Pakistan that systemically infected this line (3).

On the basis of the data obtained in this work, johnsongrass-infecting isolates of SCMV from sorghum and maize may be divided into three pathotype subgroups: 1) the Australian SCMV-Jg, 2) SCMV-Jg and MDMV-A isolates from the United States and Europe, and 3) the Venezuelan isolate.

The high resistance of QL11 to all isolates from within the three suggested groupings indicates that Krish resistance is a broad-spectrum source of SCMV resistance that can be used with good durability prospects.

The data presented have limitations because they were collected at several sites under differing environmental conditions. Furthermore, the isolates used were limited to those available to cooperators. The most appropriate means of making a comparative study of isolates would be to test them at one location under a defined set of conditions and include well-characterized isolates as standards.

The data, however, do show that a set of sorghum lines was used successfully to differentiate selected johnsongrass-infecting strains of SCMV and that the three suggested pathotype groups are in good agreement with previous relationships determined by other methods, particularly serology (21–23,25).

The 11 sorghum lines used in this work should form a basis for a set of differentials for SCMV strains. The lines could be used alone or in conjunction with selected maize inbred lines and/or other grass species.


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