Reaction of Cowpea Introductions to Infection with the Cowpea Strain of Southern Bean Mosaic Virus

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ABSTRACT

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In field and greenhouse studies, 1,029 introductions of cowpea were evaluated for reaction to infection with the cowpea strain of southern bean mosaic virus (SBMV-CS). The expression of wide genotype-specific variability for reaction to SBMV-CS infection was, in part, influenced by season. Symptom groups identified and proportion of plants in each group were: mosaic (81%), vein clearing (21%), leaf distortion (18%), stunting and dwarfing (16%), chlorosis (12%), distinct chlorotic spots (2%), early senescence (2%), generalized necrosis (1%), necrotic local lesions (1%), and spindled plants (0.2%). Distinct chlorotic spots, entire leaf chlorosis, generalized necrosis, and spindling plants have not been previously reported in association with SBMV-CS infection. Levels of field tolerance were high, in the form of symptomless carriers. Seed transmission ranged from 0 to 25%; most entries had less than 10%.

Additional key words: southern pea, *Vigna unguiculata, Vigna sinensis*

The cowpea strain of southern bean mosaic virus (SBMV-CS) was first identified by Shepherd and Fulton (10), after it was observed in seedlings of greenhouse grown plants. Symptoms in Early Wilt Resistant Ramshorn cowpeas were prominent vein clearing, which was later replaced by a marked mottle or coarse mosaic patterns, dark green vein banding along the major veins, rugosity and downward cupping of the leaf margins. Additional studies have identified other symptoms such as indistinct chlorotic spots (4), necrotic local lesions on inoculated primary leaves of Clay cowpeas (6), systemic necrosis, death of the growing point (2), stunting, early death (5), and a symptomless reaction (4). The necrotic local lesion response was found to be temperature sensitive, as it became systemic under a growing regime of 32 C (2,5). Immunity to SBMV-CS has not been identified in any of the cultivars tested.

Seed transmission of SBMV-CS has been reported to be 3–4% in Early Wilt Resistant Ramshorn (10) and 23 and 26% in Early Ramshorn and Pinkeye Purple Hull cowpeas, respectively (3).

This study was conducted to evaluate the relationship between cowpea genotype and symptom expression following infection with SBMV-CS under field conditions.

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MATERIALS AND METHODS

Initial field screening. The cowpea plant introduction (PI) collection of 1,013 entries was obtained from the Southern Regional Plant Introduction Station, Experiment, GA, and planted in the field at College Station on 12 May 1977, along with 16 locally grown cultivars. The systemic insecticide aldicarb was banded 10 cm below the soil surface at a rate of 4.5 kg/ha. All entries were grown in single 3-m rows (40–50 plants). Clay and California Blackeye No. 5 cowpeas were planted after every 10th entry to serve as checks.

Inoculum was prepared in the morning approximately 2 hr before inoculation. Fresh SBMV-CS-infected leaf tissue was homogenized in a Waring Blendor for 2 min with cold 0.1 M phosphate buffer, pH 7.2 (1:25, w/v), and filtered through cheesecloth. Carborundum was added to the final suspension at a rate of 0.5% (w/v). Half of the plants in each plot were inoculated by using the artist's airbrush technique (7,9,11) when the primary leaves of most plants were fully expanded and again 2 wk later.

Plants were visually evaluated for symptom development and severity on a continuing basis until maturity. Seeds were harvested at maturity from inoculated plants in selected plots.

Symptomless field screening. A second test with 277 symptomless and 68 other selected entries, representing each of the symptom groups identified in the original screening, was planted on 1 August 1977. Inoculation and evaluation were as before, but under midsummer (35 C day and 25 C night) growing conditions. Symptomless carriers were identified by rubbing leaf extracts in 0.1 M phosphate buffer onto fully expanded primary leaves of four virus-free California Blackeye No. 5 seedlings.

Symptom development was recorded at 4 wk. Introductions that were rated as possibly virus-free were planted and inoculated under greenhouse conditions and indexed using California Blackeye No. 5.

Greenhouse screening. A fall greenhouse screening of 100 seeds from 89 selected introductions was conducted in 8 × 8 cm plastic pots to evaluate seed transmission of SBMV-CS. Symptom development was observed from when the first trifoliate leaves were fully expanded until the plants had four to five

Table 1. Representative entries for each symptom group and number of cultivars with symptoms in each group following inoculation with the cowpea strain of southern bean mosaic virus in two field screenings[a]

Plant reaction	No. of entries	Representative entry (PI no. or cultivar)
Symptomless	147	293537, 323325, 339626
Vein clearing	219	293458, 353047, 353145
Mosaic	837	293458, 353047, 293505
Distinct chlorotic spots	16	293499, 279845, 353076
Chlorosis	122	115683, 171651, 353027
Necrotic local lesions	8	Clay, 194207, 194214
Generalized necrosis	10	183250, 293532, 354685
Spindling	2	353382, 354555
Stunting and dwarfing	167	214069, 293486, 293548
Leaf distortion	189	151563, 211110, 293512
Early senescence	24	115683, 124609, 312202

[a] Many of the 1,029 entries showed multiple symptoms and are thus represented in more than one symptom group.

Table 2. Seed transmission of the cowpea strain of southern bean mosaic virus in selected cowpea introductions

Low transmission[a]		High transmission[a]	
PI no.	(%)	PI no.	(%)
175332	0	162924	20
179555	1	177578	25
180494	0	179125	23
189374	1	184953	23
205139	1	186360	20
211109	0	186459	20

[a] Based on 100 seeds per entry.

fully expanded leaves. A low wattage fluorescent light was used to discern leaf mosaic.

RESULTS

The specific reactions of individual entries have been reported (8). The most common symptom was leaf mosaic (Table 1). Other symptoms included vein clearing, chlorosis, necrotic local lesions, generalized necrosis, distinct chlorotic spots, spindling plants, dwarfing, leaf distortion and early senescence. More than one symptom could be identified in 46% of the cultivars.

Typically, symptoms began as vein clearing in newly formed leaves approximately 1 wk after inoculation. These symptoms abated and mosaic patterns became visible as the leaf matured. No symptoms were observed on flowers, pods or seeds; however, SBMV-CS has been isolated from these parts (3). Symptoms generally were more severe on the newer leaves than on older leaves of the same plant. Reduced growth due to viral infection was most apparent when the plants neared maturity. Symptom development was generally restricted to inoculated plants. No symptoms were visible in 277 entries at the conclusion of the initial field screen.

In the second test or symptomless screen, 147 entries remained free of symptoms (Table 1). Vein clearing, mosaic and leaf distortion were the predominant symptoms in the 198 infected entries. Check plants in the smaller symptom groups, in some cases, did not produce characteristic symptoms under midsummer conditions. Notably, Clay developed a systemic reaction to SBMV-CS infection. By means of plant indexing, 123 of the 147 symptom-free entries were found to be symptomless carriers of SBMV-CS.

The 24 remaining entries developed mild mosaic symptoms in immature leaves when inoculated under greenhouse conditions. SBMV-CS presence was verified by indexing onto California Blackeye No. 5. Immunity to SBMV-CS was not found in any of the PI entries evaluated; however, high levels of field tolerance were present in the remaining entries, namely PI numbers 141355, 246132, 293537, 293541, 293569, 298051, 299895, 300176, 323325, 339581, 339602, 339606, 339623, 339626, 339639, 352834, 352960, 354599, 354671, 354829, 354861, 382109, 382114, and 382133.

Symptom expression of seed-transmitted SBMV-CS was difficult to identify in greenhouse grown seedlings with one to two trifoliate leaf clusters, without the aid of a fluorescent light. In California Blackeye No. 5, seed transmission of SBMV-CS averaged 23%, which is similar to that reported for cowpea mosaic virus by Anderson (1). Of the 89 introductions evaluated, seed transmission of SBMV-CS ranged from 0 to 25% (Table 2); 7 entries developed no symptoms, 60 had fewer than 10% infected plants, and 22 had 10–25% infected plants.

DISCUSSION

Reaction of cowpea to infection with SBMV-CS was genotype specific. A dynamic plant-virus relationship was demonstrated through symptom variation with plant age and season of planting. Kuhn and Adams (5) reported SBMV-CS to be temperature sensitive with respect to the amount of replication in the plant. A genotype-temperature interaction was also observed. This could be a major cause of symptom variation between the spring and midsummer plantings. In the midsummer trial, chlorosis and mosaic patterns were observed on Clay, which has demonstrated resistance to SBMV-CS. Although mosaic patterns were the predominant symptom, nine other symptom groups were observed. These results indicated that symptoms alone may be inadequate for identification of SBMV-CS. Previously unreported symptoms associated with SBMV-CS infection include distinct chlorotic spots, chlorosis of entire leaves, generalized necrosis, and spindling plants. High levels of field tolerance were identified in the form of symptomless carriers. This type of tolerance may be of more value than the local lesion type, which has the ability to become systemic under warm field conditions.

The variability in rate of seed transmission suggested the possibility of genetic differences; however, some low rates of transmission probably could be attributed to levels of host plant resistance. Utilization of genotypes with low seed transmission would be a factor in controlling the spread of SBMV-CS.

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