Seed Transmission and Yield Losses in Tropical Soybeans Infected by Soybean Mosaic Virus

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ABSTRACT

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Ten tropical soybean accessions—five with low incidence of soybean mosaic virus (SMV) transmission through seeds (PI 86736 [Arisoy], PI 203406, PI 325779, PI 341256, and UFV-1), three with relatively high incidence of SMV seed transmission (PI 181698, PI 281901, and PI 340901), and two tropically adapted, widely used cultivars (Improved Pelican and Jupiter)—were planted at Isabela, Puerto Rico (18° N) in a randomized complete block design with split plots. Plants of each entry were or were not inoculated with an isolate of SMV not transmissible by aphids. Entries previously identified as nontransmitters of SMV through seed were found to transmit the virus but at very low incidence ($\leqslant$0.2%). Improved Pelican also had a low incidence (0.23%) of virus transmission through seeds. Yield loss from SMV infection was linearly related to the logarithm of the percentage of seed transmission (r = 0.86). While the fundamental significance of this correlation is obscure, it is of considerable practical interest that soybean accessions are available that combine tolerance to SMV infection and low incidence of transmission through seeds.

Soybean mosaic virus (SMV) is distributed worldwide because of virus transmission through soybean seeds and the international movement of soybean germ plasm that began more than two centuries ago. Seedborne spread of SMV is reduced or prevented when seed producers harvest only plants known to be SMV-free until at least the end of flowering, thereby preventing harvest of SMV-infected seeds. This labor-intensive approach may be feasible for breeders or commercial seedsmen and is the basis of plant quarantine of SMV and other seedborne viruses. When growers must plant their own seeds, however, as in many developing agricultural economies that lack a commercial seed trade, another approach is needed. We therefore investigated the possibility of developing soybean cultivars with low incidence of SMV transmission through seeds. In a previous report (3), we identified several tropical and temperate soybean germ plasm lines that produced no SMV-infected seedlings when 1,000 seeds from infected plants were germinated and indexed. Further study of the same tropical lines has revealed that these lines do transmit the virus via seeds but at a low incidence. We also investigated the yield reductions caused by SMV in lines with different seed transmission incidence.

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MATERIALS AND METHODS

The experiment was conducted at the Estacion Experimental Agricola, Subestacion de Isabela, Isabela, PR (18°N). A randomized complete block design with split plots was used; 10 entries were replicated six times. Each plot consisted of four 1-m rows; either the left or the right two rows were inoculated with an isolate of SMV strain G2 (2) not transmissible by aphids. Which side of the plot to inoculate, as well as the position of entries within a block, was randomized.

The soybean (*Glycine max* (L.) Merr.) germ plasm accessions tested were from maturity groups VIII, IX, and X and included five entries (PI 86736 [Arisoy], PI 203406, PI 325779, PI 341256, and UFV-1) previously identified (3; *unpublished*) as having low incidence of seed transmission, three entries (PI 181698, PI 281901, and PI 340901) previously found to have relatively high incidence of seed transmission, and two tropically adapted cultivars (Jupiter and Improved Pelican). PI 240664, a nontransmitting accession reported earlier (3), was not used in the present work because of lack of seeds.

The seedlings were thinned to 15–20 plants/m on 20 June 1978, 8 days after planting. Both primary leaves of each plant were inoculated the following day with an artist's airbrush (Wren No. 2, Binks Manufacturing Co., Franklin Park, IL) operated at 75 lb/in^2. Inoculum was prepared in ice-chilled glassware immediately before inoculation as follows: SMV-infected Rampage soybean leaves were harvested 14–21 days after inoculation, chilled, and homogenized in 50 mM sodium phosphate, pH 7.0 (5 ml buffer/g of fresh tissue). The mixture was strained through two layers of cheesecloth and a layer of Miracloth, and 22-μm Carborundum (600-mesh) was added at

Table 1. Seed transmission and yield from tropical soybean accessions inoculated with soybean mosaic virus

Entry	Maturity group	Seed transmission (%)	Yield (g/m of row)		Yield reduction[a] (%)
			Uninoculated	Inoculated	
PI 181698	VIII	5.8	280	40	86
PI 203406	VIII	0.20	287	103	64
PI 281901	X	9.4	166	48	71
PI 325779	IX	0.17	379	175	54
PI 340901	IX	10.2	228	40	83
PI 341256	IX	0.39	334	136	59
Arisoy	VIII	0.05	339	153	55
Improved Pelican	VIII	0.23	317	150	53
Jupiter	X	2.9	339	84	75
UFV-1	...[b]	0.16	344	189	45

[a] Yield reduction in inoculated treatments compared with uninoculated treatments is significant for all entries (F distribution, $P = 0.01$).
[b] Not classified.

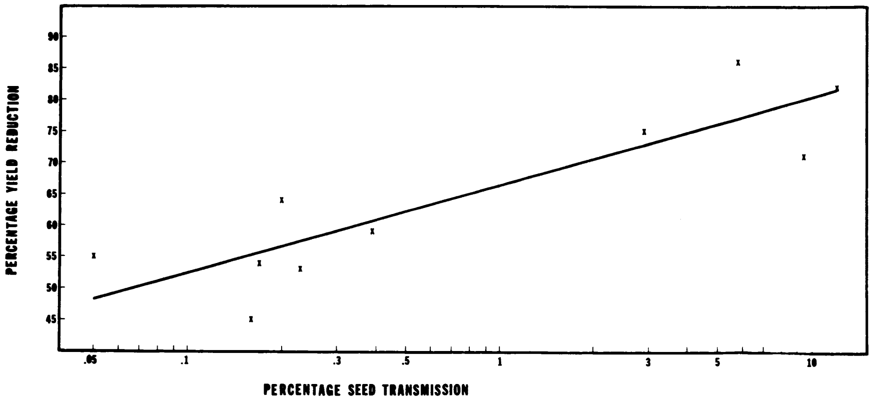

Fig. 1. Relationship between yield reduction caused by soybean mosaic virus (SMV) infection and incidence of SMV transmission through seeds in 10 tropical soybean accessions. Line was drawn by regression analysis ($r = 0.86$).

1.5 g/L. Inoculation success, judged by the appearance of typical SMV symptoms, was greater than 99%.

Plants were harvested by hand, hung to dry, and hand-threshed. Seeds from each treatment row were bagged together, dried to uniform moisture, and weighed. Seeds of each entry from rows that were inoculated were then combined. Some 5,000 seeds of each entry were planted in the field in May or June 1979. Seedlings were rated visually for SMV at the primary leaf stage (3), approximately 10 days after sowing. Total number of emerged seedlings and number of SMV-infected seedlings were recorded.

RESULTS AND DISCUSSION

Seed transmission. Soybean accessions previously identified as apparent nontransmitters of SMV through seeds (3) were found to transmit the virus but at low incidence (Table 1). The transmission rates observed were consistent with our previous failure to find infected seedlings among those emerging from 1,000 seeds (3). These results show that among tropical soybean germ plasm lines, the lower limit for incidence of SMV seed transmission in seeds produced by plants systemically infected well before onset of flowering is about 0.05%, at least for the strain of SMV we used (1,3).

While we have not found a tropical soybean accession that does not transmit SMV through seeds, the prevalence of SMV-infected seedlings arising from seeds harvested from infected plants can be reduced by a factor of 10 or more by choosing appropriate germ plasm. From crosses between soybean genotypes with low seed transmission incidence, progeny might be selected with even lower incidence.

Of more immediate practical significance is the discovery that Improved Pelican, a widely adapted, high-yielding tropical variety (4), has a low incidence of SMV transmission through seeds. In choosing adapted parental material for crossing to incorporate other characters into tropical soybean types, Improved Pelican would be a good choice because of its agronomic suitability, relatively high yield especially in equatorial areas, and low incidence of SMV transmission through seeds.

Yield. SMV caused highly significant yield reductions in all 10 entries (Table 1). The isolate of the virus used, while not highly virulent (2), causes relatively severe symptoms, including stunting and leaf distortion in susceptible soybean lines. The severity of symptoms and the timing of inoculation at the primary leaf stage maximized the effect on yield.

The data also show variation in yield loss. Surprisingly, the entries with lower incidence of seed transmission generally showed less yield reduction (Fig. 1). A correlation coefficient (r) of 0.86 was calculated for the linear relationship between yield reduction and the logarithm of the seed transmission rate. We do not understand the underlying biological significance, if any, of this correlation. Note, however, that in addition to displaying resistance to SMV seed transmission, these accessions appear to tolerate SMV infection; in spite of infection by a severe isolate of the virus early in the growing season, they produce relatively higher yields. In this respect also, Improved Pelican was among the superior entries (Table 1).

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