Squash Mosaic Virus Variability: Epidemiological Consequences of Differences in Seed Transmission Frequency Between Strains

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ABSTRACT

Seed transmission in pumpkin, cantaloupe, honeydew, squash, and watermelon was investigated for a representative of each of the serological groups of squash mosaic virus. The group I representative, IA, was seed transmitted in all cucurbits tested. The group II representative, IIA, was seed transmitted only in pumpkin and squash. These results provide an explanation for the failure to isolate members of group II from muskmelons in the field.

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Squash mosaic virus (SMV) is a seed- and beetle-transmitted virus that has so far been shown to consist of two serologically distinct strains (1, 3). These strains also differ in type and severity of symptoms produced on cantaloupe and pumpkin. Although strain II infects cantaloupe experimentally, it has never been isolated from field samples or seedlings of cantaloupes or other muskmelons. It has only been isolated from members of the genus *Cucurbita* or wild cucurbits. On the other hand, isolates of strain I, while most commonly isolated from cantaloupe or other *Cucumis* spp., have been isolated from *Cucurbita* spp.

As a result of this consistent discrepancy, and lack of information on comparative seed transmission of these strains, this study was undertaken to clarify the possible role of seed transmission, or lack of it, in the epidemiology of the diseases caused by these two SMV strains.

MATERIALS AND METHODS.–The virus isolates used in this study were strain I, isolate A (from cantaloupe collected at Yuma, Arizona in 1961) and strain II, isolate A [originally from Wisconsin (3); isolated from wild cucumber (*Echinocystis lobata*) (2) in 1953].

Seedlings of cantaloupe (*Cucumis melo* L. var. *reticulatus* Naud.); honeydew melon (*Cucumis melo* L. var. *inodorus* Naud.); scalloped summer squash [*Cucurbita pepo* var. *melopepo* (L.) Alef]; pumpkin (*Cucurbita pepo* L.), and watermelon (*Citrullis vulgaris* Schrad.), were germinated in the greenhouse and mechanically inoculated with the appropriate strain at the cotyledon stage. When symptoms appeared after 5-8 days, the plants were transplanted to a small field plot. Fruit were removed when mature and stored at 20 C (1-2 weeks) until seeds were extracted and dried.

Frequent examinations of plants in the field (2-4 times weekly) for beetle vectors consistently proved negative. Lack of virus symptoms in non-inoculated controls indicated that cross infection had not taken place and that in this particular isolated plot no other viruses had infected the plants.

Seeds from field-grown infected plants were germinated in the greenhouse and progeny seedlings observed for mosaic symptoms. Since symptoms of strain II are far milder than strain I in cantaloupes, we investigated the possibility that seed transmission of strain II might be overlooked in young seedlings. Young cantaloupe seedlings derived from known healthy seed lot were inoculated shortly after emergence and we found that symptom development, while not as marked as with strain I, was still adequate to easily identify a plant infected with strain II. Seed from individual fruit were treated as a unit; thus, it was possible to observe variability in seed transmission between fruit.

All seedlings suspected of being infected by strain II were indexed by inoculation to pumpkin and cantaloupe and checked serologically. Because of higher frequency of seed transmission of strain I only 10 percent of those cucurbit seedlings suspected of such infection, were indexed for infectivity and checked serologically. In all cases, virus and strain identity were confirmed.

RESULTS.–As summarized in Table 1, results indicate distinct differences in seed transmissibility between SMV strains I and II. Strain I was found to a greater degree in the seed of *Cucumis* (1.5 - 4.5%) than *Cucurbita* species (0.06 - 1%). Strain II was rarely or not seed transmitted in those cucurbits investigated.

Variability of transmission may occur as a result of species differences (Table 1) as well as between different fruit removed from a single infected plant (Table 2). Although considerable variability occurred between fruit, this variability insofar as investigated here was unrelated to the position of the fruit on the vine or the sequence of maturation.

DISCUSSION.–These results serve to answer the question of the relationship of seed transmission in the epidemiology of the mosaic diseases caused by these two SMV strains. Differences in seed transmission are probably responsible for isolations of strain I but not strain II from cantaloupes (3). We are therefore convinced that lack of seed transmission of strain II in *Cucumis* sp. is responsible for its absence in field muskmelons. Although seed transmission in watermelon of strain I was observed in greenhouse studies, field isolation from this host has not been

TABLE 1. Seed transmission of strains I and II of squash mosaic virus in five cucurbits[a]

Test plant	Strain I			Strain II		
	Observed (No.)	Infected (No.)	Transmission (%)	Observed (No.)	Infected (No.)	Transmission (%)
Pumpkin (cv. 'Small Sugar')	590	27	4.54	1,767	1	.06
Squash (cv. 'Scallop')	2,761	12	.4	665	2	.3
Honeydew	2,914	85	2.9	2,278	0	0
Cantaloupe (cv. 'PMR-45')	4,974	157	3.16	2,582	0	0
Watermelon (cv. 'Charleston Grey')	669	10	1.5			

[a] Data are derived from readings of progeny seedlings taken at the one- to three-leaf stage.

TABLE 2. Percentage transmission of squash mosaic (strain I) in seed from individual honeydew and cantaloupe fruit[a]

Plant tested	Observed (No.)	Infected (No.)	Transmission (%)
Honeydew Fruit 1	358	4	1.11
2	661	17	2.60
3	407	12	2.94
4	641	38	5.93
Cantaloupe Fruit 1	654	4	.62
2	436	9	2.06
3	406	36	8.08
4	413	64	13.07

[a] Data are derived from readings of progeny seedlings taken at the one- to three-leaf stage.

reported. Furthermore, commercial seed stocks of 12 watermelon varieties planted and observed by us in greenhouse trials, never yielded seedlings infected with SMV. The lack of SMV in field grown watermelons probably resulted from a combination of several factors. First, watermelon plants that arose from infected seed never developed beyond a very small stunted plant which in the field would be soon overgrown by neighboring watermelons and would never be a good virus source plant. Second, it appears that SMV is in relatively low concentration in watermelon as based on purification attempts and dilution trials with crude sap by us. Finally, watermelon is only a poor host for the cucumber beetle vectors of SMV. Thus, it would appear that seed transmission of SMV in watermelon is only an experimental curiosity of no epidemiological significance.

In the authors opinion the following conclusions are suggested by this work: (i) Isolates of SMV strain I are much better adapted, epidemiologically, to cucurbits than isolates of strain II because of equal or higher seed transmissibility in all cucurbits tested. (ii) The historically higher frequency of isolation of strain I from cucurbits in general, and *Cucumis* species in particular, supports conclusion (i) (3). (iii) Paradoxically, isolates of strain II received most attention in earlier work simply because those workers who pursued studies of SMV had obtained such isolates from *Cucurbita* spp. or wild cucurbits or workers who had.

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