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Resistance in Eggplant, *Solanum melongena* L., and Nontuber-Bearing *Solanum* Species to Carmine Spider Mite[1]

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Abstract. The Agricultural Research Service collection of eggplant (*Solanum melongena* L.) and related *Solanum* species from throughout the world was screened for resistance to the carmine spider mite *Tetranychus cinnabarinus* (Boisduval). Tolerance to mite feeding damage was found in *S. melongena* (P.I. 269663 and 269660), and antibiosis was found in *S. mammosum* L. (P.I. 245968), *S. sisymbrifolium* Lam. (P.I. 337597), and *S. pseudocapsicum* L. (P.I. 368425). P.I. accessions 245968, 368425, 269663, and 269660 were least preferred for feeding and oviposition.

Eggplant (*Solanum melongena* L.) is a minor self-pollinated vegetable crop in the U.S. with no more than 3,000 acres in production annually (8). However, in the Orient and Middle East, eggplant is cultivated as extensively as the tomato is in the U.S. (1). Eggplant is attacked by several arthropod pests including carmine spider mites *Tetranychus cinnabarinus* (Boisduval) (6). We therefore screened a representative collection of *Solanum* germplasm for resistance to this mite.

Materials and Methods

The entire Plant Introduction (P.I.) collection of eggplant (*S. melongena* and related species) maintained by the Plant Introduction Station at Experiment, GA and 3 cultivars obtained from Cornell University[4] were tested. Each accession or cultivar was seeded in Jiffy-7 peat pots, transferred to 4 inch clay pots containing a greenhouse soil mixture and fertilized every 3 weeks to maintain vigorous growth. Beltsville cultured strain of carmine spider mite was used in all tests and reared on lima beans.

a) Three hundred and forty five accessions of *S. melongena* and 12 accessions of related *Solanum* species were mass screened for susceptibility or resistance to the carmine mite; each entry was replicated 3 times (3 plants/entry). b) Selections from experiment 1 were retested with each entry replicated 5 or 7 times. c) Selected accessions and cultivars from experiment 2 were evaluated for antibiosis. d) Accessions and cultivars selected from antibiosis tests were subjected to leaf disk tests for feeding preference and oviposition in 2 tests, each replicated 9 times.

Jersey King, P.I. 143402, and P.I. 163264 were included in all tests as susceptible controls. Mass mite infestations were achieved in Experiments 1 and 2 by pinning one mite-infested bean trifoliate to each of the test entries. Injury was rated visually after 25 days, on a 1–9 scale with 1 equal to no damage and 9 equal to severe damage. In Experiment 3, five randomly selected adult female mites were placed in 22-mm-diameter cages, (9) that were attached to the top surface of the third or fourth leaf from the terminal of each test plant. The top surface was selected because of the ease in handling and transferring cages and mites. After 12–13 days, living mites and eggs (biomass) were recorded.

The test plants were 8 to 10 week-old greenhouse grown plants treated weekly with resmethrin and dichlorvos to prevent unwanted insect infestations. Pesticide treatments were terminated 5 days before testing. Experiments 1, 2, and 3 were conducted under natural photoperiods for the months of November through February at 23° ± 5°C and relative humidity was 54 ± 20%.

In Experiment 4, leaf disks (18 mm diam) were randomly cut from the test plants and arranged randomly (bottom side up) in a circle on moistened cellucotton in a 15-cm petri dish so mites could easily migrate from disk to disk. Five adult females were transferred from the stock colony to the center of each disk, and mite movement was recorded every 2 hr for the first 6 hr and at 20 and 24 hr. The preference test was conducted in a laboratory maintained at constant temperature (21° ± 2°C) and relative humidity (70% ± 10%) with 50-ft candle of illumination.

Results

Experiment 1. Of 345 *S. melongena* accessions tested in Experiment 1, 12 exhibited a moderate level of resistance and were saved for further testing. Two of the 12 accessions of the related *Solanium* species, P.I. 337597 and P.I. 245968, appeared nearly immune to mite damage (Table 1). The range of susceptibility and plant types of the *Solanum* species are illustrated in Fig. 1.

Experiment 2. Many of the *S. melongena* accessions selected for

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[4] Cultivars Dumaguete, Sinompiro, and Millionaire supplied by H. M. Munger, Plant Breeder, Cornell University, Ithaca, NY.

possible mite resistance from the first test proved to be susceptible when they were retested. No statistical differences were noted between P.I. 269663 and P.I. 269660 and 6 other accessions; however, P.I. 269663 was greener, and its general vigor indicated the presence of tolerance. Accessions P.I. 245968 (*S. mammosum*) and P.I. 368425 (*S. pseudocapsicum*) showed resistance to mite damage in Experiment 2 (Table 2). The accession P.I. 337597 was excluded from this test because its resistance was assumed to be similar to that of P.I. 245968 in Experiment 1.

Table 1. Feeding damage caused by mass infestations of spider mites on 12 of 345 *Solanum melongena* accessions and 12 accessions of related *Solanum* species.

Entry	Origin	$\overline{X}$ Damage Rating
S. melongena		
P.I. 116061	India	3.5[z]
269660 ('Pusa Purple Round')	India	4.8
277289 ('Muktakeshi')	India	5.5
173968	Turkey	5.7
143410	Iran	5.9
174364	Turkey	6.1
140457	Iran	6.3
173108	Turkey	6.3
140455	Iran	6.5
269601	Pakistan	6.5
279873	Japan	6.7
269663 ('Wyned Giant')	India	6.9
'Jersey King' (check)	U.S.A.	7.6
163264 (check)	India	8.0
143402 (check)	Iran	8.5
Related species		
P.I. 337597 (*S. sisymbrifolium* Lam)	Argentina	1.0a[yx]
245968 (*S. mammosum* L.)	Mexico	1.2a
368425 (*S. pseudocapsicum*)	Yugoslavia	3.6ab
305320 (*S. atropurpureum Schrank*)	Colombia	6.0bc
196300 (*S. ciliatum* Lam.)	Nicaragua	8.2c
280049 (*S. aviculare* Forst. f.)	U.S.A.	8.2c
319855 (*S. indicum* L.)	Thailand	8.5c
247828 (*S. nodiflorum* Jacq)	B. Congo	8.7c
194789 (*S. indicum*)	India	9.0c
194166 (*S. gild* Raddi.)	Yugoslavia	9.0c
337284 (*S. laciniatum* Ait.)	Hungary	9.0c
312110 (*S. nigrum* L.)	India	9.0c
163264 (*S. melongena* L.) (check)	India	9.0c

[z] Means of 3 replicates. Data from *S. melongena* accessions were not statistically analyzed because variation within a given accession was small.
[y] Entries rated 1–9, 1 little damage, 9 severe damage.
[x] Means followed by the same letter were not significantly different at the 5% probability level by Duncan's multiple range test.

Table 2. Feeding damage by mass infestations of spider mites to 15 selected eggplant accessions.

Entry	Origin	$\overline{X}$ Damage
Test A[z]		
S. melongena		
P.I. 269663	India	6.1a[y]
269660	India	7.1ab
279873	Japan	7.2ab
173108	Turkey	7.5ab
116061	India	7.6ab
269601	Pakistan	7.7ab
277289	India	7.9ab
140457	Iran	7.9ab
173968	Turkey	8.0b
143410	Iran	8.1b
174364	Turkey	8.1b
140455	Iran	8.2b
143402	Iran	8.2b
Test B[x]		
S. Species		
S. mammosum		
P.I. 245968	Mexico	1.4a[y]
S. pseudocapsicum		
P.I. 368425	Yugoslavia	2.0a
S. melongena		
P.I. 269663	India	6.6b
'Dumaguete'	Philippines	6.8bc
269660	India	7.0bc
'Jersey King' (check)	U.S.A.	7.5bcd
'Sinompiro'	Philippines	7.6cd
'Millionaire'	Philippines	8.3d
143402 (check)	Iran	8.4d

[z] Means of 5 replicates.
[y] Rating 1–9, where 1 was little damage and 9, severe damage. Means followed by the same letter were not significantly different at the 5% probability level by Duncan's multiple range test.
[x] Mean of 7 replicates.

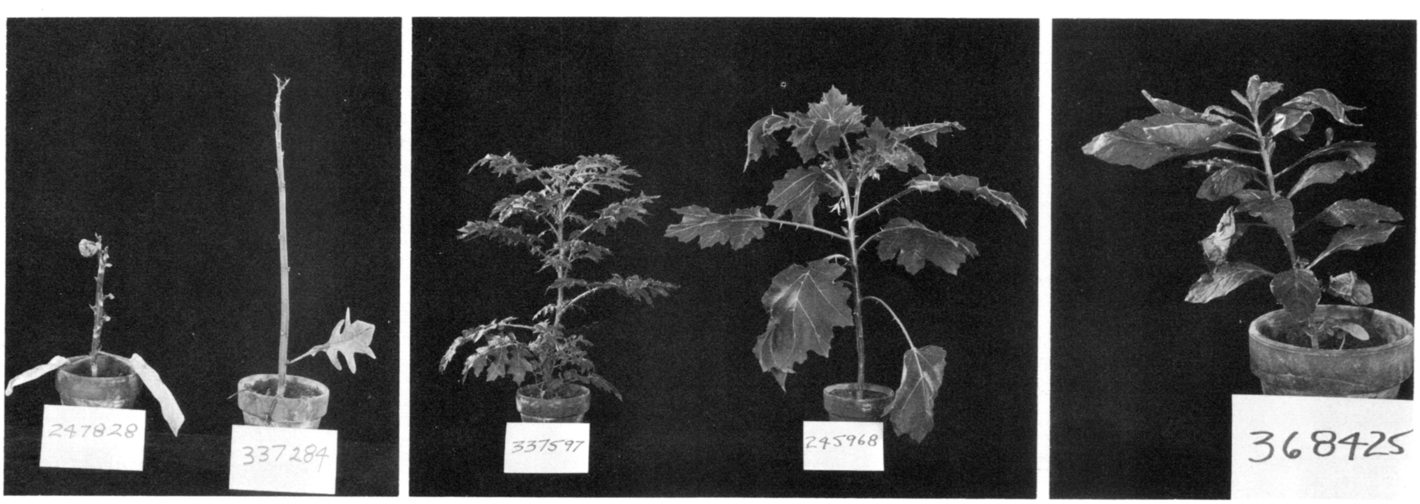

Fig. 1. The range of injury to *Solanum* species to mass infestations of mites. Susceptible accessions are P.I. 247828 (*S. nodiflorum*) and P.I. 337284 (*S. laciniatum*). Resistant accessions are P.I. 337597 (*S. sisymbrifolium*), P.I. 245968 (*S. mammosum*), and P.I. 368425 (*S. pseudocapsicum*).

Table 3. Eggs or offspring produced in days by 5 randomly selected adult female mites on 10 eggplants and related *Solanum* accessions.

Entry[z]	Biomass[y]	
	Test A	Test B
P.I. 245968 (*S. mammosum*)	0.0a	0.0c
P.I. 368425 (*S. pseudocapsicum*)	0.1a	0.0c
P.I. 337597 (*S. sisymbrifolium*)	—	0.0c
S. melongena		
P.I. 269663	18.0ab	—
143402 (check)	19.0ab	94.0a
269660	26.1ab	—
'Jersey King' (check)	37.0bc	61.0b
'Millionaire'	55.4c	—
'Sinompiro'	64.3c	—
'Dumaguete'	100.2c	—

[z] Means of 9 replicates.
[y] Total number of live eggs, nymphs and adults. Means followed by the same letter were not significantly different at the 5% probability level by Duncan's multiple range test.

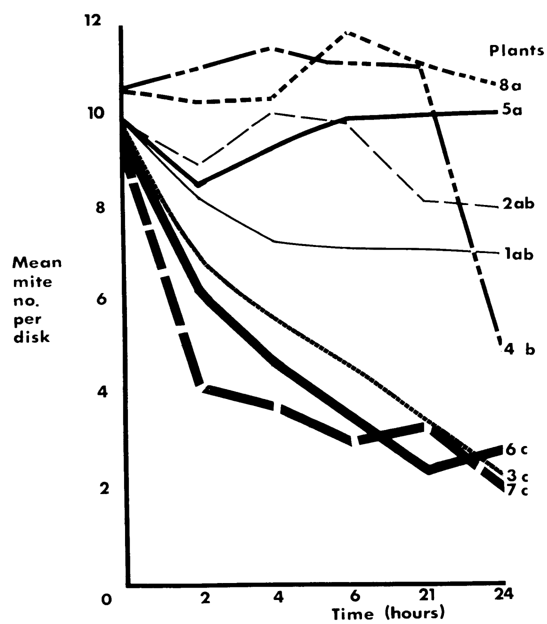

Fig. 2. Mean preference of mites for leaf disks (initial infestation 10 females/disk) of *Solanum* accessions and cultivars: 1. 'Dumaguete', 2. 'Jersey King', 3. P.I. 268425, 4. P.I. 245968, 5. P.I. 143402, 6. P.I. 269663. 7. P.I. 269660, and 8. 'Sinompiro'. Plant entries followed by the same letter were not significantly different at the 5% probability level by Duncan's multiple range test.

Experiment 3. Practically no reproduction of the mite was observed on P.I. 245968, P.I. 368425, and P.I. 337597 in Experiment 3, and reduced reproduction was noted on P.I. 269663 (Table 3). 'Millionaire', 'Sinompiro', 'Dumaguete, had higher fecundity in test A, Experiment 3. The variation in reproduction of the mites in test A and test B for 'Jersey King', and P.I. 143402 (Table 3) could have resulted from differences in mite populations, environmental conditions, plant maturity, and manipulation of the mites in testing.

Experiment 4. Variation between the 2 testing dates for mite preference and oviposition was negligible and therefore they were combined into one unit and analyzed (10 mites/disk). Entries P.I. 368425, P.I. 269663, and P.I. 269660 were least preferred for feeding and oviposition (Figs. 2 and 3).

Entry P.I. 245968 had live adults trapped by glandular hairs on the leaf surface and there had been practically no oviposition. P.I. 337597 was again excluded because its resistance in Experiment 3 was similar to that of P.I. 245968.

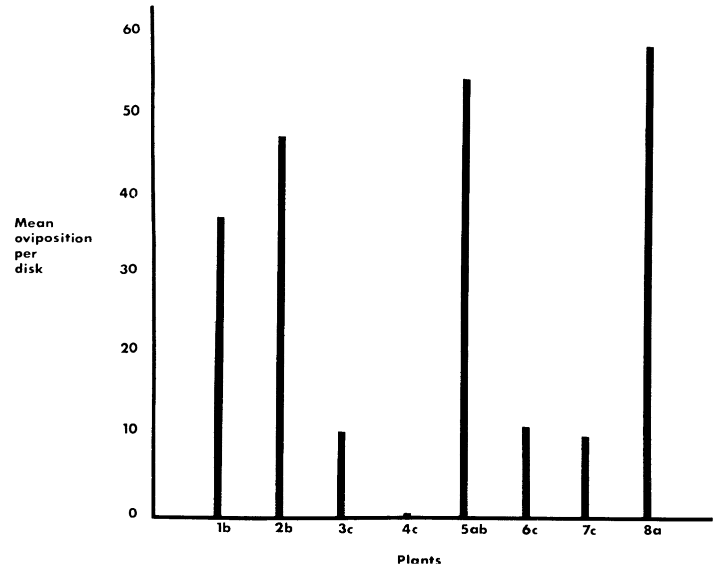

Fig. 3. Mean oviposition of mites for leaf disks. *Solanum* accessions and cultivars: 1. 'Dumaguete', 2. 'Jersey King', 3. P.I. 368425, 4. P.I. 245968, 5. P.I. 143402, 6. P.I. 269663, 7. P.I. 269660, and 8. 'Sinompiro'. Plant entries followed by the same letter were not significantly different at the 5% probability level by Duncan's multiple range test.

Discussion

No immunity to mite feeding and oviposition was found in *S. melongena*, but two entries (P.I. 269663 and P.I. 269660) showed tolerance to mite damage, though a statistical difference was not evident. Tolerance, a mechanism of resistance by which plants will repair damage or reproduce in spite of supporting a large pest population (5), has particular value because it exerts no selection pressure on the insect population as may be the case with antibiosis or nonpreference. Thus there is less chance that new biotypes of the pest will develop in response to host plant selection and the disturbance of parasites and predators (4).

Immunity was found in accessions P.I. 245968 and P.I. 337597. Glandular hairs on these plants were found to trap the mites on the leaf surface. Also, the exudate from these hairs may have had repellent, deterrent, and lack of an arrestant properties. No interspecific hybrids between *S. mammosum*, *S. sisymbrifolium*, and *S. melongena* have been reported (2, 3).

Similar comparisons on mite fecundity were noted by Soans et al. (7) on the cvs Sinompiro, Millionaire, and Dumaguete, with Dumaguete supporting higher mite populations than Sinompiro and Millionaire, respectively.

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