Natural Virus Infection in Silvery and Nonsilvery Lines of *Cucurbita pepo*

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ABSTRACT

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A silver-leaved breeding line, NJ260, and a green-leaved cultivar, Early Prolific Straightneck (EPS), of summer squash (*Cucurbita pepo*) were compared for virus disease development under natural conditions. Severity of disease was consistently lower in NJ260 than in EPS throughout the season. About 6 wk after planting, 99% of EPS and 28% of NJ260 plants showed symptoms of infection by cucumber mosaic virus and clover yellow vein virus (formerly the severe strain of bean yellow mosaic virus). By the end of the season, all plants of both lines had developed symptoms, although EPS plants were much more severely affected. Disease-related survival was 96% in NJ260 until the first frost, whereas in the EPS plants, deaths began at midseason, and at the last reading before frost, only 19% of the plants were alive.

Many of the viruses infecting squash (*Cucurbita* spp.) are transmitted by aphids in a nonpersistent manner (1,9–11,17). These viruses frequently increase in incidence during the growing season, causing 100% infection in some late plantings. Controlling the aphid vectors with insecticides is generally not an effective means of reducing disease loss (2).

Altering aphid behavior, however, has been successful in reducing virus infection (16). Aphid flight activity has been shown to be affected by light (6). Shortwave radiation seems to either repel alate aphids (7) or decrease the attractiveness of the landing site (3). Reflective surfaces such as aluminum foil mulches (2,4,15,16) have been used to reduce aphid populations and virus diseases in squash (8,18) as well as in other crops (5). Aluminum foil mulching is expensive to apply and may be ineffective when plants cover the reflective surface or the vector pressure is too high (6).

O. Shifriss has developed a summer squash breeding line designated NJ260, which expresses a uniformly silvery color on the upper leaf surface. This silvery trait is a modified expression of gene *M* (13,14). Silvery color is due to increased air space among the palisade cells and between the palisade and epidermal layers (12). Field observations of a limited number of NJ260 plants during the past 6 yr have indicated that these plants remain substantially free of serious virus symptoms, whereas all nonsilvery plants become infected (13). Preliminary tests indicated that the silvery leaves of NJ260 reflect a higher proportion of shortwave light (blue and violet in the visible region) than the nonsilvery leaves of cultivar Early Prolific Straightneck (14).

This paper reports results of preliminary field testing to examine the value of this silvery trait in reducing virus disease in squash.

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MATERIALS AND METHODS

Seeds of NJ260 (OS-NJAES, 1981) and EPS (Harris Seed Co., No. 785-8773, 1980) were germinated at 30 C. Uniform sprouts were transplanted into 5-cm peat pots and kept in growth chambers (16-hr photoperiod, about 1,000 ft-c; temperature, 20 C night, 24 C day) for about 2 wk. At the two- to three-leaf stage, they were planted in the field at the Soils and Crops Research Farm in Adelphia, NJ. Three experiments utilizing different planting designs were set up in this field.

Experiment 1 consisted of separate colonies of five silvery or nonsilvery plants spaced 0.5 m apart in a diamond pattern. Ten colonies of each type were then randomly arranged 5 m apart in a four- by five-row block. The rationale for using colonies in this experiment was to provide intense light reflectance to the alate aphids. The colonies were separated to avoid successful movement of apterous aphids among them. In Experiment 2, 16 silvery plants were placed in two rows of eight plants each with 4 m between plants and rows. Two rows of nonsilvery plants were planted in the same way, with 6 m separating the lines. This design provided rows of plants with uniform leaf surfaces but did not preclude plant to plant movement of apterous aphids. For Experiment 3, 24 plants of each line were randomly planted in a six- by eight-row block with 4 m between plants, which allowed the aphids a random selection of individual plants.

Three weeks after planting, four alternate plants of each line in the inside rows of Experiment 2 were rub-inoculated in the field with cucumber mosaic virus (CMV NY isolate 63-65) kindly provided by R. Provvidenti, New York State Agricultural Experiment Station. Plants were examined carefully each week until the onset of frost for virus symptoms. The percentage of plants displaying symptoms was recorded weekly, and a numerical index of disease severity was taken during the last 3 wk of observation. Insecticides were not applied, but plants were sprayed with benomyl and chlorothalonil for mildew control.

RESULTS

The three experiments gave similar results, indicating that aphids were able to select individual plants and that plant to plant movement of apterous aphids did not cause significant virus spread. The incidence of virus-induced symptoms was about four times higher in the nonsilvery than the silvery plants from the onset of symptoms through the sixth week of observation (Table 1). Virus incidence reached 100% by the sixth week in the nonsilvery line but not until about the ninth week in the silvery line, a delay of 2–3 wk in maximum incidence.

In addition to the more rapid spread of virus in the nonsilvery line, symptoms were much more severe than in the silvery line. During the first few weeks, the only symptoms observed were those of clover yellow vein virus (CYVV). These consisted of distinct chlorotic spots mainly on older leaves but developing systemically throughout the plant. Symptoms were very subtle and were present on only a few leaves of infected silvery plants but were quite obvious and widely distributed in infected nonsilvery plants.

About 2 wk after mechanical inoculation of a few source plants with CMV, symptoms of this virus appeared. CMV caused severe stunting, mosaic, downward leaf roll, and distortion of the youngest leaves at the growing point in both lines.

Throughout the season, the nonsilvery plants were more severely affected by both CYVV and CMV than the silvery plants. During the last 3 wk of

Table 1. Incidence and severity of virus symptoms and survival of silvery and nonsilvery lines of *Cucurbita pepo* under natural field conditions[a]

	Silvery			Nonsilvery		
Date[b]	Incidence (%)[c]	Severity[d]	Survival (%)	Incidence (%)	Severity	Survival (%)
29 July	0	–	100	0	–	100
5 August	0	–	100	0	–	100
12 August	0	–	100	3	–	100
19 August	9	–	100	38	–	94
26 August	12	–	100	52	–	90
2 September	28	–	100	99	–	88
9 September	56	1.6	100	100	3.9	87
24 September	92	2.2	100	100	4.6	65
10 October	100	2.7	96	100	4.8	19

[a] Values are averages of three experiments utilizing different plot designs, 90 plants of each line. Silvery = NJ260, nonsilvery = Early Prolific Straightneck.
[b] Planting date was 22 July 1981.
[c] Percentage of plants with distinct virus symptoms.
[d] Key to symptom severity: – = not quantified, 1 = no symptoms, 2 = very mild symptoms, almost indistinguishable from uninfected plant, 3 = mild but clearly infected, 4 = moderate with some adverse effect on plants, and 5 = severe mosaic, stunting, and/or leaf distortion.

observation, severity was about twice as high in the nonsilvery line (Table 1). By the end of the season, 96% (N = 90) of the silvery plants were alive and growing vigorously but only 19% (N = 90) of the nonsilvery plants had survived.

In contrast with the nonsilvery line, virus infection in the silvery line was delayed 2–3 wk, incidence was low, symptoms were very mild and inconspicuous, and plants were not killed or apparently reduced in vigor. In addition, preliminary observations indicated that fewer apterous aphids were present on silvery than on nonsilvery plants.

DISCUSSION

Objective comparison of these squash lines is not possible. These nonisogenic lines differ not only in leaf color but also in growth habit and degree of femaleness (13).

Three possible explanations may be offered for the apparent ability of silvery plants to escape virus infection: 1) incidence of aphid visitation is lower because of light reflectance from the silvery leaf surface, 2) plants are more resistant to aphid transmission of virus, or 3) plants are more resistant to virus multiplication or movement. Mechanical inoculations of silvery and nonsilvery plants have shown that for most squash viruses there is no difference in susceptibility, thus ruling out explanation no. 3. Experiments are in progress to examine the other explanations. Nevertheless, based on available evidence, we believe that leaf color was responsible for the difference in virus infection between the two strains.

If the value of the silvery trait is established for *Cucurbita*, it might be worth exploring similar traits in other cultivated genera such as *Pisum* and *Phaseolus* (14). This would represent a novel approach to the control of aphids and aphid-transmitted viruses.

LITERATURE CITED

1. Francki, R. I. B., Mossop, D. W., and Hatta, T. 1979. Cucumber mosaic virus. Descriptions of plant viruses. No. 213 (No. 1 rev.). Commonw. Mycol. Inst./Assoc. Appl. Biol., Kew, Surrey, England. 6 pp.
2. Harpaz, I. 1982. Nonpesticidal control of vector-borne viruses. Pages 1-21 in: Pathogens, Vectors, and Plant Diseases—Approaches to Control. K. F. Harris and K. Maramorosch, eds. Academic Press, New York. 310 pp.
3. Kennedy, J. S., Booth, C. O., and Kershaw, W. J. S. 1961. Host finding by aphids in the field. III. Visual attraction. Ann. Appl. Biol. 49:1-21.
4. Kring, J. B. 1964. New ways to repel aphids. Front. Plant Sci. 17:6-7.
5. Kring, J. B. 1969. Mulching with aluminum foil. Horticulture 42:27-52.
6. Kring, J. B. 1972. Flight behavior of aphids. Annu. Rev. Entomol. 17:461-492.
7. Moericke, V. 1955. Uber die Lebensgewohnheiten der geflugelten Blattlause (under besonderer Berucksichtigung des Verhaltens beim Landen). Z. Agnew. Entomol. 37:29-91.
8. Moore, W. D., Smith, F. F., Johnson, G. V., and Wolfenbarger, D. O. 1965. Reduction of aphid populations and delayed incidence of virus infection on yellow straight neck squash by the use of aluminum foil. Proc. Fla. State Hortic. Soc. 78:187-191.
9. Provvidenti, R., and Schroeder, W. T. 1970. Epiphytotic of watermelon mosaic among Cucurbitaceae in central New York in 1969. Plant Dis. Rep. 54:744-748.
10. Provvidenti, R., and Uyemoto, J. K. 1973. Chlorotic leaf spotting of yellow summer squash caused by the severe strain of bean yellow mosaic virus. Plant Dis. Rep. 57:280-282.
11. Rizvi, S. A. H. 1978. Identification and characterization of a cucurbit-infecting strain of bean yellow mosaic virus and differential response of squash (*Cucurbita*) cultivars to this virus. Ph.D. thesis. Rutgers University, New Brunswick, NJ.
12. Scarchuk, J., and Lent, J. M. 1965. The structure of mottled-leaf summer squash. J. Hered. 56:167-168.
13. Shifriss, O. 1981. Do *Cucurbita* plants with silvery leaves escape virus infection? Origin and characteristics of NJ260. Cucurbit Genet. Coop. Rep. 4:42-43.
14. Shifriss, O. 1982. On the silvery-leaf trait in *Cucurbita pepo* L. Cucurbit Genet. Coop. Rep. 5:48-50.
15. Smith, F. F., Johnson, G. V., Kahn, R. P., and Bing, A. 1964. Repellancy of reflective aluminum to transient aphid virus-vectors. (Abstr.) Phytopathology 54:748.
16. Smith, F. F., and Webb, R. E. 1969. Repelling aphids by reflective surfaces, a new approach to control of insect transmission of viruses. Pages 631-639 in: Viruses, Vectors, and Vegetation. K. Maramorosch, ed. Interscience Publishers, New York.
17. Van Regenmortel, M. H. V. 1971. Watermelon mosaic virus. Descriptions of plant viruses. No. 63. Commonw. Mycol. Inst./Assoc. Appl. Biol., Kew, Surrey, England. 4 pp.
18. Wyman, J. A., Toscano, N. C., Kido, K., Johnson, H., and Mayberry, K. S. 1979. Effects of mulching on the spread of aphid-transmitted watermelon mosaic virus to summer squash. J. Econ. Entomol. 72:139-143.