

# Differential Susceptibility to Leaf Silvering in *Cucurbita pepo*

Harry S. Paris<sup>1</sup>, Peter J. Stoffella, and Charles A. Powell

Agricultural Research and Education Center, Institute of Food and Agricultural Sciences, University of Florida, P.O. Box 248, Fort Pierce, FL 34954

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**Abstract.** ‘Striato d’Italia’ (cocozele group) and ‘Clarita’ (vegetable marrow group) summer squash were grown in the greenhouse and field in the presence of sweetpotato whiteflies (*Bemisia tabaci* Germ.) and their susceptibility to leaf silvering was compared. Silvering was less severe in ‘Striato d’Italia’ in the greenhouse and field.

Leaf silvering is an economically important malady of squash and pumpkins (*Cucurbita* spp.) that is incited by the sweetpotato whitefly (Schuster et al., 1991; Yokomi et al., 1990) and exacerbated by drought stress (Paris et al., 1987). The three major species of squash and pumpkins—*C. pepo* L., *C. maxima* Duch. ex Lam., and *C. moschata* (Duch. ex Lam.) Duch. ex Poir.—are susceptible, including many *C. pepo* cultivars that have been affected severely (Burger et al., 1983; Maynard and Cantliffe, 1989; Simons et al., 1989).

In Israel, during a season in which only mild to moderate leaf silvering occurred, ‘Bareqet’ was less affected by silvering than ‘Clarita’ (both *C. pepo*) (Edelstein et al., 1991). At the Agricultural Research and Education Center (AREC), Fort Pierce, Fla., some *C. pepo* cultivars were less affected by silvering than others (unpublished data). The objectives of the present work were to determine whether differential leaf silvering susceptibility occurs in *C. pepo* and if it is consistent among various growing conditions.

Based on observations by Edelstein et al. (1991) and ourselves, two cultivars were chosen for comparison: ‘Clarita’ (vegetable marrow group, probably highly susceptible) and ‘Striato d’Italia’ (cocozele group, probably less susceptible) (Paris, 1986). ‘Clarita’ seeds were obtained from Petoseed (Saticoy, Calif.). ‘Striato d’Italia’ seeds were obtained from G. Santini, Società Agricola Italiana Sementi (Cesena, Italy). ‘Striato d’Italia’ was somewhat variable in vegetative characteristics, and, because the original seed sample was small, the seeds used for this work were those that had been obtained by the self-pollination of a single plant selected and designated STI-13 by H.S.P.

Three experiments comparing the two cul-

tivars were conducted. Two were established simultaneously and conducted concurrently in the greenhouse and one was conducted later in the field at AREC.

In the greenhouse, seeds of the two cultivars were sown in pots on 24 Jan. 1992. The goal of one experiment was to determine whether the cultivars differed in degree of silvering susceptibility when soil moisture was not carefully controlled. For this purpose, the pots were arranged in a complete-block (paired) design with 12 replicates. The goal of the other greenhouse experiment was to determine whether the relative degree of silvering susceptibility of the two cultivars was differentially affected by soil moisture. For this purpose, plants of each cultivar were grown with high (90% to 100% of capacity) or low (45% to 70% of capacity) soil moisture. pots were arranged in a complete-block design with eight replicates. On 9 Feb., when the plants had one true leaf, they were thinned to one plant per pot. Whiteflies were introduced into the greenhouse on eight (two in each of four pots) infested, laboratory-grown *C. pepo* ‘Senator’ (zucchini group) plants. Ontogenically comparable, successive leaves on plants in both experiments were observed and scored for silvering severity according to a scale of 0 (symptomatic) to 5 (completely silvered) (Paris et al., 1987). The materials used to grow the plants in the greenhouse and the methods of establishing, monitoring, and maintaining the two soil moisture treatments have been described by Paris et al. (1993).

The goal of the field experiment was to determine if the differential susceptibility to leaf silvering that was observed in the greenhouse also would occur under typical growing conditions and cultural practices. The soil type was an Oldsmar fine sand (sandy, siliceous,

hyperthermic Alfic Arenic Haplaquods). Raised beds 1.1 m wide and 0.15 m high were spaced 2.1 m apart, center to center. Fertilizer at a rate of (kg·ha<sup>-1</sup>) 30N–54P–25K was incorporated into the beds. Additional fertilizer at a rate of (in kg·ha<sup>-1</sup>) 115N–75P–227K was applied to the bed surface in two bands, 60 cm from the center of each bed. Beds were then covered with white polyethylene mulch. Seeds of the two cultivars were sown in the field on 24 Mar. 1992 in hills (five hills per row, 75 cm between hills, one cultivar per row). Plants were thinned to one per hill when the first true leaf was fully expanded. The rows of each cultivar were arranged in a complete-block (paired) design with six replicates. Subsurface irrigation was used to maintain the water table at about 38 cm below the soil surface. The field received weekly applications of mancozeb (a polymer of manganous ethylene-bis-bithiocarbamate with zinc) at 1.9 g·liter<sup>-1</sup> and tribasic copper at 5.3 g·liter<sup>-1</sup> to control disease. Greenhouse-grown, potted tomato (*Lycopersicon esculentum* Mill.) plants infested with whiteflies were placed in an adjacent field (on 21 Apr.) 4 weeks after the squash was sown to supplement the naturally occurring whitefly population and ensure adequate exposure of the squash plants to whiteflies. Developing squash were removed from the plants every 2 to 5 days. The central three plants in each row were observed weekly and the most severely silvered leaf of each was scored according to the 0 to 5 scale as described above. Silvering became more severe as the season progressed; therefore, the most severely affected leaves were those that had been the latest to develop.

‘Striato d’Italia’ did not develop some of the typical symptoms—silvering was not generally in and parallel to leaf veins (Paris et al., 1987). Instead, moderate silvering was expressed in this cultivar as patches in axils of leaf veins—similar to the genetically determined silver mottling (Scarchuk, 1954). Therefore, silvering severity scores (Paris et al., 1987) were modified to consider the leaf area affected with the usual, veinal symptoms as follows: grade 2, ≈ 25% leaf surface silvered; grade 3, ≈ 50% of leaf surface silvered; and grade 4, >50% of leaf surface silvered. Scores were subjected to analysis of variance in each experiment.

Leaf silvering was less severe in ‘Striato d’Italia’ than in ‘Clarita’ in the greenhouse (Tables 1 and 2). Drought stress did not affect these two cultivars differentially; both had more severe symptoms under stress (Table 2). However, the effect of cultivar was larger than the effect of soil moisture. Leaf silvering was also more severe in ‘Clarita’ in the field (Table

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<sup>1</sup>On sabbatical. Permanent address: Dept. of Vegetable Crops, Agricultural Research Organization, Newe Ya’ar Experiment Station, P.O. Haifa, Israel.

Table 1. Leaf silvering scores of greenhouse-grown plants of two squash cultivars.<sup>1</sup>

Cultivar	Leaf no.					Mean
	6	7	8	9	10	
	Score					
Clarita	0.4	1.3	2.8	3.8	4.0	2.5
Striato d’Italia	0.0	0.0	0.2	0.4	0.7	0.3
Significance	NS	***	***	***	***	***

<sup>1</sup>Scored on a scale of 0 = no silvering to 5 = completely silvered (Paris et al., 1987).

\*\*\* Nonsignificant or significant at  $P \leq 0.001$ , respectively.

Table 2. Leaf silvering scores of greenhouse-grown plants of two squash cultivars in two soil-moisture regimes.<sup>a</sup>

Variable	Leaf no.					Mean
	6	7	8	9	10	
	Score					
Cultivar						
Clarita	0.6	2.1	3.4	4.3	4.6	3.0
Striato d'Italia	0.2	0.8	1.4	2.1	2.1	1.3
Significance	NS	***	***	***	***	***
Soil moisture						
Low	0.6	1.9	3.0	3.8	3.7	2.6
High	0.2	1.0	1.8	2.6	3.1	1.7
Significance	NS	*	**	**	NS	**
Interaction	NS	NS	NS	NS	NS	NS

<sup>a</sup>Scored on a scale of 0 = no silvering to 5 = completely silvered (Paris et al., 1987).NS,\*,\*\*,\*\* Nonsignificant or significant at  $P \leq 0.05, 0.01$ , or  $0.001$ , respectively.Table 3. Leaf silvering scores of field-grown plants of two squash cultivars.<sup>a</sup>

Cultivar	Weeks after sowing (no.)					Mean
	6	7	8	9	10	
	Score					
Clarita	0.2	0.4	3.6	4.7	4.8	2.7
Striato d'Italia	0.0	0.0	0.7	2.2	2.3	1.1
Significance	NS	NS	***	**	**	***

<sup>a</sup>Score on a scale of 0 = no silvering to 5 = completely silvered (after Paris et al., 1987).NS,\*,\*\*,\*\* Nonsignificant or significant at  $P \leq 0.01$  or  $0.001$ , respectively.

3). The differences between the cultivars were highly significant, regardless of whether the plants were grown in the greenhouse or the field and regardless of whether comparisons were made on an ontogenetic or chronological basis. In all three experiments, 'Clarita' plants developed moderately severe (grade 4) to severe (grade 5) symptoms, while not a single leaf of 'Striato d'Italia' was observed with

severe (grade 5) symptoms during all three experiments.

'Striato d'Italia' plants seemed to become as heavily infested with adult whiteflies as 'Clarita' plants, but no counts were taken. Plants of both cultivars became bleached in their apical regions, but the leaves and ovaries of 'Striato d'Italia' became green as they developed, to the extent that the fruit were of

normal color and the leaves were never severely silvered.

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