Fragaria Resistance to Spider Mites at Three Locations in the United States

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Abstract. Eleven clones of *Fragaria* spp. were tested for resistance to the twospotted spider mite, *Tetranychus urticae* Koch, at Dover, Fla.; Watsonville, Calif.; and Vancouver, Wash. Ten clones, which had been selected previously as being mite-resistant, had generally the same relative resistance when compared to susceptible 'Totem' at all three of the widely separated locations. It appears that *Fragaria* clones selected for resistance to spider mites at one location likely will be resistant elsewhere, in spite of environmental differences.

Spider mites, *Tetranychus* spp., are common pests of strawberries, causing severe damage to the leaves by sucking out cell contents when feeding, which in turn leads to yield loss (Raworth, 1986). Identification of *Fragaria* clones resistant to the mites was reviewed by Hancock et al. (1991) and further research was reported by Giménez-Ferrer et al. (1993) and Shanks and Moore (1995). Most clones were moderately to highly susceptible to spider mites, but some are very resistant, e.g., in one study Shanks and Moore (1995) reported that eight of 171 *Fragaria* clones had $\geq 75\%$ fewer mites than 'Totem', a very susceptible clone. Strawberries are grown in areas of the United States that differ greatly in environment, e.g., temperatures, daylength patterns, etc. Ten clones of *Fragaria*, which had been selected as being mite-resistant in Washington, and 'Totem', a susceptible cultivar (Shanks, unpublished data), were planted at Dover, Fla., Watsonville, Calif., and Vancouver, Wash., to determine if resistance to spider mites differs between locations with distinctly different environments.

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Materials and Methods

'Totem' was used as a susceptible standard because of its known high susceptibility to spider mites (Shanks and Barritt, 1975, 1980).

Table 1. Total number of spider mites per leaflet on 11 *Fragaria* clones during the evaluation periods in Florida, California, and Washington.

Clone	Mites/ leaflet $\pm$ SE ^z	% of Totem	Mites/ leaflet $\pm$ SE	% of Totem
<i>Dover, Fla. (field)</i>				
21 Dec. 1992–28 Apr. 1993				
Totem ^y	197 $\pm$ 67 a	100	428 $\pm$ 190 a	100
A-16 ^x	31 $\pm$ 7 b	16	111 $\pm$ 32 b	26
CL-5 ^x	26 $\pm$ 10 b	13	171 $\pm$ 21 b	40
E-15 ^x	30 $\pm$ 4 b	15	56 $\pm$ 14 b	13
G-9 ^x	41 $\pm$ 9 b	21	125 $\pm$ 17 b	29
GCL-8 ^x	24 $\pm$ 8 b	12	94 $\pm$ 25 b	22
RCP-37 ^x	37 $\pm$ 16 b	19	158 $\pm$ 26 b	37
M-1 ^x	35 $\pm$ 6 b	18	130 $\pm$ 11 b	30
WSU 2198 ^w	24 $\pm$ 4 b	12	97 $\pm$ 15 b	23
WSU 2202 ^v	52 $\pm$ 30 b	26	111 $\pm$ 33 b	26
X-11 ^x	21 $\pm$ 6 b	11	46 $\pm$ 16 b	11
<i>Vancouver, Wash. (greenhouse)</i>				
22 Apr.–15 July 1993				
Totem	197 $\pm$ 57 a	100	143 $\pm$ 27 a	100
A-16	19 $\pm$ 5 b	9	5 $\pm$ 2 bc	4
CL-5	16 $\pm$ 3 b	8	3 $\pm$ 1 bc	2
E-15	18 $\pm$ 4 b	9	8 $\pm$ 3 bc	6
G-9	22 $\pm$ 4 b	11	4 $\pm$ 1 bc	3
GCL-8	64 $\pm$ 11 b	33	7 $\pm$ 2 bc	5
RCP-37	21 $\pm$ 5 b	11	5 $\pm$ 2 bc	3
M-1	27 $\pm$ 3 b	14	5 $\pm$ 3 bc	4
WSU 2198	67 $\pm$ 7 b	34	33 $\pm$ 12 b	23
WSU 2202	18 $\pm$ 4 b	9	3 $\pm$ 1 bc	2
X-11	17 $\pm$ 5 b	9	2 $\pm$ 1 c	1
<i>Dover, Fla. (field)</i>				
3 Jan.–17 Feb. 1994				
Totem	197 $\pm$ 57 a	100	143 $\pm$ 27 a	100
A-16	19 $\pm$ 5 b	9	5 $\pm$ 2 bc	4
CL-5	16 $\pm$ 3 b	8	3 $\pm$ 1 bc	2
E-15	18 $\pm$ 4 b	9	8 $\pm$ 3 bc	6
G-9	22 $\pm$ 4 b	11	4 $\pm$ 1 bc	3
GCL-8	64 $\pm$ 11 b	33	7 $\pm$ 2 bc	5
RCP-37	21 $\pm$ 5 b	11	5 $\pm$ 2 bc	3
M-1	27 $\pm$ 3 b	14	5 $\pm$ 3 bc	4
WSU 2198	67 $\pm$ 7 b	34	33 $\pm$ 12 b	23
WSU 2202	18 $\pm$ 4 b	9	3 $\pm$ 1 bc	2
X-11	17 $\pm$ 5 b	9	2 $\pm$ 1 c	1

The other clones had all been selected in earlier trials as having resistance to spider mites (Shanks and Barritt, 1984; Shanks and Moore, unpublished data).

Field plots in all three states consisted of a row of 10 plants of each clone and clones were replicated four times in a randomized complete-block design. Washington plots were planted in May 1992 and California and Florida plots were planted in Oct. 1992. A second trial was planted in Florida in Oct. 1993.

The same 11 clones also were tested in greenhouse trials in Washington. Plants were planted in 15-cm (2.3-liter) pots in May 1992, in a greenhouse without supplemental heat or light. Fans kept the temperature near ambient. Clones were replicated four times in a randomized complete-block design.

Mite populations developed naturally in the field and greenhouse. Field trials were evaluated by picking 10 trifoliate leaves from each plot every 2 weeks (Table 1), counting the mites on the undersides of the leaves, and pooling the numbers for each plot. Greenhouse trials were evaluated by picking one leaflet from each of three trifoliate leaves on each plant, counting the mites, and pooling the numbers for each plant every 2 weeks (Table 1). The same plants were evaluated in the greenhouse in 1993 and 1994. Data from all locations and years were analyzed as a 6 environments $\times$ 11 genotypes factorial with four observations per environment per genotype.

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Table 1. Continued.

Clone	Mites/ leaflet $\pm$ SE ²	% of Totem	Mites/ leaflet $\pm$ SE	% of Totem
	<i>Vancouver, Wash. (field)</i>		<i>Watsonville, Calif. (field)</i>	
	<i>12 May–7 July 1993</i>		<i>17 Mar.–22 July 1993</i>	
Totem	24 $\pm$ 2 a	100	79 $\pm$ 22 a	100
A-16	6 $\pm$ 2 c	26	10 $\pm$ 4 b	13
CL-5	5 $\pm$ 1 c	19	4 $\pm$ 1 b	5
E-15	5 $\pm$ 1 c	21	12 $\pm$ 2 b	15
G-9	8 $\pm$ 3 c	32	7 $\pm$ 1 b	8
GCL-8	14 $\pm$ 4 b	57	12 $\pm$ 2 b	15
RCP-37	5 $\pm$ 2 c	22	9 $\pm$ 1 b	11
M-1	5 $\pm$ 1 c	19	12 $\pm$ 3 b	16
WSU 2198	16 $\pm$ 3 b	64	18 $\pm$ 4 b	22
WSU 2202	5 $\pm$ 1 c	22	4 $\pm$ 1 b	5
X-11	5 $\pm$ 1 c	20	5 $\pm$ 1 b	6

²Mean separation within columns and locations by Duncan's multiple range test ($P = 0.05$).

³*Fragaria* $\times$ *ananassa*.

⁴*Fragaria chiloensis*.

⁵*F. chiloensis* LPB2-1 $\times$ 'Totem'.

⁶ORUS 4474 $\times$ *F. chiloensis* LCM-19.

type effects ($P \leq 0.0001$), and the genotype $\times$ environment interaction also was significant ($P \leq 0.01$). When each environment was analyzed separately, the resistant selections had significantly ($P \leq 0.05$) fewer mites than did 'Totem' in all cases (Table 1), regardless of the location or whether the plants were in the field or greenhouse. Dover, Fla., has a subtropical climate, whereas Watsonville, Calif. ($\approx 37^\circ\text{N}$, 122°W), and Vancouver, Wash. ($\approx 46^\circ\text{N}$, 123°W), have moderate climates with cool summers. Summer daylengths are pro-

gressively longer from Dover to Watsonville to Vancouver. Geography seemed to have no effect on relative susceptibility to mites.

In a few cases, relative susceptibility for a clone varied from year to year at a location, e.g., CL-5 at Dover and GCL-8 in the greenhouse at Vancouver. Nevertheless, in only five of 66 cases (7.5%) mite counts exceeded one-third of the count on 'Totem' and in $\approx 67\%$ of the cases, there were $<20\%$ as many on leaves of the resistant clones as on 'Totem'. X-11 had the fewest mites, or nearly so, at every location

each year. The data show that *Fragaria* spp. clones that are found to be spider mite-resistant at a location can be expected to be resistant at other locations, even if the environment differs greatly. This situation makes mite-resistant germplasm useful for cultivar development in most or all strawberry-growing areas.

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