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Resistance in *Fragaria chiloensis* and *F.* X *ananassa* to the Aphids *Chaetosiphon fragaefolii* and *C. thomasi*[1]

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Abstract. **Nine commercial strawberry cultivars (*Fragaria* X *ananassa* Duch.) and 557 clones of wild *F. chiloensis* (L.) Duch. from the Pacific coast of the United States were tested in the field for resistance to strawberry aphids (*Chaetosiphon* spp.). No cultivar was highly resistant but 'Benton' consistently supported fewer aphids than the other cultivars. In the first evaluation year, 29 clones of *F. chiloensis* had fewer aphids than the highly resistant 'Del Norte' clone of *F. chiloensis* on 5 sampling dates, although the differences were not statistically significant but in the second year, only 1 clone, RCP-37, had fewer aphids than 'Del Norte'.**

The strawberry aphids, *Chaetosiphon fragaefolii* (Cockerell) and *C. thomasi* (Hille Ris Lambers), are important vectors of several viruses of commercial strawberries, *Fragaria* X *ananassa* (3). The 'Del Norte' and 'Yaquina' clones of *F. chiloensis* were shown to be resistant to *C. fragaefolii* (7) and the resistance was heritable when 'Del Norte' was crossed with commercial-type strawberries (1).

F. chiloensis, the beach strawberry, grows wild in North America along a narrow strip of the Pacific beach. The diverse environment causes great interpopulational genetic variability, making *F. chiloensis* an excellent source of germplasm for various physiological traits (5). Clones of *F. chiloensis* from California, Oregon, and Washington were tested in an effort to find some that were more aphid-resistant than 'Del Norte'.

Strawberry cultivars also were tested for relative resistance to these aphids. All of the commercial-type clones evaluated by Shanks and Barritt (7) were susceptible. However, field observations of recently released cultivars had indicated that 'Benton' might be less susceptible than other clones (J. G. Todd, Agrimanagement, Inc., Albany, OR; personal communication).

In August 1979, 102 clones of *F. chiloensis* collected from 16 California coastal sites (4, 5) were planted in field plots at Vancouver, Washington. In April 1980, 282 clones from 12 Oregon sites and 173 clones from 10 Washington sites were also planted at Vancouver near the California clones. The Washington and Oregon clones were collected in 1977 from various sites on the coast from Neah Bay, Wash., to Bandon, Ore., by B. H. Barritt and C. H. Shanks.

Field plots were single matted rows 1.2 m apart between centers and 1 m long. One plant was placed in the center of each plot and the new runner plants were allowed to fill in the 1-m plot. The experimental design was a randomized complete block with 5 replications (except in a few cases where there were insufficient plants). 'Totem' and 'Del Norte' were included in each block as a susceptible commercial type and a resistant check, respectively.

Aphid populations were measured by picking 3 folded, immature leaves at random from each plot. All *Chaetosiphon* aphids on the underside of the leaves were counted, and the leaves, with the aphids still on them, were returned to the plot. Counts were made 5 times at ca. 3-week intervals from June–September 1980 in the California clones and 4 times from July–September 1980 in the Oregon and Washington clones.

Clones were evaluated for resistance by comparing their aphid populations with those of 'Del Norte'. Only clones having fewer aphids than 'Del Norte' on every counting date in 1980 were re-evaluated in 1981. In the 1 exception, a comparison standard of 0.5 aphids/leaf was used in the June 23, 1980 count, since aphid populations on 'Del Norte' were only 0.1 aphid/leaf on that date. In 1981, counts were made 7 times from May 8 to August 10.

In a separate experiment, 9 cultivars of *F.* X *ananassa* were screened at Puyallup, Wash., for resistance to strawberry aphids. These clones were planted in 1978. Plots were single matted rows 7.5 m long and 1 m apart and clones were replicated 4 times in a randomized complete block design. Aphid populations from each plot were sampled weekly from May to Octover 1980 by picking 10 immature folded leaves from each plot. The leaves were frozen or placed in 70% ethanol and all *Chaetosiphon* aphids were counted at a later date. Between the July and August sample dates the plots were mowed, a common commercial practice after harvest.

Fragaria chiloensis clones. Most *F. chiloensis* clones were less susceptible to aphid colonization than was 'Totem'. In 1980, 29 of the 557 clones under trial had fewer strawberry aphids than 'Del Norte' on every counting date, although none was significantly lower than 'Del Norte' (Table 1). In 1981, only the California clone, RCP-37, had fewer, although not significantly fewer, aphids than 'Del Norte'. Many of the other clones had low aphid populations, but none of them was superior to 'Del Norte' in resistance to strawberry aphids. 'Totem', in the planting of California clones, had fewer aphids than those in the Oregon-Washington clone planting, perhaps due to weaker plant growth. This caused 'Del Norte' to appear to be relatively less-resistant in the California clone planting (compared with 'Totem') than in earlier reports (1, 7) or in the Washington-Oregon portion of the field, which was all spring-planted, and no vigor interaction was involved. However, 'Totem' in both plantings had significantly more aphids than any *F. chiloensis* clone listed in Table 1, except DL-20.

Of the 102 California clones, only 8 had fewer aphids (but not significantly so) than 'Del Norte', and 7 of those were from sites between the Oregon border and Orick (DL, PSG, RCP). Only 21 of the 455 Washington and Oregon clones had numerically fewer (but not significantly so) aphids than 'Del Norte' in 1980 and 8 of those were from Yachats State Park, Oregon (YSP). The rest were scattered among 10 Washington and Oregon sites. Since 15 of the 29 clones selected as being resistant in 1980 came from 4 sites, it may be profitable to collect more extensively from those areas in anticipation of finding clones that are even more resistant to the strawberry aphid. Hancock and Bringhurst (5) found significant interpopulational differences in traits such as tolerance to salinity and ability to accumulate biomass under nutrient and shade stress.

Only 1 of the 29 *F. chiloensis* clones tested in 1981 had numerically lower strawberry aphid populations than did 'Del Norte' in their respective fields, although most were statistically not significant from 'Del Norte' (Table 1). Further evaluation of these clones might reveal additional desirable traits such as virus tolerance, red stele resistance, and

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Table 1. Strawberry aphid (*Chaetosiphon* sp.) populations on clones of *Fragaria chiloensis* which had fewer aphids than did the 'Del Norte' clone of *F. chiloensis* in 1980. Vancouver, Wash.

Clone	No. of blocks	Avg no. aphids/leaf[z] 1980	1981
California clones[y]			
RCP-37	5	0.2a	0.6a
PSG-51	5	0.3a	1.6a
DL-40	4	0.4a	1.5a
DL-39	4	0.5a	1.1a
PSB-51	3	0.6a	1.6a
DL-20	4	0.6a	3.8b
PSG-43	5	0.7a	2.1a
RCP-19	5	0.9a	1.1a
Del Norte[x]	5	1.2a	1.1a
Totem[w]	5	5.9b	4.4b
Oregon and Washington clones[v]			
YSP-2[u]	1	0	4.6
YSP-15[u]	1	0.1	3.1
YB-7	4	0.1a	1.6ab
KBT6-2	5	0.1a	1.9abc
YSP-14	4	0.1a	1.1ab
YSP-24	5	0.1a	1.6ab
BSP-3	5	0.2a	1.5ab
LPB2-1	4	0.2a	1.5ab
TR-4	4	0.2a	1.8abc
YSP-4	3	0.2a	1.2ab
BSP-14	5	0.2a	1.7abc
YSP-18	5	0.2a	1.5ab
LPB2-14	5	0.2a	2.1abc
YSP-7	4	0.2a	3.3c
WL-8	5	0.2a	1.2ab
TDM-8	5	0.2a	2.4abc
YSP-9	4	0.2a	2.6bc
KBT3-8	5	0.3a	2.8bc
CA-12	4	0.3a	2.4abc
LCM-10	5	0.3a	2.4abc
LCM-19	5	0.4a	1.7ab
Del Norte	5	0.5a	0.6a
Totem	5	27.4b	9.7d

[z]Means separation by Duncan's multiple range test ($P = .05$).
[y]Planted in Aug., 1979.
[x]*F. chiloensis* clone already known to be resistant to *Chaetosiphon*.
[w]Aphid-susceptible cultivar.
[v]Planted April, 1980.
[u]Not included in statistical analysis because only 1 block.

Table 2. Strawberry aphid (*Chaetosiphon* sp.) populations on 9 strawberry cultivars in 1980 at Puyallup, Washington.

Cultivar	Avg no. aphids/leaf[z] May 9	June 4	July 1	Aug. 1	Sept. 2	Oct. 2	Avg (% of Benton)[y]
Totem	7.0a	24.6a	5.6abc	0.7ab	1.7ab	1.6ab	316a
Hood	6.4ab	19.6ab	4.3cd	1.4ab	1.9a	1.0abc	305ab
Tyee	2.4c	14.6bc	4.2cd	1.9a	1.4ab	2.0a	295ab
Linn	2.6bc	8.8c	7.4ab	0.7ab	1.8a	1.8ab	251abc
Northwest	5.3abc	8.5c	7.8a	1.1ab	0.9bc	1.5abc	245abc
Shuksan	4.5abc	13.2bc	2.5d	0.6ab	1.0bc	1.4abc	209abcd
Rainier	4.3abc	13.0bc	2.6d	0.35b	1.4ab	0.7bc	187cd
Olympus	2.8bc	8.3c	5.8abc	0.4ab	0.5c	1.2abc	154cd
Benton	1.8c	6.2c	5.1bcd	0.4ab	0.4c	0.4c	100d

[z]Means separation within columns by Duncan's multiple range test 5% level.
[y]Aphid numbers were converted to a percentage of 'Benton' (Benton = 100) for each evaluation date and the data presented are means of 6 dates.

spider mite resistance, which in combination with aphid resistance would make the clones useful in breeding. Bringhurst et al. (2) emphasized the usefulness of *F. chiloensis* in broadening the genetic base in strawberry breeding.

The California *F. chiloensis* clones also were tested in the greenhouse for resistance to these aphids in 1979, using methods similar to those of Barritt and Shanks (1). Results were generally similar to those in the field, but populations were higher in the greenhouse. Greenhouse results are less reliable due to the close proximity of resistant and highly susceptible clones. The close proximity (leaves of various clones may be touching) makes it possible for aphids from heavily infested plants to easily walk onto resistant plants. They may be counted at evaluation time, even though they have not colonized the resistant plant, and thus give a false impression that a clone is susceptible. In the field, after the plants make a row about 0.3 m. wide, the plants are separated by about 0.67–0.75 m from plants of other clones. Also, field environmental factors such as weather, predators, and aphid biotype can influence the results (1).

Strawberry cultivars. Aphid populations reached peak numbers in June and declined thereafter. 'Totem' supported the greatest number of aphids during the season, while 'Benton' had numerically fewer (but not significantly so) aphids on every counting date, except July 1 and August 1, and even then it was not significantly different from the clones with lower populations (Table 2). The number of aphids on 'Benton' during the entire season was only 35% of that on 'Totem' and was significantly less than the number found on the 5 clones with greatest aphid populations.

Although aphid populations on the commercial cultivars and on the *F. chiloensis* clones are not directly comparable, the latter appears to be the greater, and probably more genetically diverse, source of aphid resistance. However, origination of an aphid-resistant, commercially acceptable cultivar from an *F. chiloensis* lineage will require at least 3 backcross generations (1). Using a commercial cultivar in breeding, e.g., 'Benton', could be faster than using an *F. chiloensis* clone, e.g., 'Del Norte', because fewer generations of breeding would be required to reach commercial fruit quality.

There are no data showing the relationship between *Chaetosiphon* counts and resulting virus levels. However, Swenson (8) stated that any factors which consistently reduced aphid populations would reduce virus transmission. Kennedy (6) believed that host plant resistance which decreases vector populations would act similarly to insecticidal control. Introduction of viruses into strawberry fields by viruliferous winged aphids might not be prevented, but secondary spread within the fields should be reduced by lowering of aphid populations. If an aphid-resistant cultivar was widely planted, primary virus spread also should be reduced, since there would be fewer aphids flying to newly planted fields.

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