Predaceous Controls on

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Phytoseiulus persimilis adults on strawberry leaf infested with two-spotted spider mites (arrow).

STRAWBERRIES ARE GROWN as an annual crop in Orange County. The county yield is slightly higher than the state average and production has been recorded as high as 20 tons per acre. Summer planting is during August and September, and winter planting is in November. Berries are harvested from mid-March through July, after which the plants are disked under prior to replanting. Under these cultural conditions, cyclamen mites are not a problem and insect injury is usually minor compared with areas where the plants are retained three or more years. The two-spotted spider mite, however, is an annual problem which is often serious, affecting quality and yield where high populations occur. Repeated applications of acaricides are required to suppress high numbers of two-spotted spider mites when once established. Biological control of the pest would lower production costs by reducing the number of pesticide applications, or eliminating them altogether where insect problems do not occur. It would also offer a solution to the serious problem of resistance to formerly effective acaricides—which has been recorded in the Salinas-Watsonville strawberry-growing area of California.

Experiments designed to investigate this possibility were established at the South Coast Field Station, Orange County. Primary objectives were to (1) determine if *P. persimilis* could be established on, and result in suppression of the two-spotted spider mite on strawberry under field conditions; and (2) to study the spread of the predaceous mite from release sites. To accomplish these goals, a small plot ($\frac{1}{12}$ acre) of strawberries, 4 rows wide and 100 yards long, was planted on August 20, 1963, at the rate of 20,000 plants per acre. The longitudinal design of the plot was planned to study the spread of the predaceous mites along the row between release sites. The plot design, varieties used, release and sample sites are shown in figure 1. Weekly samples of compound leaves collected at random from September, 1963, through January, 1964, showed that the two-spotted spider mite was present, but in very low numbers. On January 28 the older, lower, discolored leaves were pruned out and plastic mulch placed along the row under the plants.

The first release of *P. persimilis* was on February 4 and the last one on April 28.

TABLE 1. EXPERIMENTAL RELEASE AND RECOVERY OF PHYTOSEIULUS PERSIMILIS DURING BIOLOGICAL CONTROL STUDIES OF THE TWO-SPOTTED SPIDER MITE ON STRAWBERRY IN SOUTHERN CALIFORNIA

Release dates	Number released*	Total released each month	Recovery attempt dates	Number recovered†
Feb. 4	1,000		Feb. 18	0
25	1,000	2,000	Mar. 3	2
March 10	1,000			
17	600		17	0
24	1,200	2,800	31	5
April 7	600		Apr. 7	8
14	1,200		14	8
21	2,400		21	7
28	3,000	7,200	28	45
Totals	12,000			75

* Predaceous mites tapped from vials onto plants along 10 to 15 feet of row.
† Based on 30-leaf sample collected at random from release sites just prior to each release.

Mite Two-Spotted Spider Mite Strawberry

Biological control of the two-spotted spider mite, Tetranychus urticae, Koch, on strawberry was obtained with mass releases of the predaceous mite Phytoseiulus persimilis Athias-Henriot, during preliminary studies in the coastal area of southern California in 1964.

Release and preliminary recovery data are shown in table 1. Recovery studies during the release period were made by collecting 30 leaves at random from release sites for microscopic examination in the laboratory for predator and pest species. The first *P. persimilis* adults were recovered on March 3, and the first eggs were observed on April 7 (the date of the first indication that the predaceous mite was established and reproducing). At this time, about half of the sampled leaves were infested with the two-spotted spider mite with approximately half of the infested leaves bearing *P. persimilis*.

After the last release of *P. persimilis* on April 28, predator and prey populations were followed at weekly intervals through May and June by sampling a total of 30 compound leaves at random from the release sites, between release sites, and from the next row adjacent to the release site (figure 1). All stages of *P. persimilis* were counted on each leaf under the binocular microscope, and total leaves infested with pest and predators were recorded. The leaves infested with the two-spotted spider mite were then brushed through a mite-brushing machine, and the mites were collected on a vaseline-coated glass counting plate. Active stages of the spider mites were then counted under a binocular microscope. Actual numbers were recorded at low populations, but at high populations the number of mites was estimated from actual counts on ¼ to ½ of the plate, according to population size.

The results are shown in table 2. The data show that 100% of the leaves from plants between release sites were infested with the two-spotted spider mite by May 19. The number of infested leaves at the release sites was lower throughout the study, reaching a peak between May 26 and June 2. *Phytoseiulus persimilis* apparently quickly moved across to the next row, but spread slowly down the row between release sites, covering a distance of about 50 ft in approximately two months from the time they were known to be established. They became established in the release row and the next row at about the same time and in approximately the same numbers—being found on 25 of 30 leaves sampled and averaging eight per leaf at their population peak on June 2.

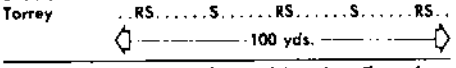

Figure 1. Plot design for studying the effect of releasing Phytoseiulus persimilis for biological control of the two-spotted spider mite on strawberry. ("R" = release sites and "S" = sample sites.)

Two-spotted spider mites averaged only 36 per leaf in the release areas compared to 247 per leaf on plants midway between release sites. During the period of greatest abundance, from May 19 through June 2, they averaged only 30 mites per leaf at the release sites compared to 208 per leaf between release sites. The number of two-spotted spider mites also built up more slowly and declined more rapidly where predators were released than did those between release sites. The decline in the two-spotted spider mite population on plants between release sites during June was due primarily to the action of native predators.

Results of the preliminary study show biological control of the two-spotted spider mite on strawberry plants is possible using mass releases of *P. persimilis*. The numbers necessary for release and the distance between releases required for effective, economical control are primary objectives of a larger experiment presently in progress at the South Coast Field Station. Similar studies are also planned for the Salinas-Watsonville area in 1965.

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TABLE 2. RESULT OF RELEASING PHYTOSEIULUS PERSIMILIS FOR BIOLOGICAL CONTROL OF THE TWO-SPOTTED SPIDER MITE ON STRAWBERRY IN SOUTHERN CALIFORNIA

Survey dates	Number of leaves infested by*						Average number of mites per leaf*					
	Two-spot			P. persimilis			Two-spott			P. persimilist		
	RS	BRS	NR	RS	BRS	NR	RS	BRS	NR	RS	BRS	NR
May 5	23	29	26	12	1	12	13.9	28.1	..‡	0.9	0.03	1.2
May 12	26	28	25	18	0	14	9.6	88.0	..	2.9	0.0	1.5
May 19	26	30	29	22	0	16	36.0	187.2	..	6.5	0.0	5.4
May 26	29	30	29	24	0	23	28.8	246.8	..	6.6	0.0	6.6
June 2	29	30	24	25	0	23	25.3	189.3	..	8.0	0.0	8.5
June 9	17	30	23	20	4	16	4.3	76.1	..	2.3	0.1	1.3
June 16	13	27	13	14	9	13	1.7	14.5	..	1.3	0.2	2.1
June 23	3	10	12	5	1	11	0.1	0.9	..	0.2	0.07	2.1
June 30	0	4	3	0	0	4	0.0	0.2	0.2	0.0	0.0	0.7

* Based on 30 compound leaves sampled at random from the release site (RS), between release sites (BRS) in same row, and from the next row (NR) adjacent to release sites; leaves examined individually under binocular microscope.

† P. persimilis counted individually during leaf examinations; two-spot counts made later by brushing leaves through mite-brush machine, estimating population from partial counts at high numbers.

‡ Data not taken.