Biological control of two avocado pests

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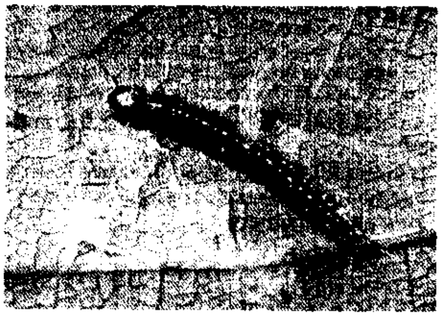
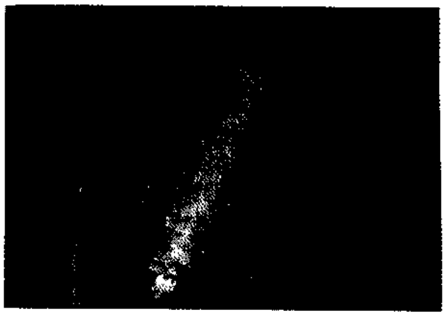
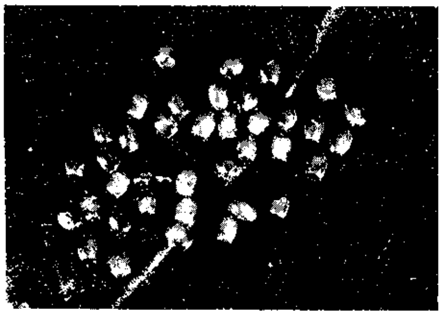
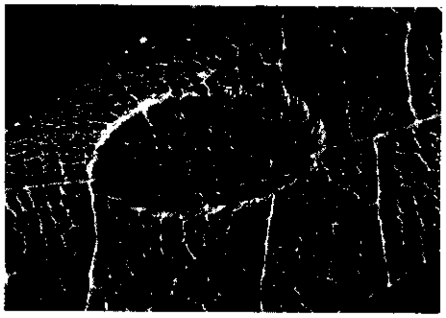
Amorbia cuneana *and omnivorous looper on avocado can be controlled by parasite*


Amorbia cuneana larva

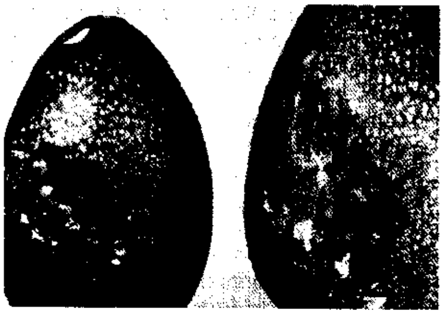

Omnivorous looper larva

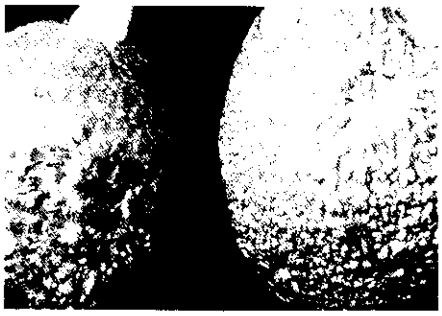

Newly laid *Amorbia* egg mass


Omnivorous looper egg cluster


Parasitized *Amorbia* egg mass


Parasitized looper egg cluster


Amorbia damage to Bacon avocado


Looper damage to Hass avocado

Two apparently native insects are the most common lepidopterous pests on avocado in southern California: *Amorbia cuneana* Walsingham and the omnivorous looper, *Sabulodes aegrotata* (Guenée). Both are generally distributed throughout avocado-growing areas.

Amorbia cuneana lays its eggs in masses on the upper surfaces of leaves; the omnivorous looper lays eggs in clusters on the lower surfaces. The average number of eggs per mass is 25.3, and the average per cluster is 5.6 (personal communication, J.B. Bailey, UC Cooperative Extension Entomologist). The larvae feed primarily on the foliage. Damage to leaves and fruit usually is light, but when populations are high, severe defoliation and fruit scarring occur.

Natural enemies usually hold both pest species at low numbers, and insecticides seldom, if ever, are used in most orchards. Nevertheless, both insects occasionally increase to high numbers, so that action is needed to prevent economic loss. In such cases, biological control is preferred over chemical control, because the latter can create an "upset" problem by destroying natural enemies of spider mites along with the lepidopterous pests.

To determine the natural enemy complex associated with each of the two pest species, we collected immature stages of the pests from avocado foliage in commercial orchards during 1978 through 1980 and held them in the laboratory for parasite emergence. Fifteen parasite species were reared from each of the pest species; seven of these were parasitic on both pests. Fifteen of the parasites were hymenopterous and eight were dipterous (Tachinidae). Of all those recorded, the egg parasite *Trichogramma platneri* Nagarkatti appeared to be the most suitable for augmenting the native *T. platneri* population in an orchard. We conducted preliminary research from 1979 through 1981 to determine if mass releases of *T. platneri* would provide biological control of both the omnivorous looper and *A. cuneana*.

Orchard studies

Results of preliminary release studies in an experimental avocado orchard in 1981 showed that the egg parasite preferred *A. cuneana* egg masses over omnivorous looper egg clusters (87 percent of the masses versus 58 percent of the clusters parasitized) and was more effective against *A. cuneana* eggs on leaves inside the tree canopy. Most of the eggs within the *A. cuneana* masses were parasitized by *T. platneri*, whereas most of those within the omnivorous looper egg clusters were not.

In additional studies, egg masses/clusters of both pest species were obtained from laboratory cultures and artificially attached to the foliage. More than twice as many *A. cuneana* egg masses were parasitized, and they were acceptable to *T. platneri* females for a longer period of time than were omnivorous looper egg clusters (three days compared with two). Releases of 30,000 of the egg parasites per tree resulted in 99 percent parasitization of *A. cuneana* egg masses; 10,000 per tree resulted in 70 to 80 percent parasitization. Up to 75 percent parasitization of *A. cuneana* egg masses occurred in adjacent trees when 10,000 were released in a given tree.

We continued studies in 1982 in Riverside and Orange counties to determine how many of the egg parasites need to be released per tree and how many releases are necessary per acre for effective, economical control of both pest species. Egg masses or clusters obtained from laboratory cultures had been deposited naturally by the two pest species on bouquets of avocado leaves. We clipped pieces of the leaves containing eggs to the upper (*A. cuneana*) or lower (omnivorous looper) leaf surfaces in parasite-release and adjacent nonrelease trees in commercial avocado orchards. Immediately thereafter, we released the egg parasite at varying rates in the release trees. After seven days, we removed the eggs and held them in the laboratory for evidence of parasitization (parasitized eggs turn black).

Parasitization of omnivorous looper egg clusters on Bacon avocado trees generally increased as release rates increased from 5,000 (average of 24.3 percent) to 30,000 (57.9 percent) per tree, and parasitization of the clusters was almost as high (about three-fourths) in adjacent nonrelease trees as in the release trees. About one-half of the eggs in the clusters were parasitized. Parasitization of *A. cuneana* egg masses on Bacon trees generally was higher than that of omnivorous looper egg clusters at release rates of 10,000 and 20,000 per tree. When the parasite was released at 20,000 per tree (Hass variety), 70.6 percent of *A. cuneana* egg masses from the inside portion of the release trees were parasitized, compared with 42.6 percent from the outside (around periphery of tree). There was essentially no difference in parasitization (inside versus outside) in adjacent nonrelease trees.

When the egg parasite was released at 50,000 per tree (Bacon variety), 81.4 percent of *A. cuneana* egg masses were parasitized in the release tree and 50, 16.7, and 16.4 percent in the first, second, and third nonrelease trees, respectively, distant from the release tree (same row). When 50,000 were released in every fifth tree (Hass variety), parasitization ranged from 57.1 to 65.5 percent in the four nonrelease trees between the two release trees (same row). The results suggest that *A. cuneana* can be effectively controlled in a mature avocado orchard (Bacon or Hass) by a release of 50,000 *T. platneri* in every fifth tree.

When both *A. cuneana* egg masses and omnivorous looper egg clusters were exposed at the same time and the egg parasite was released at 50,000 per tree (Hass variety), 84.2 and 84.1 percent of the *A. cuneana* masses were parasitized in the release and adjacent nonrelease trees, respectively, compared with 68.3 and 44.1 percent of the omnivorous looper egg clusters. The findings suggest that *T. platneri* is more effective at suppressing *A. cuneana* than omnivorous looper populations, substantiating results of previous studies.

In 1983, we continued the studies in commercial Hass avocado orchards in San Diego County, releasing *T. platneri* at weekly intervals in four uniformly spaced trees (fig. 1 and 2) at 50,000 per tree for a total of 200,000 per acre. Most avocado groves in California average 100 trees per acre. The source of *T. platneri* was a commercial insectary where the parasite had been mass-produced with *Sitotroga cerealella* (Oliver) eggs as the host.

In the Von Essen orchard we clipped laboratory cultures of egg masses or clusters of the two pest species to leaves on the release tree and on two adjacent trees at cardinal points to the release tree for a total of nine trees (fig. 1), marking the egg sites with engineer's flagging tape. We released the parasite soon after placement of the eggs and then, after seven days, removed the eggs and held them in the laboratory to determine parasitization. The replicated (two replicates) *A. cuneana* experiment was repeated weekly for four weeks; the omnivorous looper experiment was not replicated because of a shortage of egg clusters and was repeated only once.

In the Von Essen orchard, average parasitization of *A. cuneana* egg masses was 13.1 percent before release (table 1). In the release tests, average parasitization was highest (70.8 percent) in the May 19 test, ranging from 46 to 94 percent on individual trees. Parasitization ranged from 51.8 to 56.1 percent in the other three release tests. In the May 19 test, the parasite was already emerging from the release containers when placed in the trees; in the other tests, emergence was delayed four to six days. As a result, the *A. cuneana* egg masses were exposed to the full complement of the parasite for only one to three days before their removal from the orchard. This may account for the lower percentage of parasitization in the May 12, 26, and June 2 tests.

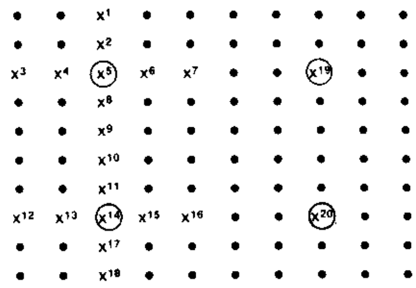


Fig. 1. Von Essen avocado orchard.

X 1-18: 30 *Amorbia cuneana* egg masses/tree clipped to leaves weekly, May 2 — June 2
X 1-9: 20 omnivorous looper egg clusters clipped to leaves on Jun 28 and Jul 5
⊗ 5, 14, 19, 20: *Trichogramma platneri* released weekly at 50,000/tree (200,000/acre)

Distribution pattern of eggs of two insect species and release of parasites to measure parasitization.

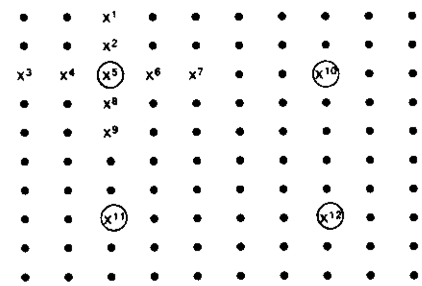


Fig. 2. Ogden avocado orchard.

X 1-9: naturally occurring omnivorous looper egg clusters found and marked weekly
⊗ 5, 10, 11, 12: *Trichogramma platneri* released weekly at 50,000/tree (200,000/acre)

In all tests, parasitization was highest in the release trees, ranging from 67 to 100 percent. Of 60 total *A. cuneana* egg masses placed in two trees (30 per tree) 12 rows from the nearest release tree, none was parasitized when recovered seven days later. The eggs were exposed from May 26 to June 2.

We conducted three weekly post-release tests in the Von Essen orchard to determine any cumulative effect of the weekly releases of the parasite. Egg masses (50 per tree in five trees) of *A. cuneana* were exposed for seven days at weekly intervals, starting June 9. The five test trees were in the center of the experimental plot. Parasitization averaged 34.9, 23.4, and 34.7 percent for egg masses exposed 7, 11, and 14 days after the last release (June 2) of the parasite. Parasitization thus remained relatively high for at

TABLE 1. Parasitization of *Amorbia cuneana* and omnivorous looper eggs in avocado trees following releases of *Trichogramma platneri* at 50,000 per release tree, Von Essen Ranch, Fallbrook, California, 1983

Test		Parasitization in tree number†																		Mean parasitization	
Date*	Condition	1	2	3	4	5‡	6	7	8	9	10	11	12	13	14‡	15	16	17	18	Egg mass/ clusters	Single eggs
		%																			
Amorbia coneana																					
May 2	Pre-release																			13.1	
12	Release	26	40	54	58	89	68	56	71	25	25	63	35	54	95	61	45	69	44	56.1	
19	Release	71	75	58	90	94	88	63	89	71	68	70	54	50	91	46	50	74	47	70.8	
26	Release	50	62	32	76	100	53	47	44	29	40	63	41	68	92	47	35	59	33	54.4	
June 2	Release	20	69	54	57	75	73	71	23	55	67	60	50	47	67	35	29	56	57	51.8	
Omnivorous looper																					
June 28	Release	53	40	39	15	63	60	65	61	47	—	—	—	—	—	—	—	—	—	49.3	21.0
July 5	Release	16	27	15	26	32	10	21	26	20	—	—	—	—	—	—	—	—	—	20.3	10.6

*Egg masses/ clusters clipped to leaves and *T. platneri* then released; eggs removed seven days later.
†Percentages rounded off to nearest whole number.
‡Release tree (see fig. 1).

TABLE 2. Parasitization of naturally occurring omnivorous looper eggs in a Hass avocado orchard, following releases of *Trichogramma platneri* at 50,000 per release tree, Ray Ogden Orchard, Escondido, California, 1983

Test date*	Parasitization in tree number									Mean parasitization
	1	2	3	4	5†	6	7	8	9	
	%									
Egg clusters										
Aug. 17	20.0	2.6	0	53.8	33.3	21.4	11.8	22.2	7.2	15.7
24	61.9	61.5	—	84.6	78.4	87.0	44.4	73.9	62.8	69.1
31	87.5	75.0	—	50.0	92.3	87.5	100	92.0	65.2	80.0
Single eggs										
Aug. 17	2.1	0.2	0	15.2	13.2	8.6	1.7	5.1	1.4	3.9
24	20.0	24.4	—	41.9	40.3	45.4	10.4	32.7	20.1	28.8
31	59.0	36.6	—	30.9	50.5	43.1	41.7	54.7	43.3	46.9

* Egg clusters located and flagged and *T. platneri* then released; eggs removed seven days later. † Release tree (see fig. 2).

least two weeks, enhancing the effectiveness of mass releases of *T. platneri* for biological control of *A. cuneana*.

Parasitization of omnivorous looper egg clusters in the Von Essen orchard averaged 49.3 percent in the June 28 test, with 21 percent of individual eggs parasitized (table 1). In the July 5 test, parasitization was only about half as high, probably because it had been necessary to use refrigerated omnivorous looper eggs that had been accumulated over a longer period of time than those used in the June 28 test. As with *A. cuneana* egg masses, parasitization of omnivorous looper egg clusters was highest in the release trees. Of 49 egg clusters placed in a check tree 12 rows away from the nearest release tree on June 28, 15.8 percent were parasitized when recovered seven days later. Thus, parasitization was increased threefold in the release area.

In a different commercial Hass avocado orchard in the Fallbrook area, a total of 50 naturally occurring omnivorous looper egg clusters were flagged in several adjacent trees on June 14, and 75,000 *T. platneri* were released in one centrally located tree immediately thereafter. The grower released the equivalent of 30,000 *T. platneri* per acre on June 16 and had made similar releases previously. The egg clusters were removed seven days later and held for determination of parasitization. Parasitization of the egg clusters averaged 77.1 percent, and 54.1 percent of the total number of individual eggs were parasitized.

In the Ray Ogden orchard, we located naturally occurring omnivorous looper egg clusters weekly, marked them with flagging tape, then released *T. platneri*. After seven days, the egg clusters were removed and held for determination of parasitization. We recorded both parasitized egg clusters and individual parasitized eggs of the omnivorous looper, but only egg masses of *A. cuneana*, since in general, nearly all of the individual eggs in a mass were parasitized.

Parasitization of omnivorous looper egg clusters in this orchard averaged 15.7, 69.1, and 80 percent after release of the egg parasite on Aug. 17, 24, and 31, respectively, with 3.9, 28.8, and 46.9 percent of the individual eggs parasitized (table 2). Thus parasitization of the naturally occurring population increased progressively with three weekly releases. We could not conduct an untreated control, because the grower had released the equivalent of 30,000 *T. platneri* per acre outside the study area on August 18. A random collection of omnivorous looper egg clusters outside the experimental area showed parasitization similar to that within. It was also known that a naturally occurring *T. platneri* population was parasitizing eggs before the first test release. Nevertheless, the results show that augmentative releases of the parasite resulted in substantial control of the pest population.

Conclusions

Results of the 1983 studies show that both *Amorbia cuneana* and the omnivorous looper, especially the former, can be effectively controlled on avocado by releases of 50,000 *Trichogramma platneri* in each of four uniformly spaced trees per acre. At least three weekly releases are required for control of the omnivorous looper, whereas only two are necessary for *A. cuneana*. Since these two pests species are not serious problems annually in most avocado orchards, the adult populations in an orchard should be monitored daily each year with pheromone or blacklight traps, as available, to determine when and if mass releases of the parasite are needed. Such records show the numbers of generations per year and when peak populations of the adults occur. Releases to control the egg populations can then be timed accordingly.

Trichogramma platneri can be purchased from several commercial insectaries. Two *Amorbia* sp. pheromones and an omnivorous looper pheromone are available for experimental use only. In California, interested individuals should contact their local Cooperative Extension farm advisors for information on the pheromones.

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