Max Badgley

Amorbia cuneana

Field-testing the sex pheromone for *Amorbia cuneana* in avocados

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A simple, effective means of monitoring avocado pests

A complex of natural enemies usually keeps the lepidopterous pest *Amorbia cuneana* (Walsingham) under control before it can cause economic losses to California avocado or citrus growers. Leaf damage mainly takes the form of leafrolling and tying and occasionally partial consumption of leaves. Damage to fruit is usually confined to the surface. Fruit damage, however, can sometimes be severe enough to result in losses, and the pest has grown in importance in California avocados and in San Joaquin Valley citrus.

Various control measures have been investigated, including supplemental releases of the wasp *Trichogramma platneri* Nagarkatti, which parasitizes and kills *A. cuneana* eggs. Experimental releases of this wasp have been effective in controlling *A. cuneana* (*California Agriculture* November-December 1985).

Timing of the wasp releases is critical, because they must coincide with the presence of the *A. cuneana* egg stage. It is therefore necessary to know when *A. cuneana* moths and consequently the eggs are most abundant. We conducted a blacklight trap monitoring program in 1980-82 to identify seasonal moth flight activity of *A. cuneana* and the omnivorous looper, *Sabulodes aegrotata* Guenée, another important pest of avocados, in most major avocado growing areas of California. Three generations of *A. cuneana* and four of the looper occurred in most areas monitored (*California Agriculture*, March-April 1988).

Sex-pheromone-baited traps, however, are preferable for monitoring seasonal moth flight activity. They are simpler to operate than blacklight traps, because they generally capture only one insect species and they do not need a source of electricity.

Because *A. cuneana* is a sporadic pest, a pheromone trapping system would be useful in identifying population cycles, and so aid in predicting outbreaks and timing releases of the parasitic wasp. We conducted field tests in 1980-81 on use of the synthetic pheromone of *A. cuneana* in California avocado and citrus groves.

Synthetic pheromone development

We collected *A. cuneana* pupae and larvae from a commercial avocado grove and reared the larvae to pupation on an artificial diet. Pupae were sexed and sent to the U.S. Department of Agriculture, Agricultural Research Service laboratory in Yakima, Washington, where moths emerged. The pheromone was extracted from the abdominal tips and/or collected from pheromone gland tissue of females. Chemical analysis of the extracted pheromone showed it to be a combination of two components or isomers, (E,E)-10,12 and (E,Z)-10,12 tetradecadien-1-ol acetates.

The pheromone was subsequently synthesized and an initial field trial was conducted near Irvine, California, in June 1980. This test demonstrated the synthetic pheromone to be attractive to male *A. cuneana* moths when used as a lure in insect traps.

Field tests

We conducted several trapping experiments with the synthetic pheromone of *A. cuneana* in 1980 and 1981 to optimize its use in monitoring. All tests were conducted in commercial avocado groves in Orange, Ventura, and Riverside counties in southern California.

The Pherocon 1C trap was used in all tests, and an extra coating of about 20 ml of Stikem Special was applied to trap bases to improve catch capacity. Traps were hung from scaffold branches of avocado trees at a height of about 6 feet and spaced no closer than 89 feet within and between trap rows. Moths were counted every one to three days. The traps were moved one position within each block every time they were checked to minimize bias due to location.

A randomized complete block experimental design was used in all tests, with five replications per treatment. Data were analyzed statistically (analysis of variance [ANOVA]; where appropriate, a square root transformation was used before ANOVA).

Except where noted, rubber septum dispensers treated with 0.2 mg pheromone (62:38 EZ:EE) were used in all tests. Each pheromone dispenser was impaled on a straight pin hung from the top inside center of the trap.

The correct amount of pheromone for maximum trap catch can vary greatly among insect species. Some respond to a narrow dose range, others to a very broad range. We conducted two tests to determine the effect of pheromone dosage on male *A. cuneana* trap catch.

A wide range of dosages was effective (table 1). Trap catch was not significantly different for doses between 0.06 and 1.7 mg per septum. We chose 0.2 mg as the standard, because it is a sufficiently greater dose than 0.06 mg to provide longer field life and is still within the range of optimal effectiveness.

Since the *A. cuneana* pheromone consists of two isomers, it was necessary to determine the ratio most attractive to the male moths. Two field comparisons of several isomer ratios were conducted in Orange County. In the first test, an EZ isomer content of 52.8 percent was most effective, followed by 40.8, then 73.0 percent (table 2). In the second test, trap catch was not significantly different for EZ values ranging from 28.6 to 73.0 percent. The 62:38 EZ/EE ratio was chosen as standard for practical reasons, since the synthetic method for producing this pheromone gives a compound of that ratio. In addition, this ratio is well within the optimum range indicated by the isomer tests.

Additional trapping studies with the *A. cuneana* pheromone indicate that populations in Santa Barbara and San Diego counties respond to a different ratio of isomers than at other locations. Research is under way to define the distribution of these two populations and determine which isomer ratio is best for monitoring in the respective areas.

Another study compared the synthetic pheromone with *A. cuneana* virgin females. Treatments in this comparison were traps baited with a caged virgin female (less than 48 hours old at the start), caged septum, or pinned septum. The females and caged septa were held in small cylindrical plastic mesh cages hung from the top inside center of the traps. Females were provided a 10 percent sugar solution at all times and were replaced every five to six days. Traps baited with

TABLE 1. Capture of male *A. cuneana* moths with various dosages of sex pheromone

	Avg. number moths/trap*	
Dosage/septum	Test I	Test II
mg		
0.06	9.8 a	59.0 a
0.19	7.0 a	56.8 ab
0.56	8.2 a	57.2 ab
1.7	6.0 a	35.8 ab
5.0	2.6 b	29.6 bc
15.0	1.2 bc	16.8 c
Blank	0.2 c	1.0 d

NOTE: test I, June 28 - July 4, 1980, Orange County; test II, Sept. 5 - 19, 1980, Ventura County, California.
* Means followed by the same letter are not significantly different at the 5% level (DMRT).

TABLE 2: Capture of male *A. cuneana* with various isomer ratios of its sex attractant, Orange County, California

Percent EZ in EE+EZ	Avg. number moths/trap*	
	Test I	Test II
4.8	0.6 c	—
28.6	—	77.0 ab
40.8	60.2 b	77.8 ab
52.8	98.0 a	96.2 a
73.0	61.6 b	92.6 ab
82.1	—	67.2 b
91.9	2.8 c	—
94.3	5.2 c	—
Blank	0	0

* See table 1 (*) footnote.

TABLE 3. Longevity of *A. cuneana* pheromone under field conditions, January 15 - May 1, 1981, Orange County, California

Pheromone ages	Avg. number male moths/trap*	
	Aging	Fresh†
days		
30	43.2 a	45.0 a
45	112.2 a	134.6 a
60	46.0 a	50.8 a
75	18.8 a	19.6 a
90	18.4 a	27.0 a
105	8.4 a	18.0 b

* Row averages followed by the same letter are not significantly different at the 5% level, five replicates per treatment, six to seven observations per 15-day interval.
† Replaced every 15 days. Obtained from stock stored at −12 C.

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Pherocon 1C sex pheromone trap.

pinned septa captured more *A. cuneana* male moths (5.92 per trap day) than those baited with either caged virgin females (3.26) or caged septa (2.63).

Once a pheromone lure has been proved effective, it is important to determine its longevity. We compared aging lures with fresh lures changed every 15 days. Over a 90-day period, there was no significant difference in trap catch between the fresh and aged lures (table 3). This test established a 90 day effective life for the pheromone-treated rubber septa.

Traps baited with rubber septa caught significantly more moths than those baited with polyethylene caps (160.8 vs. 75 moths per trap [$P > 0.5$]), mainly because the rubber septa provided for greater chemical stability of the pheromone. Unlike polyethylene, rubber gives protection against photo-oxidation. We thus selected rubber septa as the preferred pheromone dispenser.

Synthesis of a pheromone sometimes generates contaminants that are difficult to remove. During the original procedure for synthesizing the *A. cuneana* pheromone, a small quantity of one contaminant, E/Z 10-12:Ac, was generated. We performed a test in Orange County from early January to early February 1981 to find out if removal of this contaminant was necessary for maximum trap catches. Traps baited with pheromone free of the contaminant captured an average of 90.4 moths per trap as opposed to 63.0 when the contaminant was present. These trap catches are significantly different ($P > 0.05$), indicating that E/Z 10-12:Ac is moderately inhibitory to the moths. A new synthetic method has since been developed that produces the pheromone without the contaminant. All *A. cuneana* pheromone now in use is free of the contaminant.

Conclusion

The synthetic pheromone for *A. cuneana* provides an effective, simple means of monitoring this pest of avocados and citrus. Use of pheromone traps can aid in determining when infestations of the moth occur during the season and in accurately timing control measures—either supplemental releases of the parasitic wasp *Trichogramma platneri* or, if necessary, insecticide treatments.

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