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Development of an IPM programme for Californian avocados

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SYNOPSIS
Avocado acreage in California has increased dramatically during the past 15 years, presenting greater opportunities for pest species to become established. A synthetic pheromone for Amorbia cuneana *(Walsingham), a major pest of avocados, has been developed for use in the detection and monitoring of population outbreaks. Through the use of this pheromone, new Amorbia species have possibly been discovered.*

INTRODUCTION

Five major insect and mite pests attack Californian avocados. The insects include Amorbia cuneana (Walshingham) and the omnivorous looper, *Sabulodes aegrotata* (Guenee), which are lepidopterans as well as the greenhouse thrips, *Heliothrips haemorrhoidalis* (Bouche), a thysanopteran.

A. cuneana and the omnivorous looper are primarily foliage feeders, therefore light to moderate populations are generally tolerated. At high levels, both pests can cause extensive damage to the fruit, resulting in economic losses to growers.

Greenhouse thrips feed primarily on the fruit, thus even moderate infestations are of concern. This insect lives on the surface of the fruit, where it sucks juices from the skin, resulting in a russeted appearance.

The two mite pests are the avocado brown mite, *Oligonychus punicae* (Hirst) and the six-spotted mite *Eotetranychus sexmaculatus* (Riley). These mites occur primarily on the foliage where they remove chlorophyll, which often results in leaf drop. Without leaf cover, the fruit is susceptible to sunburn. The avocado brown mite is found mostly on the upper leaf surface, whereas the six-spotted mite lives primarily on the lower surface. Over 10 times as many avocado brown mites as six-spotted mites are required to cause leaf drop.

Integrated Pest Management (IPM) research has been conducted for over 10 years on avocado pests. Control methods, both chemical and biological, have been investigated by University of California researchers.

Several acaricides were tested on the two mite pests (Bailey et al, 1985). In four efficacy trials, propargite (Omite 30W) and cyhexatin (Plictran 50W) proved effective for control of both pests. Marginal control was obtained with fenbutatin oxide (Vendex

50W), sulphur, NR 415 spray oil and insecticidal soap. Sulphur and NR 415 have been registered for this use for some time. Registration of propargite is expected presently.

An insecticide evaluation and monitoring study is at present in progress for the greenhouse thrips. Materials investigated include pyrethrins (Pyrenone crop spray), malathion, sabadilla, ryania, abamectin and acephate (Orthene 75 S). Thus far, acephate is the most promising.

The majority of the research effort has focused on the omnivorous looper and A. cuneana . When the avocado IPM research began, these two pests were considered the most important. In recent years, however, the greenhouse thrips have become a pest of equal or even greater concern.

Various insecticides have been tested for control of the omnivorous looper and A. cuneana (Bailey & Hoffmann, 1980). In various efficacy trials methomyl (Lannate) and acephate (Orthene) were shown to be effective in controlling both pests. Unfortunately, in these tests cryolite (Kryocide) and Bacillus thuringiensis Berliner (Thuricide), two highly selective materials, gave poor control of both pests. New varieties of B. thuringiensis have not been tested.

An egg parasite, *Trichogramma platneri* Nagarkatti, has been field-tested for efficacy against both *A. cuneana* and the omnivorous looper. Effective control of both pests was obtained with releases of ca 200 000 wasps per acre (Oatman & Platner, 1985).

Timing of parasite releases and insecticide applications is critical, yet little was known about the seasonal life history of either the omnivorous looper or *A. cuneana*.

An areawide blacklight monitoring programme was established to monitor adult flight activity (Bailey & Hoffmann, 1980). Data from these traps indicated that three generations of *A. cuneana* and four to five generations of the omnivorous looper occur per year.

McDonough *et al* (1982) identified and synthesised the sex pheromone of *A. cuneana*. It was found to be a combination of (E,E)-10,12- and (E,Z)-10,12- tetradecadien -1-o1 acetates in a 1:1 ratio. Pheromone traps are the preferred monitoring tool because they capture only the targeted species and do not require a source of electricity.

Various field tests were conducted to show how the pheromone could best be used as a monitoring tool (Hoffmann *et al*, 1983). Tests included comparisons between different pheromone dispensers, dosages, component ratios, longevity, trap placement and trap design.

In addition, pheromone traps were stationed at sites in avocado growing areas to monitor local populations The traps were effective in all areas, except in Santa Barbara and San Diego counties even though blacklight traps in these areas indicated that high populations were present.

To determine the reason for this disparity, females were collected from Santa Barbara and San Diego counties. The sex pheromone glands of these females were extracted and analysed. The extracts gave a 9:1 (E,Z)/(E,E) component ratio instead of the 1:1 ratio of those from females analysed previously and on which the original identification of the pheromone was based. Lures with high and low ratios were field-tested in these two areas. The results of these tests are reported on below.

MATERIALS AND METHODS

Tests were conducted in commercial avocado groves in Santa Barbara and San Diego counties. Pherocon 1C® traps were used with an extra coating of Stickem Special® applied to the trap bases to improve trap efficiency.

Lures were red rubber septa (West Co, Phoenixville, Pennsylvania), impregnated with 0,2 mg of 98,5 per cent, 90 per cent, 80 per cent and 50 per cent of the EZ component of the pheromone. The synthetic pheromone consisting of a mixture of EZ and EE isomers, was prepared as previously reported (McDonough *et al*, 1982). Lures of a given EZ:EE composition were prepared from purified isomers as reported by Hoffmann *et al*, (1983). Septa were impaled on No 17 straight pins, hung from the top inside centre of the traps.

Traps were hung on peripheral branches of the trees two to three metre above the ground and spaced no closer than 27 m within and between trap rows. A randomised complete block design was used. Four treatments replicated five times, were used in the Santa Barbara county study. Traps were checked every two days and rotated once within the block, each time they were checked to minimise bias in trap catch due to location. Traps were checked eight times, so that each treatment was at each location twice during the study.

The San Diego county study was conducted in a commercial avocado grove near San Luis Rey. It was done in the same manner described above, except that the traps were checked four times, and four replicates were used.

Trap catch data were analysed using ANOVA and DMRT (P = 0,05).

RESULTS

The males in both Santa Barbara and San Diego counties preferred the lures with EZ percentages similar to those that had been found in the pheromone glands of females from these areas. The results of the Santa Barbara county study are summarised in Table 1.

The 98,5 per cent EZ and 90 per cent treatments captured the largest amount of moths. The other two treatments were ineffective.

Similar results were obtained in the San Diego county study (Table 2).

As previously, treatments with high EZ percentages captured the largest amount of moths.

TABLE 1 Test of effect of (E,E)-10,12- and (E,Z)-10-12- Tetradecadien -1-01 Acetate ratios (Per cent EZ as percentage of EE+EZ) on trap catch of male Amorbia cuneana in Santa Barbara county, Californiaa.

Per cent EZ	No of males caughtb	
Initial	Total	Per trap-day
98,5	1 403	14,8 a
90,0	926	9,7 a
80,0	39	0,4 b
50,0	24	0,3 b

a Test was conducted from 24/8/82 to 9/11 /82 (19 days), There were five replicates of each ratio.
b Means followed by the same letter are not significantly different ANOVA and DMRT (P=0,05).

TABLE 2 Test of effect of (E,E)-10.12- and (E,Z)-10,12- Tetradecadien -1-01 Acetate ratios (Per cent EZ as percentage of EE+EZ) on trap catch of male Amorbia cuneana in San Diego county, Californiaa.

Per cent EZ	No of males caughtb	
Initial	Total	Per trap-day
98.5	332	10.4 a
9Q0	152	4,8 b
80,0	83	2,6 be
50,0	14	0,4 c

a The test was conducted from 14/10/82 to 22/10/82 (eight days).
b Means followed by the same letter are not significantly different, ANOVA and DMRT (P=0,05).

DISCUSSION

Results from these tests correspond well with results of similar tests in the low ratio areas (Hoffmann *et al*, 1983). In the 1983 tests, sex pheromone glands from moths from a low ratio area were analysed and an average value of 54,8 per cent EZ was found. Data from two field-tests conducted in another known low ratio area, indicated lures with 52,8 per cent EZ to be the most attractive. Thus, males in both the high and low ratio areas prefer the component ratios emitted by females from their respective areas.

Further examination of the data obtained from females of the low ratio areas showed the EZ percentages to be grouped around two values; one at 35 per cent and one at 58 per cent. This suggests the possibility of two separate populations of *A. cuneana*

existing sympatrically in the low ratio areas. Subsequent research may show the two low ratio populations and the high ratio population to represent three different species.

Other instances of pheromonal polymorphism which have been discovered, include, among others, *Planotortrix excessana* (Walker *sensu* Dugdale 1966) and *Ctenopseustis obliquana* (Walker, *sensu* Green and Dugdale 1982) in New Zealand (Foster *et al*, 1986), each with three or four sibling species and the European corn borer, *Ostrinia nubilalis* (Hübner), which consists of three different populations (Klun & Maini, 1979; Klun *et al*, 1973, 1975; Kochansky *et al*, 1975; Carde *et al,* 1975).

The *A. cuneana* populations closely resemble those of the European corn borer. The sex pheromone of the European corn borer is (E)- and (Z)-11-tetradecen-1-o1 acetates (Carde *et al*, 1975). The three populations of this insect utilise different percentages of the Z-component of this pheromone.

Development of a synthetic sex pheromone for the omnivorous looper is near completion. Thirty four trapping sites have been established in nine of the major avocado growing counties of California to monitor this pest and the low and high ratio populations of *A. cuneana*. There are three traps at every site and every trap is baited with one of the three pheromone lures. The traps are checked weekly by selected growers, licensed pest control advisers and University of California farm advisers. Moth catches are reported to a regional co-ordinator at a local University of California farm adviser's office. The co-ordinator collects the data and makes it available to anyone requesting it.

When these pheromones are beyond the experimental and demonstration stage, they will become commercially available to everyone. When pheromone-baited trap catches are used in conjunction with recently-developed degree-day (°D) data for both pests, growers will be able to monitor the activity of these pests more accurately and make better pest management decisions.

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