Although it hasn't been considered a pest of pistachios, the obliquebanded leafroller has been discovered causing feeding damage on pistachio foliage and nuts in Madera County.

The obliquebanded leafroller: A new pest in pistachios?

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Trapping studies failed to establish pest status

The obliquebanded leafroller (OBLR) is a tortricid moth widely distributed throughout North America. Its status as a pest of economic importance varies considerably depending on geographic region and hosts. In California, OBLR, *Choristoneura rosaceana* (Harris), has been found on many plants but hasn't been considered a major pest of agricultural crops.

Persistent questions about the occurrence of lepidopteran species in stone-fruit orchards in the San Joaquin Valley led to a survey-trapping program for tortricid moths in 1983. In July of that year, OBLR larvae were discovered infesting commercial pistachio orchards in Madera County. This report gives the results of trapping studies on obliquebanded leafroller in pistachio, stone-fruit, and uncultivated areas in central California during 1983-84.

Trapping methods

Traps containing synthetic pheromones of eight tortricid species were placed in 1983 in two stone-fruit orchards in Fresno County and two uncultivated river-bottom areas in Tulare County (table 1). A single Pherocon I-C trap for each pheromone type was placed at each location on April 4: in a mature mixed stone-fruit orchard at the Kearney Agricultural Center, Parlier (Fresno County); in a mature plum orchard 4 miles north of Reedley, Fresno County; along Mill Creek in Visalia, Tulare County; and in the Kaweah Oaks Wildlife Preserve 6 miles east of Visalia. Traps were serviced and moths counted and removed weekly at Parlier and Reedley and at two-week intervals at Visalia and Kaweah Oaks. Pheromone dispensers were replaced at four-week intervals at all locations; trap bottoms were replaced as needed. Trapping ended on October 26, 1983.

In 1984, trapping was conducted from April 23 to November 1 at the Reedley site in plums and also in an adjacent uncultivated flood plain along the Kings River. Wild hosts for obliquebanded leafroller in this area included oaks (*Quercus*) and berries (*Rubus*). Three traps for obliquebanded leafroller and one for orange tortrix were placed in the plums; two OBLR traps were placed in the uncultivated area.

We also maintained traps from April 25 to November 8, 1984, in a pistachio orchard where OBLR larvae had been dis-covered in July 1983. This orchard is 9 miles northeast of Madera, Madera County, in an area with only pistachio orchards or open, uncultivated native grasslands for at least a mile in any direction. Three OBLR traps and one orange tortrix trap were placed at this location.

Traps at both 1984 sites were serviced and moths removed weekly; pheromone caps were changed at four-week intervals, and trap bottoms at least monthly or as needed.

In addition to the four seasonal monitoring traps for obliquebanded leafroller at the Madera orchard, we compared two commercial dispensers of obliquebanded leafroller pheromone (Albany International Corp., Needham, MA, and Zoëcon Corp., Palo Alto, CA) and the Zoëcon orange tortrix pheromone dispensers in the pistachios. Two traps of each of these three pheromone dispensers were used to collect OBLR at Madera from July 19 through September 6, 1984. These traps were separated from the seasonal monitoring traps by at least 980 feet of orchard. Traps were serviced and re-randomized weekly; pheromone dispensers were changed on August 16. Data from these traps were replicated weekly for a total of
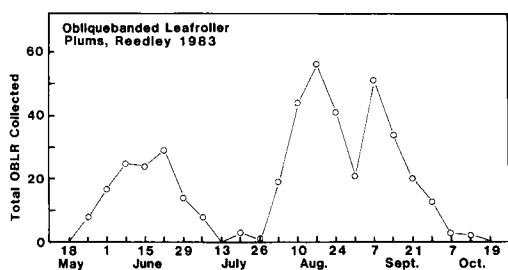
Fig. 1. Trap catches of obliquebanded leaf-roller showed two distinct flight periods during the 1983 season.
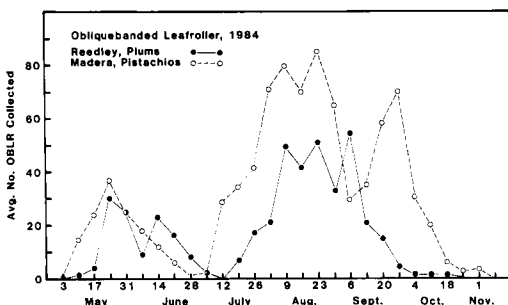

Fig. 2. Average catches per trap showed at least two flights again in 1984.

seven replicates per treatment, and statistically analyzed (by ANOVA).

Results and discussion

Total collections of obliquebanded leafroller from the four locations during 1983 in the various types of pheromone traps indicate response of OBLR to its own pheromone, but an even greater attraction to the synthetic pheromone of the orange tortrix (table 1). This response occurred at all four locations. Obliquebanded leafroller was also collected in traps containing pheromones of the filbert and redbanded leafrollers. Researchers in British Columbia have found a stronger response of OBLR to the pheromone of filbert leafroller than to its own pheromone. OBLR also responded to the filbert leafroller pheromone in our studies, but in much lower proportions. In 1983, 94.3 percent of all OBLR were collected at the Reedley location.

Other tortricids responding to several pheromones in significant numbers included fruittree leafroller, the garden tortrix, oriental fruit moth, and *Commophila umbrabsana* (table 1). A pyralid moth, *Macrotheca* sp., responded in large numbers at Parlier to the pheromones of fruittree leafroller and fruittree tortrix.

These results indicate that, among these species of tortricids, only obliquebanded leafroller, fruittree leafroller, and oriental fruit moth were present in numbers great enough for them to be considered potential pests in any of the four locations sampled. The three other moths collected in high numbers (garden tortrix, *Commophila*, and *Macrotheca*) are not known to be pest species where they have been reported.

We collected enough obliquebanded leafrollers at the Reedley site in 1983 to construct a seasonal flight graph for the male moths (fig. 1). This shows two distinct flight periods during the season, which agrees with reports of two OBLR generations in warmer climates in California and other regions of the United States and Canada.

One of the most interesting results of the comparison of pheromone types in 1983 was the response of obliquebanded leafroller to the pheromone of orange tortrix. Based on our results, a strong argument could be made for using orange tortrix traps when trapping for OBLR in central California. Similarly, fruittree leafroller responded to an even greater variety of pheromones in addition to its own. The implication is that some tortricid pheromones are not as specific as they could be, and pest control advisors and growers need to be very careful in identifying the moths collected in traps using these pheromones. It should be noted that all of the pheromones used in this study have a common major component, Z-11 tetradecenyl acetate.

Seasonal trapping of OBLR in 1984 at Reedley and in the Madera pistachio orchard again showed two flight peaks in both locations (fig. 2). The reason for the abrupt drop in moth counts in late August at Madera is not known, but it does not appear to be weather-related. The flight peak in late September at Madera may represent the development of a third generation at this location during 1984.

The comparisons of Zoëcon and Albany OBLR pheromone dispensers at Madera resulted in a total of 1093, 874, and 742 OBLR moths in the OT traps, Zoëcon OBLR, and Albany OBLR traps, respectively. Statistical analysis showed these collections to be significantly different from each other. Further confirmation of OBLR's strong response to commercial OT pheromone was seen at Reedley in 1984, where the one OT trap in plums collected 195 male OBLR, while the five OBLR traps (in plums and uncultivated flood plain) collected only 223 OBLR moths throughout the season.

The discovery of obliquebanded leafroller feeding on pistachio foliage and nuts in 1983 apparently is the first record of this tortricid on a *Pistacia* host in California. Observations of larval populations revealed mature larvae in tightly webbed leaf nests in mid-April 1984, along with smaller larvae representing several larval stages (instars).

The larvae apparently prefer to feed on pistachio foliage rather than on nut clusters. Random counts in July 1984 showed 214 OBLR nests on leaves, and only 14 nests, along with feeding, in association

TABLE 1. Summary of tortricid moth response to selected pheromones, Fresno and Tulare counties, 1983

Responding tortricid species	Pheromone type: total moths collected*							
	FTLR	FLR	FTT	OBLR	RBLR	OT	TLLR	TABM
Fruittree leafroller (FTLR), *Archips argyrospilus* (Walker)	171	105	4	85	142	0	7	0
Filbert leafroller (FLR), *Archips rosanus* L	0	0	0	0	0	0	0	0
Fruittree tortrix (FTT), *Archips podana* (Scopoli)	0	0	0	0	0	0	0	0
Obliquebanded leafroller (OBLR), *Choristoneura rosaceana* (Harris)	0	26	0	157	3	273	0	0
Redbanded leafroller (RBLR), *Argyrotaenia velutinana* (Walker)	0	0	0	0	0	0	0	0
Orange tortrix (OT), *Argyrotaenia citrana* (Fernald)	0	0	0	0	0	0	0	0
Threelined leafroller (TLLR), *Pandemis limitata* (Robinson)	0	0	0	0	0	0	0	0
Tufted apple budmoth (TABM), *Platynota idaeusalis* (Walker)	0	0	0	0	0	0	0	0
Oriental fruit moth, *Grapholitha molesta* (Busck)	4	4	12	11	0	87	62	5
Garden tortrix, *Clepsis peritana* (Clemens)	14	1053	1	1362	85	32	5	2
Commophila umbrabsana (Kearfoot)	0	0	0	0	0	0	0	231
Macrotheca sp. (Pyralidae)	364	2	638	1	0	0	0	0

* One trap of each pheromone type at the following locations: Kearney Agricultural Center, Parlier; 4 mi. N. Reedley; Visalia; and 6 mi. E. Visalia (Kaweah Oaks), CA.

with nut clusters. Among these 14, OBLR larvae had webbed together several nuts in the cluster and then fed on the stem and hull tissue. Stems were consumed at the point of nut attachment to the extent that larvae entered the mature pistachio shell cavity and fed on the nut meats. Additional random counts of nuts in July and August 1984 showed 19 of 1,053 clusters (1.8 percent) infested to some degree. Most nuts in infested clusters were not extensively damaged, however, leading to an estimate that less than 0.1 percent of all nuts sampled were lost.

Conclusions

At present, it is unclear what the potential of obliquebanded leafroller may be as a pest on pistachios. Earlier work has indicated that this leafroller is not common in the arid southwestern states, but the area in Madera County known to be infested is generally hot and dry during most of the year, with an annual rainfall of 10.7 inches and maximum temperatures routinely over 100°F from June through September. Cultural practices in the infested Madera orchards, primarily low-angle sprinkler irrigation and permanent clover ground cover, which would tend to cool the orchard, may have contributed to the development of obliquebanded leafroller in this location. Economic populations of OBLR are reported relatively slow to develop on filberts in Oregon. Thus, a decision on the potential of OBLR as a pest on pistachios should be deferred until additional observations can be made.

Examination of OBLR nests in pistachios during this study revealed the presence of two parasitic wasps. These parasites were identified as *Macrocentrus iridescens* French (Hymenoptera: Braconidae) and *Pteromalus (Habrocytus) sp.* (Hymenoptera: Pteromalidae). The effect of these and perhaps other parasites and predators, such as *Brochymena sulcata* and *Phytocoris* spp., on OBLR is undetermined.

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associated sediments. Many algae and bacteria can accumulate many times their dry weight in selenium, and the resulting concentration in their cells may be over a hundred times greater than background water levels.

Biomagnification, the uptake of selenium by way of the diet and food chain, has been questioned by some researchers, at least as far as selenium is concerned. In biomagnification, the chemical is accumulated at lower levels of the food chain and is passed up the chain as higher organisms feed on the lower forms. Due to the constant need for nourishment and the inefficiency of the energy transfer from one level to the next higher level, an organism consumes more food than its own mass. This leads to a greater concentration of the toxicant with each subsequent step in the food chain. Conflicting evidence complicates the picture; some links in the food chain result in higher concentrations in the consumer while others do not. In general, field observations, especially in small ecosystems, support the concept of biomagnification, but it has yet to be substantiated by laboratory experiments.

Seeking solutions

Numerous possibilities for dealing with excess selenium are under investigation, including oceanic or estuarine disposal. An important consideration in any proposal involving transport of selenium from one system to another, however, is whether such a solution would merely spread the problem. Obtaining more concrete knowledge of the selenium cycle is one key to planning the best time, place, and method for removal of excess selenium from a system. Unless it can be shown that selenium is not as harmful as we suspect, dealing with excess selenium will become vital for maintaining the quality of aquatic environments in the Central Valley.

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More significantly, samples of cotton terminals collected 24 hours after treatment revealed high adult mortality levels associated with combinations of DEF plus pyrethroids in Blythe, and with DEF plus cypermethrin in Brawley (table 2). Overall, DEF plus cypermethrin was the most effective treatment, in which 99.2 percent mortality was recorded in Blythe. Although 94.7 percent mortality was recorded in the DEF-plus-permethrin treatment in Blythe, a distinctly lower mortality level of 77.8 percent was recorded in this same treatment in Brawley. This discrepancy between the two locations for this treatment may be the result of the lower rates used in the Brawley trial. In addition, DEF alone caused relatively high adult mortalities of 77.3 and 81.1 percent in both locations.

The treatment associated with the lowest adult mortality overall was sodium chlorate plus cypermethrin. This was not surprising, since sodium chlorate is not known to have insecticidal or synergistic properties at the dosage used.

In general, the results obtained with the D-vac sampling method were in good agreement with those of the cotton terminal method (table 3). There were significant ($P = 0.01$) differences among all four treatments, with the highest mortality of 91.2 percent occurring in the DEF-plus-cypermethrin treatment.

Conclusion

High toxicity of DEF in combination with cypermethrin or permethrin was demonstrated in both laboratory and field trials. In the field trials, a single application of DEF plus cypermethrin also resulted in superior control of sweetpotato whitefly adults on cotton before harvest. After further evaluation, the use of DEF with pyrethroids, along with other cultural control methods, may prove useful in reducing the threat of SPWF populations to fall plantings of cucurbit and lettuce crops.

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