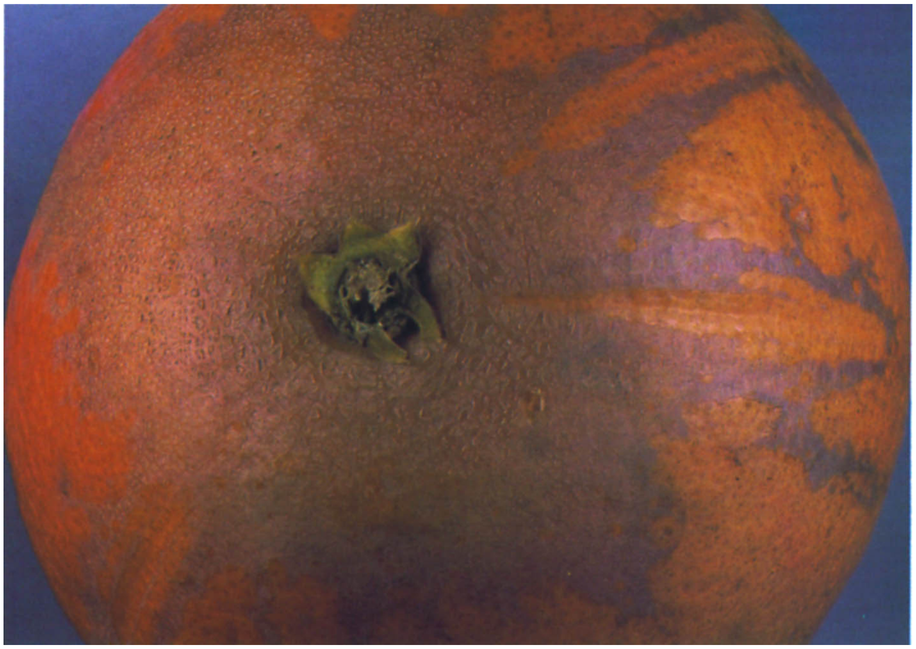

Jack Kelly Clark

Above: citrus thrips adult and larva. Pesticide applications to control thrips and the damage it causes often disturb its natural enemies and can lead to a costly "pesticide treadmill."

Beneficials and insecticides in citrus thrips management

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Variation in residual action of pesticides has to be considered

Citrus growers tend to rely on parasitoids and predators to maintain pest populations below economic threshold levels, and resort to pesticides only when necessary. Unfortunately, complete biological control has not been achieved for all important citrus pests. Pesticides are used when conditions limiting natural enemies or favoring pests permit pest populations to grow to economically damaging levels. Such conditions often occur when pests precede their natural enemies into a new area, or when natural balances are upset by unusual weather conditions or disturbance by dust or ants.

Pesticide applications to remedy these situations often disturb predator-prey or parasitoid-host relationships. This disruption can result in excessive population growth of other pest species and may require additional pesticide applications — a chain of events often referred to as a "pesticide treadmill." The situation is costly, and it is difficult to break the pesticide treatment cycle.

More knowledge of the comparative effects of different pesticides on beneficial organisms would help in decisions as to which pesticide is likely to cause the least disruption while effectively dealing with an existing pest problem. Information is needed on both direct-contact and postapplication residual toxicity. The latter is necessary in evaluating the longevity of a pesticide's effect on beneficial species and determining the waiting period necessary for repopulation or augmentation of a grove with commercially reared beneficial organisms. Reported here are comparative results on the residual impact of four pesticides commonly applied against citrus thrips, *Scirtothrips citri* (Moulton): acephate (Orthene), dimethoate (Cygon), formetanate hydrochloride (Carzol), and sabadilla (Veratran D).

Bioassay

The four pesticides were applied at commercial rates to Eureka lemon trees on the Corona Foothill Lemon Ranch on June 20, 1983. Leaves were collected from the treated trees one, three, and eight days after treatment and every seven days thereafter for a total of seven weeks.

Collected leaves were analyzed for chemical residue — the amount of parent insecticide and known toxic alteration products present. Additional leaves were used in bioassays of three species representing three groups of beneficial organisms: *Aphytis melinus* DeBach (parasitic Hymenoptera); mealybug destroyer, *Cryptolaemus montrouzieri* Mulsant (predaceous Coleoptera); and *Euseius stipulatus* (Athias-Henriot) (predaceous Acari). In bioassays of the first two species, five individuals were placed in each of 20 Munger cells (small plastic enclosures) that exposed a circular area of treated leaf surface approximately 1 inch in diameter to the insects. Bioassays of *E. stipulatus* were performed in 1-inch-diameter excised leaf disks in an open tray.

Leaves from unsprayed trees were similarly used to quantify control mortality. Mortality in untreated controls was generally very low (0 to 5 percent); data reported here were corrected by Abbott's formula to account for this mortality.

Results

In general, acephate had the longest residual effect on the beneficial organisms, followed by dimethoate, formetanate hydrochloride, and sabadilla (fig. 1). Mortality caused by acephate was closely related to the amount of leaf surface residues found in chemical analysis. The same was true for dimethoate with *A. melinus* and *E. stipulatus.* In the dimethoate treatment with *C. montrouzieri,* however, mortality corresponded more closely to the amount of dimethoxon, a more toxic oxygen analogue formed from dimethoate.

Formetanate hydrochloride did not cause any appreciable mortality in *C. montrouzieri.* Mortality of *A. melinus* was high shortly after the formetanate hydrochloride application but inexplicably declined, even though the quantity of residue found by chemical analysis remained essentially unchanged. In contrast, *E. stipulatis* consistently suffered high mortalities from formetanate hydrochloride residue until rain washed off much of the foliar residues.

Sabadilla had almost no impact on any of the three natural enemies. This insecticide is a stomach poison, and the residue probably was not consumed by the beneficial species.

The insecticides can be compared with regard to the length of time the residues affected the three species. In the case of *A. melinus,* acephate residue still caused a 50 percent mortality 23 days after treatment, whereas residues of dimethoate and formetanate hydrochloride had ceased to cause a 50 percent mortality after day 8. Acephate caused at least 50 percent mortality to *C. montrouzieri* until day 15; none of the other materials ever caused 50 percent mortality to this species.

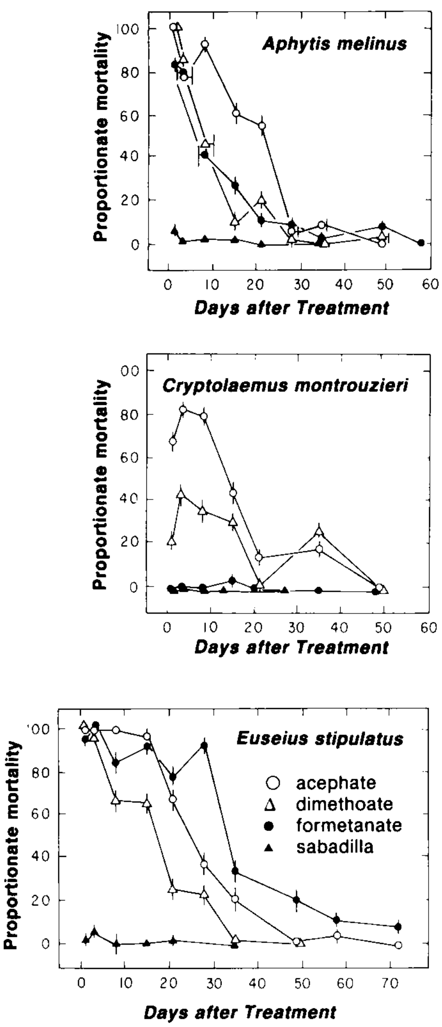

Fig. 1. Mortality of three beneficial species caused by foliar residues of four insecticides commonly applied against citrus thrips in California.

Of the three arthropods, *E. stipulatus* was the most adversely affected by the pesticides. At least 50 percent mortality occurred with acephate until day 25 after treatment, with dimethoate until day 17, and with formetanate hydrochloride until day 33, when an unseasonal rain washed off much of the residue. Formetanate hydrochloride residues are relatively stable and probably would have continued to cause high mortalities in *E. stipulatus* for a considerable time if the rain had not occurred.

Conclusions

Pesticides used against citrus thrips vary considerably in their postapplication residual effect on three beneficial organisms. The four pesticides tested in this study ranged from almost no impact (sabadilla) to a moderately long effect, with 50 percent mortalities occurring as much as a month after treatment.

Along with the timing of the treatment and efficacy against the target organism, considerations in selecting a pesticide for use against a particular pest include the importance of natural enemies in regulating other pest species. It is crucial to know the pesticide's relative effect on the principal natural enemies in an orchard. For example, where California red scale is a potential problem, protection of *Aphytis melinus* is important. Our study suggests that, after dimethoate has been used for citrus thrips control, a 10-day postapplication period would be required before releases of *A. melinus* might result in establishment. A similar period would be required after use of formetanate hydrochloride, a longer period (23 days) after acephate, and no post-application delays following sabadilla.

The actual duration of the effects on these beneficials would vary depending on weather conditions, but the relative times would be similar (for example, acephate would affect *A. melinus* approximately twice as long as dimethoate). These relative times will be of value in making informed decisions when selecting pesticides for use in situations where biological control and reestablishment of natural enemies are important in citrus pest management.

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The authors thank James A. McMurtry, Horace G. Johnson, Jr., and Stanley C. Warner (UC Riverside) and Harry Griffiths and Joe Barcinas (consulting entomologists, Corona) for helpful discussion; Corona Foothill Lemon Co. for providing access to field plots; and Associates Insectary (Santa Paula) for providing Cryptolaemus montrouzieri. *This study was supported in part by the California Citrus Research Board, the University of California Appropriate Technology Program, and the International Atomic Energy Agency, Vienna.*

Aphytis melinus DeBach

Cryptolaemus montrouzieri Mulsant

Euseius stipulatus (Athias-Henriot)

Three species representing three groups of beneficial organisms that help control citrus thrips. Pesticides applied to control thrips have varying residual effects against these organisms. Knowing the duration of these effects is important in maintaining effective biological control.