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NATURAL BALANCE OF MITE PESTS IN AN AVOCADO GROVE

C. A. Flesthner, J. C. Hall, and D. W. Ricker
Associate Entomologist; Senior Laboratory Technician; and Laboratory Technician, all at the University of California at Riverside, respectively.

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What would happen if all of the beneficial insects were suddenly removed from our untreated avocado groves, and all harmful species were permitted to increase unchecked? Perhaps the full measure of the catastrophe that would result in such a case will never be demonstrated. A partial answer to this question was obtained, however, during the past year.

For a period of 84 days, from July 17 through October 10, 1954, all beneficial species were removed by hand from a portion of an avocado tree in the Palmer Grove in Carlsbad, San Diego County. During this time the omnivorous looper, *Sabulodes caberata* Gn., the six-spotted mite, *Eotetranychus sexmaculatus* (Riley), and the long-tailed mealybug, *Pseudococcus adonidum* (Linn.), developed to seriously damaging numbers on the portions of the tree from which the beneficial insects were removed. In addition, relatively high populations of the avocado brown mite, *Oligonychus punicae* (Hirst), and the latania scale, *Hemiberlesia lataniae* (Sign), developed.

In order to save the leaves on the experimental portion of the tree, the omnivorous looper larvae had to be removed. However, a careful study of the natural balance of the looper larvae at this time disclosed that over 90 percent of the very young larvae were parasitized by two species of small wasps, *Apanteles* sp. and *Meteorus* sp. (Fig. 1). These two wasps, which had not previously been reported as parasites of the looper larvae, were largely responsible for the excellent natural control of the loopers that was maintained in the Palmer grove during these studies.

Throughout this entire experimental period there were no observed pest problems on the rest of the test tree or on any other tree in the grove.

This simple experiment clearly demonstrated that except for the protective action of beneficial mites and insects, the damage caused throughout the grove by the pests mentioned would have been truly disastrous. There is little doubt that a number of other pests would have developed to damaging numbers had these experiments been continued over a longer period of time.

Inasmuch as these experiments were primarily designed to study the natural balance of avocado mites, a more detailed account will now be given of that phase of the work.

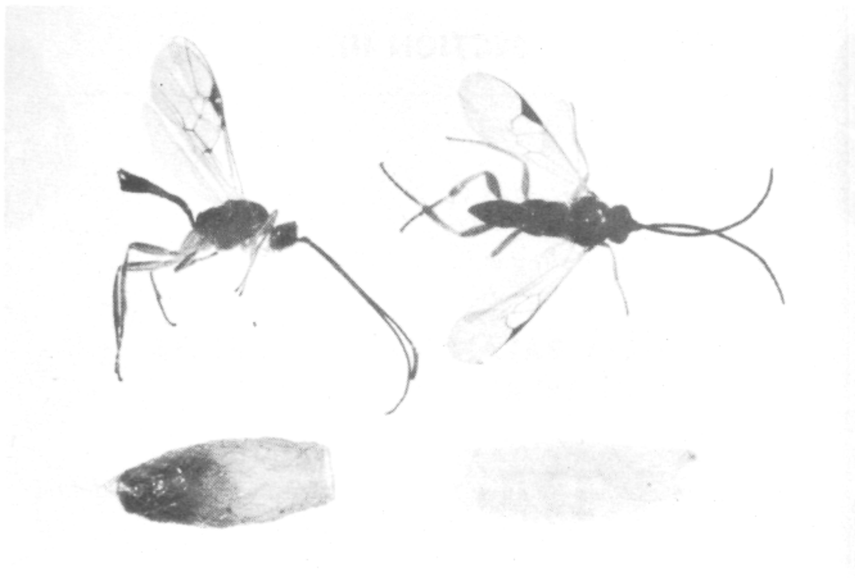

Fig. 1. Two wasp parasites of the omnivorous looper. Left: Meteorus sp. and its cocoon. Right: Apanteles sp. and its cocoon.

On July 17, 1954, a limb having about 200 leaves was selected as the main experimental limb (Fig. 2). This limb was at a height of about 6 feet on the west side of a tree of the Anaheim variety. Two smaller experimental limbs were selected, one on the south side and one on the north side of the tree. These limbs were all trimmed so that there was no leaf contact with neighboring limbs.

The main experimental limb was under constant observation during the daylight hours for the entire 84-day period. All natural enemies that came to this limb were immediately removed by hand. In addition, .each leaf on the limb was examined periodically with a hand lens in order to remove all predaceous mites. Thus the plant-feeding mites on this limb were permitted to feed and reproduce naturally under field conditions in the absence of their enemies. The smaller limbs on the north and south sides of the tree were examined at frequent intervals during the day and were kept practically free of beneficial species.

Fig. 2. Experimental limb of about 200 leaves on west side of avocado tree.

When this study was started, on July 17, there was no visible injury by the avocado brown mite on the main experimental limb. At this time the population was about one mite for every four leaves. For the first month these mites reproduced slowly. By August 17 previously selected sample leaves averaged 7.6 mites per leaf. At this time the brown mites were actually more abundant on the neighboring check tree (Fig. 3). Figure 3 shows the relative brown mite populations on a 10-leaf sample from the experimental limb and on a 10-leaf sample from the check tree. The brown mite population on the check tree continued to increase until September 9, at which time it peaked at 395 mites per 10 leaves; by September 25, it had decreased to practically zero. The brown mite population on the experimental limb continued to increase until September 18, when it peaked at 1098 mites per 10-leaf sample. After this time the brown mite population on the mature leaves of the experimental limb began to drop rapidly. It may also be seen in figure 3 that during this same interval the brown mite population began to increase on the new growth developing on the predator-free terminals. The brown mite population density continued to increase rapidly on this new growth until the experiment was discontinued on October 10.

It is interesting to note that in the complete absence of natural enemies the numbers of brown mites began to decrease on the older leaves of the experimental limb. It is obvious that this reduction could not have been due to meteorological conditions as the mites were increasing in numbers on the new growth during this same time. It is probable that the reduction of brown mites on these older leaves was due to some physiological change within the leaves which rendered them less suitable for the brown mites.

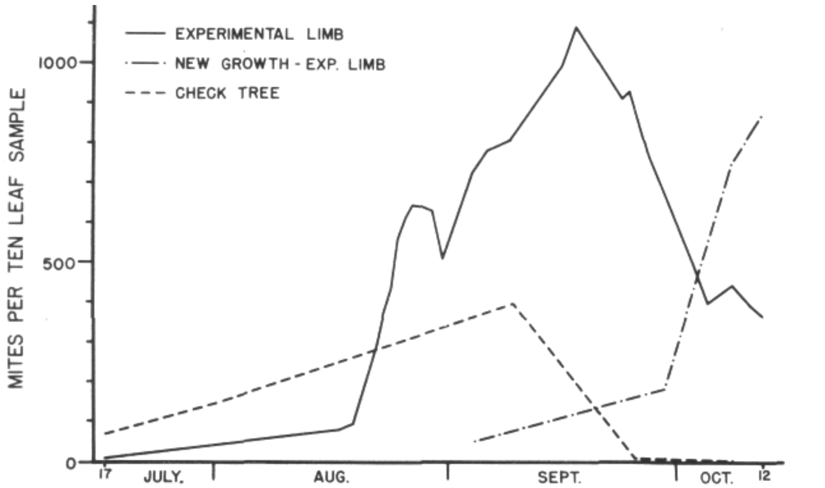

Fig. 3. Avocado brown mite populations on old and new growth on the experimental limb from which natural enemies were removed, compared to those on check tree.

In any event the curves of figure 3 clearly show that the developing brown mite populations were soon brought under excellent control on the check tree, where they were exposed to the action of natural enemies. On the limbs from which the natural enemies were removed, however, they soon developed to much greater numbers, and these greater numbers persisted until the experiment was discontinued. At the close of the experiment the mite-damaged leaves of the experimental predator-free limbs stood out in sharp contrast to the undamaged leaves surrounding them. There is little doubt that, except for the protective action of natural enemies, all of the trees in the grove would have suffered severe damage from brown mite feeding injury.

The predators responsible for this control of brown mites were the small black lady beetle, *Stethorus picipes* Casey; several species of predaceous mites, *Typhlodromus* spp.; the predaceous larvae of a cedidomyiid fly, and the small black stephylinid beetle, *Oligota oviformis* (Casey), named in order of importance.

Stethorus picipes was most effective in reducing the population peak. *Stethorus* is an excellent predator for reducing mite populations which have attained these proportions, as the adults migrate into such infested trees from surrounding areas. In addition, both adults and larvae work well on the upper surface of the avocado leaves where the brown mites feed. At the time the brown mite population had reached its peak on the check trees, on September 9, from 5 to 9 adult *Stethorus* per day were collected from the 200-leaf experimental limb.

The typhlodromid mites were largely responsible for reducing the brown mite population on the check tree to the extreme low which had been reached by September 25. At this time there were more predaceous mites per leaf than there were brown mites.

This excellent control was obtained in spite of the fact that the typhlodromid mites generally avoid strong light and are found on the lower surfaces of protected leaves, whereas the brown mites feed almost exclusively on the upper leaf surfaces and prefer leaves exposed to the sun. Night studies in this grove disclosed that after sunset the typhlodromid mites begin to search both upper and lower leaf surfaces and that by Midnight they may be generally distributed over all leaves on the trees.

The natural control of the six-spotted mite was more spectacular and of much greater value to the grower than that of the brown mite. This was true because the feeding of the six-spotted mite proved to be much more injurious to the tree than that of the brown mite. When not interfered with, the natural enemies kept the six-spotted mites under excellent control and prevented injury to the trees.

It was soon found that the six-spotted mites reproduced rapidly on the north experimental limb. Within 30 days after this limb was freed of natural enemies (mainly predaceous mites) the six-spotted mites had increased to sufficient numbers to cause leaf drop. The six-spotted mites on the check tree and on the portion of the experimental tree to which natural enemies had access were under excellent natural control during the entire experimental period. The six-spotted mites on the south experimental limb did not attain sufficiently high populations to cause serious damage.

During these studies it was found that relatively small numbers of six-spotted mites caused much greater damage to avocado trees than large numbers of avocado brown mites. For example, it was learned that frequently, by the time a developing population of six-spotted mites had reached the density of 25 to 30 mites per leaf, the leaves would drop and twigs thus defoliated would die. On the other hand, it was found that exceptionally high populations of avocado brown mites, as many as several thousand per leaf, would not cause leaf drop. The upper surface of these leaves, on which such large numbers of brown mites were feeding, was severely bronzed, but the lower surface remained green and apparently free of feeding damage, and subsequent twig and leaf growth was normal. Thus it is readily seen that the six-spotted mite in the coastal districts is potentially a much more serious pest of avocados than the brown mite.

During the same period of time that the experiments on the hand removal of natural enemies was in progress the injurious effect of six-spotted mite feeding was studied on a neighboring tree. This tree was treated to a height of about 7 feet with monthly mist-spray applications of DDT. This DDT treatment killed the natural enemies but not the six-spotted mites. The "DDT tree" had been treated several times before the hand-picking experiment was started. Figure 4 shows the populations of six-spotted mites which developed on the "DDT tree" during the time interval of the above hand-picking experiment, and the populations of six-spotted and predaceous mites which developed on the check tree during the same period.

These predaceous mites kept the six-spotted mites on the check tree under almost perfect control during these experiments. It should be recalled that these same predaceous mites were also preying on the brown mite population shown for the check tree in figure 3.

The high population of six-spotted mites which developed on the "DDT tree "in the absence of natural enemies caused very serious damage.

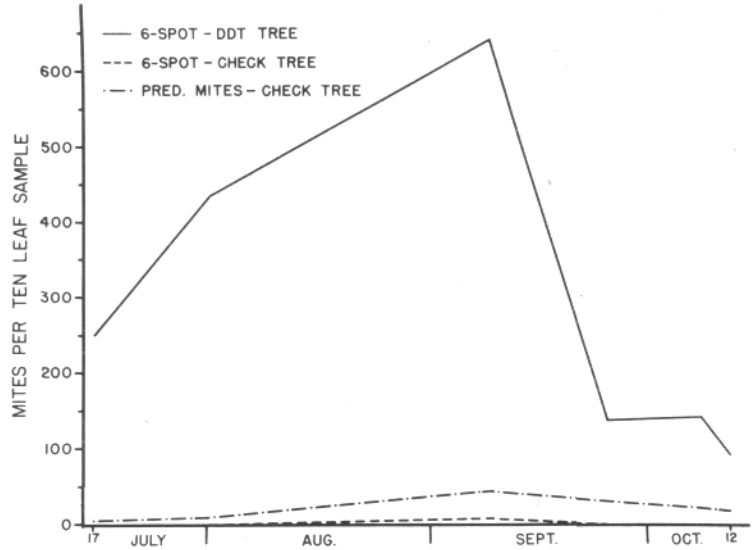

Fig. 4. Population curve for six-spotted mites on "DDT tree" which was free of natural enemies, compared to population curves for six-spotted and predaceous mites on check trees.

Fig. 5. Defoliated and dead limbs on north side of DDT-treated tree. This damage was caused by the feeding of large numbers of six-spotted mites which developed on this tree after the natural enemies of the mites were killed by the use of DDT.

Figure 5 shows some of the defoliated and dead limbs on the north side of the "DDT tree". The leaves seen above the dead limbs were un-sprayed and thus were kept free of mites by natural enemies. The entire DDT-treated portion of the north side of the tree was completely defoliated, however, and suffered much permanent damage from this six-spotted mite injury.

A simple test was made to determine whether or not the death of the limbs was due to some type of injury associated with the six-spotted mite feeding other than defoliation. At the time that the first leaf was observed to drop from mite damage on a small limb on the north side of the "DDT tree", all of the leaves were removed by hand from a limb of similar size and age on the north side of a neighboring tree of the same variety. At the time the experiment was terminated the limb on the "DDT tree" had been defoliated by mites and was dead. By the same time, the limb which had been defoliated by hand-picking of all leaves (including the tiniest) had developed a healthy terminal growth and new leaf buds were prominent all along the limb. The terminal portion of this limb was cut from the tree so that it could be held next to the limb defoliated by mite damage for contrast. Figure 6 shows the cut terminal of the limb previously defoliated by hand being held beside the dead limb, defoliated by six-spotted mite feeding. Shortly after this picture was taken the dead limb dropped from the tree. The results of this experiment indicated that the severe damage caused by six-spotted mite feeding is associated with factors more complicated than mere defoliation.

All of these experiments clearly demonstrated that, except for the protective action of beneficial insects and mites, the damage caused by pest species in the Palmer grove at this time would have been truly catastrophic.

Fig. 6. Avocado limb which had developed healthy terminal growth and numerous leaf buds after complete defoliation by hand-picking, compared to limb which died after defoliation caused by six-spotted mite damage.