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SOME FACTORS THAT INFLUENCE PEST POPULATION ON AVOCADOS

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Infestation of avocado trees and their fruit by insect and mite pests varies with location, seasonal climatic conditions, variety, nearness to favored hosts, planting distances, natural enemies and the factors that affect the abundance of the latter. The high temperatures of the last two winters have brought to the forefront certain pests, such as greenhouse thrips and six-spotted mites, of which the majority of avocado growers have not been aware for a decade or more.

Geographic Location. The majority of avocado pests, including the most important ones, are either confined to the coastal areas or are more abundant there. The greenhouse thrips and six-spotted mites are found exclusively in the strictly coastal areas of moderate temperatures and high humidity. The avocado worms are more abundant near the coast than farther inland. On the other hand, certain sporadic pests such as June beetles, Adaleres beetles, and chinch bugs, are apt to be more abundant in inland areas adjoining the uncultivated foothills in which the infestations originate.

Seasonal Climatic Conditions. Within a given climatic zone, pest populations are affected by variations in mean temperature from year to year. In 1946-47 the relatively small difference in the temperature between an orchard in Carlsbad, California, about a mile from the coast, and the experimental orchard at U.C.L.A. about 5 miles from the coast, made the difference between injury to fruit by greenhouse thrips and no injury on the same variety of avocado, the Northrop. At Carlsbad there were 4 weeks during the winter when the mean low temperature averaged below 45°F. and at U.C.L.A. there were 6 weeks. As a result of the few degrees difference in mean temperatures in these two localities, all active stages of the thrips were found on the foliage throughout the winter in Carlsbad, while at U.C.L.A. only the eggs survived the winter. Newly hatched nymphs were not found until the middle of February. There were nearly 6 generations of thrips that year in Carlsbad but there were somewhat less than 5 at U.C.L.A.

Avocado trees lose much of their foliage during the flowering season, and some varieties are nearly bare for a brief period in the spring. Almost the entire overwintering thrips population is annually destroyed by this severe defoliation, and usually the thrips do not reappear in numbers sufficient to cause injury until some time during the fall. In fact, some years they never become sufficiently abundant to cause injury even on the

most favored varieties. During the past two years the winters have been unusually mild and the greenhouse thrips has become sufficiently abundant to cause damage. A spray of 2 Ibs. of 25% malathion wettable powder plus 1 Ib. of 50% Ovotran wettable powder (for mites) has proved to be an effective treatment with a minimum of adverse effect against natural enemies, in tests made in Santa Barbara County.

The same climatic conditions that favor the greenhouse thrips also favor the six-spotted and avocado brown mites. Malathion is quite effective against the active stages of these mites and the addition of Ovotran insures effective action against the eggs.

Planting Distance. The planting distance of the trees has an important effect on the pest population, particularly in the case of varieties, like the Fuerte, which have a tendency to spread. In old orchards in which the intertwining branches form almost a continuous canopy, the removal of alternate trees may reduce severe infestations of pests such as avocado worms (omnivorous looper, amorbia, and orange tortrix) and greenhouse thrips to population levels of no economic consequence. Production will normally return to the original quantity within a few years and may exceed it eventually. However, a less drastic measure might be to cut the alternate trees back to the trunk and graft them to a variety of upright growth habit, such as the Hass or the Anaheim.

Variety. Great differences in varietal susceptibility to pests have been found. In one orchard, over a five-year period, there were about twice as many omnivorous loopers on the Fuerte variety as on the Hass, and about four times as many on the Fuerte as on the MacArthur. Likewise, the Hass variety had only 39% as much latania scale as the Fuerte and the MacArthur had 47% as much scale. The Anaheim is highly susceptible to the amorbia because it has such dense clusters of young terminal foliage, which the larvae tie together with webs, feeding inside the resulting shelter. The Fuerte is also highly susceptible to attack by amorbia, as well as the orange tortrix and omnivorous looper.

The Hass, Anaheim, Nabal, Wurtz, and Carlsbad, appear to be the varieties that are most susceptible to infestation by the six-spotted mite. If you are looking for six-spotted mites in your orchard, and have any of these varieties, they are the ones to examine first. If they have no mites, the other varieties are almost certain not to have any. In a 2½ acre orchard made up of Hass, Anaheim, and Wurtz trees, the relative density of six-spotted mites, according to counts made in December, 1957, and March, 1958, and considering the population on the Wurtz variety to be 1, was as follows: Hass 5.25, Anaheim 1.96, and Wurtz 1. The relative density of latania scales according to counts made in January, 1958, was as follows: Hass 0.58, Anaheim 0.43, and Wurtz 1.

The Anaheim and Nabal, although they are among the most susceptible of all varieties to the six-spotted mite, are the least susceptible to the greenhouse thrips. The Fuerte and Dickinson are also relatively resistant to greenhouse thrips when compared with such highly susceptible varieties as are Itzamna, Hass, Carlsbad, Benik, Queen, Panchoy, Milly-C, and Wurtz.

Since the planting of Hass trees in large numbers in coastal areas is a relatively recent development, we do not yet know whether the thrips infestations of recent years on this variety are the result of currently abnormally favorable climatic conditions for this insect, or whether the greater concentration of the Hass variety in coastal areas has resulted in

a permanent thrips problem.

In any event, those who plant the Hass variety in coastal areas should be aware of either a sporadic or a permanent hazard as a result of the variety's special susceptibility to both greenhouse thrips and six-spotted mites. Some growers have tried to solve the thrips problem by early harvesting of the fruit, but by so doing they have not been able to take advantage of one of the variety's most favorable characteristics —its long harvest season.

Nearness to Favored Hosts. Host plants on which a pest may develop high populations near the commercial varieties the grower is trying to protect are obviously a menace. They may be avocado varieties of little or no importance, but particularly favored by the pest, or they may be ornamentals or vines that can be replaced by varieties not infested by avocado pests.

The Mexican seedling avocados, such as the Northrop or Puebla, are better hosts for the greenhouse thrips than most commercial varieties. Therefore, they become heavily infested earlier than the commercial varieties and serve as a source of early-season infestation. They may also become a source of reinfestation after treatment of the orchard for thrips. Among the ornamental plants, the carissa, rose, arbutus, vibournum, statice, mandevilla, fuchsia, eugenia, myrtle, azalea, euonymus, hibbertia, mesembryanthemum, cypress, and eucalyptus are especially subject to infestation. Berry and grape vines also are subject to infestation. Active stages of the thrips may survive the winter on the foliage that is close to the ground and therefore comparatively warm. In the spring these individuals may infest nearby avocado trees and start an infestation much earlier than would result from the progeny of overwintering eggs.

The six-spotted mite, orange tortrix, aphids, and red scale, when they occur abundantly on citrus trees, may be the source of infestation of nearby avocado trees. Aphids and red scale are pests of the avocado only when they are near citrus trees or other sources of infestation, but the other two species have become a part of the permanent avocado fauna and occur on this host regardless of its distance from citrus trees.

Some of the sporadic pests occur on native vegetation and, if this vegetation dries up unseasonably early in the spring, they are forced to feed on cultivated crops, including the avocado. Examples are the false chinch bugs, harlequin bugs (near fields of mustard), June beetles, darkling ground beetles, banded flea beetles, and cutworms.

Natural Enemies. The avocado is particularly favored by having effective natural enemies, both parasites and predators, to aid in keeping pest populations usually at low levels. For example, two severe pests of former years, the latania scale and the long-tailed mealybug, are now of practically no importance because new natural enemies were introduced to combine with native species in combating these pests. However, the long-tailed mealybug can still injure the new growth on grafted scions because the natural enemies cannot find and attack them soon enough to prevent injury. Ant control ordinarily obviates this particular problem.

The importance of natural enemies in the control of latania scale was demonstrated in a spectacular way in one instance in Escondido reported to the writer by Fred Thorne, Deputy Agricultural Commissioner in San Diego County. Young avocado trees had their

trunks wrapped with cardboard, thus excluding beneficial insects. The latania scale infested the protected areas so severely that the bark split and the trees were seriously injured.

Parasites are adversely affected by dust, and pest populations can be seen to be greatest near dusty roads. This has been found to be true of the avocado worms as well as the mites and scales. Populations of natural enemies are also severely decreased by insecticides with long-lasting residues. These residues do not necessarily have to be contact poisons to be detrimental to natural enemies. In 1957 a grove in Encinitas was sprayed with various chlorinated hydrocarbons, organophosphorous materials, and basic lead arsenate. One pound of Aramite 15% wettable powder and ½ pound of Ovotran 50% wettable powder were added to each 100 gallons of spray.

Table 1. Relative population densities of six-spotted mites and latania scales found at various periods after treatment of avocado trees with different insecticides.[1]

	Number of six-spotted mites per sample		Number of latania scales per sample
Treatment	12/2/57	3/13/58	1/7/59
DDT, 50W, 2 lbs.-100	105.0	6.5	3.6
TDE, 50W, 2 lbs.-100	190.0	29.3	14.5
Basic lead arsenate, 4 lbs.-100	160.0	167.0	7.4
Malathion 25W, 2 lbs.-100	9.0	13.7	3.4
Parathion 25W, 2 lbs.-100 (dusty)	5.3	5.7	1.0
Parathion 25W, 2 lbs.-100 (clean)	0.3	0.7	0.0
Untreated (dusty)	2.0	40.0	21.3
Untreated (clean)	0.3	0.0	2.6
Untreated (clean)[2]	1.3	0.0	5.9

[1]*The trees were sprayed on September 4, 1957. A pound of Aramite 15% wettable powder, ½ pound of Ovotran 50% wettable powder, and 1½ pounds of zinc sulfate were added to each 100 gallons of spray. The six-spotted mite counts were made on 1-leaf samples on certain marked trees in each plot on December 2, 1957, after which the entire orchard was sprayed with Aramite-Ovotran, then counts were made again on March 13, 1958. The counts of latania scale included all individuals beyond the whitecap stage on the undersides of 20 leaves taken from every tree in the orchard.*

[2]*These trees had never been sprayed with insecticide since the orchard was planted, but were sprayed with the Aramite-Ovotran mixture on December 3, 1957.*

Table 1 shows that about three months after treatment the plot sprayed with basic lead arsenate had nearly as many six-spotted mites as the one sprayed with TDE and more than the one sprayed with DDT. The infestation was so severe in these plots that the entire grove was resprayed with the Aramite-Ovotran mixture. When counts were made about three months later, the plot sprayed with basic lead arsenate had 5.7 times as many six-spotted mites per tree as the one sprayed with TDE, 25.7 times as many as the plot sprayed with DDT, and 64.2 times as many as the untreated plot.

The greater relative abundance of mites in the basic-lead-arsenate-sprayed plot, compared with organic insecticides, is probably owing to the greater persistence of the inorganic residues of the arsenate. These residues are conspicuous months after the residues left by the other insecticides have largely disappeared. Although these residues are probably not toxic to natural enemies, the mere presence of a finely-

divided powder appears to have an adverse effect on the activity of natural enemies.

Table 1 also shows the great difference in the population density of both six-spotted mites and latania scales in plots treated with parathion, or left untreated, on the west side of the grove next to a road (marked "dusty" in the table) and plots on the east side of the grove and relatively free of dust (marked "clean" in the table). The adverse effect of dust on natural enemies is clearly indicated in the experiment.

The avocado grower is justified in treating with insecticides if it is obvious that he will suffer substantial loss if he does not do so. However, he may find that it is desirable to suffer a moderate amount of damage some years rather than to use insecticides that will upset the natural balance of the pest with its natural enemies. This in the long run may lead to an increase in the pest against which the treatment is directed, and may also lead to outbreaks of secondary pests that are of little or no importance if insecticides are not applied.