generation of codling moth was controlled in this orchard with Guthion (azinphosmethyl) applied on June 17, 1980.

Walnut aphid populations began to develop on June 24. On June 27, one tree of each pair was treated with Zolone (phosalone) to exclude walnut aphids. A second Zolone treatment was applied to these trees on July 15 to further suppress aphids.

We monitored walnut aphid populations throughout the infestation period. Numbers of aphids on each test tree were averaged using 10 leaflets per tree.

The economic threshold of 15 walnut aphids per leaflet was exceeded on untreated trees for 19 days from July 11 to July 30. A maximum average of 52 aphids per leaflet occurred on July 21. After July 30, populations declined to near zero for the remainder of the season (see graph). Trees treated to exclude aphids did not sustain populations of more than five aphids per leaflet at any time.

At harvest, samples of 100 nuts were collected from each tree, dried, and submitted to Diamond Walnut Growers, Inc., for quality analysis. Walnut quality from each treated and untreated tree of a pair was compared using a paired "T" test.

Results and discussion

Untreated trees showed a loss of 7.4¢ per inshell pound in this test (see table). This meant a loss of approximately 0.4¢ per inshell pound for each day the economic threshold of 15 aphids was exceeded.

Walnut aphids caused highly significant decreases in the percentage of both light-colored and total edible kernels. A significantly increased percentage of moldy and shriveled kernels also occurred.

These results clearly show that midsummer walnut aphids in excess of 15 per leaflet contribute significantly to reduced quality and subsequent value loss of English walnut.

Economic populations of walnut aphid can develop rapidly in midsummer when temperatures are over 95 °F. Guthion applied for second-brood codling moth control suppresses the walnut aphid parasite, allowing an undisturbed aphid population to develop.

In addition to stress from direct feeding of the aphids, honeydew accumulation on nuts and subsequent sooty mold development results in sunburn injury to the husk, causing kernel shrivel. Preharvest husk injury, such as that caused by sunburn, significantly promotes moldy kernels, as was detected in this test.

G. Steven Sibbett is Farm Advisor; Larry Bettiga is Staff Research Associate; and Marion Bailey is Field Assistant. All are with University of California Cooperative Extension, Tulare County, Visalia.

Radioactive measurement of brown mite injury on avocados

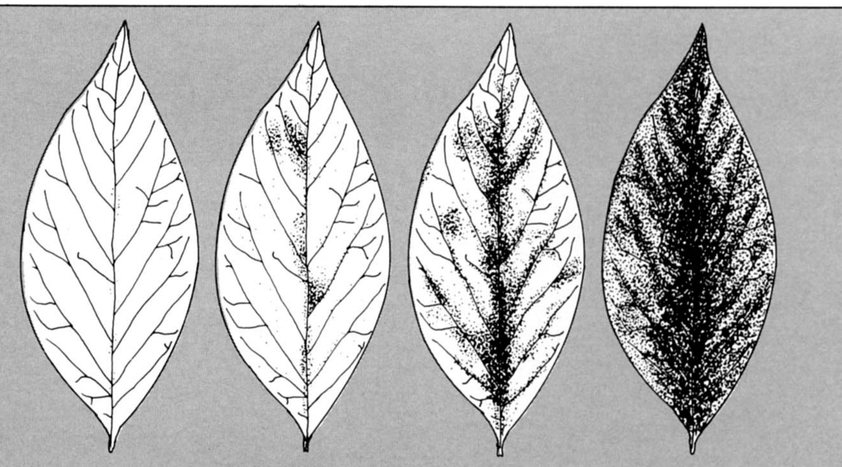
Frank V. Sances □ Nick C. Toscano □ Michael P. Hoffmann
Larry F. LaPre´ □ Marshall W. Johnson □ J. Blair Bailey

Avocado brown mite can reach high population densities in southern California avocado-growing areas with a coastal or intermediate climate. Its feeding on avocado leaves is initially confined to the area surrounding the midrib on the upper leaf surface. Later, feeding extends along the smaller veins and may eventually cover the entire leaf if mite densities become high. The upper surfaces of recently expanded avocado leaves are the most favorable for adult survival, population increase, egg-laying, and development of immatures as compared with new leaves and the lower surfaces of mature leaves. Many workers have also observed that the accumulation of webbing and mite cast skins on the leaves can limit brown mite population growth.

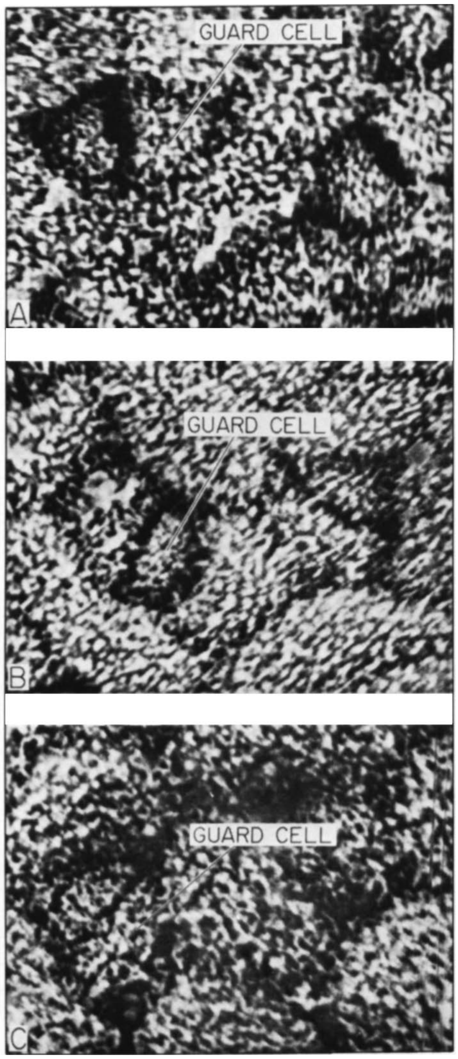
Feeding by avocado brown mite, *Oligonychus punicae* (Hirst), causes a brownish discoloration of the leaves commonly referred to as bronzing. Heavy infestations may cause complete bronzing of the upper leaf surface with only small portions of the lower leaf surface showing visible injury. Large populations for extended periods lead to partial defoliation of the tree. This leaf drop can occur when population densities average 70 adult females per leaf during short periods or 50 females per leaf for several weeks. However, it has not been determined if partial defoliation affects growth or fruit yields during the season in which the injury occurs.

Plant productivity

Reductions in photosynthesis rates have been detected in apple, citrus, strawberry, and cotton heavily infested with spider mites. Photosynthesis, the process by which sugars (photosynthates) are produced by the binding of carbon and water molecules into carbon-based chains, occurs within the chloroplasts of leaf cells and is powered by solar energy absorbed by the pigment chlorophyll. The required water is brought up from the roots by translocation. Carbon dioxide enters leaf tissue through small closable apertures in the epidermis (stomata), but at the same time, large quantities of water are lost by evaporation to the atmosphere (transpiration). When transpiration rates exceed the rate of water uptake by the roots, plants



Schematic representation of levels of avocado brown mite feeding injury.



Photosynthesis was reduced by decreased stomatal openings. Micrograph shows stomata (A) open, (B) partially open, (C) closed.

become stressed. Photosynthates are required for respiration, growth of leaves, stems, and roots, and fruit production.

We conducted investigations on five-year-old avocado trees (Haas variety) in a commercial orchard at Highland Valley, San Diego County, to determine the effects of avocado brown mite feeding injury on photosynthesis and transpiration. We also measured chlorophyll content of upper and lower leaf surfaces to evaluate the effect of spider mite feeding on mesophyll cells between these surfaces. The percentage of leaf area scarred was recorded to provide a visual indicator related to physiological measurements.

For the measurements we used leaves with preestablished injury levels of no injury, light, medium, and heavy injury, which corresponded to actual bronzing of 5, 46, 91, and 100 percent, respectively, of the upper leaf surfaces. Mean chlorophyll content was consistently higher in the mesophyll cells adjacent to the upper leaf surface, except in leaves that sustained 100 percent injury (fig. 1).

Chlorophyll content in the upper cell layer was decreased by feeding injury levels greater than 65 percent, but in the lower cell layer, it remained the same at all injury levels. This finding would be expected, because avocado brown mite feeding is normally confined to the upper surface of the leaf until spider mite populations become extremely high. Reductions in leaf chlorophyll content (chlorosis) have been associated with spider mite injury on many crops, although the injury is usually noticeable on both leaf surfaces.

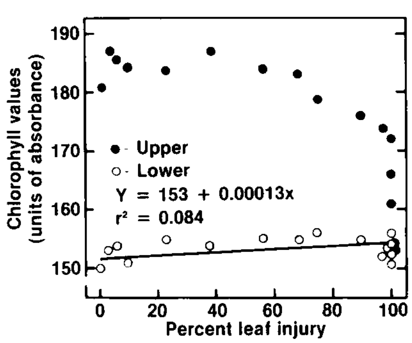


Fig. 1. Influence of avocado brown mite feeding on chlorophyll in cells adjacent to upper and lower leaf surfaces. (Each data point = mean of 8 readings.)

Physiological responses

Physiological processes were measured with a dual isotope porometer, which uses radioactive isotopes ($C14O_2$ and tritiated water vapor) in an airstream. An artificial atmosphere was established around the tested leaves in the field, which were taken to the laboratory for analysis. Levels of these isotopes in leaf tissue reflect the rate of photosynthesis and transpiration occurring at the time the sample was taken.

Photosynthesis decreased as mite damage increased (fig. 2). Leaves sustaining 46 percent damage on the upper surface showed a 30 percent reduction in photosynthesis rates, as compared with leaves with 91 percent damage, where rates decreased 41 percent. Transpiration was also negatively correlated with mite injury. Reduced transpiration not only indicates decreased loss of water from the leaf, but signifies reduced uptake of carbon dioxide through stomata, which also limits photosynthesis. We further found that photosynthesis was reduced not only by decreased stomatal opening, but also by the destruction of mesophyll cells and reduction of chlorophyll content of injured leaves (fig. 3).

These results indicate that avocado brown mite feeding injury on avocado leaves reduces rates of important processes in the plant. The extent of feeding and time of season that injury occurs is important when considering chemical or other control methods for this pest.

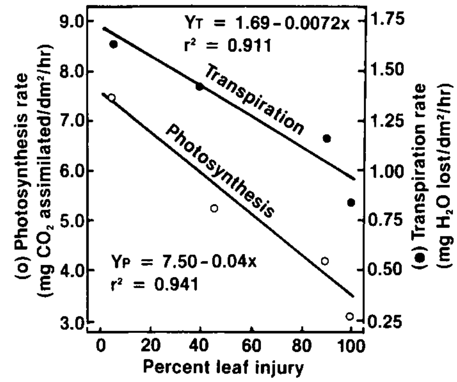


Fig. 2. Effects of avocado brown mite feeding on physiology of avocado leaves. (Each data point = mean of 20 readings.)

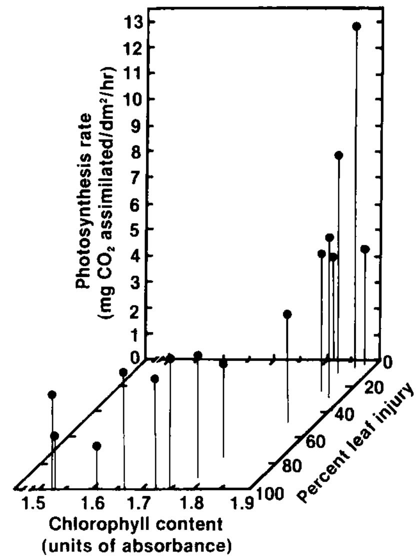


Fig. 3. Relation of avocado leaf chlorophyll and mite feeding to photosynthesis.

Although the study indicates the physiological stress caused by various infestation levels of avocado brown mite, the relation between this stress and avocado yield reduction has not been demonstrated. These critical pest levels probably vary with avocado variety, overall plant condition, and environmental factors. Information of this type is thus necessary before accurate economic threshold levels can be established.

Frank V. Sances, former Post-graduate Research Assistant, University of California, Riverside, is now head of Pacific Agricultural Laboratories, San Diego County; Nick C. Toscano is Entomologist, Cooperative Extension, U.C., Riverside; Michael P. Hoffmann, former Staff Research Associate, South Coast Field Station, is now Graduate Research Assistant, Department of Entomology, U.C., Davis; Larry F. LaPré is a private environmental consultant; Marshall W. Johnson is Post-graduate Research Assistant, Department of Entomology, and J. Blair Bailey is Entomologist, Cooperative Extension, U.C., Riverside.