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# Biological Control of Pests on Avocado in California

Continuing Project, Year 2 of 2

*Orlando Aponte, Mark Hoddle and John Heraty*
*Department of Entomology,*
*UC Riverside*

*Cooperating Personnel: Horace Johnson and Tracy Pinckard*

## Benefit to the Industry

Because of restrictions on the use of pesticides on avocado in California, it is important to continue research on alternative methods to control insect and mite populations below damaging levels. Our focus is mainly on the population dynamics of the Persea mite, *Oligonychus perseae* (Acari: Tetranychidae) and its predators (Acari: Phytoseiidae), and secondarily on a new pest, the avocado thrips, *Scirtothrips sp.* (Thripidae: Thysanoptera). This project aims to reduce populations of *Oligonychus perseae* by using predaceous mites, to economically acceptable levels. The project is aimed at developing strategies to manipulate predaceous mites and parasitoids for maintaining long-term control of the Persea mite and avocado thrips, respectively.

## Objectives

The objectives of the project are to: (1) continue monitoring the Persea mite and its predators; (2) assess the multi-year impact of the predaceous mites *Galendromus helveolus* and *Galendromus annectens;* (3) conduct experimental releases of different numbers of predaceous mites at different times of the year to determine effect on population densities of Persea mite; (4) evaluate the pest population density at which predaceous mites should be released; (5) include surveys of new localities affected by Persea mite in northern California; (6) conduct foreign exploration for additional predaceous mites in Costa Rica, Mexico and Venezuela; and (7) evaluate the distribution of the new pest, the avocado thrips, and its natural enemies.

## Summary

### Persea mite

The Persea mite, *Oligonychus perseae* continues to be a serious pest attacking avocados since it was first discovered in southern California in 1991. The mite is most damaging to Hass avocado, the main variety planted in California. Feeding and reproduction of the Persea mite take place in a "nest" of silken webbing under which foliage damage is found. Damage caused by the mite occurs mainly on the underside of the leaf along the midrib, main veins and leaf depressions. Large necrotic areas on the underside of the leaves result from feeding when high population levels occur. Damage caused by the mite has resulted in defoliation of trees, eventually leading in a decline in fruit production. Presently, Persea mite is established in most counties where avocado is grown.

Population trends of Persea mite (Fig. 1) and its predators (Fig. 2) were monitored in 5 orchards in southern California. Localities were Gopher Canyon, Escondido, Pala Mesa, Temecula and East Mission, all of which had releases of *G. helveolus* (a strain introduced by UCR from Lake Alfred, Florida, and reared by Biotactic®) in previous years. During 1996, early augmentative releases of *G. helveolus,* and *G. annectens* (a strain introduced from Mexico, reared by Biotactic®) of about 500 predators per tree were conducted in the East Mission, Pala Mesa, Escondido and Temecula orchards. Predaceous mites were released when Persea mite populations averaged one or more mites on 25% of the leaf samples. Biweekly, 10 leaves were picked from release and control (non-release) trees. Each orchard had 4 release and 2 control trees. The number adult female Persea mite on the under and upper side of leaves were recorded. All active stages of predaceous mites were recorded.

GOPHER CANYON. During 1996, increases of the Persea mite population in the Gopher Canyon (Fig. 1), for both the release and control plots, occurred at the beginning of July. The highest peaks were observed at the beginning of October (201.83 ± 5.61 and 218.80 + 23.87 females per leaf for the release and control plots). After the highest peaks, an abrupt decline was observed in mite populations. No differences were observed in Persea mite populations between the release and control plots. The highest levels of the predaceous mite populations were found in both release and control plots at the beginning of January (Fig. 2) when the persea mite populations was low (11.92 + 2.71 and 11.20 + 1.40 predators per leaf in the release and control. The predaceous mite populations decline after the Persea mite populations until they reached low densities during April and June. Secondary peaks were found during November (5.23 ± 0.49 and 6.75 ± 0.94 predaceous mites per leaf, for release and control plots).

ESCONDIDO. In the Escondido orchard at the beginning of the year, Persea mite populations were lowest in February (Fig. 1). The highest population densities were reached during September (108.90 ± 12.73 and 93.25 ± 16.54 females per leaf, for the release and control plots). Persea mite populations declined to low densities at the end of the year. Releases of *G. helveolus* and G. *annectens* were conducted during the beginning of August. The highest populations for the predaceous mites for both the release and control plots were about 6 predators per leaf (Fig. 2). A continuous decline of predaceous mite populations was observed at the end of October for all plots. After releases of predators, oil (Unipar 415 ®) applications were made by the grower, and were followed by declines in both predator and prey populations.

PALA MESA AND TEMECULA. The Pala Mesa and Temecula orchards showed increases in Persea mite populations at the beginning of July (Fig. 1). Highest populations were observed at the end of August (Pala Mesa orchard 55.68 ± 6.44 and 136.20 ± 17.27 females per leaf for the release and control plots, and in Temecula orchard, 121.73 ± 12.50 and 205.60 ± 27.99 females per leaf for the release and control plots). Populations of the Persea mite in the release plots were lower than those observed in the control plots after augmentative releases of *G. helveolus* and G. *annectens* at the end of April (Figs. 1,2). In the Pala Mesa orchard, the highest population of the predators in the release and control plots were 7.80 ± 1.87 and 7.17 ± 1.24 predators per leaf, respectively. No significant increases of predaceous mites were found after augmentative releases in the Temecula orchard (Fig. 2). The highest value, 3.15 ± 0.75 predators per leaf was found in the control plots. Less than 1 predaceous mite per leaf was found in the release plots.

EAST MISSION. In the East Mission orchard increases in Persea mites for the release and control plots were observed at the beginning of May (Fig. 1). The highest peaks of 81.20 ± 12.21 and 108.90 ± 12.65 females per leaf were found at mid June, for the release and control plots, respectively. The East Mission orchard showed marginally lower Persea mite populations in the release plots than the control plots. Augmentative releases of G. *helveolus* and G. *annectens* were conducted during April and June. Another predaceous mite, *Iphiseius degenerans* was released during June 1996. Increases of predaceous mites were observed in the release plots (Fig. 2). The highest number of predaceous mite (2.83 ± 0.71 per leaf) was observed in the release plots during June. Less than 1 predaceous mite per leaf was observed for the control plots.

Reductions of Persea mite populations were found in release plots at Pala Mesa, Temecula and East Mission orchards. Reduction of Persea mite populations in the release plots (Fig. 1) can be attributed to the effect of established predators. No differences were found in Persea mite populations between release and control plots in Gopher Canyon in which no augmentative releases of predaceous mites were made during 1996. In Escondido, a 24% and 38% reduction of the Persea mite population was observed after the oil applications in the release and control plots, respectively. However, as releases were conducted on all studied plots, the reduction of the Persea mite population resulted from combined effects of predators, oil application and changes in temperature.

In all the orchards studied, except Gopher Canyon, *G. helveolus* was the main predaceous mite and probably responsible for the reduction of Persea mite densities (Table 1). Because of augmentative releases during 1996, native *G. annectens* increased in numbers in some orchards, and declines of Persea mite populations appear to be correlated with the combined effects of G. *helveolus* and G. *annectens.* After augmentative releases in 1996, G. *annectens* was not recovered in the Temecula. Early releases of G. *helveolus* and G. *annectens* have been shown to reduce Persea mite populations at Pala Mesa, Temecula and East Mission (Fig. 1)..

During August 1996, a 15-day period of high temperatures (ranging from 32-44°C) affected southern California (Figs. 1,2). The heat wave did not affect the Persea mite populations in Gopher Canyon and Pala Mesa, but in Escondido and Temecula, Persea mite populations decreased after the heat wave. Results from our laboratory studies have shown that temperature of 30°C caused 37% mortality of immature Persea mites. Significant mortality did not occur for adult mites. Observed decreases of Persea mite populations appear to be related to increases of predaceous mites rather than high temperatures. However, Persea mite populations under field conditions were measured using adult females, and temperatures over 30°C may be have a greater effect on mortality of immature stages.

**Table 1. Highest peaks, percentages (year range) and species of predaceous mites associated with the declines of Persea mite populations during 1996**

| ORCHARD | PEAK Pred./leaf | SPECIES G. helveolus %(range) | G. annectens %(range) | E. hibisci %(range) | SPECIES ASSOC. WITH DECLINES OF PERSEA MITE POPULATIONS |
|---|---|---|---|---|---|
| Gopher Canyon | 2.08 | 0 | 0 | 100 | *E. hibisci* ? |
| Escondido | 1.83 | 0 | 5(0-5) | 95(95-100) | *E. hibisci* ? |
| | 2.63 | 51(0-66) | 21(0-50) | 28(15-100) | *G. helveolus and G. annectens* |
| | 5.55 | 59(0-66) | 16(0-50) | 25(15-100) | *G. helveolus* |
| Pala Mesa | 5.43 | 94(0-94) | 0 | 6(0-100) | *G. helveolus* |
| | 7.80 | 16(0-94) | 31(0-31) | 53(6-100) | *G. annectens and E. hibisci* ? |
| Temecula | 0.33 | 80(0-80) | 0 | 20(0-100) | *G. helveolus* |
| East Mission | 2.83 | 100(0-100) | 0(0-50) | 0(0-100) | *G. helveolus* |
| | 2.40 | 100(0-100) | 0(0-50) | 0(0-110) | *G. helveolus* |

The native *Euseius hibisci,* a predaceous mite and pollen feeder was found in all of the orchards studied. *E. hibisci* populations decreased as populations of G. *helveolus* and *G. annectens* increased as Persea mite became more numerous (Table 1). The relation among the highest peaks, percentages (year range) and species of predaceous mites associated with the declines of Persea mite populations during 1996 are shown in Table 1. As *E. hibisci* does not penetrate the webbing of the Persea mite, its effectiveness is restricted because it feeds only on Persea mites outside of the webbing. For this reason *E. hibisci* effectiveness in reducing Persea mite populations is questionable. Increases of *E. hibisci* populations are correlated during the spring and summer with avocado pollen rather than Persea mite populations.

Releases of predaceous mites, native and introduced, have been conducted in some of the studied orchards since 1992. (Table 2). *G. helveolus* and *G. annectens* became established in at least 4 of the orchards following the 1993 releases. No establishments were observed in other predaceous mite releases in previous years or during 1996. *I. degenerans* and *N. califonicus* were recorded only within the first month after their release. Like *E. hibisci,* the species /. *degenerans* and /. *zuluagai* (quarantine conditions) are unable to penetrate Persea mite nests, but feed on mites outside webbing. The non-establishment of these species suggests environmental conditions (e.g., humidity) were unfavorable in these localities.

**Table 2. Predaceous mite releases, recoveries and establishments in southern California 1996**

| SPECIES | ORIGIN | ORCHARDS | | | | |
|---|---|---|---|---|---|---|
| | | G. CYN | ESCOND. | P. MESA | TEMECULA | E. MISSION |
| *Galendromus annectens* (1996) | Native-Mexico* | X | X,A | X,A | E | X,A |
| *G. helveolus* (1992, 1993,1996) | Florida | r | X,A | X,A | X,A | X,A |
| *G. pilosus* (1994,1995) | Costa Rica | -- | -- | -- | -- | -- |
| *G. porresi* (1992) | Guatemala | r | -- | -- | -- | r |
| *Euseius hibisci* | Native | X | X | X | X | X |
| *Iphiseius degenerans* (1996) | Morocco | -- | -- | -- | -- | R |
| *Iphiseiodes zuluagai* | Venezuela | in quarantine | | | | |
| *Metaseiulus occidentalis* (1993) | California | r | -- | -- | -- | -- |
| *Neoseiulus californicus* (1995) | Netherlands* | -- | r | r | r | r |
| *Typhlodromus rickeri* (1992) | California* | r | -- | -- | R | -- |

* strain. X= recovery and establishment, r= previous release 1996 but not recovery, R= release 1996, A= augmentative release 1996, E= earlier release but no recovery 1996.

Other predators encountered were *Scolothrips sexmaculatus, Feltiella acarivora* and *Stethorus* sp. These insects occur sporadically in avocado orchards and their role in suppressing Persea mite populations needs to be investigated.

**Avocado thrips.**

Avocado thrips, *Scirtothrips* sp. is a new pest in avocado orchards in Ventura, Orange and Santa Barbara Counties, California. Damage caused by avocado thrips consists of scarring of young fruits, close to the neck or under the calyx, with scarring then spreading over the entire surface of the fruit. Feeding on the stem may cause flower or fruit drop during development. Leaves are damaged on both surfaces, with feeding, causing noticeable lines on the underside, and darkened leathery patches on the upper side. Advanced damage produces heavily scared fruit and dropping of immature fruits.

The biology of avocado thrips has not been studied. Its distribution, biology, natural enemies and effective chemical treatments have to be determined.

During 1997, avocado thrips will be monitored in Ventura County. Hass avocado is the predominate variety in the area, and the most affected by the new pest. Susceptible avocado varieties will be determined by field observations. To conduct observations on the avocado thrips, 2 Hass avocado orchards will be selected. Thrips damage will be determined on fruit and leaves, and defoliation and dropping the fruit will be monitored. Leaves, fruit and flowers will be randomly selected at heights between 25 and 200 cm. Degree of damage to fruits will be scored 0-5 (0, fruit surface non damaged; 2, < fruit surface damaged; etc.).

Sampling of natural enemies (predators or parasitoids) will be done in the field, and rearing thrips natural enemies will be conducted in the laboratory. Collection of first and second instar thrips will be done by cutting the end of twigs with new foliage, blossoms or small fruits, and placing into containers (1 gallon) with clear collecting vials (3 ml) attached externally to the lids. Containers will be observed in the laboratory for numbers of thrips and natural enemies. The thrips pre-pupae and pupae will be collected by attaching white cloth bags (47X37X18 cm) to horizontal twigs, 35 cm, above ground on the trees. Biweekly, cloth bags will be collected and later observed for natural enemies in the laboratory. Distribution of the avocado thrips will be conducted by collecting adults in different orchards. Specimens will be placed into conical micro centrifuge tube (2 ml) with a solution of alcohol 70% and Triton X-100 ® and identified. Foreign explorations for natural enemies of the avocado thrips will be conducted to Costa Rica, Mexico and Venezuela.

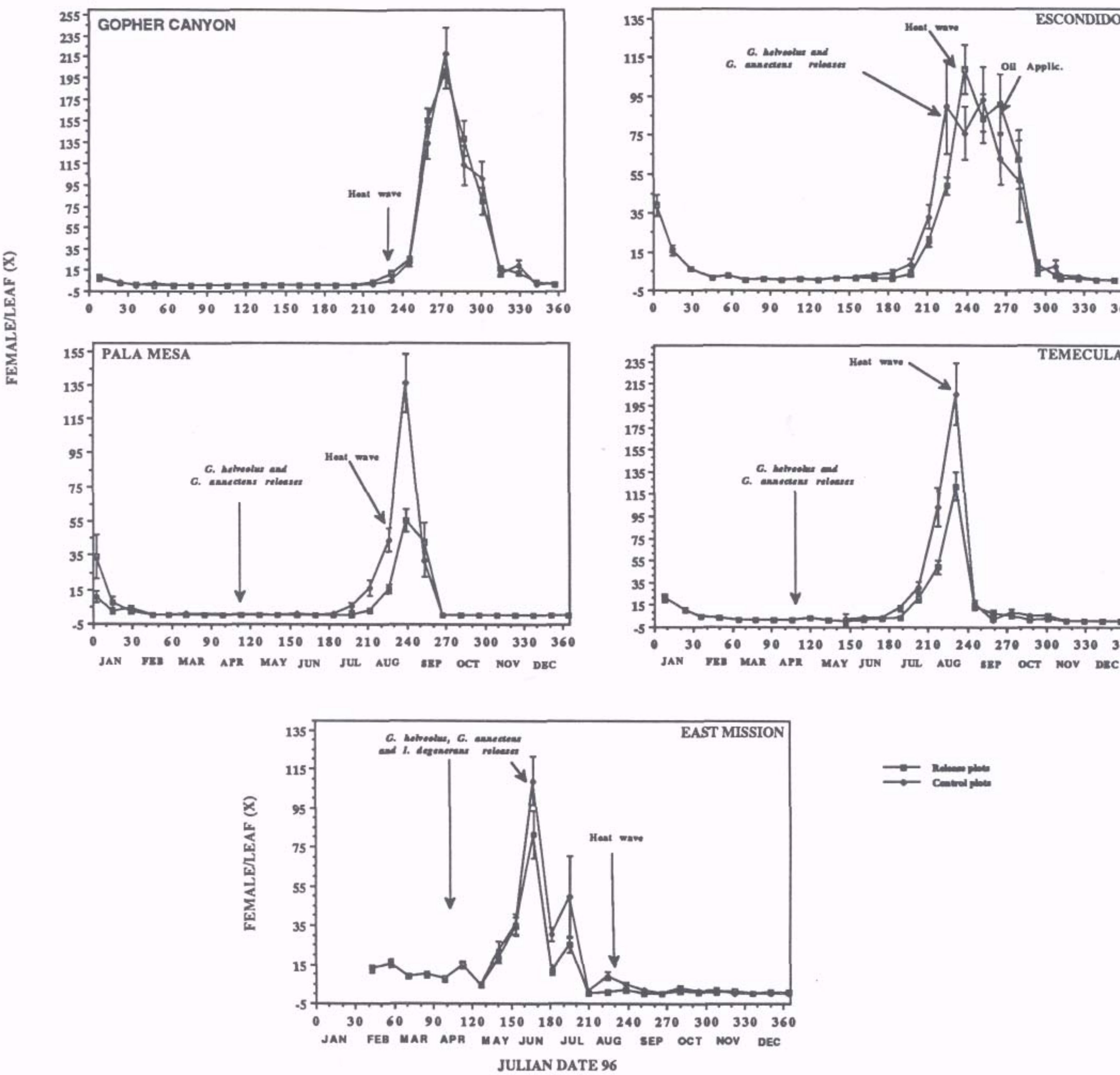


Figure 1. Seasonal population trends of *Oligonychus perseae* on "Hass" avocado orchards in southern California.

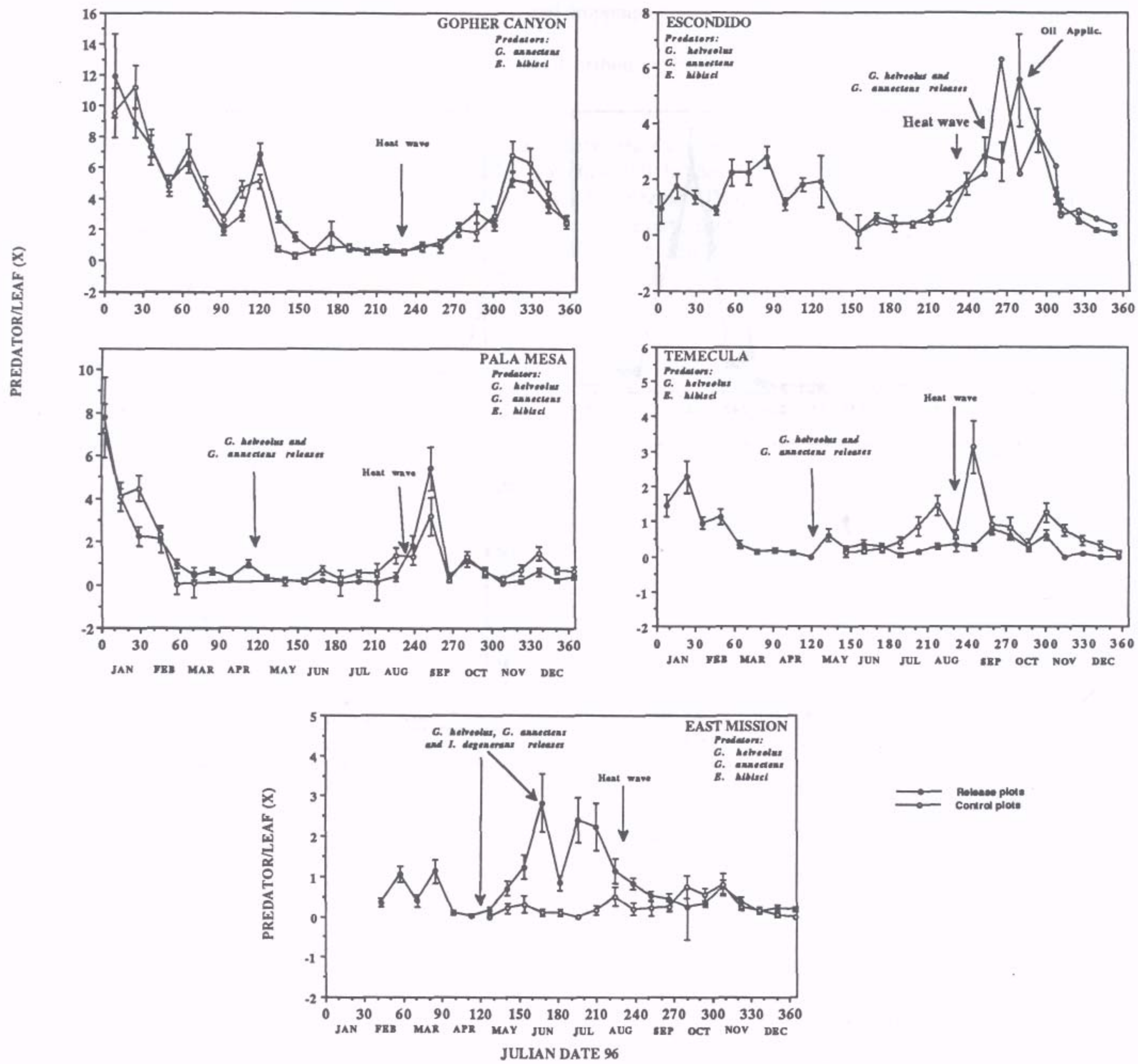


Figure 2. Seasonal population trends of predaceous mites on "Hass" avocado orchards in southern California