# Seasonal Abundance and Field Testing of a Citrus Thrips Temperature Development Model in Arizona Citrus

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### *Abstract*

*Citrus thrips populations (adults and nymphs) were monitored through the spring of 1991-1992 in several locations throughout most of the commercial citrus production areas in Yuma County to determine if citrus thrips seasonality was similar to that previously reported in California. Study findings indicate that seasonality is similar throughout the winter and very early spring. Adult thrips numbers increase rapidly in groves due to attractive foliage, whether it is weeds or citrus. High nymph numbers did not always follow adult peaks, and were not statistically correlated. Predatory mites and rains may have affected 1992 results.*

## Introduction

The citrus thrips, *Scirtothrips citri* (Moulton), is an annual major problem for most citrus producers in Yuma County, with multiple insecticide applications often necessary for adequate control. Attempts to control citrus thrips has cost Arizona growers as much as $250/acre in the late 1980's and early 1990's (Bates, 1991). Growers have commented on how thrips numbers vary from year to year with short flushes of nymphal thrips some years and damaging nymphal citrus thrips numbers lasting 6-8 weeks in other years.

Thrips damage citrus by feeding on the outside of young developing fruit, resulting in scarring over the feeding area. Packing lines have to be slowed at great cost to allow growers to remove all scarred fruit from the grade packs (Bates, 1991). Severely scarred fruit goes to processing rather than fresh market, and price differential between the two markets often averages about $9/carton some years. Thrips scarred fruit accounts for a major share of fruit going to processing.

A heat unit model developed at the University of California-Riverside for modeling citrus thrips development (Rhodes et al., 1989) indicated that adult citrus thrips are active during the winter, laying eggs which hatch as nymphs in February and March. These nymphs then pupate and emerge as adults in March and early April, completing the first generation. Adult females appearing in March lay the second generation of eggs. Nymphs hatching from these eggs reach peak population numbers in late March and April and are responsible for most of the scarring on the citrus fruit.

Low temperature for citrus thrips development is reported to be 14.59°C (58.26°F), and 435.55 heat units minimum are required per generation. Of the 435.55 units, 167.25 heat units are needed for egg development, 78 heat units for the larval stages, 61.15 heat units for the pupal stage, and another 129.15 heat units for the adult pre-oviposition stage (Rhodes et al., 1989). No upper development temperature threshold was established.

Based on the development time for thrips, generation peaks might be calculated and adult peaks might be used to predict nymphal hatch and peak numbers, thereby resulting in efficient applications of insecticides for thrips control. Based on the development model, nymphal peaks would be expected to occur approximately 270 heat units after an adult peak. This value is the midpoint between egg development which would occur about 167 heat units after adult peak, and the egg development plus larval and pre-ovipositional periods which would occur about 374 heat units after the adult peak.

This study was initiated to determine if the thrips development model would reliably predict nymphal peaks in Arizona citrus and to obtain further information about the seasonal abundance of citrus thrips in Yuma County citrus.

## Methods and Materials

Citrus groves were sampled in both 1991 and 1992 by tapping/beating 20-25 terminals (tender when possible) per grove over a sampler. The sampler was a wire-grid mesh-screened, internally silver colored can approximately 8 inches deep that contained a white organdy cloth. The cloth's purpose was to assist in differentiating thrips species and aid in counting both adult and nymphal citrus thrips. Although samples at times contained both western flower thrips, *Frankliniella occidentalis* (Pergande), and citrus thrips, only citrus thrips numbers were recorded.

Groves were sampled twice weekly in the spring of 1991 from approximately March 21- June 4. Five citrus groves were used for sampling across Yuma County to create a temperature gradient to test the thrips development model and obtain seasonality. These citrus groves were located in the Yuma Valley (UA Yuma Valley Agr. Center), on the Yuma Mesa (UA Yuma Mesa Agr. Center), and in commercial production groves in Gila Valley, near Tacna (field designated as Zac) and at Roll (designated as RN #3) in the Dome Valley. The Yuma Valley site continued to be sampled twice weekly through November.

In the fall of 1991 five sites in addition to Yuma Valley were sampled for citrus thrips twice weekly from approximately October 22-December 2 to ascertain thrips numbers in the fall. Four of these sites were on the Yuma Mesa (Dos Rios Nursery, Sunset Nursery (2 sites) and the UA Mesa Agr. Center) with one site in Gila Valley (Glen Curtis Co., Avenue 5E), again using the same technique as previously described.

In 1992, three groves were sampled twice weekly from approximately mid-February through May as previously described, to obtain additional information on seasonality and verification of the thrips development model. Sampling occurred at the Yuma Valley, Yuma Mesa and at a commercial site in the Gila Valley

Temperatures were recorded from the closest AZMET weather station for the Yuma Valley, Yuma Mesa and Gila Valley sites for spring of 1991 and 1992, and grower and Wellton-Mohawk Irrigation District weather data were used for the two sites in Dome Valley for spring 1991 period. The heat unit accumulations using these temperature data were calculated utilizing a 58°F base using a degree-day heat accumulation program (Heatsum-Datasum) based on maximum and minimum temperatures developed by Dr. Roger Huber of the University of Arizona Department of Entomology. No upper temperature limit had been established for thrips development, so a maximum of 100°F was used.

Adult peaks and following nymphal peaks based on heat unit accumulations were then compared when possible to determine if adult peaks would be followed by nymphal peaks at approximately 270 heat units, thus verifying the developmental model or parts of the model under Arizona field conditions. Data were analyzed using the $X^2$ (chi-squared) method.

## Results

Weather differed between 1991 and 1992, with 1991 being considered a typical year in that there were no rains and few predatory mites. Insecticide applications were made for thrips in the three commercial grove sites (Gila Valley, Wellton, and Tacna) as growers decided necessary. The temperatures in 1992 were similar to those in 1991 during January and February. Temperatures were warmer in 1992 during the next two months, especially in April, and accumulated heat units for the year were 120 greater by the end of April in 1992 (947) than in 1991 (815 heat units). Rainfall was also greater in 1992, with precipitation greater than 0.1 inches received on January 5, February 6 and 15, March 2, 7, 26 and 27, April

1 and May 5. In 1992 an outbreak of Texas mite was observed, later followed by an unidentified predatory mite that fed on the Texas mite and citrus thrips nymphs.

*Seasonal Abundance and population peaks:*
Citrus thrips populations appear to behave similar to those noted by Rhodes et al. (1989) in that adults appear to come through the winter, nymphs are noted in February and early March, followed by an adult peak in mid to late March. In Yuma County citrus this adult peak was followed by greater, second peak of adults in April, closely followed by nymphs. Nymphs continue to dominate thereafter through the spring as adult numbers declined and were not collected in samples from the Yuma Valley grove from mid-May until late June when young weeds began growing (Figures 1a-d). Adult thrips predominated during the late summer and early fall in all commercial groves as well as in nursery stock, although numbers were higher where fresh growth was available, usually occurring in the nursery.

In the spring of 1991 these double adult citrus thrips population peaks were noted in every grove (Figures 1a,b through Figures 5a,b), peaking at approximately 570 heat units (base 58°F) after January 1st (Table 1). Exceptions were the Gila Valley which peaked earlier (perhaps due to insecticide treatment), and one of the Dome Valley sites where temperature data were not available from January 1st. In 1992 these peaks occurred four-14 calendar days later, with average peak at 744 heat units after January 1st.

The timing of the adult peak may be related to the spring flush of new growth and floral scent availability. Adult citrus thrips are apparently attracted to citrus when fresh citrus foliage is available. (Figures 1a, 1b), probably attracted to various essential (aromatic) oils which are present in young, new, tender leaves. Although interactions between *S. citri* and the essential citrus oils have not been fully investigated, circumstantial evidence supports such a relationship. Citrus thrips attack buds, young foliage and developing fruits, and lay their eggs beneath the cuticle of new leaves, green twigs, fruit stems and under fruit sepals (Jeppson, 1989). This corresponds to the location of oil glands. Citrus oil glands differentiate very early in newly forming organs, and occur just under the epidermis in primary tissues of the shoot (i.e. leaf, thorn, prophylls, sepals, etc.) (Schneider, 1968). The essential oil content of the leaves declines with age. Scora and Torrisi (1966) demonstrated that the amount of citrol in two month old Valencia leaves was appreciably higher than in nine- to ten-month old leaves.

Thrips behavior also supports this relationship. Rethwisch (1991) reported that the population of jojoba thrips *(S. ewarti* Bailey), significantly increased in one day when Kenauf orange oil was sprayed on jojoba, and increased thrips numbers were noted for two other essential citrus oils, lemon (cold pressed) and d-limonene, although no increases in thrips numbers were noted when Valencia orange was used. Hare et al. (1989) reported that citrus thrips scarring was higher on orange trees that were heavily fertilized in 1986 and 1987 studies. Heavy fertilization usually provides more fresh leaf area and resultant high oil content for a longer period of time. This is consistent with an observation, which noted that older, mature citrus leaves were not as attractive to citrus thrips for feeding and oviposition (Grout et al., 1986).

These observations lead to the conclusion that tender growth/floral initiation in the spring attracted a great number of adult thrips from outside the sampling groves into these areas, probably from weeds, other crops, etc., and that adult thrips are highly mobile. Nymph numbers after these spring peaks could not be correlated with adult thrips numbers as nymphs were present but few or no adults had been present in samples for at least the a month (Fig. 1a) although subsequent nymph numbers indicate their presence and egg laying in citrus.

Adult and nymphal numbers were quite different in 1991 and 1992. In 1991, adults were dominant from 400- 600 heat units after January 1st, and nymphs thereafter. In 1992, adults were dominant from 350 heat units until sampling ended in May (approximately 1300 heat units) at all three sample locations. Why were the two years so different? One reason may be that in 1992 predatory mites were very active and feeding on thrips. These mites had become established when an outbreak of Texas mite had occurred earlier in the year (late winter) perhaps due in part to the rainy conditions during 1992. Rains also may have affected thrips populations by washing nymphs from foliage and drowning them.

*Using adult peaks to predict nymphal hatches*:
Adult peaks were not correlated with nymphal peak numbers, assuming that 270 heat units are necessary, after 600 heat units had accumulated from January 1st. Sampling in 1991 detected higher adult numbers at initiation of sampling in most groves

(about 400 heat units from Jan. 1) which preceded nymphal numbers by about 200 heat units, although this observation was not consistent across all groves. Only one adult peak was noted during the spring at Yuma Valley in 1991 (Figure 1), although 5 nymphal peaks were noted during the period when fruit would be susceptible to scarring by nymphal thrips feeding. Part of the difference may be attributed to only twice a week sampling. When temperatures are warm it is possible that 100+ heat units may accumulate in a week. Sampling more often (every two days during this period) may have detected peaks differently.

In 1992 adult peaks after 400 heat units (March 19) were not followed by corresponding large nymphal populations in April. It does not appear that using adult thrips peaks on citrus terminals to forecast nymphal thrips peaks utilizing heat units during April and May will be accurate.

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**Table 1. Adult citrus thrips spring peaks by date and accumulated heat units (58°F base) in Yuma County citrus in 1991 and 1992.**

| Location | Calendar date | Accumulated heat units |
|---|---|---|
| Yuma Valley - 1991 | April 10 | 601 |
| Yuma Mesa - 1991 | April 10 | 590 |
| Gila Valley - 1991* | April 2 | 457 |
| Tacna (RN #3)-1991 | April 8, 23 | 521 |
| Wellton/Roll- 1991 | April 8 | ** |
| Yuma Valley - 1992 | April 23 | 793 |
| Yuma Mesa - 1992 | April 14 | 673 |
| Gila Valley - 1992 | April 24 | 766 |

* Data may have been affected by insecticide treatment applied to grove approximately April 5, 1991.

** Accumulated heat units from January 1 were not available for this location.

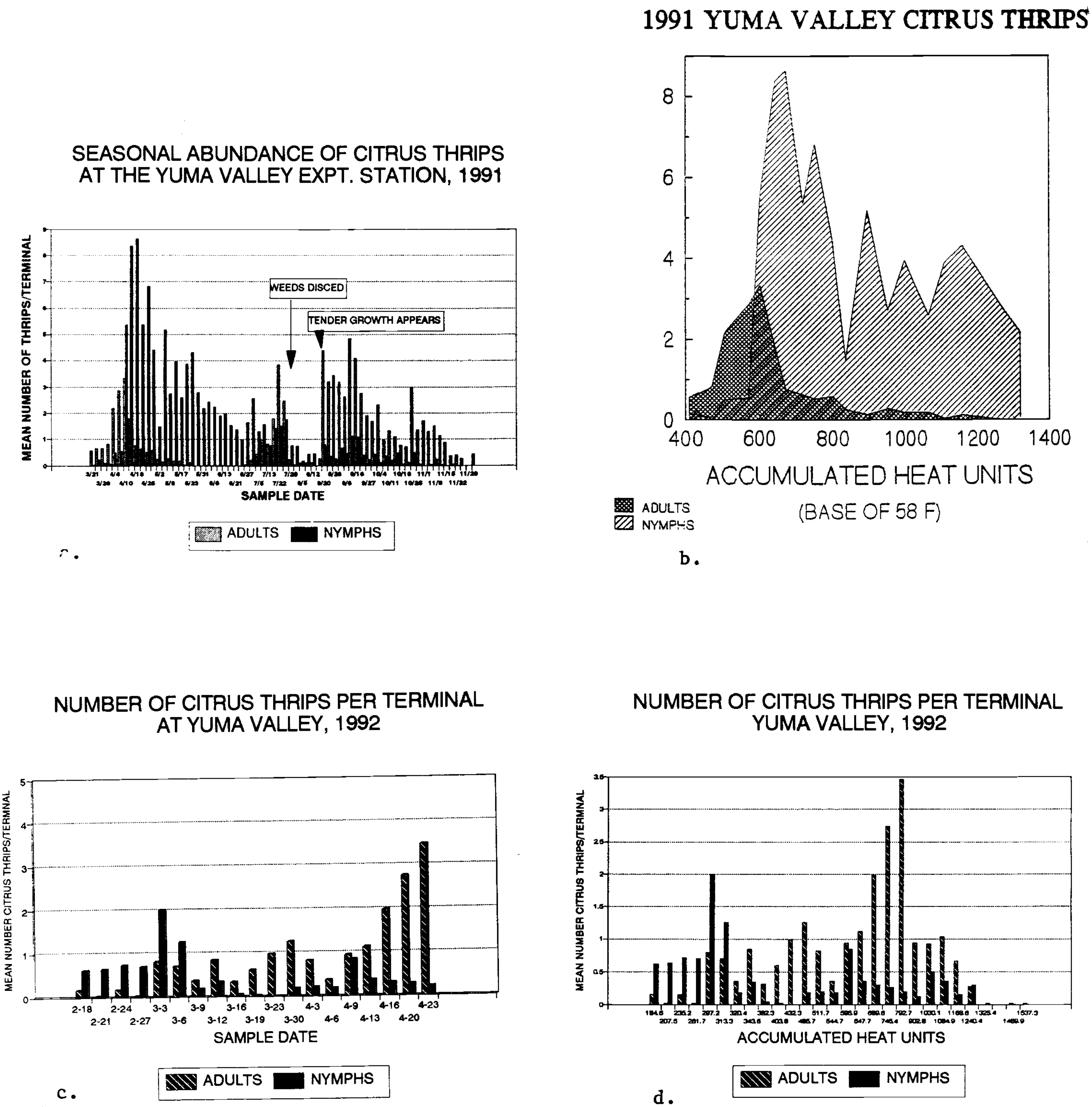



Figure 1. Citrus thrips numbers at Yuma Valley during 1991 and Spring 1992.

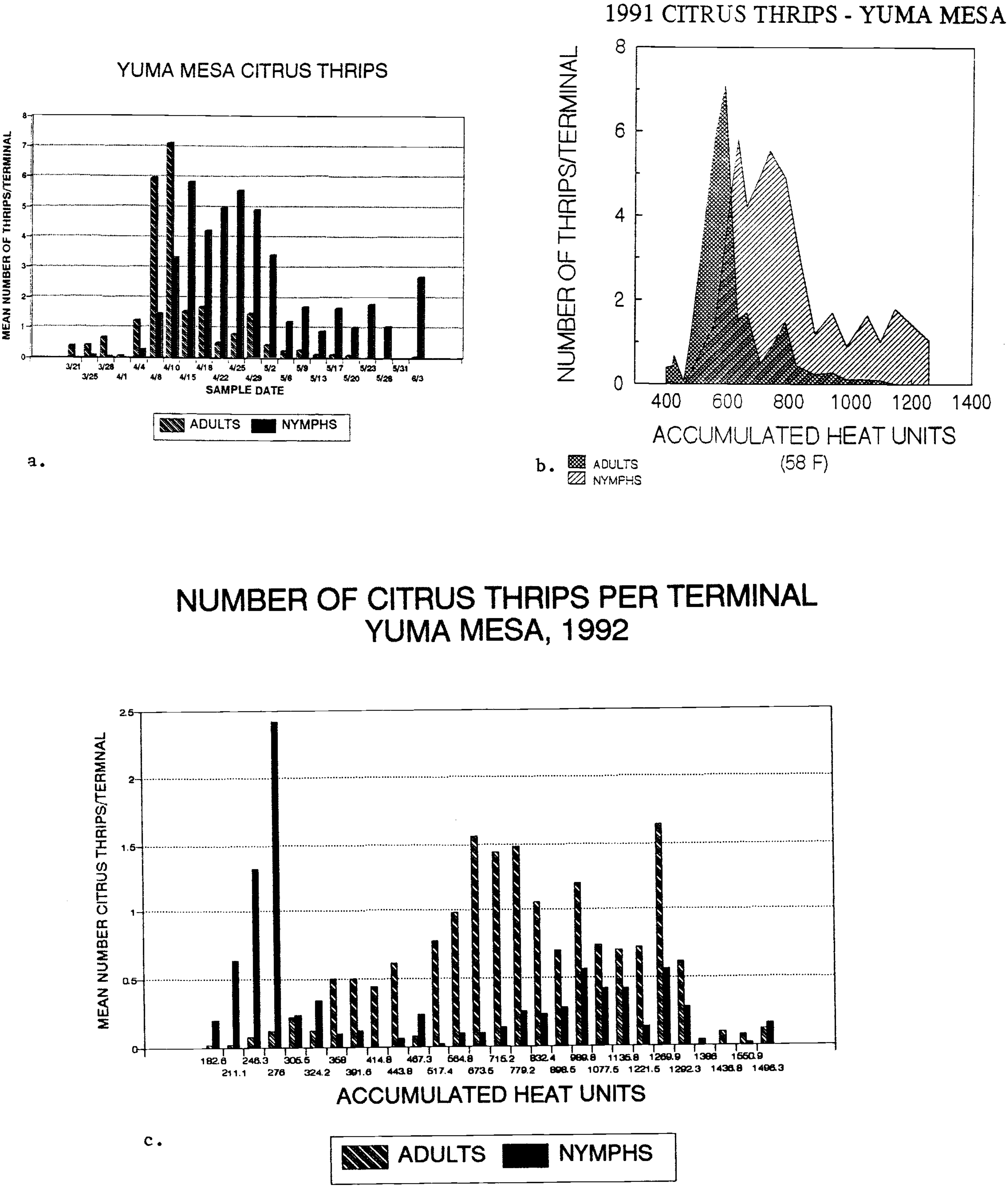
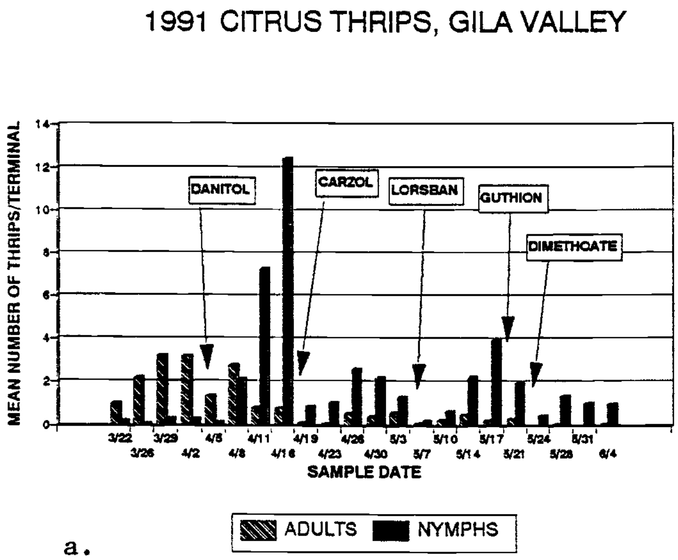
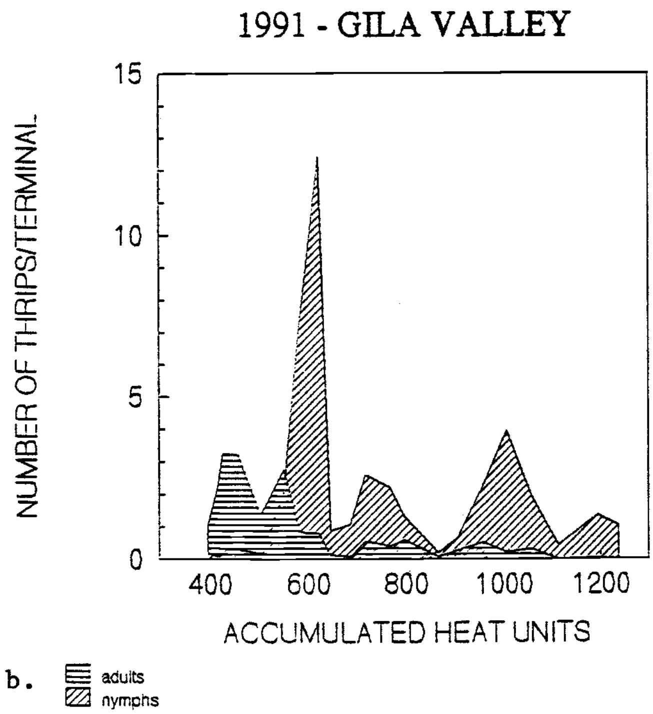


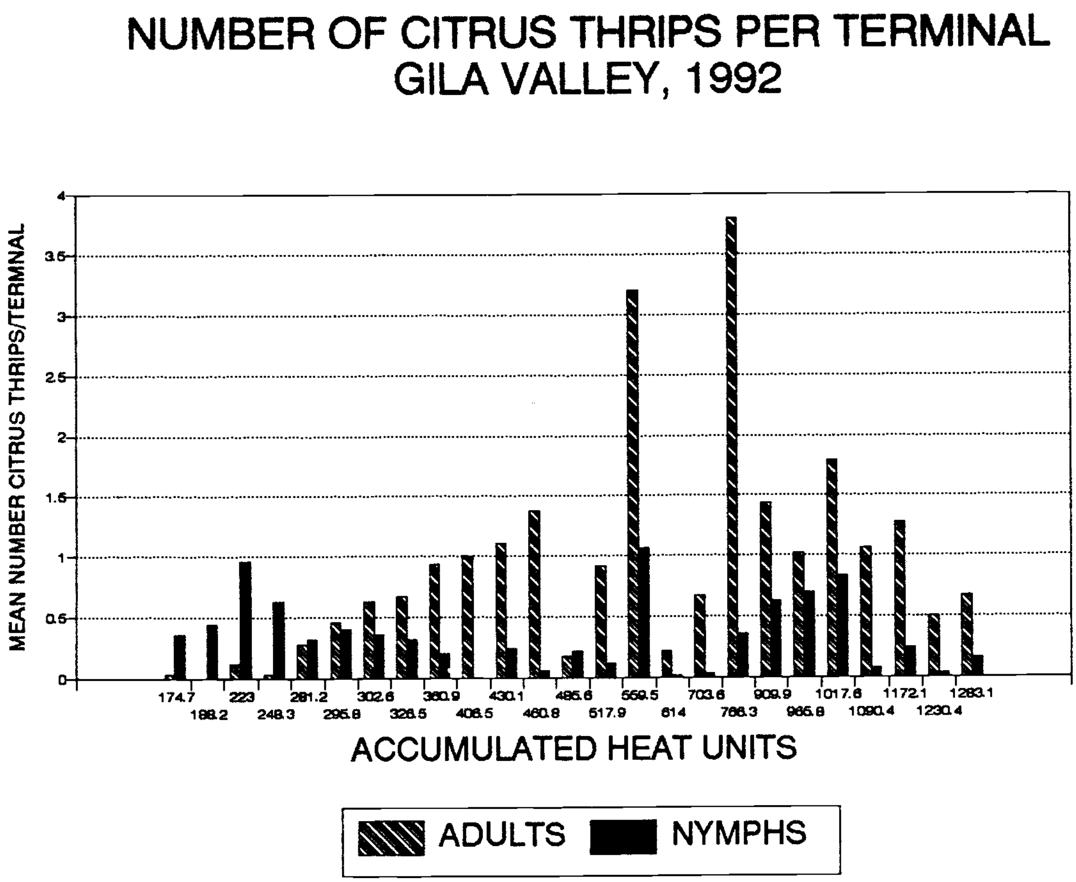

**Figure 2. Citrus thrips numbers at Yuma Mesa during springs of 1991-1992.**




a.



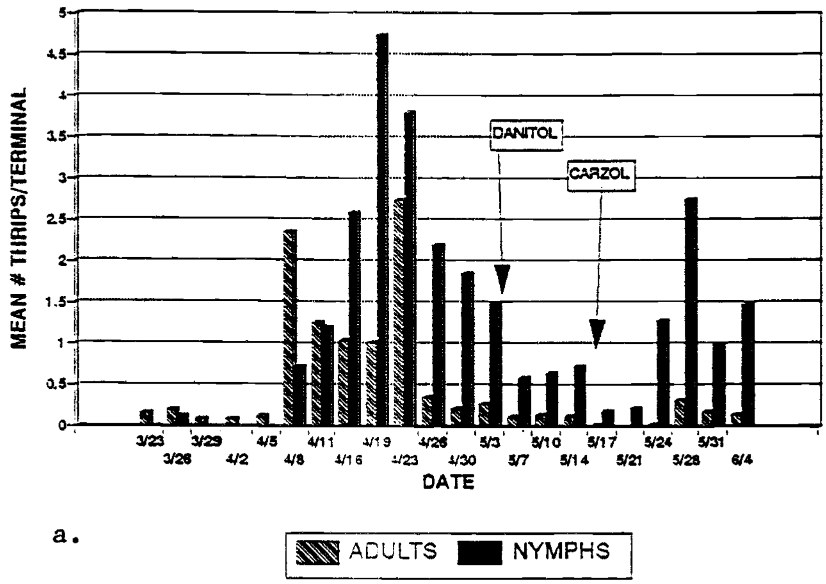

b.



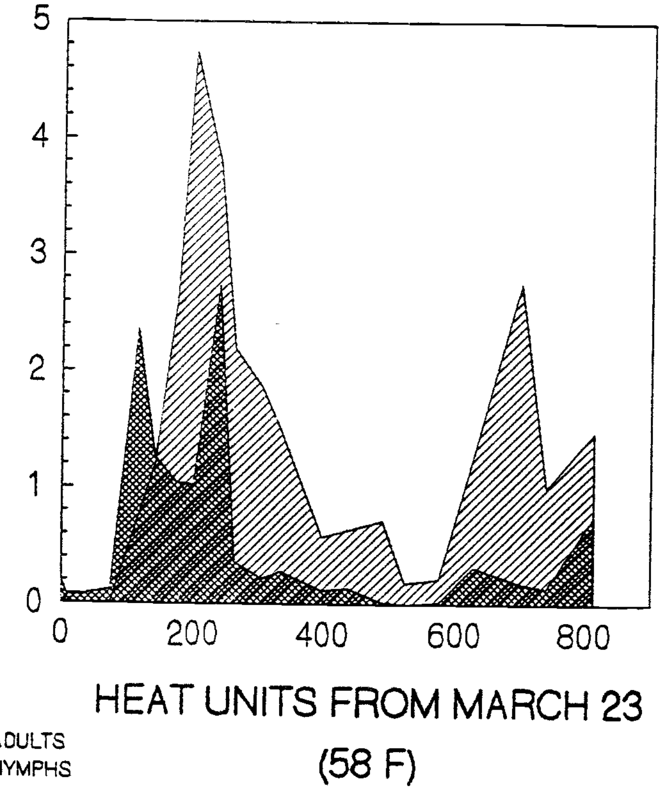

c.

Figure 3. **Citrus thrips numbers** during spring **1991 at Gila Valley.**

## 1991 CITRUS THRIPS - ROLL



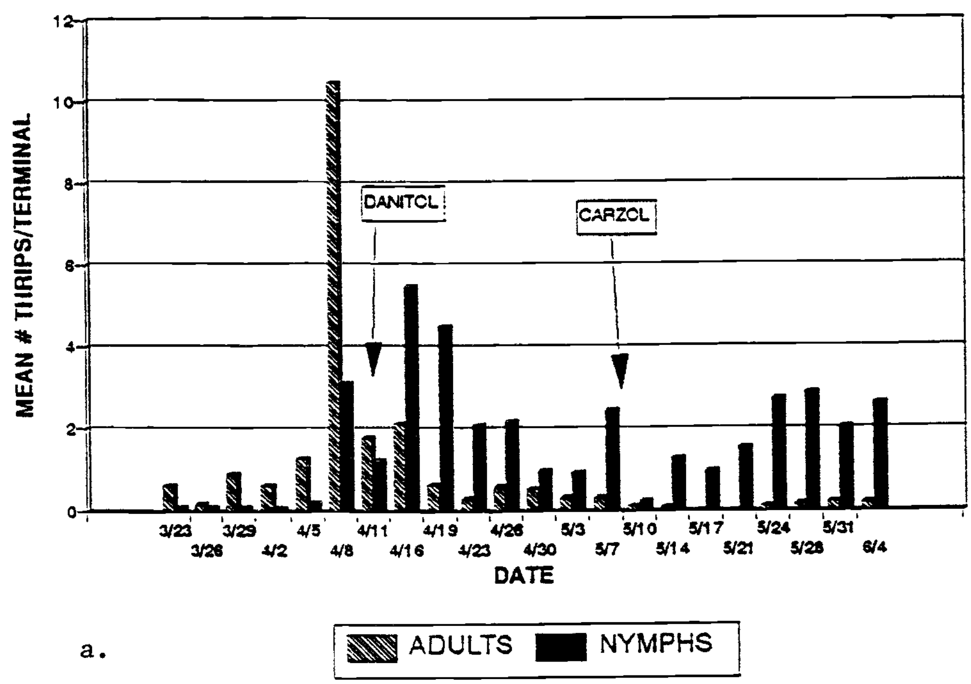

a.



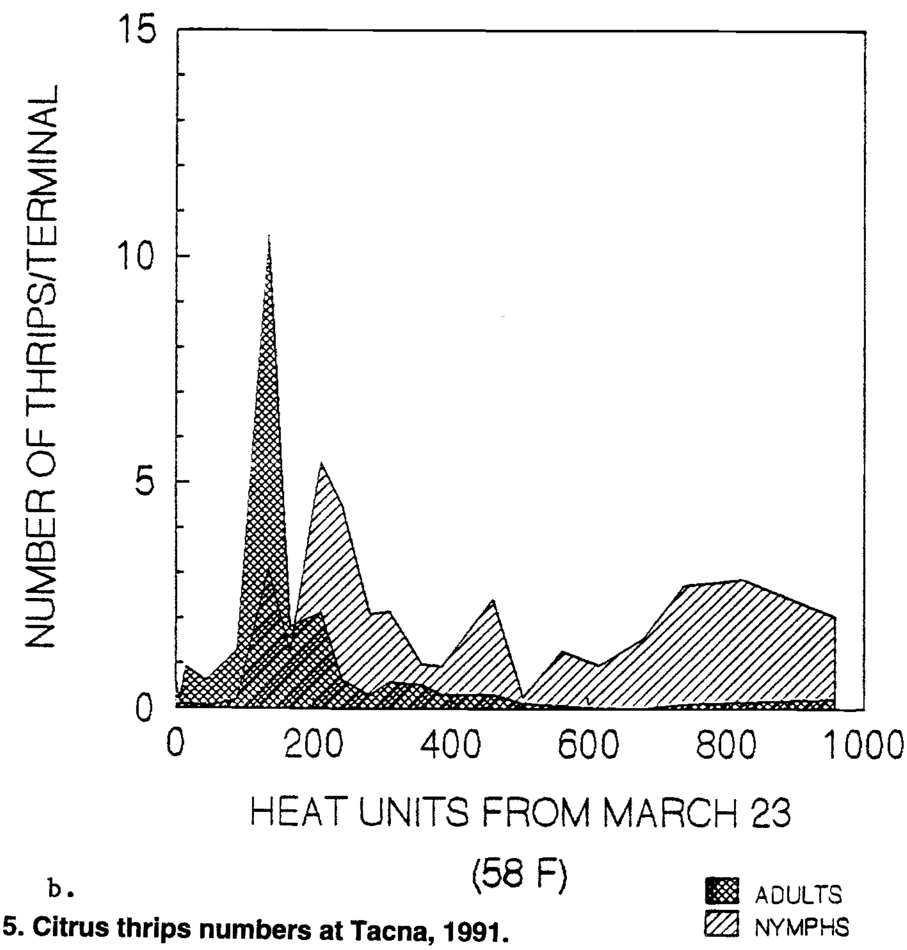

b.

**Figure 4. Citrus thrips numbers during spring 1991** at Roll/Weston.

# 1991 CITRUS THRIPS - TACNA (ZAC)




a.




b.

**Figure 5. Citrus thrips numbers at Tacna, 1991.**

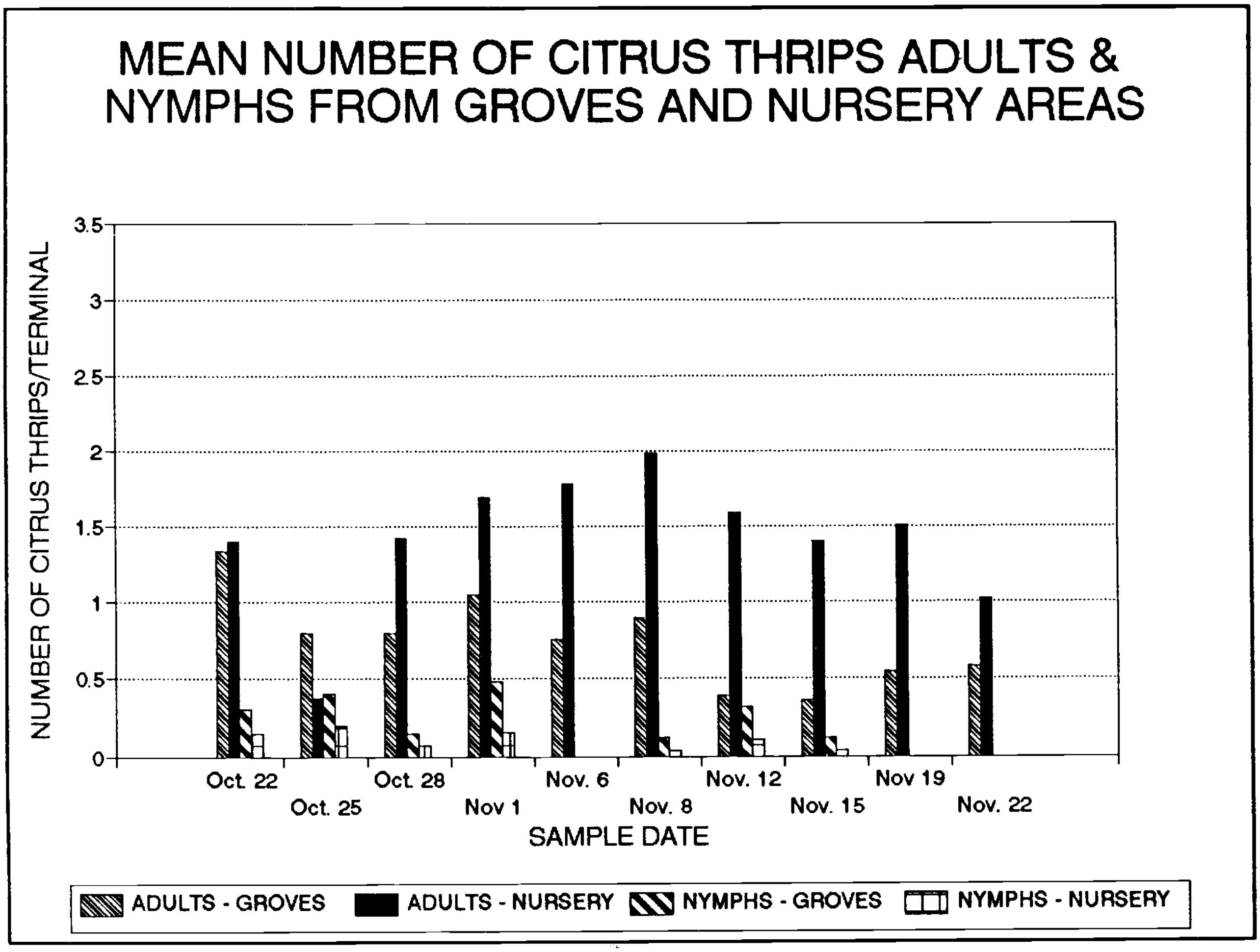



Figure 6. Mean numbers of citrus thrips during fall, 1991, from nurseries and commercial citrus groves.