Population Distribution of Flower Thrips and the Western Flower Thrips (Thysanoptera: Thripidae) in Nectarines and their Relative Association with Injury to Fruit in the Southeastern United States[1,2]

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ABSTRACT Thrips populations and injury attributed to thrips feeding on fruit surfaces was monitored in unsprayed middle Georgia nectarines during 1986 - 1988. The flower thrips, *Frankliniella tritici* (Fitch), the western flower thrips, *Frankliniella occidentalis* (Pergande), and the soybean thrips, *Neohydatothrips variabilis* (Beach), were the most abundant thrips species recovered from the orchard. Their relative abundance changed each year. The western flower thrips particularly appears to be most damaging in causing russeting on fruit surfaces. Silvering injury was caused by either or both of the flower thrips and coincided with peak populations of adults at or near final fruit swell. Soybean thrips caused little or no injury to fruit. None of the above mentioned flower thrips species were recovered from various weed and grass species in and near the nectarine orchard during two years of overwintering studies.

KEY WORDS Nectarine, pest management, silvering, russeting, sampling techniques, *Frankliniella occidentalis*, western flower thrips, *Frankliniella tritici*, flower thrips.

Development of new nectarine cultivars for the southeastern United States has stimulated a renewed interest in commercial nectarine production. Although nectarines are similar to peach, their glabrous surface, distinctive color, flavor, and aroma distinguish them from peach (Okie et al. 1985). Generally, the same complex of arthropods and diseases attack both peach and nectarine, but nectarine fruit are apparently more susceptible to superficial surface injury. Major markets expect nectarines to be almost flawless. Even minute cosmetic blemishes on fruit can cause extensive cullage. Pest management strategies for arthropod pests of peaches have been static for several years, but little information is available on thrips and their pest potential to nectarines in the southeastern United States. Researchers in California, France, Italy, and Greece have emphasized the importance of controlling thrips in commercial nectarine orchards (LaRue et al. 1972, Bournier 1973, Kourmadas et al. 1982, Cravedi et al. 1983, Cravedi & Molinari 1984).

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[2] This paper reports the results of research only. Mention of a pesticide does not constitute recommendation for its use by USDA or the University of Georgia. It does not imply registration und FIFRA as amended. Also, mention of a commercial or proprietary product does not constitute endorsement by USDA.

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Life history studies of thrips associated with nectarines in the southeast are lacking. Our purpose was to gather information that could be used in developing a pest management program for nectarines.

Material and Methods

The study was conducted in a small tree planting which consisted of an advanced nectarine cultivar selection (no. 6-366) from the breeding program at the Southeastern Fruit and Tree Nut Research Laboratory, Byron, GA. This selection was used because it is better adapted to southern climates as opposed to most established cultivars which are adapted to climates of the western United States. The planting cosisted of a 9 × 14 array of 126 trees. Four sets of ten trees each were randomly labeled and color coded throughout the planting. Thus, we were able to sample a different set of ten trees at a given sampling time and consequently, individual trees were never sampled more than once per four weeks, ensuring that control was not exerted on the thrips population and their natural behavior was not interrupted. Fruit from the cultivar selection ripens in early June and trees were beginning their fourth leaf (growing season) when the study began. Technical piperonyl butoxide 60% ai plus 6% ai pyrethrins, was used as a quick knock-down insecticide at the rate of 1.3 ml per liter of water (Yonce et al. 1990). A modified version of a method designed for sampling pecan arthropods was used to sample the nectarines (Tedders 1983). Two aluminum trays (117 × 76 cm) each with three vertical sides (2.54 cm high) and one open side on the long edge, were placed below limbs under the canopy of the tree. The insecticide was applied with a battery-powered sprayer. After 20 - 30 min, the trays were picked up and placed on a framework over a trough and washed down with water into a funnel which had a fine mesh sheer cloth attached to its end with a tight fitting rubber band. Thrips were trapped in the cloth and immediately put into 70% ethanol for later examination. Thrips were later identified by methods described by Moulton 1948, Stannard 1968, Allen and Broadbent 1986, and Sakimura 1986. Voucher specimens were sent to S. Nakahara (USDA-Insect Identification Lab, Beltsville, MD 20705) for verification and returned to Department of Entomology, University of Georgia Insect Collection at Griffin, GA.

Sampling began in 1986 at the pink bud flower stage. Samples were taken every week until harvest; thereafter, sampling was done every two weeks until the first week of September. The same procedure was used in 1986, 1987 and 1988. Sampling was done during early morning daylight when insects were least active. The stage of flower and fruit development, temperature, and rainfall were recorded at each sampling until harvest. During the first five weeks of 1986 sampling (pink bud - shuck off) the sampling procedure was tested for efficiency. One hour after thrips samples were recovered by knock-down spraying, 10 buds, blooms, or small fruit from each tree were examined for thrips.

Studies were conducted in the winters of 1986-87 and 1987-88 to determine if flower thrips were overwintering in the vicinity of the nectarine planting. Grass and broad leaf weed samples were extracted via Berlese funnels to allow collection of motile overwintering arthropods. Berlese sampling was done from eleven different potential overwintering sources which included ten species of weeds and grass and ground litter. Plant species sampled included dandelion, *Taraxacum officinale* Wiggers; curly dock, *Rumex crispus* L.; vetch, *Vicia sativa* L.; henbit, *lamium* amplexicaule L.; mouse ear chickweed, *Cerastium vulgatum* L.; cudweed, *Gnaphalium purpureum* L.; buckhorn plantain, *Plantago lanceolata* L.; blue toadflax, *Linaria canadensis* (L.) Dumont; common chickweed, *Stellaria media* (L.) Vill.; and winter ryegrass, *Lolium perenne* L. All thrips captured were identified and recorded.

Fruit were assessed for thrips injury each week from pre-shuck split until harvest during 1987 and 1988. Injury was determined to be either russeting or silvering. Russeting is a rough textured, tan blemish. Russeting injury is sustained in the early stages of fruit development while the young fruit is still protected by the shuck (Fig. 1) (LaRue 1972). Silvering is a light silvery colored, bleached out condition on the red blush of the fruit. It is caused principally by adult feeding during final swell of fruit (Fig. 2) (LaRue 1972). Damage was recorded as either light, moderate or heavy.

Fig. 1. Thrips induced russeting on mature nectarine fruit.

Results

Sampling in nectarines during 1986, 1987 and 1988 yielded eighteen different species of thrips of which seventeen species were in the suborder Terebrantia and only one species in the suborder Tubulifera (Table 1). Three species were captured in enough abundance to warrant attention. Their distribution patterns and assessment of fruit injury are presented herewith.

Thrips knock-down efficiency, 1986. A few adults, but no larvae were recovered from the first spray sampling (pink bud). Neither adults nor larvae were recorded after spraying. However, on 11 March, near full bloom, no adults or larvae were recovered from spraying, but some adults were found after spraying. On 18 March (petal fall), most adults were recovered from spraying, but larvae

Fig. 2. Silvering on nectarine fruit apparently caused by adult thrips feeding during the final swell of fruit phenology.

were not. By the shuck off stage, the majority of adults were recovered but most of the larvae were not. The sampling efficiency test revealed that pyrethrin sprays were acceptable to recover adults but it performed poorly for thrips larvae at petal fall (Table 2).

Flower Thrips and Soybean Thrips Distribution, 1986, 1987 and 1988. The first adult thrips captures of the 1986 season (pink bud) were the flower thrips, *Frankliniella tritici* (Fitch) (Fig. 3). Moderate captures were recorded until 4-5 weeks before harvest (29 April, fruit size 4 cm), but a substantial increase in adult numbers (7X) had occurred by 6 May. Adult thrips captures remained high for ca. three weeks peaking on 27 May. By harvest, Flower Thrips captures were decreasing and they were substantially reduced one week post-harvest. Captures continued to be low and the last capture was on 4 August. Western flower thrips, *F. occidentalis* (Pergande), populations followed a similar pattern, but their peak was three weeks earlier (6 May) and the total capture was 5X less than Flower Thrips. They were not captured after harvest. Populations of the soybean thrips, *Neohydatothrips variabilis* (Beach), were much lower than either of the flower thrips species. They peaked at harvest time, but were captured throughout the summer until 2 September when sampling ended.

In 1987, Flower Thrips were captured 132X fewer than in 1986. Western Flower Thrips were almost non-existent (only one specimen for the entire season) and Soybean Thrips was the dominant species captured. They were first captured at petal fall, increased on 14 May, and peaked on 11 June one week before harvest. Captures substantially subsided one week later at harvest and remained relatively low (Fig. 4).

Table 1. Thrips captured in unsprayed nectarines using pyrethrin and piperonyl butoxide knockdown sampling technique. Byron, GA, 1986-88.

INSECTA
- Thysanoptera
- Terebrantia (suborder)
  - Aeolothipidae Uzel (1895)
    - *Aeolothrips melaleucus* Haliday
  - Heterothripidae Bagnall (1912)
    - *Heterothrips sp.*
  - Thripidae Stephens (1829)
    - *Bregmatothrips venustus* Hood
    - *Caliothrips* sp.
    - *Frankliniella bispinosa* (Morgan)
    - *Frankliniella fusca* (Hinds)
    - *Frankliniella occidentalis* (Pergande)
    - *Frankliniella tritici* (Fitch)
    - *Limothrips cerealium* (Haliday)
    - *Microcephalothrips abdominalis* (D. L. Crawford)
    - *Neohydatothrips variabilis* (Beach)*
    - *Pseudothrips inequalis* (Beach)
    - *Oxythrips divisus* Hood
    - *Scirtothrips* sp.
    - *Scolothrips pallidus* (Beach)
    - *Thrips hawaiiensis* (Morgan)
    - *Thrips treherni* Priesner
  - Tubulifera (suborder)
  - Phaeothripidae Uzel (1885)
    - *Leptothrips mali* (Fitch)

* According to Nakahara 1988.

Table 2. Flower thrips recovered from pyrethrin and piperonyl butoxide sprayed nectarine trees and by post spray dissection of flowers and/or fruit from same trees 1 hour after spraying to determine effectiveness of pyrethrin and piperonyl butoxide knock-down methods of sampling. Byron, GA 1986.

Sample Date	Phenological stage	Total thrips/10 trees (10 flowers or fruit per tree)			
		Adults		Larvae	
		spray	post-spray dissection	spray	post-spray dissection
4 March	pink bud	9	0	0	0
11 March	60% bloom	0	7	0	0
18 March	petal fall	24	1	0	19
25 March	shuck tight	12	4	18	34
1 April	shuck off	240	2	8	45

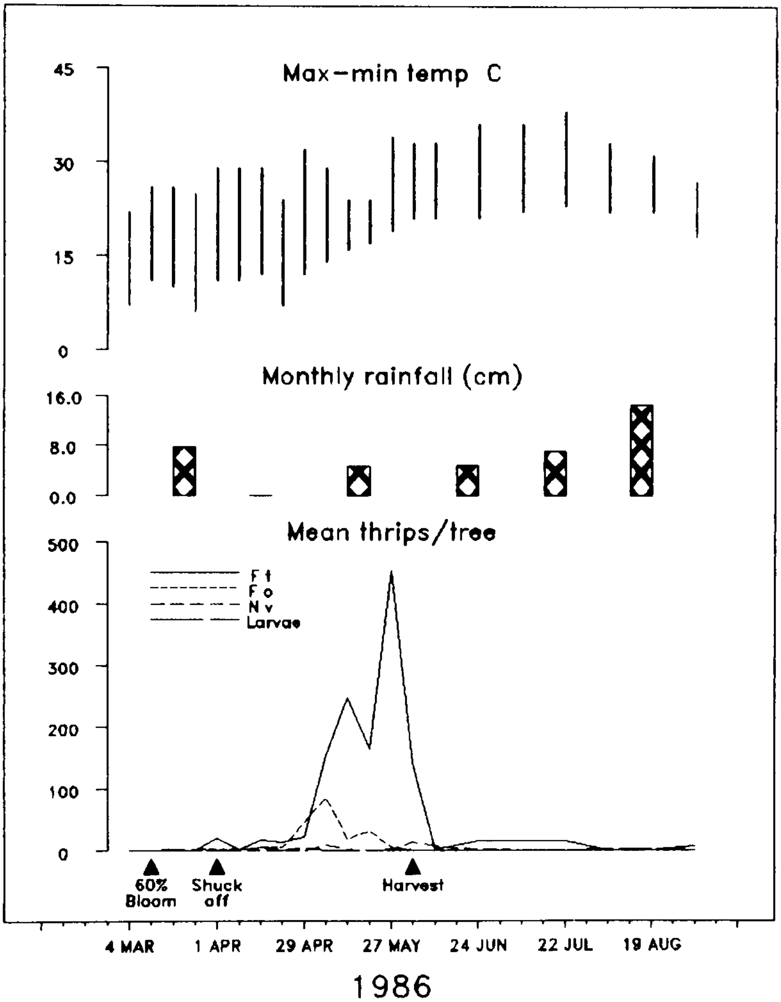

Fig. 3. Seasonal distribution of adults of the flower thrips (Ft), the western flower thrips (Fo), the soybean thrips (Nv), and undetermined thrips larvae in unsprayed nectarines.

In 1988, distribution patterns were again completely different. Flower Thrips were captured first at full bloom. Although their captures were higher than in the previous year (4X), they were lower in numbers to Western Flowerthrips. Soybean thrips captures were quite low. They were first captured on 4 May and peaked on 22 June, three weeks after harvest (Fig. 5).

Thrips Overwintering, 1987. Four adult species of Terebrantia (40 specimens) were recovered and identified during 29 January - 11 March, 1987. Forty four specimens of the suborder Tubulifera were not identified to species. Also, 257 specimens of thrips larvae were recovered but identification keys do not exist to

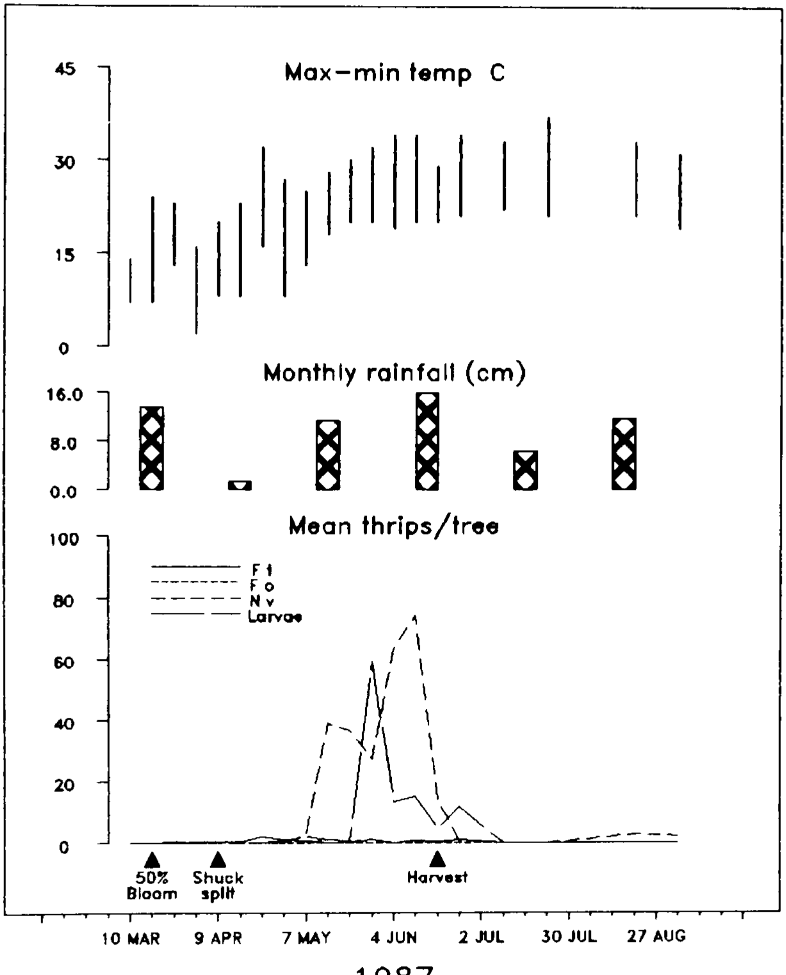

Fig. 4. Seasonal distribution of adults of the flower thrips (Ft), the western flower thrips (Fo), the soybean thrips (Nv), and undetermined thrips larvae in unsprayed nectarines.

positively identify them. Our best estimates were that they were mostly of the suborder Terebrantia.

The tobacco thrips, *F. fusca* (Hinds), was recovered from all plants, but most came from common chickweed. Tubulifera were found on all plant species except common chickweed. *Frankliniella* sp. were recovered primarily from common chickweed but one specimen was recorded each from winter ryegrass and blue toadflax. *Microcephalothrips abdominalis* (D. L. Crawford) were recovered from dandelion, and one specimen also came from blue toadflax. One specimen of *Thrips nigropilosus* Uzel was recovered from buckhorn plaintain. Thrips larvae

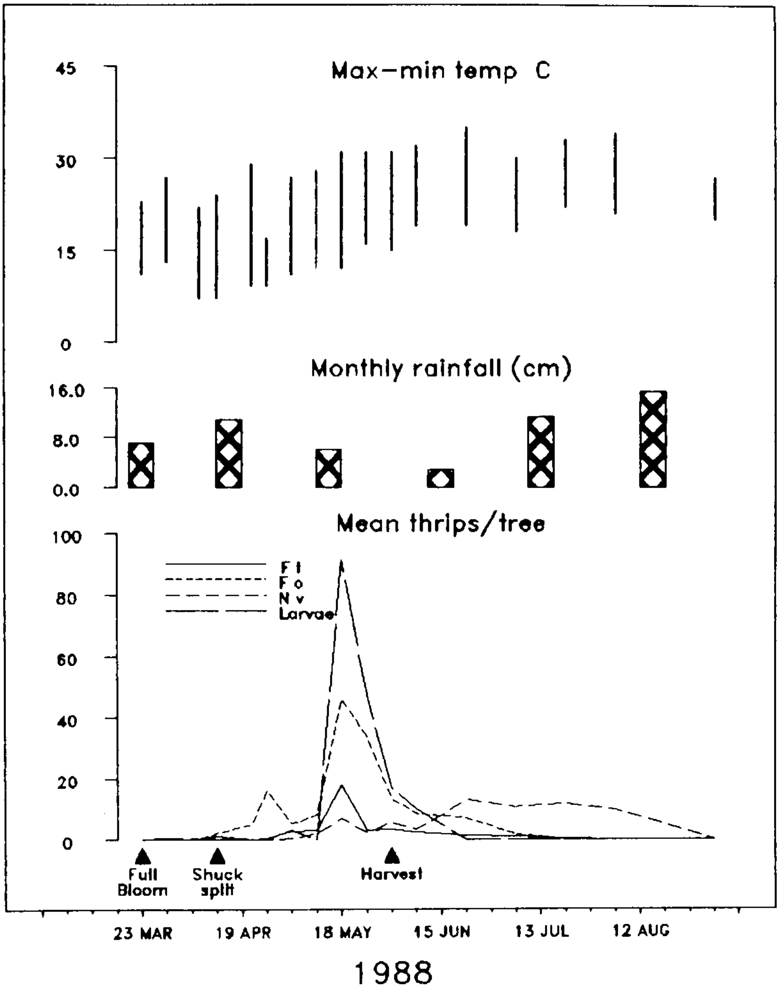

Fig. 5. Seasonal distribution of adults of the flower thrips (Ft), the western flower thrips (Fo), the soybean thrips (Nv), and undetermined thrips larvae in unsprayed nectarines.

(probably Terebrantia) were recovered from all plants sampled, but most came from common chickweed. Neither adults of the flower thrips, the western flower thrips, nor the soybean thrips were recovered during the seven week sampling period. One specimen of the tobacco thrips, one specimen of Tubulifera, and one specimen of a thrips larva were recovered from ground litter. Obviously, we were unable to find the overwintering flower thrips and the western flower thrips.

Thrips Overwintering, 1987-88. Sampling began on 11 November 1987, at or near first frost when the nectarine trees had lost their leaves and were just beginning dormancy. Since no flower thrips were recovered from identified plants within and near the orchard the previous year, we elected to concentrate sampling within the orchard and sample sod within middles between rows of trees. Sampling was done irregardless of identifiable plant species from selected sites throughout the orchard floor. An even distribution of twelve sites revealed the following captures from Berlese funnels during fourteen sampling periods that extended to 10 March 1988. *Plesliothrips perplexus* (Beach) were most abundant with 697 specimens; Tubulifera with 363, thrips larvae with 273; *F. fusca* with 19; *Bregmatothrips venustus* Hood with 14; and two specimens yet to be identified. Again, our sampling failed to reveal overwintering flower thrips species.

Fruit Injury and Damage Assessment, 1987 and 1988. No injury was found when fruit samples were first picked on 2 April, 1987, when the shucks were still tight surrounding the fruit (Table 3). On 6 April, at shuck split, light russeting was recorded on 12.5% of the fruit. Each week thereafter, russeting was recorded until harvest. Preharvest russeting injury varied, probably due to small sample size, but it did not appear to increase after shuck off. Overall, russeting was light. Silvering was also light and it was first observed on 27 April when fruit was ca 2 cm in diameter.

Table 3. Thrips injury and damage assessment to fruit in unsprayed nectarines. Byron, GA, 1987.

		Mean % Damage*					
Sample	Fruit	Russeting			Silvering		
Date	Development	Light	Moderate	Heavy	Light	Moderate	Heavy
2 April	shuck tight	0	0	0	0	0	0
6 April	shuck split	12.5	0	0	0	0	0
13 April	shuck off	8.0	1.0	0	0	0	0
20 April	fruit 1.3 cm	24.0	1.0	0	0	0	0
27 April	fruit 2 cm	2.0	0	0	8.5	0	0
4 May	fruit 2.5 cm	7.0	1.5	0.5	2.0	0	0
11 May	fruit 3.2 cm	15.0	0.5	0	21.5	0	0
18 May	fruit 3.8 cm	8.0	1.0	0	23.5	1.0	0
26 May	fruit 3.8 cm	17.0	1.5	0	3.0	0	0
1 June	fruit 3.8 cm	17.5	3.0	1.0	16.5	0	0
8 June	fruit 4.4 cm	27.0	1.5	0.5	13.5	3.5	0
15 June	fruit 5.1 cm	21.5	3.0	1.5	3.5	0	0
22 June	*harvest*	22.0	0	0	8.5	0	0

* means computed from 4 replications (10 fruit/rep 2 Apr and 6 Apr, 25 fruit/rep 13 Apr and 20 Apr, 50 fruit/rep 27 Apr-22 June).

In 1988, injury to fruit was higher than the previous year (Table 4). Light russeting ranged from 13 - 32.5%, moderate russetting 13.5 - 26%, and heavy russeting 1.5 - 12.5%. Silvering was mostly light and moderate with some heavy silvering occurring during final fruit swell.

Table 4. Thrips injury and damage assessment to fruit in unsprayed nectarines, Byron, GA, 1988.

Sample	Fruit	Mean % Damage*					
		Russeting			Silvering		
Date	Development	Light	Moderate	Heavy	Light	Moderate	Heavy
12 April	shuck split	22.5	22.0	11.5	0	0	0
20 April	shuck off	31.5	17.5	2.5	0.5	0	0
25 April	fruit 2.5 cm	20.5	18.5	12.5	0.5	0	0
2 May	fruit 3.8 cm	27.0	19.0	12.0	0	0	0
9 May	fruit 4.4 cm	23.5	19.5	9.0	0	0	0
16 May	fruit 5.1 cm	13.0	13.5	3.0	6.0	7.5	1.0
23 May	fruit 5.7 cm	20.0	15.0	5.0	0	0	0
30 May	fruit 6.4 cm	24.0	22.0	5.0	28.0	9.0	1.5
6 June	*harvest*	32.5	26.0	1.5	38.6	27.4	5.5

* means computed from 4 reps (50 fruit/rep 12 Apr-30 May, 200 fruit/rep on 6 Jun)

Discussion

Flower thrips are capable of inducing severe cosmetic injury to nectarines in the southeastern United States. The western flower thrips is established in middle Georgia and appears to have considerably more damage potential than the flower thrips. The western flower thrips was first observed in middle Georgia peach orchards in 1983. Since that time populations have been increasing and in 1988, they were widespread throughout middle Georgia in peach and nectarine (Yonce et al. 1988, Horton et al. 1988). In 1986, there was very little thrips injury. The flower thrips were extremely abundant compared to the western flower thrips. Fruit injury was not recorded and only light russeting and silvering were observed.

According to Watts (1936), flower thrips populations are influenced by rainfall. He stated that, "heavy dashing rains are probably the most important natural control." The extremely low rainfall recorded during the early season of 1986 may have contributed to favorable weather conditions for the flower thrips population to build up during May. Rainfall was almost non-existent during April (Fig. 3). However, there was no evidence that the lack of rainfall had any positive effect on the build up of the western flower thrips or the soybean thrips since their population levels were much less than the flower thrips.

In 1987, the soybean thrips were more abundant than either of the flower thrips species. They were recorded in equal numbers from trees with and without fruit. The flower thrips population levels were low and the western flower thrips was almost non-existent (Fig. 4). It is noteworthy to mention that rainfall was near normal in March, but low in April, although much higher than the previous year. Whether rainfall influences other thrips species as much as the flower thrips is not known. Damage was present on fruit, but it was mostly light (Table 3).

In 1988, fruit injury was noticeably more severe and the western flower thrips was the dominant species for the first time. Although its population level was similar to 1986, it was more abundant than the flower thrips (Fig. 5). Rainfall was greater during the early season than previous years and may have influenced the low population level of the flower thrips. Damage was heavier than previous years and since the western flower thrips was the dominant species, evidence points to it as being the most important species of thrips associated with nectarine fruit damage in 1988 (Table 4).

Russeting is, by far, the most critical injury on nectarine fruit and consequently, flower thrips, particularly the western flower thrips must be controlled if blemish-free fruit is grown in the southeast. If our pyrethrin knockdown insecticide is a valid indicator, young larvae are apparently protected within the flower parts. At present, we do not know where flower thrips overwinter. They may overwinter as pupae in the soil in the vicinity of the orchard or possibly they move into the orchard from some other earlier blooming flowers. Future research should disclose where flower thrips overwinter and when they move to developing fruit. Answering some of these questions about flower thrips would enhance pest management. Control options and thresholds should be pursued.

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