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THRIPS (THYSANOPTERA: THRIPIDAE) PESTS OF FLORIDA GRAPEFRUIT: BIOLOGY, SEASONAL AND RELATIVE ABUNDANCE, FRUIT DAMAGE AND MONITORING

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Abstract. **The orchid thrips, *Chaetanaphothrips orchidii* (Moulton), *Danothrips trifasciatus* Sakimura, and the greenhouse thrips, *Heliothrips haemorrhoidalis* (Bouché) can cause rind blemish injuries to clustered grapefruit that are touching each other. Red grapefruit varieties in Florida tend to produce more interior clustered fruit that increase the protective micro-environment for these pest thrips compared to white grapefruit. Damaged fruit can be rejected for the fresh market depending on the extent of thrips-induced rind blemish. Any of the three thrips species are capable of causing rind blemish injury from onset of clustered fruit contact beginning in early May until harvest. Adults as well as first and second instar larvae are feeding stages. Only *H. haemorrhoidalis* completes its entire life cycle within the tree canopy, either between touching fruit or between leaves or twigs and touching fruit. All three thrips species have alternate hosts in Florida, including various weed species within citrus groves. Effective insecticidal control options currently labeled for citrus are limited to Danitol 2.4EC sprayed at concentrations of one pint per acre (1.403 liters per ha) or chlorpyrifos 4EC at five pints per acre (5.845 liters per ha). Sticky traps of 13 different colors or hues were tested at two citrus grove sites in Collier and Hendry County, Florida during 1994. No *C. orchidii*, *D. trifasciatus*, or *H. haemorrhoidalis* adults were collected from any of these traps. Scouting is essential to minimize both fruit damage and insecticidal applications due to the long period of potential vulnerability to thrips feeding. Three monitoring methods including destructive clustered fruit samples washed in 80% ethanol, visual inspection for adult thrips pests between clustered fruit and nascent fruit damage by the orchid thrips complex were compared. Advantages and disadvantages for each method are discussed.**

Plant feeding thrips species are capable of producing a variety of cosmetic injuries to various tree fruits, vegetables, flowers, or ornamental plants (Childers, 1997). Included among these are the orchid thrips, *Chaetanaphothrips orchidii* (Moulton), *Danothrips trifasciatus* Sakimura (no common name), and the greenhouse thrips, *Heliothrips haemorrhoidalis* (Bouché). The orchid thrips and the greenhouse thrips are known pests of citrus and several other important horticultural commodities such as avocado in various countries including: Brazil, Dominican Republic, Puerto Rico, Honduras, Australia, Taiwan, Egypt, Palestine, and Israel (Argov, 2003; Beattie and Jiang, 1990; Childers and Nakahara, unpublished; Jeppson, 1989; Medina Gaud, 1959; Rivnay, 1935; Smith et al., 1997) as well as in California and Florida (Childers and Frantz, 1994; Griffiths and Thompson, 1957; Jeppson, 1989; Thompson, 1939). Several of these report the rind blemish injuries characteristic of orchid thrips or greenhouse thrips feeding damage. In addition, rind blemish injury on Florida grapefruit by the orchid thrips and the greenhouse thrips have been verified with caging studies and field observations for the two species, respectively (Childers and Achor, unpublished). *Danothrips trifasciatus* was collected for the first time within the continental United States on fruit of *Citrus paradisi* MacFadyen, in LaBelle, Hendry County, Florida, by Childers in October 1992 and identified by S. Nakahara, USDA, ARS, Systematic Entomology Laboratory, Beltsville, Maryland. According to Sakimura (1975), *D. trifasciatus* is usually associated with the orchid thrips on various hosts and has similar feeding habits. This species was previously known only from Hawaii, Indonesia and the Caribbean (Bhatti, 1980; Sakimura, 1975). *Danothrips trifasciatus* has been frequently associated with the orchid thrips on the plant genus *Anthurium*. The genus *Danothrips* previously was known only from the Indo-Pacific region (Kudo, 1985).

Beginning about 1990, several citrus growers in central and southwest Florida began noticing a rind blemish problem primarily on maturing fruit of red grapefruit varieties. White grapefruit varieties in Florida are less frequently damaged (Childers, unpublished data). The damage was characterized by a brown ring or smooth russeting that occurred at points of contact between clustered fruit (Figs. 1A, B). Confusion was created when the blemish was incorrectly reported as citrus rust mite feeding injury in a trade magazine (Coleman, 1993).

The orchid thrips was identified as the primary cause of the rind blemish damage to clustered fruit in Florida (Childers and Achor, unpublished). However, two other thrips species, the greenhouse thrips and *D. trifasciatus*, were also found in many of the samples and are capable of causing similar types of damage to clustered fruit (Childers and Frantz, 1994). In addition, Lorsban and ethion + petroleum oil were identified as effective insecticides for control of this thrips complex. Meanwhile, ethion is no longer labeled for citrus but Danitol has been added to the insecticides recommended in the 2005 Florida Citrus Pest Management Guide (Stansly et al., 2005). This paper elaborates on the known biologies, host plants, seasonal and relative abundance of the orchid thrips complex and attempts to identify colors or hues that attract one or more of these three thrips species. Also, several studies are summarized that rationalize the need for monitoring this pest thrips complex to minimize rind blemish damage on grapefruit varieties as well as to reduce the number of insecticide applications required for effective control.

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Material and Methods

Thrips species and frequency data. Developing or mature clustered fruit, primarily red and white grapefruit varieties, were sampled between 1993 and 1998 to determine the frequencies of the three plant feeding thrips species. Fruit were picked and immediately washed in a bucket containing about 200 ml of 80% ethanol. Each fruit was vigorously agitated in the alcohol to dislodge any arthropods present. Each fruit was then discarded and the wash was poured into a one pint Mason jar with label information and returned to the laboratory for processing. Usually, samples consisted of a total of 20 clustered fruit taken from at least 5 trees within a citrus grove site. The contents of each jar were poured individually into a Petri dish and examined for the presence of thrips. All thrips were counted, removed and slide-mounted in Hoyer's mounting medium (Krantz, 1978), oven-cured for at least two weeks at 43-45 °C and then identified to species. All adults and white to yellow thrips larvae of the three thrips species were identified. Only the three thrips pest species recovered from these samples are reported in this paper.

Attraction to colored sticky cards. Thirteen colors or hues were selected for comparison in their attraction to orchid thrips, greenhouse thrips or *D. trifasciatus* adults between 27-31 May 1994 in a red grapefruit block at the Duda site in Hendry County, Florida, and then repeated in a red grapefruit block at the Berry site in Collier County, Florida, between 29 Aug. and 1 Sept. 1994. Trap colors or hues included: blue (O-B), yellow (O-Y), and white (O-W) Olson traps (Olson, Medina, Ohio); yellow paper file folder (SH-Y) (Smead, Hastings, Minn.); blue plastic file folder (DT-B) (Duo-Tang, Paw Paw, Mich.); red (PF-R) Oxford file folders (Esselte, Garden City, N.J.); Chromolux violet C65 (C-V), Chromolux pale blue C61 (C-PB), Chromolux metallic blue pearl M64 (CM-BP), Chromolux metallic blue M84 (CM-B), Chromolux marigold C25 (C-M), Chromolux yellow C22 (C-Y), Chromolux metallic blue M64 (CM-B) (Zellerbach, Miamisberg, Ohio), and Mark V Krome Cote white (K-W) (Jones Printing, Lake Alfred, Fla.). All of these colors or hues were previously evaluated against *Frankliniella bispinosa* (Morgan) along with spectral reflectance measurements (Childers and Brecht, 1996).

Each color or hue was on a 15 by 15 cm card stapled individually onto plywood plates (15 by 15 cm) on stakes (5 by 5 cm) set at 2.0 m heights about 10 m apart within an interior tree row facing each of the four cardinal directions (E, W, N, S) in a completely random design. Tangle-Trap® (Tangle Foot Co., Grand Rapids, Mich.) adhesive was applied in a thin, uniform layer on each card with a putty knife immediately prior to placement in the field. Traps were set in a grove of red grapefruit at A. Duda & Sons in Hendry County on 27 May 1994 and exposed for 96-h intervals to compare differences in numbers of thrips that were caught. The experiment was repeated with the same colors or hues in a red grapefruit grove at the Berry site in Collier County on 29 August 1994 and exposed for 72-h intervals.

Chemical control and timing studies. In 1994, two field trials were established to assess insecticidal activity and duration of control of orchid thrips. Treatments consisted of a May or June only, July only, May or June + July, an untreated or Agrimek + either a 435 or 455 horticulture mineral oil (=HMO) program or the grower's spray program. Two locations were selected for the insecticidal timing studies to minimize rind blemish injuries on developing 'Ruby Red' grapefruit and included an Alico grove in Hendry County and a Berry grove in Collier County.

Treatments were assigned to plots in three to six parallel rows of 30-50 trees in a randomized complete block design and replicated four times at each site. At the Alico site, treatments were applied either on 1 June or 14 July or on both dates in 250 gallons per acre (gpa) ($2.338\ kL\cdot ha^{-1}$) with an airblast sprayer driven at 1.5 mph (2.4 kmph). At the Berry site, treatments were applied either on 27 May or 15 July or both dates in 200 gpa ($1.870\ kL\cdot ha^{-1}$) with an airblast sprayer at the same speed.

A total of 26 clustered fruit per treatment replicate were picked individually from 2, 3, or 4 fruit in different clusters at random within and around the canopy perimeter of various trees. Each fruit was immediately washed in 80% ethanol by vigorous agitation and samples were processed as mentioned previously.

Damage ratings of fruit were assessed on 28 June and again on 24 Aug. in the Alico site and 27 June and 5 Sept. at the Berry site. A total of 70 pairs of clustered fruit were examined for the presence of the characteristic ring spot damage (Fig. 1A, B) on one or both fruit in each treatment replicate on each date indicated.

Fig. 1. (A) Characteristic thrips feeding damage at the touch points between a pair of red grapefruit, (B) Appearance of thrips damaged fruit out of the packing house.

Comparison of monitoring procedures. In 1998, two red grapefruit blocks located at a grower, CPI in Immokalee, Fla. and Duda in Felda, Fla. that had previous histories of thrips damage to red grapefruit varieties were selected for thrips frequency/action threshold studies. The CPI block consisted of 'Red Marsh' grapefruit on Swingle with 116 trees/acre and planted in 1985. The Duda block consisted of 'Ruby Red' grapefruit with 110 trees per acre and planted in 1977. Each block was divided into 12 plots with 9 rows wide by 20 trees long. Four treatments were assigned to these plots at each site in a randomized complete block design and replicated 3 times. The treatment threshold levels at which the trees would be sprayed were 10%, 20%, or 40% of the fruit clusters being infested versus a control. Weekly samples were initiated on 20 May and 2 June and continued through 14 September and 18 November, at Duda and CPI, respectively. Three monitoring methods were compared as follows. Method One: A visual inspection for the presence of adults and larvae of the orchid thrips complex using a 5× magnification headset on 20 fruit clusters per replicate was completed per date. Method Two: A visual examination of ring spot injury was also included beginning 24 August. Method Three: Ten fruit clusters of two fruit each (totaling 20 fruit) were picked at random from within each plot and washed in alcohol. Each sample was examined later in the laboratory using a stereomicroscope for thrips adults and larvae. A total of 17 alcohol samples were taken weekly or every other week at both sites from 3 June to 19 Oct. Visual sampling of thrips activity between 20 clustered fruit in the grove, visual assessment of the beginnings of rind blemish injury and collection of 20-clustered fruit samples washed in alcohol, were compared at both sites.

Statistical analysis. For the chemical control and timing studies conducted during 1994, an *F-protected* ($P \leq 0.05$) analysis of variance (ANOVA) was conducted on each data set followed by an LSD treatment mean separation (SAS Institute, 1991). Percentage data were transformed using an arcsine (proportion)$^{1/2}$ transformation. Untransformed means are listed.

Results and Discussion

Thrips species and their frequencies. Adults of *C. orchidii* and *D. trifasciatus* are yellowish thrips about 1.2 to 1.4 mm in length and with distinctive banding on the front wings. There are two dark bands present on the front wings of *C. orchidii* (Fig. 2A). In contrast, *D. trifasciatus* has three bands (Fig. 2B). Populations of the orchid thrips consist only of females whereas *D. trifasciatus* has both males and females. The greenhouse thrips, *H. haemorrhoidalis* is 1.0 to 1.5 mm in length. Only females occur in this species. Adult females usually are black with distinctive ornate body sculpturing, yellowish legs, and white wings that are folded over the abdomen (Fig. 2C) (Childers and Frantz, 1994). Sometimes all or parts of female bodies will be brown to yellow in color. Unlike the previous two species, the entire life cycle of the greenhouse thrips is found on citrus between touching fruit or between a leaf and fruit. Immature stages of all three species are white to yellowish and include first and second instar larvae (feeding stages), pre-pupal and pupal stages. Neither the pre-pupal nor pupal stages of the orchid thrips or *D. trifasciatus* have been recovered between touching fruit or leaf-fruit habitats on citrus.

Both the orchid thrips and *D. trifasciatus* have been found on citrus fruit every month of the year throughout the citrus growing areas of Florida. Both are more commonly found on grapefruit, especially red varieties. Orchid thrips also has been recovered from 'Hamlin' and 'Valencia' oranges in Florida. The greenhouse thrips has been found on citrus fruit in Florida between January and June, and October through December. The orchid thrips generally is the most abundant species, with a relative frequency of 53% to 99% (Table 1). *Danothrips trifasciatus* is the second most common species and ranges from less than 1% to 47% of the complex. *Heliothrips haemorrhoidalis* has been the least commonly collected species of the three with a maximum of 13% in one sample.

Chaetanaphothrips orchidii has a wide host range that includes: *Acer* (maple), *Adiantum* (maidenhair ferns), *Ageratum conyzoides*, *Alternanthera*, *Amaranthus*, *Begonia*, *Bidens pilosa*, *Bracharia purpurescens* (grass), *Cattleya labiata* (orchid), *Cyclamen*, *Chamaedorea fragrans*, *Citrus*, *Croton lobatus*, *Commelina erecta*, *Dracaena*, *Emilia*, *Ephiphyllum*, *Ficaria*, *Hypoxis*, *Ipomoea tiliacea*, *Monstera*, *Musa*, *Paspalum paniculatum*, *Philodendron*, *Portulaca oleracea*, *Rhododendron simsii*, *Saintpaulia ionantha*, *Sonchus oleraceus*, *Spathoglottis*, *Torilinium ferax*, and *Tradescantia* (Delattre and Torregrossa, 1978; Mantel and van de Vrie, 1988; Morison, 1957; Sakimura, 1975).

Sakimura (1975) proposed that *D. trifasciatus* was native to the Philippines and *Anthurium andreanum* the preferred host. Host plants include: *Alpinia purpurata*, *Bougainvillea*, *Citrus paradisi* fruit, *Costus*, *Desmanthus virgatus*, *Ipomoea alba*, *Melicoccus bijugata* fruits, *Panax*, *Paspalum conjugatum*, *P. orbiculare*, *Petroselinum crispum* (parsley), *Zea mays* (young corn leaves), and *Zingiber zerumbet* (Nakahara, 1993; USDA ARS Report, 15 January).

Developmental times and fecundity for both the orchid thrips and the greenhouse thrips are summarized in Table 2. The long developmental times of the two larval instars (feeding stages), adult longevity and high fecundity of the orchid thrips combine to demonstrate why this species can be troublesome to citrus growers.

Attraction to Colored Sticky Cards. Adults of the orchid thrips, greenhouse thrips, or *D. trifasciatus* were not recovered from any of the 13 colors or hues on the sticky cards during either experiment at the Duda or Berry sites in late May or August. Earlier field experiments conducted during citrus flowering intervals by Childers et al. (1998) never recorded a single orchid thrips, greenhouse thrips or *D. trifasciatus* adult on any of the colors or hues tested between February and April.

Orchid thrips adults and larvae were present from the beginning of sampling in the two timing experiments conducted at the Alico and Berry sites during 1994. Maximum numbers of 79 adults and 333 larvae were collected during the 11 May sample date from 26-clustered fruit per plot (32 plots × 26 clustered fruit per plot = 832 clustered fruit per date) at Alico. In contrast, a maximum number of 40 adults were collected on 11 August at the Berry site and a maximum number of 182 larvae collected on 5 September from the 832 clustered fruit sampled. Fifteen adults was the maximum number collected from a single 26 clustered fruit sample at Alico on 11 May compared with 69 larvae on the same date. The maximum total number of combined adults and larvae was 76 at the Alico site on 11 May. In contrast, 12 adults was the maximum number collected from a 26 clustered fruit sample at Berry on 11 August. Sixty-seven larvae was the maximum number collected from Berry on 20 May with a combined maximum of 76 orchid thrips adults and larvae collected from one 26 clustered fruit sample on 20 May.

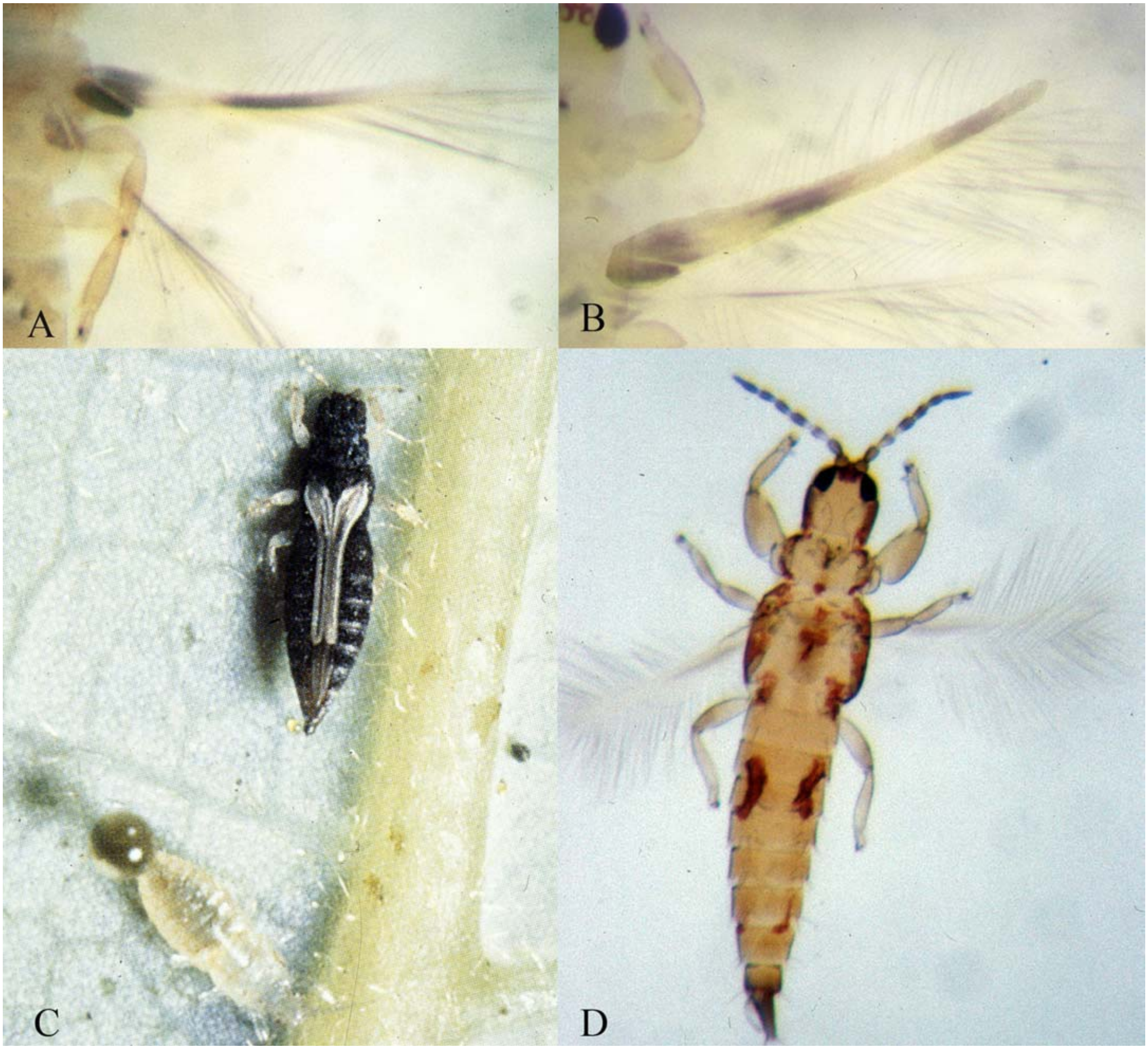

Fig. 2. (A) *Chaetanaphothrips orchidii*, Orchid thrips female has 2 bands on front wing. (B) *Danothrips trifasciatus* female has 3 bands on front wing. Adults in (A) and (B) are 1.2 to 1.4 mm long. (C) *Heliothrips haemorrhoidalis* female and larval stages; females are 1.0 to 1.5 mm long, (D) *Adraneothrips decorus*, adults and reddish larvae are commonly found between clustered citrus fruit.

Large numbers of both adult and larval orchid thrips were present between clustered red grapefruit prior to the first spray application on 1 June at Alico or 27 May at the Berry site (Fig. 3). Consequently, there were no differences between treatments based on percentage of fruit clusters damaged at the Alico site on 28 June (Table 3) because the insecticide treatment was applied too late. Much of the damage caused by orchid thrips feeding occurred soon after onset of clustered fruit coming into contact with each other during early May. A subsequent insecticide treatment application of ethion + 455 HMO on 1 June resulted in significantly reduced percentages of damaged fruit clusters at the Alico site by the 24 August damage assessment. Ethion + 455 HMO applied on 15 July, Agri-mek + 455 HMO applied on 15 July or the grower's spray program of 455 HMO applied on 1 June followed by an Agri-mek + 455 HMO application on 15 July all failed to provide comparable control of rind blemish damage to clustered fruit by 24 August (Table 3). The 15 July treatment application of ethion + 455 HMO provided no benefit in reducing the level of fruit damaged by orchid thrips feeding.

Much lower numbers of orchid thrips adults and larvae were present in the Berry site prior to the first insecticide application on 27 May than at the Alico site (Fig. 3). The numbers of orchid thrips at the Berry site on 11 May were roughly one-half of those recorded at Alico on the same date. In addition, the percentage of damaged clustered fruit recorded on

Table 1. Frequencies of thrips species causing rind blemish problems on Florida citrus.

County	Location	Years	Citrus variety	*Chaetanaphothrips orchidii*	*Danothrips trifasciatus*	*Heliothrips haemorrhoidalis*
Hendry	Several sites	1992-1995	Red GF	227 (70%)	85 (26%)	11 (4%)
	Several sites	1992-1995, 1998	Red GF	380 (99%)	3 (<1%)	2 (<1%)
Collier	Immokalee vic.	1993-1995	Red GF	90 (98%)	2 (2%)	0
	Several sites	1993-1994	Red GF	181 (94%)	12 (6%)	0
Polk	Winter Haven	1995	Red GF	71 (92%)	6 (8%)	0
	Fort Meade	1997	Red GF	69 (53%)	62 (47%)	0
	Fort Meade	1997	White GF	115 (71%)	48 (29%)	0
DeSoto	Arcadia vic.	1998	White GF	20 (83%)	1 (4%)	3 (13%)
Highlands	Lake Placid	1995	Red GF	39 (89%)	5 (11%)	0
			Totals	1,192 (83%)	224 (16%)	16

27 June at the Berry site was approximately one-half that of Alico (Fig. 3, Table 4). However, orchid thrips numbers doubled in the Berry block during June compared with numbers recorded in Alico during that same time. Although we recorded differences between treatments, untreated trees (treatment 3) versus the other treatments, the actual differences between treatments is questionable given the fact that neither treatment 2 (ethion + FC455 HMO) nor treatment 5 (Agrimek + FC455 HMO) had a pesticide application until 15 July. Both were not significantly different from the two treatments receiving a 27 May application of ethion + 435 HMO (Table 4). However, by 5 Sept. there were significantly lower percentages of damaged fruit clusters in the three treatments receiving ethion + 435 HMO applications on either 27 May alone, 15 July alone or on both dates compared to the grower's acaricide program shown as treatment 5 or the untreated trees in treatment 3. Some short-term benefit was achieved with the grower's acaricide treatment regime although it was not as effective as the ethion + 435 HMO treatments by 5 Sept. The untreated trees in treatment 3 sustained the highest percentage of damaged clustered fruit by 5 Sept.

These two field trials demonstrated that seasonal development of orchid thrips numbers can vary from site to site within the same year. This study also demonstrated the potential for orchid thrips feeding injury occurring from onset of fruit touching in early to mid-May to harvest. Previous survey results above have demonstrated that the orchid thrips complex is present throughout the year (Childers, unpublished data). Grapefruit left on the trees remains subject to attack through the winter months into very early spring. Florida citrus growers need effective monitoring methods to assure their ability to respond rapidly to identify presence of these destructive thrips pests.

Table 2. Comparative developmental times (in days) and fecundity at 77 °F.

Stage/Interval	*Heliothrips haemorrhoidalis*[a] on *Viburnum* leaves	*Chaetanaphothrips orchidii*[b] on *Anthurium* leaves
Egg	19.20	11.5
Larva I	5.70	4.4
Larva II	4.10	9.3
Prepupa	1.50	2.7
Pupa	2.50	6.3
Egg to adult	33.00	34.2
Larva I to adult	—	22.7
Preoviposition	2.70	2 to 3
Egg to egg	35.70	37.2
Eggs/day	2.05	—
Total eggs/female	29.00	75.0
Adult longevity	36.00	28.0

[a]Data from Del Bene et al., 1998.
[b]Data from Argov., 2003.

Comparison of monitoring procedures. Populations of thrips at CPI were very low throughout the season. No more than 2 orchid thrips were ever found in alcohol samples of 100 fruit clusters. The highest percentage of fruit clusters with observed damage was only 2%. Orchid thrips populations in alcohol samples from the Duda site were low to moderate and reached a maximum of 13 per 100 fruit clusters on 13 Aug. (Fig. 4). Thirteen thrips were sub-sampled, slide-mounted, identified to species, and included 12 *C. orchidii* (93%) and 1 *D. trifasciatus* (7%). No thrips were seen in the visual samples on that date. The maximum number of target thrips observed in visual samples was 8 in 200 fruit clusters on 15 September that equaled a 4% infestation level. No spray was required since the incidence was below the 10% treatment threshold.

Incidence of observed damaged fruit clusters was 3% on 25 Aug. and reached a maximum of 29% on 19 Oct. (Fig. 4). This damage may have been avoided if a spray had been timed based on the 13% thrips incidence level recorded in the alcohol samples taken on 25 Aug. However, the alcohol sampling and evaluation procedure was considered a research tool and not a practical method for growers at that time. Furthermore, the alcohol samples were not processed immediately because their purpose was as a check for the visual sampling method. Thus, no spray was applied even though the 10% threshold had been reached on 25 Aug. Therefore, the visual method was deemed ineffective based on the excessive amount of subsequent damage to the fruit. The observed 3% incipient damage level might be a more practical treatment threshold level for grower monitoring than the 10% thrips incidence level used in this study. Based on this study the effectiveness of the alcohol wash method for estimating thrips numbers was validated. A tentative action threshold of 3% incipient damage was determined to be more realistic for grower usage.

Direct evaluation of thrips populations by the grower could be difficult given the fact that other thrips species are commonly found between clustered fruit in Florida including a very common fungal feeding species, *Adraneothrips decorus* Hood (Fig. 2D). Although looking for orchid thrips and greenhouse thrips between clustered fruit by citrus growers in

Location	Date	Adults - Alico	Larvae - Alico	Adults - Berry	Larvae - Berry
Berry	May 11	79	333	33	157
Berry	Jun 7	13	32	10	84
Berry	Jun 23	13	31	6	58
Berry	Jul 13	20	49	13	94
Berry	Jul 27	6	17	13	41
Berry	Aug 11	4	19	40	104
Berry	Sep 5	16	11	20	182
Berry	Sep 15	9	27	20	146
Berry	Oct 4			37	68

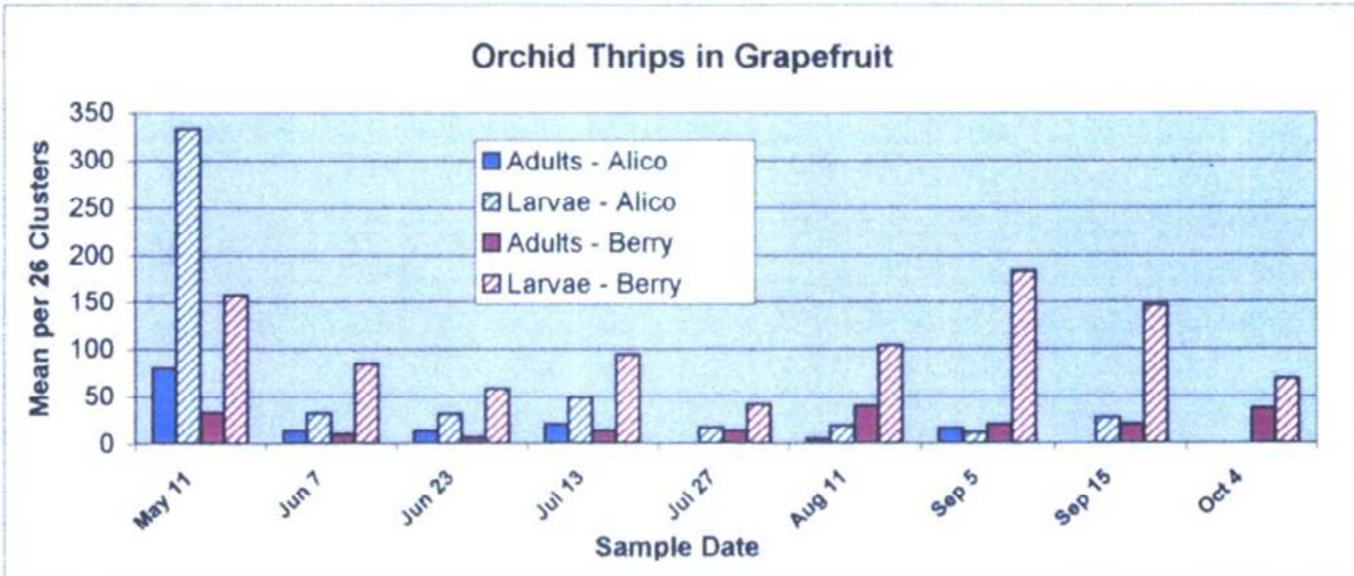

Fig. 3. Comparison of orchid thrips and *Danothrips trifasciatus* adults and larvae collected from 832 red grapefruit clusters per sample date between May and October.

Australia is the recommended approach (Beattie and Jiang, 1990), it is not considered a practical method in Florida due to presence of other thrips species. The mere presence of thrips between clustered fruit in Florida does not constitute potential feeding damage. A trained observer or scouting service could be effective by inspecting for orchid thrips development only from inner canopy fruit clusters beginning at the onset of fruit touching until harvest.

Table 3. Percentage of fruit clusters (n = 13 clusters or 26 fruit per treatment replicate) damaged by Orchid thrips on 'Ruby Red' grapefruit at the Alico site, Immokalee vicinity, Hendry County, Florida 1994.

Treatment		Rate per acre	Application date(s)	% Fruit clusters damaged	
				28 June	24 August
1.	Ethion 4EC	6 pints			
	+ FC 455 HMO	2 gallons	1 June	33 a	38 b
2.	Ethion 4EC	6 pints			
	+ FC 455 HMO	2 gallons	15 July	40 a	63 a
3.	Agri-mek 0.15EC	10 oz.			
	+ FC 455 HMO	7 gallons	15 July	26 a	60 a
4.	Ethion 4EC	6 pints			
	+ FC 455 HMO	2 gallons	1 June, 15 July	24 a	33 b
5.	FC 455 HMO	7 gallons	1 June		
	Agri-mek 0.15EC	10 oz			
	+ FC 455 HMO	7 gallons	15 July	32 a	57 a
					LSD 16.945

Table 4. Percentage of fruit clusters (n = 13 clusters or 26 fruit per treatment replicate) damaged by Orchid thrips on 'Ruby Red' grapefruit at the Berry site, Immokalee vicinity, Collier County, Florida 1994.

Treatment		Rate per acre	Application date(s)	% Clusters damaged	
				27 June	5 September
1.	Ethion 4EC	6 pints			
	+ FC 435 HMO	5 gallons	27 May	12 b	22 c
2.	Ethion 4EC	6 pints			
	+ FC 435 HMO	3 gallons	15 July	13 b	33 c
3.	Untreated	—	—	30 a	76 a
4.	Treatments 1 + 2		27 May		
			15 July	12 b	26 c
5.	Dicofol 4EC	6 pints			
	+ FC 435 HMO	5 gallons	27 May		
	Agri-mek 0.15EC	10 oz			
	+ FC 435 HMO	5 gallons	15 July	19 b	53 b
				LSD 7.8996	LSD 12.145

A field trial was established in 1995 in the Frostproof, Fla. vicinity on a ten-acre block of red grapefruit to evaluate a number of different insecticides for control of orchid thrips. Interestingly, the first indication of adult thrips activity was found on outer trees at one end of the 10-acre block. This suggested movement from non-citrus host plants since there

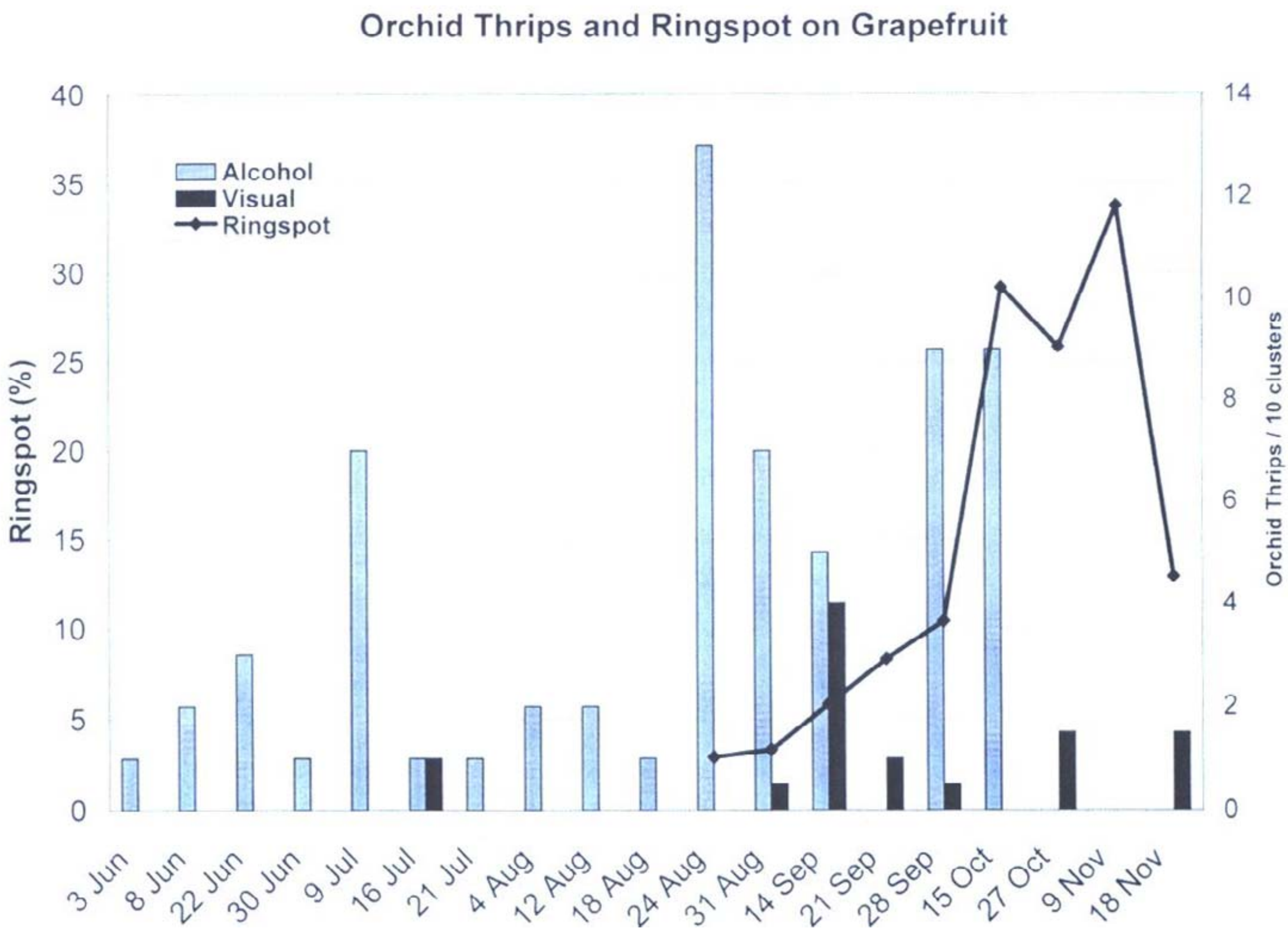

Fig. 4. Comparison of orchid thrips numbers in alcohol versus visual sampling and compared with incidence of observed feeding damage to the clustered grapefruit.

were no other citrus blocks in the immediate area. Therefore, when monitoring smaller blocks of trees less than about 20 acres it would be advantageous to select at least half of the sample trees on the outer perimeter of the block to optimize the potential interception of migrating pest thrips into the citrus grove.

The orchid thrips was identified long ago as a pest on Florida grapefruit by Thompson (1940). Re-occurrence of this problem likely is the result of pesticide substitutions away from ethion and other organophosphate insecticide uses applied during the postbloom and/or summer sprays. More specific acaricides such as Agri-mek + an HMO or dicofol, or an HMO applied alone have been substituted in the postbloom and/or summer sprays since the late 1980s to 1990. These spray programs were not effective in minimizing feeding damage to maturing fruit by the orchid thrips, *D. trifasciatus*, or the greenhouse thrips.

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