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SHIFTS IN WESTERN FLOWER THRIPS, *FRANKLINIELLA OCCIDENTALIS* (THYSANOPTERA: THRIPIDAE), POPULATION ABUNDANCE AND CROP DAMAGE

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ABSTRACT

Since the first report of Florida establishment in 1982, the western flower thrips (WFT), *Frankliniella occidentalis* (Pergande), has caused economic damage to vegetable crops, notably peppers, *Capsicum annuum* L. A survey of thrips infesting peppers in Palm Beach County, FL in 2006-07 showed that WFT populations were more prevalent than in a survey conducted in 1995-96, and exceeded economic thresholds for much of the growing season. The possible contribution of pyrethroid insecticide use to damaging populations of WFT is discussed.

Key Words: *Frankliniella occidentalis*, *Frankliniella bispinosa*, pepper, pyrethroid, *Orius insidiosus*

RESUMEN

Desde el primer informe de su establecimiento en la Florida en 1982, el trips occidental de flores (WFT), *Frankliniella occidentalis* (Pergande), ha causado daño económico a los cultivos de hortalizas, notablemente en chile, *Capsicum annuum* L. Un reconocimiento de los trips que infestan chile en el Condado de Palm Beach en la Florida durante 2006-07 mostró que las poblaciones de WFT fueron más prevalentes que en el reconocimiento realizado en 1995-96, y fue en exceso del umbral económico por mucho de la temporada de crecimiento del cultivo. Se comenta sobre la posible contribución del uso de insecticidas piretroides hacia poblaciones dañinas de WFT.

The western flower thrips (WFT), *Frankliniella occidentalis*, became established in Florida in 1982 (Kirk & Terry 2003) and quickly adapted to local farming environments. By 1985, significant damage and economic losses had occurred in vegetable crops. The largest economic loss to this pest resulted from the transmission of Tomato Spotted Wilt Virus (TSWV) in tomato crops in north Florida and south Georgia. Additional damage resulted from WFT oviposition and feeding (Frantz & Mellinger 1990; Funderburk & Salguero 1989; McRitchie 1986).

WFT numbers have exploded in Palm Beach County, FL (PBC), resulting in severe feeding damage to peppers and less so in tomatoes. The rapid change in WFT abundance in Palm Beach County has been attributed to resistance development to spinosad (Spintor, Dow AgroScience), with the population increase exacerbated by frequent applications of pyrethroid insecticides (GCC, unpublished data). The development of high WFT populations is noteworthy because the Florida flower thrips (FFT), *Frankliniella bispinosa* (Morgan), historically the prevalent species, has not caused significant feeding damage to the pepper and tomato crops in PBC. In this paper we discuss the scope and dynamics of the WFT population shift in Palm Beach County and factors that contributed to the change.

MATERIALS AND METHODS

Thrips populations were monitored in surveys during the 1995-96 and 2006-07 pepper growing seasons at 3 different sites in Palm Beach County, Boynton Beach (1995-96), Delray Beach (2006-07) and Jupiter (both seasons). The Delray and Boynton Beach sites are separated by approximately 8 km, and are located about 48 km south of Jupiter.

Populations of thrips and a major predator, the minute pirate bug (MPB), *Orius insidiosus* (Say), were monitored by collecting samples of 15-25 pepper blooms into self-sealing plastic bags. The number of samples collected during a sample interval ranged from 1 (Boynton Beach) to 10 (Delray Beach). Two samples per interval were collected during both surveys in Jupiter. Sampled insects were killed with 70% isopropyl alcohol. Thrips were separated from blooms by agitating the sample with water and pouring the contents through a coarse screen to remove flower parts, followed by a fine (120-mesh) filter. The filtrate was transferred to Syracuse dishes for examination under 20-40 X magnification to count and separate adult thrips by species. Larval thrips were counted, but not identified to species. All samples collected within approximate weekly intervals were pooled and are reported as thrips per bloom.

To explore causes of the explosive WFT population increases observed in the PBC survey of 2006-07, a trial was conducted in Fort Pierce, FL, with candidate insecticides. Subsamples of thrips infesting pepper blooms were collected from plots treated with methoxyfenozide (Intrepid, Dow AgroScience), an insect growth regulator, permethrin (Pounce, FMC Corporation) and gamma-cyhalothrin (Proaxis, Loveland Products, Inc.), alone and in combination (Table 1). Test materials were applied at labeled rates on 05/08, 05/14 and 05/21/2007. The total number of MPB and thrips including adults and larvae, collected on each sampling date in each treated area was determined by the survey methods described above.

RESULTS

The results of the 1995-96 survey in Boynton Beach are shown in Fig. 1. FFT made up over 99% of the population with a fall and spring population peak of 5 thrips per bloom. During this period, no crop damage was detected. Fig. 2 shows the results of the 2006-07 survey in Delray Beach. Following an early season peak of 7 thrips/bloom during Nov, FFT declined to 0-0.3 thrips/bloom, and did not rebound until Apr, 4 months later. The WFT population was low from Sep through Dec, but increased rapidly as FFT declined, and continued to rise, reaching a peak of over 50 thrips/bloom in Mar. A rapid decline followed and continued through the end of the crop. The ratio of thrips to MPB for each sampling date is shown in Fig. 3 (the MPB numbers have been multiplied by 100 for improved readability). MPB were present in fall and spring samples, but were absent from winter samples.

During both seasons in Jupiter, FFT were most numerous, although WFT were detected at the low level of 0.2 thrips/bloom in 1996. FFT populations peaked at 17 thrips/bloom in 1996 and in 2007 peaked at 34 and 46 thrips/bloom (Figs. 4 and 5).

Insecticides applied to peppers affected thrips populations, resulting in average numbers over the 3-week sampling period between approximately 200 thrips per sample in the untreated

check and 600 in the gamma-cyhalothrin treated plots (Fig. 6). Total thrips populations in plots treated with permethrin were intermediate between these extremes (~350 per sample). Methoxyfenozide applications did not significantly affect numbers of thrips or MPB. Average numbers of MPB per sample ranged from approximately 1 per sample in gamma-cyhalothrin treatments to 4.6 in the permethrin treatments to approximately 7 in the untreated plot. Methoxyfenozide did not significantly affect MPB numbers.

DISCUSSION

The results show that WFT was virtually absent from Boynton Beach pepper crops in 1995-96. Eleven years later, in the intensively farmed area around Delray Beach, the WFT population increased rapidly following the Dec-Jan decline in FFT. Growers were surveyed and reported thrips feeding damage to pepper pods and tomato fruits from Jan 2007 through May, the end of the growing season (GCC, unpublished data). WFT populations during this entire period exceeded the economic threshold of 2-3 thrips per bloom, recommended by the University of Florida, Institute of Food and Agricultural Sciences (Gillett et al. 2006). By comparison, FFT populations exceeded this level on only 1 sample date in Oct, and no thrips feeding damage to pods was reported by the growers.

Several important differences exist between Jupiter and the 2 southern survey sites. While the southern sites are intensively farmed by numerous large vegetable-growing interests, the Jupiter site is the only vegetable farm in the vicinity and is immediately adjacent to several large citrus groves. Dispersal of large numbers of FFT from citrus during the late winter blooming period is a common event, which is reflected in both surveys from the Jupiter site.

The Dec 2006 FFT decline in Delray Beach occurred when MPB numbers were adequate to control the thrips population through predation during the Oct-Dec period. Gillett et al. (2006) indicates biological control occurs when there is at least 1 predator per 180 prey. MPB undergo a

TABLE 1. AVERAGE NUMBER OF THRIPS, INCLUDING ADULTS AND LARVAE OF ALL SPECIES, AND MINUTE PIRATE BUGS (MPB) COLLECTED FROM PEPPERS IN FORT PIERCE, FL DURING MAY 2007.

TREATMENT	TOTAL THRIPS/SAMPLE (ALL DATES)	MPB/SAMPLE (ALL DATES)
UTC	202.3	7.1
Methoxyfenozide	206.4	7.3
Permethrin	342.7	4.6
Permethrin + Methoxyfenozide	362.4	4.6
Gamma-cyhalothrin	600.1	1.1
Gamma-cyhalothrin + Methoxyfenozide	536.4	1.6

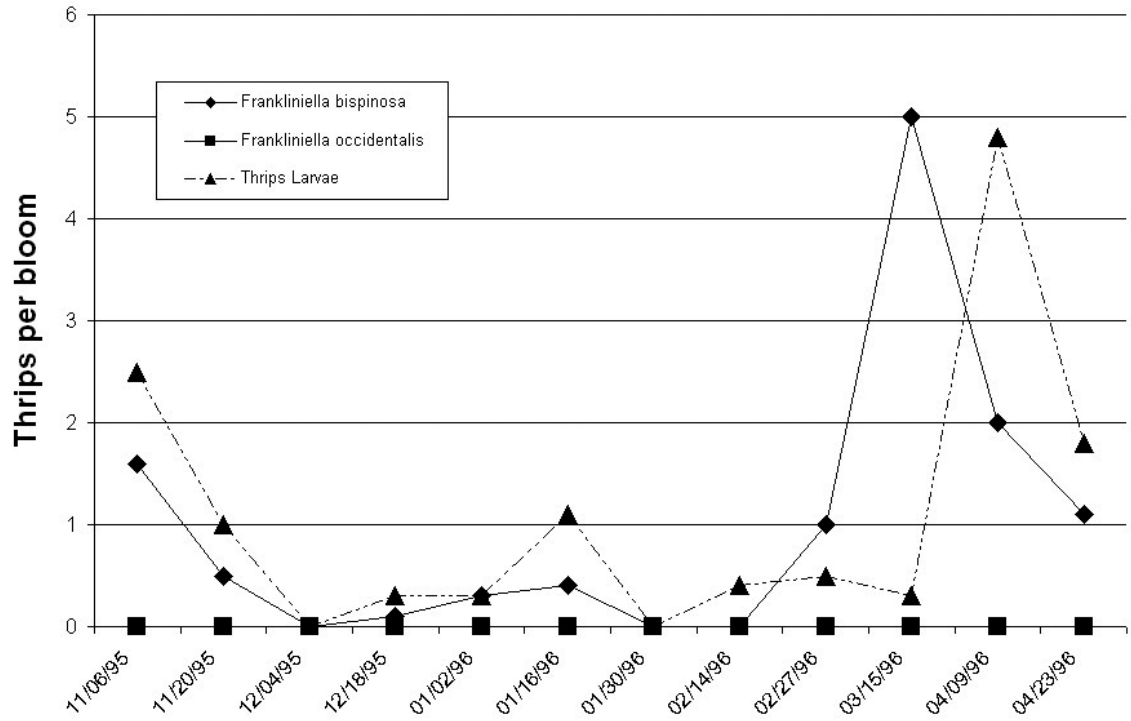


Fig. 1. Number of adult and larval thrips collected from pepper blooms, Boynton Beach, FL 1995-96.

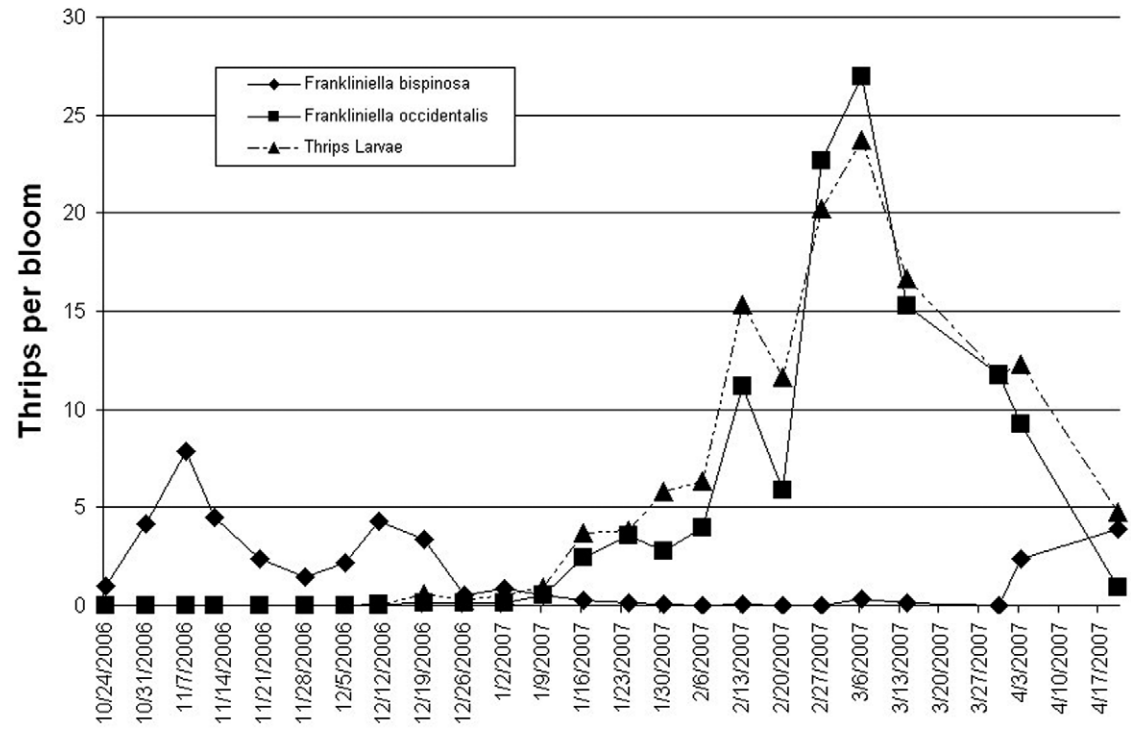


Fig. 2. Number of adult and larval thrips collected from pepper blooms, Delray Beach, FL 2006-07.

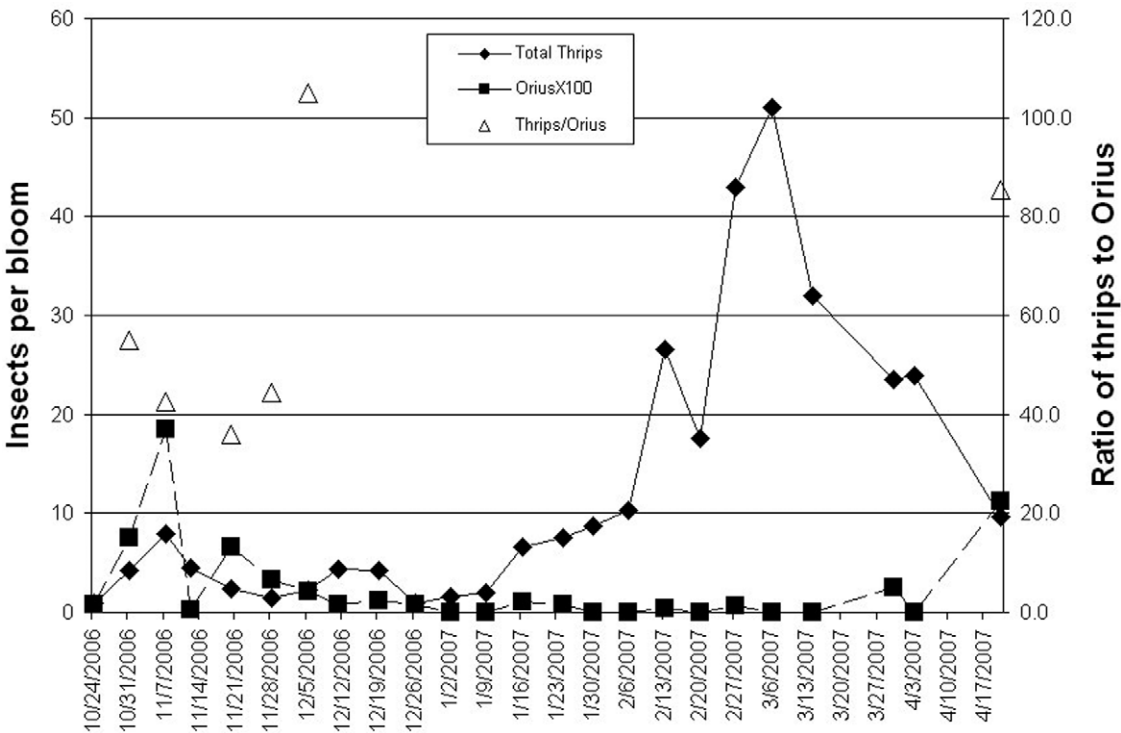


Fig. 3. Incidence of MPB, *Orius insidiosus*, in pepper blooms in Delray Beach, FL 2006-07. MPB counts are multiplied by 100.

winter reproductive diapause and were absent from Dec through Apr, both in Delray Beach and in Jupiter.

The distribution of thrips larvae throughout the crop cycle has economic importance. Larval numbers were low when FFT were abundant, yet larval numbers nearly equaled WFT adult numbers during the latter part of the season. The rapid increase in WFT adults and especially the abundance of larvae from Dec to Mar may be due in large part to the

absence of MPB. Baez et al. (2004) found that larvae of WFT are significantly more susceptible to predation by MPB than adults.

Further contributing to the WFT population explosion is frequent pyrethroid use. The explosion occurred during a period of intense insecticide use throughout the farming area, and many applications of several pyrethroid insecticides registered for use in peppers were made (GCC, unpublished data). Economically damaging popu-

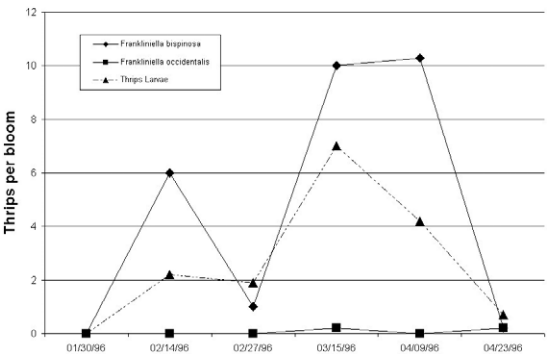


Fig. 4. Number of adult and larval thrips collected from pepper blooms, Jupiter, FL 1996.

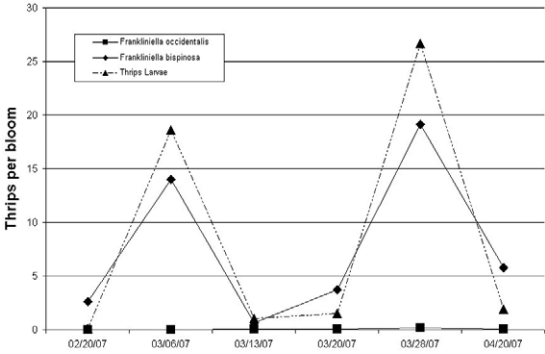


Fig. 5. Number of adult and larval thrips collected from pepper blooms, Jupiter, FL 2006-07.

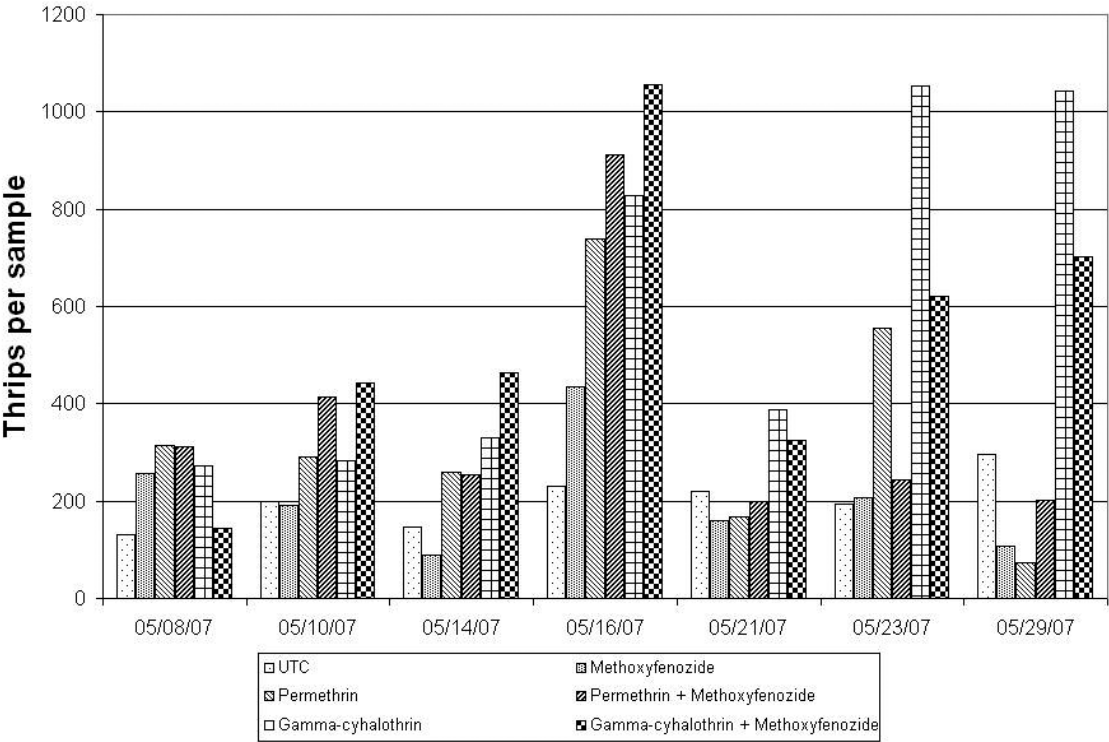


Fig. 6. The impact of insecticides on adult and larval thrips infesting peppers, Fort Pierce, FL May 2007.

lations of the melon thrips, *Thrips palmi*, also have been observed in pepper crops treated regularly with pyrethroids, compared to non-damaging populations where pyrethroid use is restricted (GCC, unpublished data). Similar effects of pyrethroid insecticides on thrips numbers have been reported from vegetable insect control trials in Virginia (Kuhar et al. 2007).

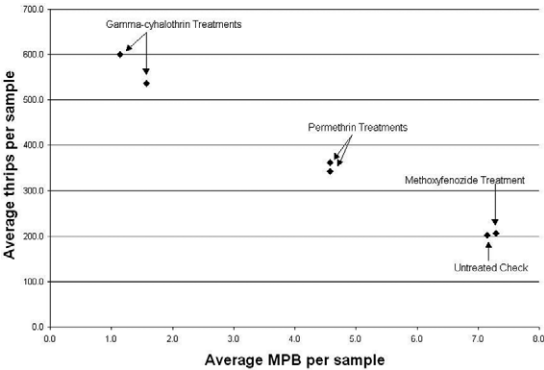


Fig. 7. Impact of minute pirate bugs (MPB) on thrips populations in peppers treated with insecticides, Fort Pierce, FL May 2007.

The most likely way that pyrethroid applications increase thrips populations is their toxicity to beneficial organisms, specifically MPB. The average numbers of thrips and MPB over all sampling dates in the Fort Pierce insecticide trial were clearly affected by the pyrethroid insecticides, permethrin and gamma-cyhalothrin (Table 1 and Fig. 7). The most favorable ratio of thrips to MPB occurred in the untreated check and methoxyfenozide treatment (~28:1), followed by the permethrin treatments (~75:1). The ratio in plots treated with gamma-cyhalothrin was over 340 thrips per MPB, clearly too high to allow biological control to occur. The possible stimulation of WFT reproduction, hormoligosis, by pyrethroid insecticides must also be considered, although such increased fecundity has been demonstrated among Thysanoptera only in the citrus thrips, *Scirtothrips citri* (Morse & Zareh 1991). Considering the obvious impact of pyrethroids on MPB, any significant hormoligotic impact on WFT reproduction would synergistically accelerate the rate of population increase.

In summary, WFT populations during the 2006-07 survey in Delray Beach increased as populations of FFT and MPB declined, resulting in significant economic crop damage. Strategies to avoid such losses in the future must focus on preserving MPB while minimizing the potentially detrimental frequent use of pyrethroid insecticides.

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