Proc. Fla. State Hort. Soc. 110:295-297. 1997.

ASPECTS OF BIOLOGICALLY BASED PEST MANAGEMENT IN COMMERCIAL PEPPER PRODUCTION

G. FRANTZ AND H. C. MELLINGER
Glades Crop Care, Inc.
949 Turner Quay
Jupiter, FL 33458

Abstract. **Biologically based management of insect pests, especially *Thrips palmi* Karny, is an important goal for south Florida pepper (*Capsicum annuum* (L.)) growers. Populations of thrips and naturally occurring biological control agents were studied over two growing seasons in peppers and ground cover plantings. The ground covers evaluated for suitability to the pepper field environment and as refuge or nursery areas for beneficial arthropods included crimson, ladino and arrowleaf clovers, and creeping oxeye, *Wedelia trilobata* (L.) A. S. Hitchcock. The minute pirate bug, *Orius insidiosus* (Say), occurred in all plantings monitored, and was a major factor in thrips control in fall plantings. High thrips immigration in spring plantings required insecticide applications for adequate control. Pest management costs for the two seasons are examined and compared to those from other farms using more conventional pest management programs.**

Introduction

Thrips have damaged Florida vegetable crops for many years. The native Florida flower thrips (FFT), *Frankliniella bispinosa* (Morgan) is the most common thrips species encountered in the southern part of the state, inflicting economic levels of damage in several crops, including citrus, strawberries, and tomatoes (Childers and Achor, 1991). Thrips management has become more complicated with the recent introductions of the western flower thrips, *F. occidentalis* (Pergande), in the late 1980s (Frantz and Mellinger 1990) and the melon thrips, *Thrips palmi* Karny, in 1990. Both pests can transmit virus diseases and cause novel types of damage to Florida vegetables, notably tomatoes and peppers (Salguero et al., 1991). Conventional chemical control of these species is fairly ineffective because of insecticide resistance resulting from years of exposure to many active ingredients.

The purpose of these studies was to determine whether biological control agents were present in sufficient numbers to reduce the thrips population and whether they could be found in planted cover crops or in naturally occurring weeds. The costs of a pesticide program designed to be compatible with these biological control agents, while providing adequate thrips control were also examined.

Materials and Methods

This report covers three aspects of thrips management in peppers. The research on each of these aspects is described below.

1995-96 Host plant survey: Pepper fields were located at Green Cay Farms (GCF), Boynton Beach, FL, and at Shiloh Farms (SHF), Jupiter, FL. The west part of GCF was planted in August and September, 1995 (fall crop). The east part was planted in October and November (winter crop). A 3-acre woody ornamental nursery and a series of buildings separated the fall and winter pepper crops. Spring peppers were planted at SHF in December and January, and harvested until 10 May, 1996.

Greenhouse-grown transplants were set into plastic-mulched beds fumigated with methyl bromide/chloropicrin. Irrigation was through drip irrigation tubes placed under the plastic mulch in the fall peppers at GCF. At SHF and in the winter crop at GCF, seepage irrigation was used. Fertilization and other grower practices were standard for this area.

Insecticides were applied on an as-needed basis, based on scouting reports, and were chosen for the preservation of beneficial insects. The insecticides were azadarachtin, *Bacillus thuringiensis* (*B.t.*), imidacloprid, and methomyl. Azadarachtin was used during high armyworm incidence in August-October, and was discontinued after their incidence decreased. *B.t.* was used as-needed throughout the season. The spring crop received imidacloprid during a thrips peak in mid-March, followed by methomyl when the population rebounded. The later applications of methomyl were used because of lower cost, known efficacy against *F. bispinosa*, and its short residual activity.

Cover crops evaluated included crimson clover (CCL), arrowleaf clover, ladino clover, and a naturally occurring patch of *Wedelia trilobata*, creeping oxeye (COE). Seeds for the clover plantings were obtained from a commercial source, and were mixed with Japanese millet before planting. Clovers were planted in the driveway middles running through the pepper blocks in the winter crop. Drive middles in four adjacent blocks were planted, 2500 feet long by 4 feet wide with each variety. COE occurred in an extensive area on a ditch bank on the east end of the winter crop.

Thrips and predator evaluation: Insects were collected by picking flowers directly into plastic bags containing 70% isopropyl alcohol. Samples were sifted through a coarse strainer then through a 120 mesh strainer. The thrips and other small insects collected on the fine strainer were transferred to Syracuse dishes, and identified under 40× magnification. Thrips identifications were double checked by examining occasional specimens with a compound microscope. Larval thrips were not identified to species. Predatory mites and other predators were submitted to the Division of Plant Industry, Florida Department of Agriculture and Consumer Services for identification.

Samples consisted of 25 blooms of each of the host plants. Collections were made approximately every 14 days during the bloom period for each host, except fall peppers, where sampling was delayed until scouting reports indicated thrips presence. One sample of 25 blooms was taken from CCL and COE on each sample date. The number of samples from peppers ranged from 1 to 5 for each date, depending on the availability of blooms.

Control cost analysis: The cost of the pesticide program at GCF was determined by examining the grower's records, determining the amount of each pesticide used, and applying a current price to each product. This cost was compared to the countywide average pepper pesticide cost obtained from the Cooperative Extension Service (K. Shuler, personal communication). The average pepper pesticide cost for southwest

Florida was also included in the Extension Service information.

Results and Discussion

1995-96 Host plant survey: The clovers seeded in drive middles emerged by mid November. Only CCL grew well enough to compete with the normal weedy growth in this environment. The weed competition included grasses, nutsedge, and white sweet clover. CCL formed a dense growth and became an effective weed barrier through early April. Blooming occurred from February to early April. With the cessation of blooming, CCL declined quickly. By late May, grasses and nutsedge dominated the seeded area. Thus, CCL appears to have potential utility as a ground cover for driveways and other non-crop areas. Weed control in some parts of the field, primarily the walkways around the planted beds, would have to follow conventional grower practices. In driveways, however, good weed control could be maintained by mowing. This would be compatible with the use of clovers as ground covers and refuges for beneficial insects.

COE grew luxuriantly on a ditch bank and blooms were present when insect sampling began in early November. Blooming continued through mid-January. The plants remained green through the remainder of the winter and a rebloom flower sample was collected in late May.

White Dutch clover had been seeded in parts of SHF several years earlier. During the cropping cycle at SHF, white Dutch clover was observed growing vigorously in many of the drive middles. Blooming began in mid-winter, and continued through the end of May, when the driveways were mowed. An exploratory insect sample containing numerous thrips and parasitic wasps indicated that this variety may warrant comparison with CCL in the future.

Thrips and predator evaluation: The primary species of thrips collected were *Frankliniella bispinosa* (Morgan), the Florida flower thrips (FFT); *Microcephalothrips abdominalis* Crawford, the composite thrips (CT); and *Thrips palmi* Karny, the melon thrips (MT). FFT occurred on all hosts surveyed. MT was only collected from peppers. Except for a few pepper blooms, CT was only found in COE. Predatory mites in the genera *Neoseiulus, Proprioseiopsis,* and *Typhlodromalus* were collected from one or more hosts. Minute pirate bugs (MPB) were also collected from all hosts. The seasonal abundance of the insects collected is presented in Table 1.

The seasonal cycle of thrips collected from peppers followed that observed in a previous survey on the west coast of Florida (Frantz et al., 1995). After a low peak in November, FFT declined through the winter months. Their numbers rose again in March. This pattern was observed in the fall and winter peppers at GCF. At SHF, FFT increased sharply with the onset of the citrus bloom in February, and remained at high levels (10 to 17/bloom) until reduced by insecticide treatments.

In the cover crops, thrips abundance was related to the availability of blooms, and to the abundance of thrips in the pepper crop. Thus, thrips numbers increased in CCL blooms proportionately with the increase in the winter pepper blooms. In COE, thrips were most common from November to December. Blooming in COE stopped in January, but CT reinfested the new bloom in large numbers when blooming resumed in May.

MPB were common in the fall crop, where they were detected in the first collection on 21 November, 1995. Thrips and MPB remained at stable, low levels through December and January. The short daylength and lower than normal temperatures were probably the cause of these low population numbers. Both thrips and predator numbers increased when a portion of the fall crop was destroyed. The predators were able to keep thrips numbers from increasing unchecked after being forced to leave destroyed blocks.

The sampling periods in the fall and winter crops overlapped, and similar trends in thrips numbers were seen in both crops. MPB were not as numerous at the outset in the

Table 1. Insects collected from peppers, crimson clover, and creeping oxeye in Boynton Beach and Jupiter, FL 1995-96. The frequency with which each insect was collected is shown as the number of detections over the total number of samples. Figures in parentheses indicate the range in numbers of each insect per bloom.

	Hosts				
Species	Fall peppers	Winter peppers	Spring peppers	Crimson clover	Creeping oxeye
Thyanoptera: Thripidae					
Frankliniella bispinosa (Morgan)	5/8 (0-1.28)	8/11 (0-5.08)	6/6 (0.08-10.02)	5/5 (0.04-1.85)	4/6 (0-1.30)
Frankliniella insularis Franklin		1/11 (0-0.02)			
Frankliniella kelliae Sakimura	3/8 (0-0.13)	2/11 (0-0.02)	2/6 (0-0.02)		
Frankliniella occidentalis (Pergande)	2/8 (0-0.02)	3/11 (0-0.04)	1/6 (0-0.12)	3/5 (0-0.07)	
Frankliniella schultzei Trybom		1/11 (0-0.01)			
Microcephalothrips abdominalis Crawford	1/8 (0-0.02)	1/11 (0-0.04)			5/6 (0-5.00)
Thrips palmi Karny	5/8 (0-0.07)	7/11 (0-0.12)	5/6 (0-1.32)		
Hemiptera: Anthocoridae					
Orius insidiosus Say	8/8 (0.10-0.74)	5/11 (0-0.30)	3/6 (0-0.10)	3/5 (0-0.24)	1/6 (0-0.12)
Acarina: Phytoseiidae					
Neoseiulus, Proprioseiopsis and *Typhlodromalus* spp.	4/8 (0-0.02)	3/11 (0-0.04)	1/6 (0-0.04)	3/5 (0-0.07)	5/6 (0-0.68)

Table 2. Comparison of pest management costs at Green Cay Farms to average Palm Beach County and Southwest Florida areawide costs.

Chemical Type	Palm Beach County 1994-95	Palm Beach County 1996-97	SW Florida 1996-97	Green Cay Farm 1994-95	Green Cay Farm 1996-97
Fungicide		$137.00	$183.00		$41.91
Insecticide/Miticide		$387.00	$427.00		$257.50
Total Cost per Acre	$591.00	$524.00	$610.00	$251.95	$299.41
Average Yield per Acre[z]	1136	1100	1000	1145	1250
Cost per Package	$0.52	$0.48	$0.61	$0.22	$0.24

[z]Numbers of 1 1/9 bushel cartons per acre.

winter crop, but rebounded with the thrips increase in March, and probably had a role in reducing peak numbers of thrips in April. Predatory mites were collected at very low levels in both the fall and winter crops.

The situation in the spring pepper crop at SHF was notable, in that the farm is bordered on the north by a large citrus grove. The citrus grove began blooming in February, which coincided with an explosive increase in FFT, that reached peak numbers over 10/bloom in March. Despite the abundant prey, MPB were not present in sufficient numbers to lower the thrips population. This resulted in the grower applying imidacloprid and methomyl to lower the population below the damage threshold. Withholding insecticide applications from fields with FFT infestations at or below the damage threshold may be a valuable way to allow populations of MPB to become established. Having a well-established population of thrips, which cause little or no damage can also deter the establishment of the more damaging MT.

The low number of beneficial insects in the spring crop is most likely due to the lack of opportunity for MPB to become established early in the season, as they did at GCF. Thrips immigrated from the neighboring citrus, without a simultaneous immigration of beneficials. Thus thrips numbers increased unchecked until insecticides were applied and these insecticides further suppressed the predator population.

The ability to use cover crops such as CCL and COE as breeding grounds for beneficial insects would be a significant help in avoiding the situation that occurred at SHF. The key would be to have suitable hosts for both thrips and their predators in bloom throughout the year. The overlap in bloom periods for these two hosts suggests strong possibilities for further development of this tactic. This is made more attractive by the fact that COE is infested primarily by a species of thrips that rarely infests pepper. Further exploration of Dutch white clover as a nursery crop is also warranted, as its blooming period lasts longer than that of CCL. It also has a track record of being well adapted to the field environment in south Florida, while the adaptability of CCL needs further observation. An important step in this process will be to investigate the possibility that manipulating these hosts through mowing may serve to force whatever beneficial insects that are on them to move to the pepper crop.

Control cost analysis: The cost of pesticides used at GCF in 1994-95 and 1996-97 was compared to the county-wide average (K. Shuler, Florida Cooperative Extension Service, personal communication) for the same periods. Detailed information on the 1995-96 pesticide cost at GCF was not available. The average pepper pesticide cost for the southwest Florida region was also included in the comparison (Table 2). These figures indicate that a pest management program which is compatible with biological control of thrips, and which provides adequate control of thrips and other insect and disease pests of peppers, is considerably more economical than the standard type of program used in Palm Beach County or in southwest Florida. Insecticide costs were lower for both seasons at GCF than in either of the comparison regions. Fungicide costs were sharply lower than in the comparison areas, possibly due to the higher cost of controlling bacterial spot in peppers without resistance to races 1, 2, and 3 of *Xanthomonas campestris* pv *vesicatoria.* The varieties grown at GCF had resistance to these races. The total cost of fungicides and insecticides at GCF was 50% or less than that of the comparison areas. Yields at GCF were comparable to those in the other areas.

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