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REFUGE AND COVER CROP PLANTINGS FOR BENEFICIAL INSECT HABITATS

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Abstract. **Flower-infesting thrips are a major concern in Florida pepper production due to fruit damage and virus disease dissemination. Natural enemies, such as the minute pirate bug [*Orius insidiosus* (Say)], can keep thrips populations below the economic threshold. Attracting and augmenting beneficial insect populations in and around pepper fields may maintain yields and reduce pesticide costs. We evaluated the potential of selected cover crops and weedy hosts to serve as refugia for beneficial insects. *Bidens alba* supported a low to moderate, stable population of the minute pirate bug and a plethora of other beneficials as it bloomed year round. Sunflower planted as a windbreak attracted high numbers of *Orius*, but only a single planting was evaluated. *Wedelia trilobata*, blooming from March to December, proved important in carrying *Orius* during the summer months into the fall season. White dutch clover planted in drivemiddles and White sweet clover on field margins supported moderate to high *Orius* populations but only towards the end of the spring season and therefore cannot contribute to early-season thrips control.**

Introduction

Flower-infesting thrips are a major concern in Florida pepper production due to fruit damage and virus disease dissemination. Natural enemies, such as the minute pirate bug [*Orius insidiosus* (Say)], can keep thrips populations below the economic threshold. Attracting and augmenting beneficial insect populations in and around pepper fields may maintain yields and reduce pesticide costs. We evaluated the potential of selected cover crops and weedy hosts to serve as refugia for beneficial insects.

Materials and Methods

Blooms of pepper (*Capsicum annuum* L.), beggar ticks (*Bidens alba* (L.) DC), creeping oxeye (*Wedelia trilobata* (L.) Hitchc.), sunflower (*Helianthus annuum* L.) white dutch clover (*Trifolium repens* L.) and white sweet clover (*Melilotus alba* Ders.) (hereafter referred to as pepper, *Bidens*, *Wedelia*, WDC and WSC, respectively) were collected once weekly from March 1998 to May 1999 from 11 sites across seven counties in south Florida (Table 1). Various other plant species, including pigeonpea, and black medic also were sampled occasionally. Habitat types sampled are specified in Table 1. Selected pepper fields and adjacent habitats in two sites in Palm Beach (Green Cay) and Martin (Shiloh) counties were sampled twice a week to track thrips and *Orius* populations more accurately.

Each collection consisted of a bulk sample of 35 blooms (or racemes in the case of WSC), picked randomly from an area of at least 1,000 ft^2. The number of blooms per square foot was estimated at each collection. Blooms were stored in a ziplock bag with 70% isopropyl alcohol. Arthropods were separated from the blooms by shaking the contents repeatedly with water, pouring it through a coarse sieve and then through fine mesh sieve. Samples were examined with a 40× stereomicroscope and categorized into a total of 60 taxa, including 12 thrips species and seven predator categories (minute pirate bugs, predatory thrips and mites, spiders, lacewings, syrrphids and ladybeetles). All parasitic wasps were grouped together as parasitoids and were not further identified to species. Data were analyzed with SAS version 6.12 for Windows.

Results and Discussion

Thrips Species

The results are summarized in Table 1, showing key parameters of the population dynamics of thrips and their major predator, *Orius insidiosus* (Say). Other predators found in the blooms were too variable or scarce for analysis. *Frankliniella bispinosa* (Morgan) was the dominant thrips species, although in the three Asteraceae (*Bidens*, *Wedelia*, sunflower), *Microcephalothrips abdominalis* Crawford also occurred in significant proportions, particularly during the summer months. In previous surveys, *F. bispinosa* was the dominant thrips species collected from vegetables in Collier, Hendry, Lee, DeSoto and Manatee counties (Frantz and Mellinger, 1990). In other parts of Florida, this species also was common in blooms of citrus (Childers and Beshear, 1992), wild radish (Eger et al., 1998) and a variety of wild host plants (Chellemi et al., 1994). However, *Frankliniella occidentalis* Pergande and *Frankliniella fusca* Hinds appear to dominate in northern Florida (Chellemi et al., 1994).

Thrips palmi Karny was present in very low numbers during the 1998-99 sampling period. From a total of 560 bloom samples containing a total of 127,017 thrips only 33 *T. palmi* were found in a total of 14 samples. Thirty of these were recovered from pepper in Collier County; two from *Bidens* and one from *Wedelia* in Palm Beach County. A serious pest of vegetables in SE Asia, *T. palmi* was first detected in Florida in 1990 and has occasionally caused severe damage to peppers (Childers and Beshear, 1992).

Predator-Prey Dynamics

Thrips and *Orius* population fluctuations varied by plant species. Only *Bidens* bloomed year round and carried thrips and *Orius* throughout with peak numbers occurring in April-May and October. *Wedelia* bloomed from March to November; thrips and *Orius* peaked in May-June and September-October. WDC and WSC bloomed only during the spring season from March to May; peak thrips and *Orius* numbers developed in March-April. Among other leguminous plants sampled at least five times, *Cajanus cajan* L., *Crotalaria juncea* L., and *Medicago lupulina* L., mean *Orius* populations did not exceed 0.01 adults and/or nymphs per bloom. The carrying capacity of a plant species, i.e., the maximum number of thrips or *Orius* per square foot, was obtained by multiplying the peak blooming density with the peak thrips or *Orius* density (Table 1). WDC had the highest carrying capacity for thrips; sunflow-

Table 1. Summary of population characteristics of flower-feeding thrips and associated natural enemies in blooms of white dutch clover, beggar ticks, creeping oxeye, sunflower and pepper, sampled from fourteen sites in seven counties across South Florida, between March 1998 and May 1999.

	White Sweet Clover *Melilotus alba*	White Dutch Clover *Trifolium repens*	Beggar Ticks *Bidens alba*	Creeping Oxeye *Wedelia trilobata*	Sunflower *Helianthus annuus*	Pepper *Capsicum annuum*
Samples	19	52	185	127	7	189
Counties	St. Lucie, Martin, Palm Beach, Collier	Palm Beach, St. Lucie	St. Lucie, Martin, Palm Beach, Collier, Lee, Dade	Martin, Palm Beach, Collier	Hendry	St. Lucie, Martin, Palm Beach, Collier
Habitat	Field margins, road sides, ditch banks	Drive middles	Field margins, ditch banks, road sides	Field margins, ditch banks, road sides	Field margins	Field
Bloom period	January-April	March-May	Year round	March-November	February	September-April
Peak bloom period	March	April	Year round	June-September	February	October-March
Peak bloom density	20 racemes/sq ft	30 blooms/sq ft	20 blooms/sq ft	3 blooms/sq ft	2 blooms/sq ft	5 blooms/sq ft
Thrips						
Density[a] range	0.2-30.6	0.3-63.3	1.4-40.4	0-19.7	4.6-21.2	0-42.3
Mean	9.5	10.8	9.6	3.9	12.1	4.1
% *M. abdominalis*	0	0.3	8.1	58.7	42.6	0.17
% *F. bispinosa*	99.6	98.8	91.4	37.1	57.4	91.7
% *F. occidentalis*	0	0.5	0	0.02	0	2.47
% *F. insularis*	0.4	0	<0.01	0.13	0	<0.01
% *other Frankliniella*	0	<0.01	<0.01	<0.01	0	<0.01
% *T. palmi*	0	0	<0.01	<0.01	0	2.8
% *Haplothrips*	0	0.3	0.5	2.7	0	1.0
Minute Pirate Bug[b]						
Density[b] range	0-0.37	0-1.20	0-0.60	0-0.46	0.30-16.00	0-0.80
Mean	0.08	0.25	0.09	0.04	6.6	0.06
Other predators[c]						
Density[b] range	0-0.22	0-0.09	0-0.48	0-1.08	0-1.00	0-0.07
Mean	0.04	0.04	0.20	0.32	0.20	0.01
Parasitoids						
Density[a] range	0-0.06	0-0.04	0-0.17	0-0.20	0-0.20	0-0.09
Mean	<0.01	<0.01	0.03	0.02	0.06	<0.01
Carrying capacity[d]						
Thrips	612.0	1809.0	808.0	59.0	42.4	211.5
Orius	7.4	36.0	12.0	1.4	32.0	4.0
Thrips:Orius ratio	82.7	50.3	67.3	42.1	1.3	52.9

[a]Insects per bloom.
[b]*Orius insidiosus* (Say) adults and nymphs combined.
[c]Includes immature and adult spiders, predaceous mites, and ladybeetles; immature syrrphids and lacewings; and adult predaceous thrips (Haplothrips sp.).
[d]In number of insects per square foot.

er the lowest. WDC had the highest carrying capacity for *Orius* as well; *Wedelia* had the lowest. The thrips: *Orius* ratio was much lower for sunflower (1.3) than for other plant species (42.1 to 82.7). This means that sunflower produces fewer thrips in relation to *Orius*, which would be a desirable characteristic as thrips dispersing from a cover crop can invade an adjacent pepper crop.

Orius populations were low from December to February, but nymphs and adults were found during any given week. This suggests that *Orius* does not enter diapause during the winter months in south Florida. In Arkansas, female *O. insidiosus* adults overwinter in reproductive diapause on grasses from early November to mid March (Elkassabany et al., 1996).

Pepper in south Florida is planted in two seasons: the fall crop, which is planted in August-October; and the spring crop, which is planted in December-February. Pepper blooming started in October and continued up to May; in 1998 thrips and *Orius* peaked in April, but in 1999 thrips peaked in March and *Orius* in May, respectively. Thrips and *Orius* populations were lower in the fall crop than in the spring crop. In the spring crop at Shiloh, later planted fields had higher thrips numbers in the blooms than earlier planted fields. The relationship of the number of thrips per bloom with planting date in days from November 6, 1998, was highly significant (Thrips = 0.06 + 0.14*days, $F = 103.8$, $p < 0.01$, $df = 3$, $R^2 = 0.97$). Data from three fall pepper fields at Green Cay (planted 8/18 to 10/28/98) show that *Orius* and thrips colonized pepper blooms at the same time, 39 ± 8 and 40 ± 5 days after planting, respectively. However, in the spring crop (five blocks at Shiloh farm planted from 11/7/98 to 2/3/99), *Orius* colonization was delayed (71 ± 12 days after planting) while the onset of thrips colonization remained similar (36 ± 6 days after planting). *Orius* showed a functional predator-prey relationship with thrips in six pepper fields (equally divided over fall and spring crops). *Orius* peak populations were highly significantly related to thrips peak populations in a positive, linear fashion (*Orius* = -0.065 + 0.035*Thrips, $F = 44.2$, $p < 0.01$, $df = 4$, $R^2 = 0.92$). *Orius* populations peaked from 14 to 32 days after thrips populations peaked; at this time thrips numbers were greatly reduced. Reduction in thrips population ranged from 90-100% in the fall crop and from 36-78% in the spring crop.

These predator-prey relationships were not as apparent in *Bidens* blooms. Normally, *Orius* and thrips fluctuated nearly simultaneously. Moreover, they fluctuated less compared to

populations in pepper blooms as indicated by the coefficient of variation of the mean (CV). In pepper fields (without thrips control) the CV of thrips and *Orius* populations ranged from 73-115% and 123-198%, respectively. In blooms of *Bidens* growing within cane windbreaks along pepper fields, the CV's of thrips and *Orius* populations ranged from 22-48% and 73-111%, respectively. In an undisturbed *Bidens* habitat around a cypress hammock in Collier Co., thrips and *Orius* populations were even more stable: over a period of three months *Orius* averaged 0.24 per blooms with a CV of 33% and thrips averaged 9.25 per bloom with a CV of 38%. It is possible that the constant availability of pollen in *Bidens* habitats, attracts *Orius* more then the presence of thrips. In addition to *Orius*, a wide variety of predatory arthropods and parasitoids were found in *Bidens* blooms throughout the year. These included various aphid predators, such as larvae of syrphids, aphid midges, ladybeetles, and lacewings, predatory mites (*Proprioseiopsis* nr *mexicanus* (Garmon) and *Typhlodromalus peregrinus* (Muma)), and spiders. *Bidens* bloom stalks were commonly infested by *Aphis craccivora* Koch.

WDC planted in driveways at the Shiloh farm started blooming in late January and reached a maximum of 15 blooms / ft^2 in mid April after which it declined. Pepper bloom density normally reached a maximum of 5 blooms/ft^2, 6-8 weeks after planting, depending on variety, growing conditions and harvest frequency. In two pepper blocks with WDC driveways during the spring 1999 crop, *Orius* appeared in WDC and pepper blooms around the same time. However, thrips and consequent *Orius* build-up reached higher levels than in the adjacent pepper fields.

Wedelia, growing on field borders between cane plants, on ditch banks, and as an ornamental cover crop, bloomed from March to November, with a peak density of 2-3 blooms/ft^2 from June to September. *Orius* populations peaked in June and dropped off rapidly during the fall. A predatory tubuliferan thrips, *Haplothrips gowdeyi* (Franklin) was relatively common on *Wedelia* throughout its blooming period. A wide variety of mites also were collected, including *Pseudoparasitus* sp. (Laelapidae), *Brevipalpus* nr. *selas* Pritchard and Baker (Tenuipalpidae), *Asca* nr. *duosetosa* Fox (Ascidae), *T. peregrinus*, and unidentified Oribatidae.

Sunflower, planted in November 1998 as windbreaks in a tomato farm in Hendry Co., bloomed from late January to mid March 1999. Peak bloom density was only two blooms/ft^2, but blooms were much larger in size (5-8" diameter) than any other crop sampled, thus providing large quantities of pollen per unit surface area. The number of *Orius* per bloom greatly exceeded that of any other crop sampled: from 2.8 to 16 per bloom. *Orius* numbers peaked in mid February, a week prior to the peak in thrips numbers, possibly because they were attracted by the pollen. The thrips species *M. abdominalis* and *F. bispinosa* were equally dominant.

Implications for Managing Cover Crops as Beneficial Insect Habitats

Timing of the blooming period of the companion crop relative to the pepper crop is critical. *Orius* is attracted to the pollen and thrips. Ideally, the companion crop should start blooming well ahead of the pepper crop to give the *Orius* population a jump-start.

Sunflower bloomed in February, which would be compatible with a spring pepper crop. It may be possible to plant sunflower on a monthly basis and thus extend the blooming period. *Bidens* bloomed year round and was the only plant that occurred as a common weed throughout South Florida. Its presence around pepper fields depended on weed management. Where it was allowed to flourish undisturbed, relatively high populations of *Orius* and other beneficials (predatory mites, syrphids, ladybeetles, lacewings, predatory thrips, and various parasitoids) developed which could be of potential benefit to natural biological control in the pepper crop. *Bidens pilosa* L., a closely related species which may be synonymized with *B. alba* (C. R. Artaud, pers. comm., 1999), is known as a host of six viruses (Brunt et al., 1996). This may be a concern for the widespread adoption of *Bidens* as a refuge for beneficials.

Wedelia bloomed from March to December, but supported *Orius* only during the summer months after the spring pepper season had ended. It therefore has limited potential, but it combines well with sugarcane in windbreaks where it covers the ground between cane plants. Both *Wedelia* and *Bidens* are easy to control by tillage in field walkways and do not present a direct threat to pepper growth.

WDC in drive middles can carry high levels of *Orius*, but peak numbers occur only towards the end of the spring crop. Therefore its potential contribution to thrips control on peppers early in the season is limited.

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