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SURVEY OF PREDATORS OF THE BROAD MITE IN SOUTHERN FLORIDA

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The broad mite (BM) *Polyphagotarsonemus latus* is one of the major pests of lime (*Citrus latifolia* Tan.) in southern Florida. Broad mites reduce the market value of the crop by feeding on the fruit surface and causing silvering of the fruit (Campbell 1979). Since reaching pest status in 1968, broad mites have been controlled exclusively with pesticides (Wolfenbarger 1974). Few acaricides are effective against the broad mite (Brown & Jones 1983), and the use of broad spectrum pesticides to control various pests of limes has eliminated or reduced levels of naturally occurring predators of the broad mite. Therefore, an integrated pest management program (IPM) for limes must include development of control tactics which are compatible with natural enemies.

The potential of phytoseiid mites as predators of the broad mite has been reported for other areas (Badii & McMurtry 1984, McMurtry et al. 1984) but has not been examined in the lime tree agro-ecosystem in Florida. The major objective of this study was to identify the predaceous mites on lime fruits and to measure their impact on the broad mite.

Selection of a sampling unit. Two preliminary surveys were conducted to determine the relative frequency of predaceous mites on fruits, leaves and flowers. Initially, twenty small fruits (4 cm or less in diameter) and 80 new leaves were collected weekly (August-December 1984) from a lime orchard near Homestead, Florida. Fruits and leaves were placed separately in plastic bags. These were placed in an ice chest (ca.

7-10°C) and transported to the laboratory where frequency of predaceous mites was assessed. Secondly, flowers (n = 20), fruits (n = 20) and 20 branches (ca. 12 cm in length) were collected weekly (October-December 1984) from 5 lime orchards and individually bagged and taken to the laboratory.

During the first survey no significant difference in frequency of predaceous mites was observed between leaves and fruits [χ^2 .05 [1] = 3.84]. During the second survey, more predators were observed in the flowers ($\bar{x} \pm SE = 6.96 \pm 0.81$) than in leaves ($\bar{x} \pm SE = 0.84 \pm 0.60$) or fruits ($\bar{x} \pm SE = 0.24 \pm 0.11$). Even though fruits represented only 19% of the total population, we selected them as the sampling unit since the chances of contact with broad mites would be higher for those predators observed on the fruit.

Field survey. Six commercial lime groves were selected in 1985-1986 as study sites. Groves were sampled for broad mites and predatory mites each week to measure seasonal differences among winter (January-February), spring (March-May) summer (June-September), and fall (October-December) populations. The insecticidal-acaricidal program (sulfur, ethion, citrus oil and malathion) at each pair of groves was classified as low if it included one or no application, moderate if two to three were used and high if more than four were applied annually. Twenty small fruits were randomly selected from each grove and placed in plastic bags. These were transported to the laboratory in am oce chest (ca. 7-10°C) and examined. The number of phytophagous mites. i.e. all motiles broad mites and citrus rust mites (*Phyllocoptruta oleivora* (Ashmead)) on each cm^2 of fruit surface were counted with 10X hand lens following the methodology of Childers & Selhime (1983). Predatory mites were counted and then transferred to 8 ml vials with 70% isopropyl alcohol and later mounted individually in Hoyer's solution on microscope slides for identification.

Exclusion Experiment. A 0.30 ha lime grove was selected to verify the effect of the native predaceous mite complex on broad mites and rust mites. Treatments were assigned to 3-tree plots in a completely randomized block design and replicated 5 times. An unsprayed buffer tree separated treatment trees within and between rows. The plots planted at a density of 286 trees/ha were treated either with permethrin (1.9 g ai/100 l) or sulfur (19.82 g ai/100 l), or remained unsprayed as a control. Materials were applied every month with a hand gun sprayer at 450 PSI and ca 7.56 l/tree. Weekly counts of broad mites, citrus rust mites and predatory mites on fruit were taken from December 1985 through December 1986. Five fruits/tree, with a total of 75/treatment were randomly inspected and the number of mites/cm^2/fruit was determined with aid of a 10x hand lens. Predatory mites/fruit were counted. Fruits were harvested in May and August, 1986 and the number of fruits with less than 15% damaged surface ara was noted per tree.

Field Survey. A total of 443 predaceous mites representing 6 species (4 Phytoseiidae, 1 Bdellidae, 1 Ascidae) were collected from lime fruits. *Typhlodromalus peregrinus* (Muma) which accounted for 72.4% (n = 356) of the predaceous mites, and outnumbered *Typhlodromips dentilis* (De Leon) (n = 68), *Amblyseius aeralis* (Muma) (n = 5), *Galendromus helveolus* (Chant) (n = 3), *Bdella distincta* Baker & Balock (n = 9) and *Asca muma* Hurlbutt (n = 2).

The temporal trends of the predatory mites exhibited small peaks and were not always correlated with broad mite abundance. One reason for this may be that two of the phytoseiid species, *T. peregrinus* and *A. aerialis* are considered facultative predators of other prey species (eg. *Chrysomphalum aonidum* (L.) and *Lepidosaphes beckii* (Newn.) and are able to survive on fungi and non-living organic materials (Muma 1955, 1971). Also, *T. peregrinus* also preys commonly on *Panonychus citri* (McGregor) which attains peak populations in lime groves during winter and spring months (Baranowski et al., unpublished data).

The distribution of predators in relation to spray regime indicated that predatory mites were more abundant in less frequently sprayed groves than in more frequently sprayed groves (Table 1). Two to twenty-seven times more predators were observed in groves with low spray programs than with moderate or high spray regimes. Broad mites were generally more abundant in groves with high and moderate spray regime fields than in groves with low spray regimes. In contrast, citrus rust mite density was lower under high and medium spray regimes than under a low regime.

Exclusion Experiment. As in the field survey, *T. peregrinus* was the most abundant predator on fruit followed by *T. dentilis* and *A. muma*. *Galendromus helveolus*, *A. aerealis* and *B. distincta* were almost absent from the experimental plots. All phytoseiid species were extremely susceptible to permethrin.

Population density of phytophagous mites began to increase in the plots treated with permethrin immediately after the first application. The seasonal occurrence of broad mites showed differences between the predator-free plots and untreated plots (Fig. 1). In the predator-free plots, broad mite density was greater from mid-March through April and decreased steadily in May to July. Peaks were again observed in August and October. In the predator plots peaks were apparent only in January and September. Phytoseiids increased steadily in the predator plots in February through April and in September-October. In the predator-free plots, phytoseiid density did not increase until November.

During the winter and spring 1986 the number of broad mites was higher in the predator-free plots than in the predator-plots or in the sulfur treated plots ($P < 0.05$). In contrast, there were no significant differences for citrus rust mite *P. oleivora* density in the predator-free plots and sulfur treated plots (Table 2). The mean number of predators observed per fruit was 7.5 times higher in the untreated plots than in the treated permethrin plots. The percent of damaged fruit/tree was 3.2 and 3.65 times higher in

TABLE 1. MEAN, SE OF BROAD MITES, CITRUS RUST MITES AND PREDATORY MITES IN LIME FRUITS IN DADE COUNTY, FLORIDA

Insecticide-acaricide program	Season	Broad mites/ $cm^2 \pm SE$	Citrus rust mites/ $cm^2 \pm SE$	Predators/ fruits $\pm$ SE
Low	Summer 1985	0.11 ± 0.011	0.67 ± 0.011	0.03 ± 0.011
	Fall	0.00 ± 0.001	0.04 ± 0.041	0.04 ± 0.011
	Winter 1986	0.01 ± 0.001	0.08 ± 0.011	0.06 ± 0.001
	Spring	0.03 ± 0.001	0.35 ± 0.010	0.07 ± 0.002
	Summer	0.00 ± 0.000	0.05 ± 0.050	0.01 ± 0.028
	Fall	0.00 ± 0.000	0.07 ± 0.001	0.02 ± 0.001
Moderate	Summer 1985	0.06 ± 0.007	0.65 ± 0.001	0.03 ± 0.001
	Fall	0.16 ± 0.005	0.50 ± 0.002	0.01 ± 0.010
	Winter 1986	0.00 ± 0.000	0.15 ± 0.003	0.03 ± 0.005
	Spring	0.00 ± 0.000	0.01 ± 0.001	0.02 ± 0.000
	Summer	0.04 ± 0.001	0.04 ± 0.001	0.03 ± 0.000
	Fall	0.02 ± 0.000	0.03 ± 0.001	0.01 ± 0.000
High	Summer 1985	1.76 ± 0.072	0.14 ± 0.003	0.00 ± 0.000
	Fall	0.00 ± 0.000	0.05 ± 0.002	0.00 ± 0.000
	Winter 1986	0.00 ± 0.000	0.08 ± 0.000	0.00 ± 0.000
	Spring	0.00 ± 0.000	0.04 ± 0.001	0.01 ± 0.001
	Summer	0.03 ± 0.001	0.06 ± 0.001	0.00 ± 0.000
	Fall	0.02 ± 0.001	0.02 ± 0.001	0.00 ± 0.000

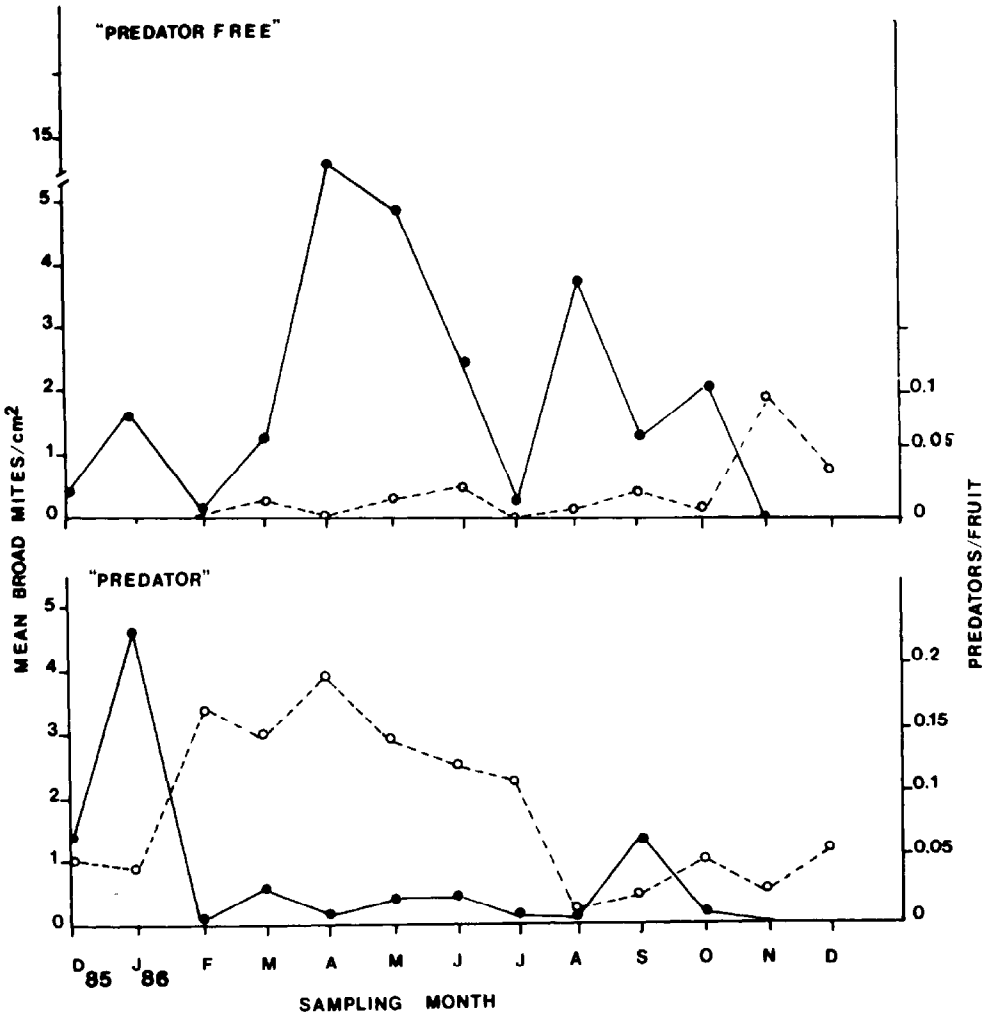

Fig. 1. Seasonal incidence of broad mites and predatory mites in lime fruits in 'predator free' plots and 'predator' plots ——— Broad mites, o----o predators.

the predator-free plots than in the sulfur and predator plots, respectively (Table 2). Other alternative prey species (e.g., *P. citri*) were not observed in the test plots. During the summer and fall of 1986 the broad mite density was again higher in the predator-free plots than in the other treatment plots.

During fall, there were no significant differences between the percent of fruits injured per tree in the predator-free plots and predator-plots (Table 2). Several factors could be responsible for this. Since most of these mites are facultative predators, the presence of other preferred prey or food substrate during fall might influence the predator-broad mite response. Also, since broad mite has a short generation time (Jones & Brown 1983) and fruit injury is observed in 4 to 6 days (Pena et al., unpubl. data) the ratio of predator to broad mite population may need to be higher than the one observed during the fall to obtain better broad mite control.

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TABLE 2. THE NUMBER OF BROAD MITES, RUST MITES AND PREDATORY MITES AND THE PERCENT LIME FRUITS INJURED IN PREDATOR FREE AND PREDATOR PLOTS.

Treatment	Season	BM/cm²	RM/cm²	Predators/ fruit	% fruit damaged/tree
Predators excluded	Winter-spring	4.79 a*	6.89 a	0.02 b	29.5 a
Sulfur		0.19 b	0.88 b	0.07 b	9.2 b
Predators present		1.09 b	5.23 a	0.15 a	8.1 b
Predators excluded	Summer-fall	2.89 a	4.87 a	0.01 c	94.0 a
Sulfur		0.71 b	1.16 b	0.07 b	8.0 b
Predators		0.26 b	5.83 a	0.12 a	73.0 a

*Means followed by a different letter in ths same column were significantly different (P = 0.05) by DMRT.

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