PREDATION BY *TAPINOMA MELANOCEPHALUM* (HYMENOPTERA: FORMICIDAE) ON TWOSPOTTED SPIDER MITES (ACARI: TETRANYCHIDAE) IN FLORIDA GREENHOUSES

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ABSTRACT

Natural infestations of *Tapinoma melanocephalum,* (Fab.) found in central Florida greenhouses were observed attacking *Tetranychus urticae* Koch in test evaluations of two chemicals. Subsequent laboratory tests using isolated leaf discs, greenhouse data, and whole plants demonstrated that *T. melanocephalum* is a significant predator of *T. urticae*.

Key Words: Biological control, ants, spider mites.

RESUMEN

Durante la evaluación de dos productos químicios en invernaderos de la región central de la Florida fueron encontradas infestaciones naturales de *Tapinoma melanocephalum* (Fab.) atacando *Tetranychus urticae* Koch.

Las pruebas de laboratorio realizadas posteriormente usando discos de hojas, datos de invernadero y plantas completas demostraron que *T. melanocephalum* es un depredador significativo de *T. urticae.*

The first report of movement of beneficial insects to control a pest insect was by Forskål (1775) who reported that date palms in the Middle East were protected from pests by ants. Annually, colonies of predatory ants were moved from the mountains into infested areas. Groff & Howard (1924) stated that chinese citrus growers of Kwangtung province would commonly use colonies of the cultured ant, *Oecophylla smaragdina* Fab., as predators for citrus pests.

Ants found in greenhouses are generally treated as pests because they tend aphids, mealybugs or soft scales or they are of quarantine importance (i.e., red imported fire ants, *Solenopsis invicta* Buren). In almost all cases, we have traditionally recommended the use of a pesticide to kill the pest insect being tended by the ants or, specifically, to kill the ants. Ants are not thought of as biological control agents in greenhouses, rather, they are considered disruptive to biological control of various homopterous pests.

One species of ant that can be found in greenhouses is *Tapinoma melanocephalum* (Fab.). This species is considered a nuisance ant and occasionally an important pest in houses. Field populations are found in south Florida but are limited to greenhouses and buildings in the north (Nickerson & Bloomcamp 1988). This tropical species has been so widely distributed by commerce that it is difficult to determine its origin, but it is believed to be African or Oriental (Smith 1965). The workers are monomorphic and approximately 1 mm long. The worker head and thorax are black, legs and abdomen and gastor are clear or light yellow. Colonies of this highly adaptable species contain multiple queens (polygyny) and are often found in transient habitats, such as plant debris, under potted plants, rotting wood planks and plant stems (Nickerson & Bloomcamp 1988). Colonies may break into subunits that occupy different sites, but individual ants will move between them (Oster & Wilson 1978).

Smith (1965) reported that *T. melanocephalum* fed on many different foods in the house, but seemed to prefer sweets. In the greenhouse, she reported that they fed on honeydew and on live or dead insects. Nickerson & Bloomcamp (1988) noted that a colony of *T. melanocephalum* had established in the quarantine greenhouse of the Florida Department of Agriculture in Gainesville, Florida, where it preyed on small beetle larvae and lepidopterous larvae from the insect cultures in quarantine. In Venezuela, *T. melanocephalum* is the primary predator of eggs of *Rhodnius prolixus* Stål (Gomez-Nunez 1971). The only report of this ant interacting with Arachnida was by Shepard & Gibson (1972) who reported that a symbiotic relationship had developed in Costa Rica between *T. melanocephalum* and jumping spiders (Araneae: Salticidae) which were found inhabiting the nests. It is believed that the spiders provided some protection to the ants from natural enemies and the nest served as a foundation for web construction.

In this paper, we report chemical evaluations conducted in 1993 for control of twospotted spider mites, *Tetranychus urticae* Koch, in the University of Florida-Apopka greenhouses. The tests results led us to the conclusion that mite numbers declined significantly on both treated and untreated plants because of predation by *T. melanocephalum*. This paper describes this preliminary experiment and other tests to define the interaction between *T. urticae* and *T. melanocephalum*.

Materials and Methods

Pesticide Trials

Salvia splendens cv. Red Hot Sally seedlings were potted into 15.2-cm round plastic pots using Verlite Nursery Mix A (without superphosphate; Verlite Co. Tampa, FL) amended with 4.4 kg Osmocote (19:6:12 slow release fertilizer; Grace-Sierra Chemical Co., Milpitas, CA), 4.2 kg dolomite, and 0.9 kg Micromax per m^3 (micronutrient source; Grace-Sierra Chemical Co.). The pots were placed on raised benches in a glass greenhouse. Forty plants were infested on September 16, 1993 with twospotted spider mites (TSM) by placing pieces of infested Henderson Bush lima bean (*Phaseolus limensis* Macfady) leaves on each plant. An initial count of all TSM stages on two marked leaves per plant was conducted and five plants were assigned to each of five treatments. Additional counts were conducted five days later. The five treatments were: three with an experimental formulation containing neem oil supplied to us under a non-disclosure agreement (UK-1%, UK-1.5%, UK-2%), the labeled rate of a standard acaricide (Pentac Aquaflow® - dienochlor) and an untreated control.

Disc Trials

Henderson bush lima bean seeds were planted into 12.7-cm square black plastic pots using the same soil described above. Five 20-mm diam discs were cut from mature leaves and placed on the bottoms of 10 cm^2 plastic-petri dishes filled with moist cotton. The pattern of placement was one disc at each corner of a square for the first test; for the second and third tests one additional disc (total=5) was placed in the center of this pattern. Five adult female TSM were placed on each disc. Two dishes were prepared for each experiment. Half the dishes were individually isolated by placing them in a saucer on an inverted 10-cm square plastic pot sitting in a second saucer filled with soapy water. This served as an efficient method to prevent ants from obtaining access to mites on these discs. The remaining dishes were placed on a greenhouse bench on which worker ants were observed foraging. The number of live TSM (all stages) were counted on each leaf on days 1, 2, 3, and 6. This study was repeated three times. All data from each test were pooled and the median number of mites per disc for each treatment was compared using Mann-Whitney Rank Sum Test (SigmaStat version 1.01; Jandel Scientific, San Rafael, CA, 1994).

Whole Plant Trials

Twenty Henderson bush lima bean seeds were planted into 12.7-cm square black plastic pots using the same soil previously described. When the first true leaves were fully expanded (two-leaf stage), each plant was infested with 10 adult female TSM per leaf by hand with a camel-hair brush. Ten plants were individually isolated by placing each pot in a saucer on an inverted 10-cm square plastic pot resting in a second saucer filled with soapy water. This served as an efficient method to prevent ants from foraging on these test plants. The remaining 10 plants were placed on a greenhouse bench on which worker ants were observed foraging.

The numbers of live TSM (all stages) were counted on each leaf on day 7, 11, 14, 18, and 22. This study was repeated three times. All data from each test were pooled and the median number of mites per leaf for each treatment was compared using Mann-Whitney Rank Sum Test (SigmaStat version 1.01; Jandel Scientific, San Rafael, CA, 1994).

TABLE 1. COMPARISON OF THREE RATES OF NEEM OIL, A MITICIDE STANDARD AND NON-TREATED CONTROL FOR THE CONTROL OF *TETRANYCHUS URTICAE* ON *SALIVA SPLENDENS* CV. RED HOT SALLY SEEDLINGS (MEAN ± SE FOR TSM/2 LEAVES/PLANT).

Treatment	Pre-count	7-Day Count	14-Day Count
UK-1.0%[1]	51.4 ± 13.0[2]	32.2 ± 28.7	1.6 ± 1.4
UK-1.5%	51.0 ± 13.4	34.8 ± 11.7	12.0 ± 4.9
UK-2.0%	51.2 ± 12.9	47.8 ± 16.1	34.2 ± 14.7
Dienochlor	51.0 ± 12.6	15.0 ± 6.9	0.0 ± 0.0
Control	43.8 ± 19.1	11.2 ± 6.9	0.0 ± 0.0

[1]This experiment consisted of five treatments, three with an experimental neem oil formulation of unknown composition and supplied to us under a non-disclosure agreement (UK-1%, UK-1.5%, UK-2%), the labeled rate of a acaricide standard (Pentac Aquaflow®-dienochlor) and an untreated control.

Results and Discussion

Pesticide Trials

The results of the pesticide trials were contrary to those expected for a standard pesticide efficacy study (Table 1), because mite numbers on *all* treatments declined compared to the initial counts. In the three treatments where neem oil was applied, the number of mites increased with the concentration applied. These results prompted us to inspect all plants for the presence of predatory mites. No phytoseiid mites were found on any treatments. We did notice a significant number of ants on many plants in this study and on closer observation we found worker ants leaving plants with mites, adult whiteflies, thrips and immature aphids in their mandibles. This observation prompted us to conduct the disc and individual plant studies reported below.

Disc Trials

Results of the disc tests are presented in Fig. 1. Number of mites on each disc were significantly different ($P<0.01$; Mann-Whitney Rank Sum Test) on days 1, 2, 3, and 7.

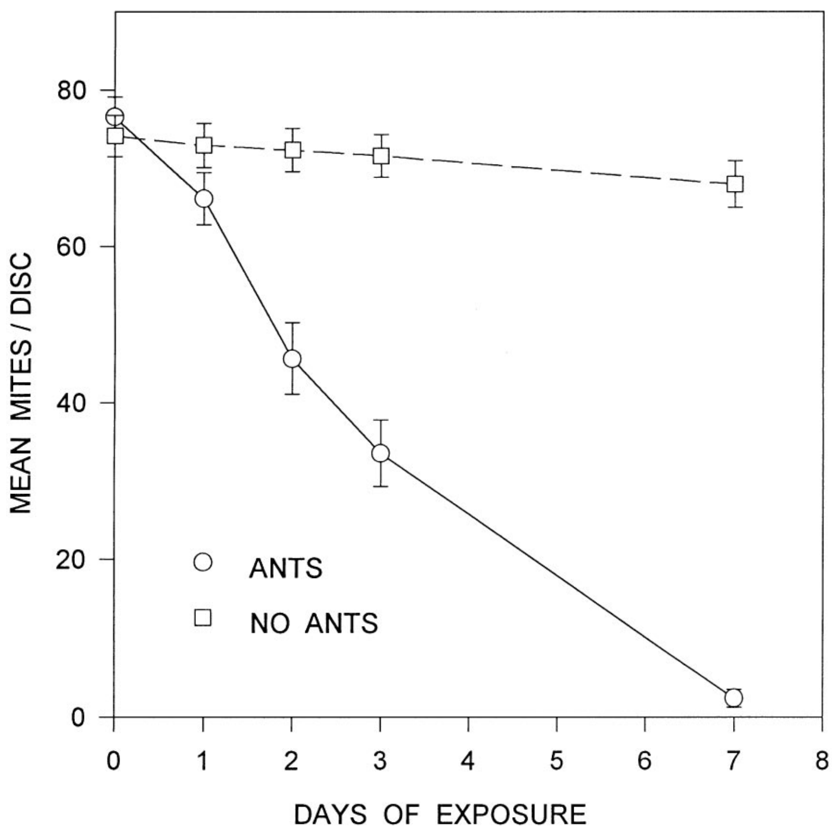

Figure 1. A comparison of the number of mites (mean ± SE) per leaf disc when ants were allowed to forage versus when they were excluded; plotted against time (day 1, 2, 3, and 7).

Worker ants were observed walking across the wet cotton substrate used to maintain the disc and prevent mites from escaping. They were never observed carrying eggs; however, they were seen removing other stages of *T. urticae* from these discs. No ants were observed on the isolated treatments. It appeared that the ants were able to move across the moist cotton, find the mites, and remove them within 24 h from the time the dishes were placed in the infested greenhouse.

Whole Plant Trials

Results of the individual plant tests are presented in Fig. 2. Numbers of mites on each leaf were significantly different (P<0.01; Mann-Whitney Rank Sum Test) on days 7, 11, 14, 18, and 22. Ants were observed foraging on the exposed plants after 1 day of exposure. Numbers of mites increased until day 11 after which the population declined to a very low level. The age distribution of surviving mites changed throughout the course of this study. Initially, the active stages were mainly adult females but most of the mites counted after day 14 were nymphs or newly hatched larvae. We

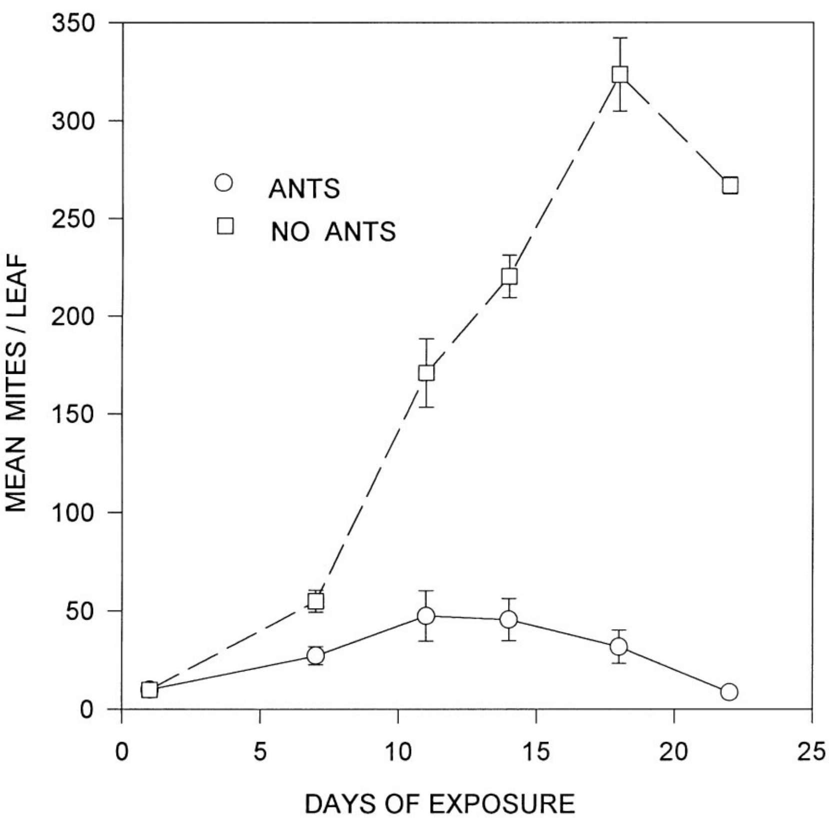

Figure 2. A comparison of the number of mites (mean ± SE) per leaf when ants were allowed to forage versus when they were excluded; plotted against time (day 7, 11, 14, 18, and 22).

never observed a reduction in the numbers of mite eggs nor did we observe ants removing eggs from the discs or whole plants.

T. melanocephalum is usually considered to be a pest because of its impact on mite colonies and its disruptive effect on experiments by feeding on the mites in controls. Results of these studies show that *T. melanocephalum* can be a significant predator of twospotted spider mites; however, there are several important questions that must be addressed before employing these ants as predators in a commercial setting. Extensive studies should be conducted to learn what foods they will feed on under greenhouse conditions. This would include extensive host range studies to determine if they pose any threat to ornamental plants. Because we have observed *T. melanocephalum* feeding on a number of other arthropod prey, we also must determine if they have a preference when given the option of feeding on a array of different prey. Secondly, we would like to determine if *T. melanocephalum* only feed on twospotted spider mites when other food sources are scarce. We have noticed that they will feed on western flower thrips and *Ecinothrips americanus* when no aphids or spider mites are present, but when these hosts are in sufficient numbers the ants seem not to attack thrips.

The final step would be to determine their sensitivity to pesticides so that they could be eradicated from a greenhouse if necessary, or to prevent their movement in or on ornamental plants. *T. melanocephalum* is considered a “fugitive” or opportunistic ant (Hölldobler & Wilson 1990) and its status as an urban pest cannot be ignored. Because this ant can infest potted plant material, cardboard boxes, and other material commonly used to ship plants, it may be necessary to develop management programs for control.

ACKNOWLEDGMENTS

We wish to extend our appreciation to Drs. R. K. Yokomi, G. L. Leibee and F. L. Petitt for their critical review of this work. This is Florida Experiment Station Journal Series No. R-04739.

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