Although most insecticides tested were highly effective against insect pests of squash, long-term sustainable management of pests and preservation of natural enemies requires the identification of less toxic control methods. The use of mineral oil formulations and *Bacillus thuringiensis* appears to be compatible with biological control and should be tested further for use in cucurbit pest management.

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CHEMICAL CONTROL OF THE TWOSPOTTED SPIDER MITE, *TETRANYCHUS URTICAE* KOCH (ACARI:TETRANYCHIDAE), IN STRAWBERRIES

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Abstract. **Two experiments were conducted on plots of strawberry (*Fragaria* × *ananassa* Duch. cv. Sweet Charlie) in Dover, Florida, to compare new and long-used pesticides as control agents of the twospotted spider mite (*Tetranychus urticae* Koch). A single application of bifenthrin and the combination of hexakis with pyrethrum plus rotenone and other cube resins resulted in reductions in spider mite densities. Abamectin and propargite resulted in reductions after 2 or 3 weekly applications. Hexakis alone reduced spider mite densities after 2 weekly applications, but did not do so after 3 applications. Dicofol, alanycarb, and methomyl were ineffective in reducing spider mites, but alanycarb and methomyl greatly reduced pameras (*Pachybrachius bilobatus* (Say)) and flower thrips (*Frankliniella bispinosa* Morgan).**

Florida strawberries were produced on 1903 ha that yielded fruit valued at $94.7 million during the 1991-92 crop season (Fla. Agric. Statistics Service, 1993). The twospotted spider mite feeds and lives on leaves and is the major arthropod concern on all strawberries produced in Florida (Howard et al., 1985). Reductions in fruit yield may occur from the mite's morphological or physiological effects on leaves and thus mite populations may require management (Oatman et al., 1981; Sances et al., 1979a, 1979b; Sances et al., 1981).

The new insecticides and miticides, abamectin, bifenthrin and alanycarb, were compared to the long-used compounds, propargite, hexakis, dicofol, methomyl, and pyrethrum with rotenone and other cube (pronounced "koo-bay," *Lonchocarpus* spp.) resins for their effects on the twospotted spider mite in strawberries. In addition, observations were recorded on effects of alanycarb and methomyl on the incidental species, pameras and flower thrips. Results of those investigations are reported herein.

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Materials and Methods

Two experimental areas were prepared similarly in spring 1993. Rooted 'Sweet Charlie' strawberry plants were set in mid-Oct. 1992 in Dover, Florida, on raised beds of Scranton fine sand (3% organic matter). The soil was adjusted with dolomite to a pH of 6.5, provided 225 N, 32 P, and 187 K kg/ha fertilizer, and fumigated with 98% methyl bromide and 2% chloropicrin at 450 kg/ha. Beds 60 cm wide were spaced on 1.2 m centers and covered with 1.25 mil black polyethylene mulch. Constant daytime overhead irrigation was provided during the first 2 weeks after transplanting. Thereafter, plants were irrigated based on need.

Plots were 2 rows, each with 10 plants spaced at 30 cm intervals. A 2.5 m or greater unplanted buffer separated plots in all directions. All plants were treated with captan (1.7 kg/ha) twice weekly during fruiting; methomyl (Experiment 1 only) was applied at 1.0 kg/ha 5 times at weekly intervals beginning 10 Jan. to reduce biological control agents and enhance spider mite population development.

Experiment 1. Miticidal treatments (Table 1) were applied as mite densities increased in Mar. (Poe, 1972). Sprays were applied at 947 liters/ha (of mulched bed) via a hand-held sprayer, outfitted with a hollow cone nozzle and pressurized by CO_2 to ca. 4.2 kg/cm². Designs for experiments were randomized complete blocks with 4 replications.

Four treatments were applied at 7 day intervals beginning on 11 Mar. after mite population densities had begun to increase. Ten terminal leaflets were sampled periodi-

Table 1. Pesticides evaluated for control of twospotted spider mites on strawberries.

Experiment no.	Chemical	Formulation	Product/ ha
1	Untreated Check		
	Abamectin	0.15 EC	1.17 liter
	Bifenthrin (low concentration)	10 WP	0.67 kg
	Bifenthrin (high concentration)	10 WP	1.12 kg
	Dicofol	35 WP	3.36 kg
	Hexakis	50 WP	1.12 kg
	Pyrethrum (0.6%) + Rotenone (0.5%) + Other cube resins (0.5%)	EC	2.34 liter
	Hexakis +	50 WP	1.12 kg
	Pyrethrum (0.6%) + Rotenone (0.5%) + Other cube resins (0.5%)	EC	2.34 liter
	Propargite	30 W	2.80 kg
2	Untreated Check		
	Alanycarb (low concentration)	2.5 EC	1.68 liter
	Alanycarb (high concentration)	2.5 EC	2.48 liter
	Alanycarb (low concentration)	40 WP	1.26 kg
	Alanycarb (high concentration)	40 WP	1.88 kg
	Methomyl (low concentration)	1.8 L	2.34 liter
	Methomyl (high concentration)	1.8 L	3.50 liter

cally at random from each plot to assess mite population densities. Samples were taken prior to spraying on days sprays were applied. Leaves were brushed with a mite brushing machine onto a rotating disc (Price et al., 1980). Motile mites and eggs, adhering to a marked 10% area of the plate, were counted to represent an average number brushed from 1 leaflet.

Analyses of variance, means and their separations were performed by SAS procedures (SAS Institute, Inc., 1985) on the square root of original (+ 0.5) motile mites. Where transformations were used, means were reported in the original scale.

Experiment 2. A second experiment was designed and performed as with the earlier experiment. However, chemical treatments (Table 1) were applied on 29 Apr. and again 2 weeks later. In addition to assessments of spider mite densities (taken 1 day after each spray), numbers of pameras were recorded per plot and numbers of flower thrips were recorded per 10 newly opened flowers.

Table 2. Numbers of twospotted spider mites per strawberry leaflet after weekly applications of pesticides.

Treatment	Spider mites 1 week after indicated application (No. per leaflet) First	Second	Third
Untreated Check	104 a[z]	188 a	79 ab
Abamectin 0.15 EC	42 abc	43 c	5 d
Bifenthrin 10 WP (low concn)	8 cd	9 d	15 bcd
Bifenthrin 10 WP (high concn)	3 d	1 e	7 cd
Dicofol 35 WP	33 abc	80 abc	36 abc
Hexakis 50 WP	70 abc	73 bc	19 bcd
Pyrethrum (0.6%) + Rotenone (0.5%) + Other cube resins (0.5%) EC	75 ab	143 ab	112 a
Hexakis 50 WP + Pyrethrum (0.6%) + Rotenone (0.5%) + Other cube resins (0.5%) EC	13 bcd	40 c	9 bcd
Propargite 30 W	58 abc	39 c	6 d

[z]Mean separation in columns by Duncan's multiple range test, 5% level.

Results and Discussion

Experiment 1. The data in Table 2 indicate that 1 week after the first experimental treatments, greatest reductions in spider mites occurred on plants treated with bifenthrin or the combination of hexakis and pyrethrum, rotenone and other cube resins. At that time, there were no significant reductions of spider mites on strawberry plants treated with abamectin, dicofol, hexakis alone, or pyrethrum with rotenone and other cube resins alone, or propargite. One week after the second application, significant mite reductions were found among treated plants except with dicofol and pyrethrum with rotenone and other cube resins; greatest mite reductions were found where bifenthrin was applied.

One week after the third application, numbers of spider mites recorded on the untreated plants had declined from the high level recorded 1 week earlier. The greatest mite reductions at that time were among plants treated with abamectin or propargite, however there was no significant difference between densities on those plants and densities on plants treated with bifenthrin, hexakis alone or in combination with pyrethrum, rotenone and other cube resins. Leaves that had hosted large numbers of spider mites deteriorated and hosted reduced numbers of mites (*viz.* untreated check plants) 1 week after the fourth application, rendering comparisons of treatments effects questionable. Data from that date are not presented.

Experiment 2. Results from the second experiment are recorded in Table 3. There was no effect of alanycarb nor methomyl on numbers of spider mites 1 day after the first application. One day after the second application, there were large numbers of spider mites on plants where alanycarb 2.5 EC or 40 WP were applied at the higher concentrations and where methomyl was applied at the lower concentration compared to untreated check plants. These treatments may have reduced activities of spider mite predators that resulted in reductions of spider mites on untreated plants. All chemical treatments significantly reduced pameras 1

Table 3. Numbers of arthropods on strawberry 1 day after one and two applications of pesticides separated by 14 days.

Treatment	Spider mites/ leaflet		Pameras/ plot		Flower thrips/ 10 flowers	
	One	Two	One	Two	One	Two
Untreated Check	21 a[z]	2 b	9 a	21 a	7 a	9 a
Alanycarb 2.5 EC (low)	27 a	17 ab	1 c	5 bc	1 b	4 b
Alanycarb 2.5 EC (high)	20 a	26 a	1 c	3 c	1 b	3 b
Alanycarb 40 WP (low)	22 a	17 ab	3 b	11 b	1 b	2 b
Alanycarb 40 WP (high)	25 a	21 a	4 b	8 bc	1 b	2 b
Methomyl 1.8 L (low)	26 a	20 a	4 b	7 bc	4 ab	2 b
Methomyl 1.8 L (high)	19 a	17 ab	4 b	8 bc	2 b	2 b

[z]Mean separation in columns by Duncan's multiple range test, 5% level.

day after the first application; all chemical treatments, except methomyl applied at the lower concentration, similarly reduced flower thrips 1 day after the first and second applications.

Results of these experiments indicate that of the miticides evaluated, only bifenthrin and the combination of hexakis and pyrethrum with rotenone and other cube resins reduced spider mite populations after 1 application. Abamectin and propargite resulted in spider mite reductions after 2 or 3 applications. Under the condition of these experiments, dicofol, alanycarb, and methomyl were ineffective in reducing spider mites. Alanycarb and methomyl greatly reduced pameras and flower thrips.

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INFLUENCE OF SOIL PH, NITROGEN SOURCE, AND TRANSPLANT DRENCHES ON DEVELOPMENT OF CROWN ROT OF TOMATO

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Abstract. **Lowering the pH of EauGallie fine sand from 5.5 to 4.5 during Aug. and Sept. 1992 increased the incidence of the stem rot phase (topple) of tomato (*Lycopersicon esculentum* Mill.) Fusarium crown rot (49 vs 11%) and disease severity (64 vs 20%) during fall 1992 and disease incidence (40 vs 22%) and severity (23 vs 8%) during spring 1993. The use of NH_4-N compared to NO_3-N significantly increased disease incidence (92 vs 84%) and severity (48 vs 36%) the fall season and disease incidence (40 vs 23%) and severity (20 vs 11%) the spring season. Disease incidence and severity were much lower the second season than the first season indicating that the pathogen did not survive well in the soil. Fruit yields (25 lb boxes/acre) both seasons were decreased by decreasing the soil pH from 5.5 to 4.5 (850 vs 467 fall, 2015 vs 1308 spring) and by the use of NH_4-N compared to NO_3-N (537 vs 780 fall, 1183 vs 2140 spring). Fungicide and biocontrol agents drenched onto container-grown seedlings before transplanting did not affect crown rot development either season.**

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Fusarium crown and root rot of tomato is caused by the soil-borne pathogen *Fusarium oxysporum* Schlecht. f.sp. *radicis-lycopersici* Jarvis and Shoemaker. In both growth room and field experiments in Florida, disease development was greatly retarded by the use of NO_3-N compared to NH_4-N (Jones, Woltz, and Scott, 1990). Similarly, disease development was consistently inhibited in growth room studies by the addition of calcium carbonate to the potting mix and by the concomitant increase in mix pH (Jones, Woltz, and Scott, 1990). However, disease development was not much influenced by an increase in soil pH in the field perhaps because even the low pH (6.0) regime was sufficiently high to inhibit disease.

Benomyl (Benlate 50WP), especially when combined with high soil pH and NO_3-N, is an effective fungicide for the control of Fusarium wilt of various ornamentals (Engelhard and Woltz, 1973). The wilt Fusaria are morphologically identical to the crown rot Fusarium and in theory should be controlled by similar chemicals. Consequently benomyl drenches at first were compared to biocontrol drenches applied to container transplants prior to transplanting. In a second experiment, benomyl drenches were