MANAGEMENT STRATEGIES FOR THE SWEETPOTATO WHITEFLY

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The sweetpotato whitefly Bemisia tabaci Gennadius (SPWF) has been the primary pest of tomato in south Florida since causing serious economic losses in spring 1988. That year an irregular ripening condition of fruit went undetected until post-harvest ethylene treatment (Maynard & Cantliffe 1988). The following fall, a tomato geminivirus (TGV) transmitted by SPWF appeared simultaneously in the Immokalee/Naples and Palmetto/Ruskin production areas (Hiebert 1990, Kring et al. 1990). TGV seriously impacts yield with reductions of up to 75% if plants are symptomatic 4 weeks post-planting (Stansly & Schuster 1990). High numbers of SPWF are not necessary to initiate and maintain a potentially catastrophic disease cycle, especially when the cycle is prolonged by overlapping plantings. This occurred in the Immokalee area during the 1990/91 season following a warm winter which allowed harvested fields to serve as a source of both inoculum and whiteflies for the spring crop. Insecticides were of little help in stemming the tide of viruliferous whiteflies into newly planted fields with disastrous results.

Clearly, more effective management strategies are required to deal with SPWF and TGV. In addition to more economical and effective insecticides to control whitefly within the crop, it is also necessary to manage the entire cropping system to avoid build-up and movement of SPWF and TGV from crop to crop. Fields heavily infected during spring 1991 had been relatively clean the previous spring after the Christmas freeze eliminated SPWF and TGV along with the fall crop. We can learn from that painful experience how to better manage these twin treats to tomato production.

Carryover between crops. Standard post-harvest practice is desiccation with a herbicide or simply curtailing irrigation, driving whiteflies out of the field in search of greener "pastures". The crop may be left standing "in limbo" while managers watch the market, causing a slower but larger exodus.

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The effect on newly planted fields nearby can be devastating as seen last spring in Immokalee. Although fall and spring tomato crops do not generally overlap in the Palmetto/Ruskin area, winter crops such as cabbage may provide a bridge between seasons, at least for SPWF (Table 1).

Ideally, old and new crops should be widely separated in time and/or space, but unfortunately, this is not always practical. An alternative would be a practical method of killing both plants and whiteflies. We are still working on this problem and carrying out field tests to compare the effectiveness of herbicides either alone or in combination with insecticides and propane flamers to kill vines and whiteflies, especially adult whiteflies.

Insecticide Resistance. Faced with the threat of serious economic losses, growers are forced to rely on a limited arsenal of insecticides, each application of which increases selection pressure for resistant strains of SPWF. Reduced susceptibility is now detectable in both the Immokalee and Palmetto/Ruskin productions areas, especially to endosulfan (Thiodan) and fenvalerate (Pydrin) (Table 2). These levels of apparent resistance signal the need for careful management i.e, rotation and reduced usage of particular classes of insecticide.

Spray materials. During the 1990/91 season there was widespread interest in the use of household liquid detergents for control of SPWF. The initial inspiration may have been articles appearing in national and local newspaper reporting results obtained by USDA researchers at the Western Cotton Insects Laboratory in Tempe, Arizona (Butler & Henneberry 1990). The experiments were done in the greenhouse by individually spraying leaves heavily infested with SPWF nymphs and pupae. The leaves were picked 24 hours later, and placed in a petri dish, their undersides in close contact to water-sensitive paper. Live nymphs secrete honeydew which will leave a visible spot on the paper. After 15 minutes mortality is evaluated by comparing the number of spots on papers from treated leaves to an unsprayed control. Many detergents and oils were tested in this way, and most caused greater than 90% mortality to SPWF immatures at concentrations of 1% (Butler et al. 1991).

In this same paper we report similar results from a field trial on cucumber at SWFREC and the effect on adults in a commercial cucumber field near GCREC using a hand-held motorized "Solo" sprayer to obtain underleaf coverage of mature vines. The plots were sampled before and after spraying by shaking 5 leaves over a black aluminum baking pan coated with an oil/detergent mixture to trap adult whiteflies. Significant reductions in SPWF populations were obtained with 0.5% solutions of detergent, M-Pede insecticidal soap, soybean oil and Saf-T-Side oil, with no significant differences between treatments

although the lowest counts were obtained from the detergent plots.

Another field experiment at SWFREC in spring 1991 tested the efficacy of one detergent (Liquid Tide) sprayed either twice a week, or once a week alternated with a crop oil (JMS Stylet Oil) to three chemical insecticide regimes: Asana XL tankmixed with Lorsban alternated with Thiodan every 7 days, Danitol tankmixed with Monitor alternated with Thiodan every 10 days, and Danitol alternated with Monitor alternated with Thiodan ever 7 days. The overall rates per acre of Danitol and Monitor were the same in both treatments employing these materials. Plots were 2 rows wide and 25 feet long, and there were 8 replications of each material.

Plots were planted 15 March and two TGV-infected plants per plot were set out on 21 March to provide an inoculum source. Treatments began on 26 March and ended on 9 May. Whitefly immatures were counted on the terminal trifoliate of the 6th leaf from the top of 3 randomly selected plants per plot at 2-week intervals (N=4). Adult whitefly were counted on 4 alternate weeks by carefully inverting the 3rd leaf from the top of 3 randomly chosen plants per plot. All plants were inspected weekly for geminivirus symptoms. Fruit was not suitable for normal grading due to a heavy infestation of tomato pinworm, and only total fruit number and weight was obtained (harvest 25 May).

Only in plots treated with 0.25% Tide Liquid Detergent twice a week were there significantly fewer SPWF (small and large sessile nymphs) than either the unsprayed check or some other treatment (Table 3a). Three treatments had significantly lower geminivirus incidence through 47 days post-planting than the unsprayed check: Tide Liquid Detergent twice a week, Tide Liquid once a week alternated with JMS Stylet Oil and Monitor + Danitol alternated with Thiodan once a week (Table 3d). There were no significant differences in yield.

Although it appears that detergents may be useful in augmenting the arsenal against SPWF, it must be stressed that the results reported here are still preliminary. Of even greater concern are the possible phytotoxic effects of detergents reported by Vavrina & Stansly at this meeting.

Additional results from field tests with chemical insecticides and petroleum oils carried out by DJS at GCREC in Bradenton are given in Tables 4 through 7.

Applications methods. All lifestages of SPWF normally occur on the underside of the leaf where adequate spray coverage is most difficult. The excellent control of SPWF with oils and detergents reported by Butler et al. (1991) were obtained by hand spraying the leaf underside to runoff or nearly so.

Growers apply less material and the coverage obtained in commercial applications is inferior. It is clear that many materials are effective in killing SPWF if adequate coverage can be obtained.

The spring 1991 field trial at SWFREC described above compared two types of sprayers, one using high pressure technology, and the other ("Berthoud") employing a high-speed ,fan-generated airstream to atomize and propel the spray material and also to agitate the plant canopy. Four of the 8 replications for each treatment were randomly chosen to be sprayed with a tractor-drawn boom sprayer using a diaphragm pump and drop nozzles fitted with Albuz ceramic hollow cone tips (ATR lilac delivering ca. 0.223 gal/min @ 400 lbs/in^2) calibrated at 103 gal/acre at the maximum of 8 nozzles per row. The other 4 replications were sprayed with "Berthoud" airboom sprayer, which when employing all 4 nozzles per row (bottom "fan" and top "cannon") was calibrated at 104 gal/acre. However, 163 gal/acre were inadvertently put out with the airboom sprayer when only 2 nozzles per row were used for the first 2 applications.

Differences between the two kinds of sprayers were not significant for any particular lifestage of SPWF. However, the airboom sprayer gave consistently better control over all lifestages including adults (Table 8), and over all observation dates, including later ones when the two sprayers were calibrated at the same rate. In contrast, there were no differences between sprayers in counts of leafminer and tomato pinworm, whose control on the outside, sampled leaves probably did not depend on underleaf coverage.

In another field test, water sensitive paper was used to compare coverage obtained with the two sprayers. One inch squares of the paper were stapled to the underside of leaves in 4 locations on the plant. The paper sections where then separated into 5 coverage categories and the results tabulated (Table 9). They showed that significantly better coverage was obtained with the airboom sprayer, especially of the inside portions of the plant.

Biological Control. Anyone searching for SPWF in relatively undisturbed habitat, even where host plants are abundant, will probably be struck by its scarcity compared to cultivated fields. The reasons for this scarcity is uncertain, although it is likely that mortality from naturally occurring predators, parasites, and pathogens is a significant factor. Recent surveys have shown that hymenopteran (wasp) parasites are a significant component in the natural enemy complex attacking SPWF in Florida, with the relative importance of specific parasite species showing seasonal and host-plant variations (Fig 1.)

Table 1. Sticky trap catches of sweetpotato whitefly in the Palmetto/Ruskin production area (DJS, unpublished data).

	Number of Sweetpotato Whitefly Adults/Trap					
	Week of Sampling					
Commodity	2/18	3/5	3/18	4/1	4/15	4/29
Cabbage	143	35	86	28	46	8
Potatoes	2	5	24	33	36	29
Tomato	<1	<1	<1	6	7	11
Cherry Tomato	0	1	1	4	22	27
Pepper	0	1	0	2	2	2
Squash	<1	<1	2	<1	92	0
Cucumber	0	<1	1	0	8	6

Table 2. Mortality of field-collected SPWF in 1991 compared to a laboratory-reared susceptibile colony as determined by bioassay at a dose equal to the LC 50 for the reference colony (G. L. Leibee & C. E. Mantilla, unpublished data).

		Insecticide		
Location	Date	Endosulfan	Fenvalerate	Chlorpyrifos
Immokalee_1	7 Feb.	26%	57%	79%
Immokalee_1	18 Apr.	88%	45%	180%
Immokalee_2	2 May	20%	57%	23%
Immokalee_3	2 May	45%	69%	20%
Ruskin	16 May	35%	86%	49%
Parrish	16 May	10%	83%	42%

Table 3a. Mean number of SPWF per sample and tomato geminivirus incidence over 4 sampling periods.

Treatment	Rate (ai/100Gal.)	Frequency	Whitefly Stage						
			Eggs	Crawlers	Sm. Nymphs	Lg. Nymphs	Pupae	Adults	Virus
1. Tide Liq.	0.25gal.	2 x per week	5.1a[1]	0.3a	19.9b	0.5b	0.5a	2.0a	41.9c
2. JMS Stylet Oil Tide Liquid	0.75gal.	1 x per week	6.7a	0.0a	34.5a	5.5a	1.0a	2.2a	40.5c
3. Monitor+ Danitol or Thiodan	0.75lbs. 0.2lbs. 0.5lbs.	Sequentially, every 10 days.	10.6a	0.1a	23.6a	2.4ab	0.8a	1.8a	47.3c
4. Monitor or Danitol or or Thiodan	0.75lbs. 0.2lbs. 0.5lbs.	Sequentially, every 7 days.	6.0a	0.0a	22.9a	3.8ab	0.3a	2.2a	59.9bc
5. Asana+ Lorsban or Thiodan	0.05lbs. 1.0lbs. 0.5lbs.	Sequentially, every 10 days.	10.7a	0.1a	32.5a	4.9ab	2.0a	2.8a	65.3ab
6. Unsprayed Check			7.1a	0.0a	38.2a	5.2a	1.4a	3.1a	73.3a

[1]Means in the same column followed by the same letter are not significantly different (P < 0.05; LSD test).

Table 3b. Mean number of tomato pinworms per 3 trifoliate sample and mean yield per plot.

Treatment	Rate (a.i./100gal)	Frequency	Pinworms		Fruit	
			Live	Dead	Number	Weight
Monitor w/ Danitol or Thiodan	0.75lbs. 0.2lbs. 0.5lbs.	Sequentially, every 7 days.	0.2c	33.1ab	277 a	37.9a
Asana & Lorsban or Thiodan	0.05lbs. 1.0lbs. 0.5lbs	Sequentially, every 10 days.	1.1a	49.7a	345 a	44.3a
Unsprayed Check			0.9ab	48.4a	281 a	33.7a
Stylet Oil	0.75gal.	2 x per week	0.6abc	33.8ab	283 a	35.5a
Tide Liquid	0.25gal.	2 x per week	0.4bc	25.0b	357 a	41.8a
Monitor & Danitol or Thiodan	0.75lbs. 0.2lbs. 0.5lbs.	Sequentially, every 10 days.	0.5bc	27.3b	290 a	39.3a

Table 4. Management of SPWF and FTGV with insecticides, GCREC Bradenton, Fall 1990 - a. SPWF, b. yield, c.,d. FTGV incidence.

Treatment and lb (AI)/acre		No. sweetpotato whitefly immatures/10 leaflets							
		Eggs		Crawlers		Sessile nymphs		Pupae	
		25 Oct	27 Nov	25 Oct	27 Nov	25 Oct	27 Nov	25 Oct	27 Nov
Brigade 10 WP	0.1	1.7a*	0.5a	2.3ab	0.5a	0.0a	0.2a	0.3a	0.0a
Brigade 10 WP	0.05	2.2a	0.5a	1.8ab	1.5a	1.8ab	0.0a	0.8a	0.0a
Asana XL 0.66 EC + Monitor 4 EC**	0.05 0.75	3.2abc	0.5a	3.5ab	0.5a	2.8abc	0.2a	1.0ab	0.2a
Asana XL 0.66 EC + Lorsban 50 WP	0.05 0.75	2.0a	0.0a	2.0ab	0.8a	0.5a	0.0a	0.2a	0.2a
CME 13411 100Gm/L***	0.06	2.8ab	0.2a	3.2ab	1.2a	4.2abc	0.0a	2.0b	0.0a
Danitol 2.4 EC	0.2	3.5abc	0.5a	1.5ab	1.8a	2.2abc	0.2a	0.0a	0.2a
Danitol 2.4 EC + Monitor 4 EC	0.2 0.75	2.0a	0.8a	1.0a	1.2a	0.5a	0.0a	0.0a	0.2a
Danitol 2.4 EC + Monitor 4 EC**	0.2 0.75	4.0abc	1.2a	0.8a	1.0a	3.0abc	2.2a	0.0a	0.8a
FCI 1555B		9.8c	0.8a	4.0ab	1.2a	5.8bc	0.2a	0.8a	0.2a
Lorsban 50 WP	1.0	4.0abc	0.2a	3.0ab	0.5a	2.0abc	0.0a	0.2a	0.0a
SN 85292 400 Gm/L SC	0.375	5.0abc	1.0a	6.2ab	0.8a	2.0abc	1.5a	0.0a	0.0a
Check (water)	---	9.2bc	0.5a	6.8ab	2.2a	6.8c	0.8a	0.8a	0.2a

*Means within a column followed by the same letter are not significantly different at P<0.05 level, Duncan's multiple range test.
**Applied every two weeks.
***Applied weekly until 13 Nov., then every two weeks thereafter.

Three row (5 ft centers) by 20 ft plots, 4 replications, planted 5 Sep., 13 applications from 14 Sep. to 3 Dec., using "highboy sprayer @ 200 psi 3.4 mph with #3 disks & 25° cores, 4 nozzles per row minimum (50 gpa) 8 nozzles maximum (100 gpa). Seventh or 8th terminal leaflet sampled for immature SPWF, all plants examined for FTGV, all fruit harvested three times beginning 14 Nov., 50 fruit samples ripened in paper bags and graded 1 to 4 for irregular ripening.

Table 4b.

Treatment and lb (AI)/acre		Fruit yield/10 plants No.	Wt(lb)	Wt/fruit	Irregular ripening Rating	% Unmarketable
Brigade 10 WP	0.1	348.0a	87.9a	0.254abc	2.0a	1.0a
Brigade 10 WP	0.05	342.8a	77.3a	0.226bc	2.0a	0.7a
Asana XL 0.66 EC + Monitor 4 EC**	0.05 0.75	344.5a	80.7a	0.235abc	2.0a	0.0a
Asana XL 0.66 EC + Lorsban 50 WP	0.05 0.75	340.8a	74.5a	0.217bc	2.0a	0.6a
CME 13411 100Gm/L***	0.06	294.3a	80.5a	0.289a	2.0a	0.0a
Danitol 2.4 EC	0.2	336.5a	78.2a	0.232abc	2.0a	0.7a
Danitol 2.4 EC + Monitor 4 EC	0.2 0.75	370.5a	92.0a	0.247abc	2.0a	0.5a
Danitol 2.4 EC + Monitor 4 EC**	0.2 0.75	344.5a	85.7a	0.243abc	2.0a	0.4a
FCI 1555B		341.0a	95.8a	0.278ab	2.0a	0.0a
Lorsban 50 WP	1.0	321.0a	80.2a	0.252abc	2.0a	0.4a
SN 85292 400 Gm/L SC	0.375	373.8a	78.0a	0.211c	2.0a	0.2a
Check (water)	---	352.5a	71.1a	0.202c	2.0a	0.8a

*Means within a column followed by the same letter are not significantly different

Table 4c.

Treatment and lb (AI)/acre		% virus infected plants					
		19 Sept	27 Sept	4 Oct	12 Oct	18 Oct	24 Oct
Brigade 10 WP	0.1	0.0a*	9.7ab	20.0a	30.9a	54.1a	63.8a
Brigade 10 WP	0.05	0.0a	11.0ab	22.6a	34.1a	62.9a	79.6abc
Asana XL 0.66 EC	0.05						
+ Monitor 4 EC**	0.75	0.0a	9.0ab	23.1a	33.3a	69.3a	86.5abc
Asana XL 0.66 EC	0.05						
+ Lorsban 50 WP	0.75	0.0a	7.1a	19.4a	26.4a	58.0a	72.2abc
CME 13411 100Gm/L***	0.06	0.0a	14.8ab	33.3a	47.5a	77.6a	87.8bc
Danitol 2.4 EC	0.2	0.0a	12.3ab	26.4a	32.9a	63.9a	85.2abc
Danitol 2.4 EC	0.2						
+ Monitor 4 EC	0.75	0.0a	9.7ab	16.8a	26.5a	51.6a	66.5ab
Danitol 2.4 EC	0.2						
+ Monitor 4 EC**	0.75	0.0a	10.3ab	21.2a	30.2a	59.2a	77.8abc
FCI 1555B		0.0a	14.8ab	33.9a	43.0a	76.9a	90.4a
Lorsban 50 WP	1.0	0.0a	21.2b	30.2a	42.4a	68.2a	82.5abc
SN 85292 400Gm/L SC	0.375	0.0a	16.0ab	28.9a	43.0a	77.6a	91.0c
Check (water)	---	0.0a	15.4ab	25.6a	39.8a	74.4a	85.9abc

Table 4d.

Treatment and lb (AI)/acre		% virus infected plants			
		1 Nov	7 Nov	16 Nov	23 Nov
Brigade 10 WP	0.1	80.0ab	87.1ab	87.1a	87.1a
Brigade 10 WP	0.05	90.5abc	96.2abc	96.8abc	96.8abc
Asana XL 0.66 EC + Monitor 4 EC**	0.05 0.75	95.5ab	99.4c	100.0c	100.0c
Asana XL 0.66 EC + Lorsban 50 WP	0.05 0.75	85.7abc	87.6abc	88.2ab	88.2ab
CME 13411 100Gm/L***	0.06	95.5ab	96.8abc	98.1bc	98.1bc
Danitol 2.4 EC	0.2	98.1b	98.7bc	98.7bc	98.7c
Danitol 2.4 EC + Monitor 4 EC	0.2 0.75	78.7a	86.4a	89.0ab	90.3abc
Danitol 2.4 EC + Monitor 4 EC**	0.2 0.75	88.9abc	92.2abc	93.4abc	94.1abc
FCI 1555B		94.9ab	97.4abc	97.4abc	98.1bc
Lorsban 50 WP	1.0	94.8ab	98.7bc	98.7bc	98.7c
SN 85292 400Gm/L SC	0.375	96.2b	98.1abc	98.1bc	98.7c
Check (water)	---	94.9ab	96.2abc	96.8abc	97.5bc

Table 5. Management of SPWF and FTGV with insecticides, GCREC Bradenton, Spring 1991, a. SPWF, b. leafmines and yield, c.,d. FTGV incidence.

Treatment and lb (AI)/acre		No. sweetpotato whitefly immatures/10 leaflets				
		Eggs	Crawlers	Sessile nymphs	Pupae	Pupae exuviae
Agri-Mek 0.15 EC	0.01	46.5b*	244.5a-c	115.5a-c	10.8b-d	18.8a-d
Agri-Mek 0.15 EC + Saf-T-Side Oil	0.01 1% v/v	54.8b	249.0a-c	106.8a-d	4.8c-e	8.3cd
Asana XL 0.66 EC + Lorsban 50 WP	0.05 1.0	33.5b	64.7d	29.8c-f	1.0de	2.0d
Asana XL 0.66 EC & Lorsban 50 WP**	0.05 1.0	41.3b	83.0cd	25.8c-f	0.5de	1.3d
Danitol 2.4 EC + Monitor 4 EC	0.2 0.75	21.3b	127.2b-d	11.3f	0.8de	1.0d
Foil OF	3qt***	56.5b	454.0a	102.0b-e	23.3ab	9.5cd
Lorsban 50 WP + crop oil****	1.0 1% v/v	52.3b	263.8ab	83.5b-f	5.3c-e	8.3cd
Margosan-O 3%	20 ppm	31.5b	305.5ab	229.8a	48.0a	78.8a
MK-936 MPF 0.15 EC	0.01	42.8b	232.5a-c	165.5ab	28.8ab	51.0ab
RH-9999 20 WP*****	0.1	35.0b	209.3a-c	63.5b-f	8.5b-e	15.8b-d
RH-9999 20 WP	0.05	41.8b	269.5a-c	208.0ab	14.0a-c	19.3a-d
RH-9999 20 WP	0.025	58.5b	280.3ab	152.0ab	23.5ab	29.5a-c
SN 85292 40SC	0.38	48.3b	267.0a-c	25.0d-f	0.3e	3.0cd
Trophy 1EC + Lorsban 50 WP	0.03 1.0	24.3b	168.5b-d	18.5ef	1.0de	1.8d
Check (water)	---	150.5a	288.8ab	104.5a-d	16.0a-c	42.0ab

Methods as in Table 4. Planting date 14 Mar., 10 applications between 10 Mar. and 29 May, 2 harvests 28 May and 3 June.

Table 5b.

Treatment and lb (AI)/acre		No. leafmines/ min search	Fruit yield/10 plants No.	Wt(lb)	Wt/fruit
Agri-Mek 0.15 EC	0.01	28.0b	281.0a-c	78.0a	0.28a
Agri-Mek 0.15 EC + Saf-T-Side Oil	0.01 1% v/v	11.3b	242.0a-e	65.0a-d	0.27a
Asana XL 0.66 EC + Lorsban 50 WP	0.05 1.0	110.3a	264.8a-d	68.5a-d	0.26a
Asana XL 0.66 EC & Lorsban 50 WP**	0.05 1.0	66.5a	239.5a-e	58.0a-e	0.24a-c
Danitol 2.4 EC + Monitor 4 EC	0.2 0.75	100.8a	251.5a-e	60.1a-d	0.24a-c
Foil OF	3qt***	68.0a	199.5de	49.0df	0.24a-c
Lorsban 50 WP + crop oil****	1.0 1% v/v	91.5a	216.0c-e	50.2c-f	0.23a-c
Margosan-O 3%	20 ppm	118.0a	190.0e	40.1ef	0.19bc
MK-936 MPF 0.15 EC	0.01	21.0b	200.0de	37.8f	0.18c
RH-9999 20 WP*****	0.1	115.0a	271.0a-c	75.9ab	0.28a
RH-9999 20 WP	0.05	92.3a	217.8c-e	52.8b-f	0.24a-c
RH-9999 20 WP	0.025	65.8a	218.8b-e	51.5c-f	0.23a-c
SN 85292 40SC	0.38	96.8a	288.5ab	73.5a-c	0.25ab
Trophy 1EC + Lorsban 50 WP	0.03 1.0	105.3a	236.3a-e	60.0a-d	0.26a
Check (water)	---	117.8a	296.5a	80.4a	0.27a

*Data were transformed square root of X+0.5 prior to analyses but are presented in the original scale. Means within a column followed by the same letter are not significantly different at P<0.05 level, Duncan's multiple range test.
**Alternated every three to four days.
***Amount of product.
****Lorsban was combined with Saf-T-Side Oil for the first 8 applications and with Sunspray Ultrafine Oil for the last two applications.
*****Combined with Triton B-1956 at 0.06% v/v.

Table 5c.

Treatment and lb (AI)/acre		virus infected plants				
		10 Apr	17 Apr	24 Apr	3 May	8 May
Agri-Mek 0.15 EC	0.01	0.0b*	3.3ab	3.3ab	6.4a	10.9a
Agri-Mek 0.15 EC + Saf-T-Side Oil	0.01 1% v/v	0.6ab	1.3a-c	2.6ab	5.1ab	7.0a-c
Asana XL 0.66 EC + Lorsban 50 WP	0.05 1.0	0.0b	1.3a-c	2.5ab	3.8ab	5.8a-c
Asana XL 0.66 EC & Lorsban 50 WP**	0.05 1.0	0.6ab	0.6bc	0.6ab	1.9ab	3.2a-c
Danitol 2.4 EC + Monitor 4 EC	0.2 0.75	0.0b	0.0c	0.0b	0.0b	0.6c
Foil OF	3qt***	0.0b	0.0c	1.3ab	2.5ab	2.5a-c
Lorsban 50 WP + crop oil****	1.0 1% v/v	0.0b	0.0c	0.6ab	3.2ab	5.8a-c
Margosan-O 3%	20 ppm	0.6ab	1.3a-c	1.3ab	2.6ab	3.8a-c
MK-936 MPF 0.15 EC	0.01	0.0b	0.6bc	2.6ab	5.1ab	5.8a-c
RH-9999 20 WP*****	0.1	0.0b	1.3a-c	2.6ab	5.1ab	8.3ab
RH-9999 20 WP	0.05	1.3a	3.2a	3.8a	7.0a	9.0a
RH-9999 20 WP	0.025	0.0b	0.0c	1.3ab	2.6ab	3.8a-c
SN 85292 40SC	0.38	0.0b	0.6bc	1.3ab	6.4a	10.3a
Trophy 1EC + Lorsban 50 WP	0.03 1.0	0.0b	0.0c	0.0b	1.3ab	1.3bc
Check (water)	---	0.0b	0.6bc	1.3ab	2.5ab	7.1a-c

Table 5d.

Treatment and lb (AI)/acre		virus infected plants		
		17 May	23 May	30 May
Agri-Mek 0.15 EC	0.01	12.2ab	21.1a-c	27.6a
Agri-Mek 0.15 EC + Saf-T-Side Oil	0.01 1% v/v	7.7a-c	17.3a-d	17.3a-c
Asana XL 0.66 EC + Lorsban 50 WP	0.05 1.0	5.8bc	14.7a-d	14.7a-c
Asana XL 0.66 EC & Lorsban 50 WP**	0.05 1.0	4.5bc	7.7b-d	7.7bc
Danitol 2.4 EC + Monitor 4 EC	0.2 0.75	4.5bc	7.0d	7.1c
Foil OF	3qt***	10.3a-c	17.9a-d	17.9a-c
Lorsban 50 WP + crop oil****	1.0 1% v/v	9.6a-c	18.0a-d	20.5ab
Margosan-O 3%	20 ppm	10.9a-c	21.7a-c	21.7ab
MK-936 MPF 0.15 EC	0.01	10.3a-c	14.1a-d	16.0a-c
RH-9999 20 WP*****	0.1	10.9ab	25.0ab	25.0ab
RH-9999 20 WP	0.05	21.8a	29.5a	29.5a
RH-9999 20 WP	0.025	8.3a-c	12.8a-d	13.5a-c
SN 85292 40SC	0.38	10.9a-c	21.8a-c	21.8ab
Trophy 1EC	0.03	1.3c	7.1c-d	7.7bc
Check (water)	---	8.4a-c	19.9a-c	19.9ab

Table 6. Management of SPWF and FTGV with pyrethroid/organophosphate combinations, GCREC Bradenton, Spring 1991, a.,b. SPWF adults, c.,d. SPWF immatures, e. FTGV incidence, f. yield.

		No. adults/trap							
		20	27	3	11	17	24	3	15
Treatment and lb (AI)/acre		Mar	Mar	Apr	Apr	Apr	Apr	May	May
Asana XL 0.66 EC	0.05								
+ Monitor 4 EC	0.75	0.0a*	1.5a	0.5a	27.0a	7.0a	3.0a	3.5a	2.0b
Danitol 2.4 EC	0.2								
+ Monitor 4 EC	0.75	0.0a	0.0a	0.0a	28.0a	8.5a	21.0a	2.0a	0.5b
Check (water)	---	0.0a	1.0a	1.5a	19.5a	13.5a	29.0a	21.5a	21.5a

Table 6b.

		No. adults/30 leaves							
		28	4	10	17	23	2	8	23
Treatment and lb (AI)/acre		Mar	Apr	Apr	Apr	Apr	May	May	May
Asana XL 0.66 EC	0.05								
+ Monitor 4 EC	0.75	1.5a	4.0a	1.5a	0.5a	1.5a	9.0a	2.5a*	19.0b
Danitol 2.4 EC	0.2								
+ Monitor 4 EC	0.75	0.0a	0.5a	2.0a	0.5a	1.0a	8.5a	0.5a	4.5b
Check (water)	---	6.0a	6.0a	4.5a	1.0a	13.5a	4.0a	2.0a	228.5a

Methods as in Table 4 and 5 except that plots were 50 ft long and separated by 50 ft. Adult SPWF sampled each plot for 24 hr with a 4 in^2 yellow water pan trap and counted on an upper, middle and lower leaf of 10 plants/plot. Planting date: 8 Mar., 11 applications from 15 Mar. to 29 May, harvests: 24 May, 3 June.

Table 6c.

Treatment and lb (AI)/acre		No. sweetpotato whitefly immatures/10 leaflets											
		Eggs				Crawlers				Sessile nymphs			
		23 Apr	9 May	23 May	7 June	23 Apr	9 May	23 May	7 June	23 Apr	9 May	23 May	7 June
Asana XL 0.66 EC + Monitor 4 EC	0.05 0.75	0.5a*	0.0b	9.5b	15.0a	1.5a	1.5b	8.0b	71.5b	0.0b	1.5b	1.5b	29.5b
Danitol 2.4 EC + Monitor 4 EC	0.2 0.75	0.5a	0.0b	4.5b	4.0a	0.5a	1.0b	2.0b	56.5b	0.0b	1.5b	0.0b	4.0c
Check (water)	---	11.5a	53.0a	335.0a	24.0a	13.0a	45.5a	158.5a	325.5a	16.5a	105.0a	121.5a	260.5a

Table 6d.

Treatment and lb (AI)/acre		No. sweetpotato whitefly immatures/10 leaflets							
		Pupae				Pupae exuviae			
		23 Apr	9 May	23 May	7 June	23 Apr	9 May	23 May	7 June
Asana XL 0.66 EC + Monitor 4 EC	0.05 0.75	0.0a	0.0a	0.0b	11.0b	0.0a	0.0a	0.0b	18.5b
Danitol 2.4 EC + Monitor 4 EC	0.2 0.75	0.0a	0.0a	0.0b	1.5b	0.0a	0.0a	0.0b	2.5b
Check (water)	---	0.0a	1.0a	19.0a	49.0a	2.0a	0.0a	56.0a	90.0a

*Data were transformed $\log_{10}$ (X+1) prior to analyses but are presented in the original scale. Means within a column followed by the same letter are not significantly different at $F \leq 0.05$ level, orthogonal contrasts in analyses of variance.

Table 6e.

Treatment and lb (AI)/acre		% virus infected plants								
		27 Mar	3 Apr	10 Apr	17 Apr	24 Apr	8 May	17 May	23 May	30 May
Asana XL 0.66 EC + Monitor 4 EC	0.05 0.75	1.0a*	1.0a	1.5a	2.0a	4.0a	4.0a	4.5a	6.5a	6.5a
Danitol 2.4 EC + Monitor 4 EC	0.2 0.75	0.5a	0.5a	0.5a	2.5a	4.0a	4.0a	5.5a	6.0a	6.0a
Check (water)	---	5.5a	5.5a	12.0a	15.0a	19.0a	19.0a	37.5a	46.0a	50.0a

Table 6f.

Treatment and lb (AI)/acre		Fruit yield/20 plants								Irregular ripening rating	
		Extra large		Large		Medium		Cull			
		No.	Wt(lb)	No.	Wt(lb)	No.	Wt(lb)	No.	Wt(lb)	Internal	External
Asana XL 0.66 EC + Monitor 4 EC	0.05 0.75	115.5a**	48.1a	158.0a	49.7a	277.0a	65.4a	174.5a	33.1a	2.0a	3.6a
Danitol 2.4 EC + Monitor 4 EC	0.2 0.75	103.5a	42.9a	178.0a	59.2a	259.0a	64.3a	110.0a	24.1a	2.0a	3.3a
Check (water)	---	147.5a	62.2a	177.5a	55.0a	172.0a	42.3a	87.5a	26.3a	2.3a	4.1a

Table 7. Management of SPWF and FTGV with petroleum oils, GCREC Bradenton, Fall 1990: a. adults, b. SPWF immatures, c. FTGV incidence, d. yield.

Treatment	Gal/ 100 gal	Application pressure	No. sweetpotato whitefly adults/30 leaves					
			21 Sept	2 Oct	17 Oct	2 Nov	9 Nov	20 Nov
JMS Stylet Oil	0.5-0.75*	400	10.0a**	28.5ab	1.5a	13.5ab	21.5a	58.5a
JMS Stylet Oil	0.5-0.75	200	8.0a	17.5b	5.5a	12.0ab	10.5a	52.5a
Saf-T-Side Oil	2	200	7.5a	16.5b	13.0a	8.5b	14.0a	38.0a
Sunspray Ultrafine	2	400	7.0a	16.5b	6.5a	11.5ab	6.0a	48.5a
Sunspray Ultrafine	2	200	9.0a	17.5b	9.0a	11.5ab	12.5a	53.0a
Super Savol	2	200	6.0a	20.5ab	5.0a	8.0b	13.0a	55.5a
Check (water)	-	200	9.0a	40.5a	9.0a	10.0ab	64.0a	68.5a

*The 0.5 gal rate was applied the first three applications and the 0.75 rate the remaining applications.
**Means within a column followed by the same letter are not significantly different at the P<0.05 level, Duncan's multiple range test.

Plots 3-25 ft rows, 2 replications planted 10 Sep. Twelve applications from 12 Sep. - 26 Nov. using tracter drawn boom sprayer @ 200 psi D3 disks & 25^{0} cores, 4 nozzles per row (80 gpa with 1 ft extensions (4 times) or 50 gpa without extensions (once), 6 nozzles 75 gpa (twice), 8 nozzles 100 gpa (5 times) or @ 400 psi with TX5-SS hollow core nozzles (6 per row with 2 overhead delivering 85 gpa 4 times, 4 per row, 35 gpa once, 6 per row 50 gpa twice, and 8 nozzles per row, 70 gpa 5 times). Harvest 15 Nov., 5, and 18 Dec.

Table 7b.

Treatment	Gal/ 100 gal	Application pressure(psi)	No. sweetpotato whitefly immatures/10 leaflets							
			Eggs		Crawlers		Sessile nymphs		Pupae	
			23 Oct	20 Nov	23 Oct	20 Nov	23 Oct	20 Nov	23 Oct	20 Nov
JMS Stylet Oil	0.5-0.75*	400	38.0a**	83.5a	11.0a	110.5ab	69.5a	105.5a	3.0a	17.0a
JMS Stylet Oil	0.5-0.75	200	31.5a	28.0a	7.0a	76.5ab	40.5a	37.0a	2.0ab	13.0a
Saf-T-Side Oil	2	200	27.0a	132.5a	13.0a	170.0a	24.0a	106.0a	0.0b	6.5a
Sunspray Ultrafine	2	400	31.5a	9.0a	8.0a	26.0b	32.0a	32.0a	0.5ab	2.5a
Sunspray Ultrafine	2	200	48.0a	39.0a	33.5a	43.5b	39.5a	52.0a	1.5ab	3.0a
Super Savol	2	200	41.0a	38.0a	24.5a	78.5ab	29.0a	49.0a	0.5ab	3.0a
Check (water)	-	200	39.5a	37.0a	29.5a	78.5ab	40.5a	58.5a	2.5ab	10.0a

Table 7c.

Treatment	Gal/ 100 gal	Application pressure(psi)	% virus infected plants							
			20 Sept	27 Sept	4 Oct	12 Oct	18 Oct	24 Oct	1 Nov	7 Nov
JMS Stylet Oil	0.5-0.75*	400	0.0b**	0.0a	5.9cd	17.7ab	69.6ab	87.3a	98.0ab	100.0a
JMS Stylet Oil	0.5-0.75	200	0.0b	1.0a	8.8bcd	22.6ab	74.5ab	91.2a	98.0ab	100.0a
Saf-T-Side Oil	2	200	0.0b	0.0a	3.0d	10.9b	48.9c	70.8b	94.9ab	100.0a
Sunspray Ultrafine	2	400	0.0b	2.0a	15.7ab	24.5ab	57.8bc	85.3ab	96.1ab	99.0a
Sunspray Ultrafine	2	200	0.0b	1.0a	12.7abc	26.5ab	64.7abc	88.2a	96.1ab	100.0a
Super Savol	2	200	0.0b	2.0a	4.9cd	16.6b	63.6abc	77.7ab	92.3b	100.0a
Check (water)	-	200	2.0a	6.9a	20.6a	35.3a	79.4a	91.2a	100.0a	100.0a

Table 7d.

Treatment	Gal/ 100 gal	Application pressure(psi)	Yield/10 plants No.	Yield/10 plants Wt (lb)	Yield/10 plants Wt/fruit	Irregular ripening Rating	Irregular ripening % unmarketable
JMS Stylet Oil	0.5-0.75*	400	224.5a**	60.1bc	0.27a	2.2a	16.1a
JMS Stylet Oil	0.5-0.75	200	227.0a	67.8ab	0.30a	2.2a	11.7a
Saf-T-Side Oil	2	200	316.0a	83.1a	0.26a	2.1a	8.8a
Sunspray Ultrafine	2	400	290.5a	46.8c	0.16b	2.1a	5.4a
Sunspray Ultrafine	2	200	285.0a	66.8ab	0.24ab	2.2a	15.1a
Super Savol	2	200	226.5a	59.4bc	0.26a	2.1a	9.5a
Check (water)	-	200	292.5a	72.5ab	0.25a	2.3a	19.2a

*The 0.5 gal rate was applied the first three applications and the 0.75 rate the remaining applications.
**Means within a column followed by the same letter are not significantly different at the P<0.05 level, Duncan's multiple range test.

Table 8. Average numbers of SPWF, leafminers and tomato pinworm per sample by sprayer type.

Treatment	WF Eggs	Crawlers	Sm. Nymphs	Lg. Nymphs	Pupae	Total Immatures
Berthoud	5.20a	0.20a	22.75b	2.06a	0.38a	30.59
None	7.06a	0.00a	38.22a	5.19a	1.44a	51.91
Pressure	10.43a	0.03a	30.61ab	4.79a	1.49a	47.34

Treatment	Leafminer Live	Leafminer Dead	Leafminer Total	Leafminer Emerged	Live Stings	Dead Pinworm	Pinworm	SPWF Adults	%Virus
Berthoud	3.65a	0.25a	7.47	2.29a	4.42a	0.50a	30.09b	3.06b	50.58b
None	3.72a	0.25a	6.56	2.37a	6.91a	0.88a	48.41a	3.01a	73.33a
Pressure	3.34a	0.17a	7.01	2.09a	5.17a	0.59a	37.40ab	2.44ab	49.02b

Table 9. Number of water-sensitive paper cards per coverage category by sprayer type. Ratings from 5 = VERY GOOD to 1 = VERY POOR.

	Rating					
Sprayer	1	2	3	4	5	Average
Airboom	0	16	23	13	12	3.3
Pressure	16	23	16	5	4	2.3

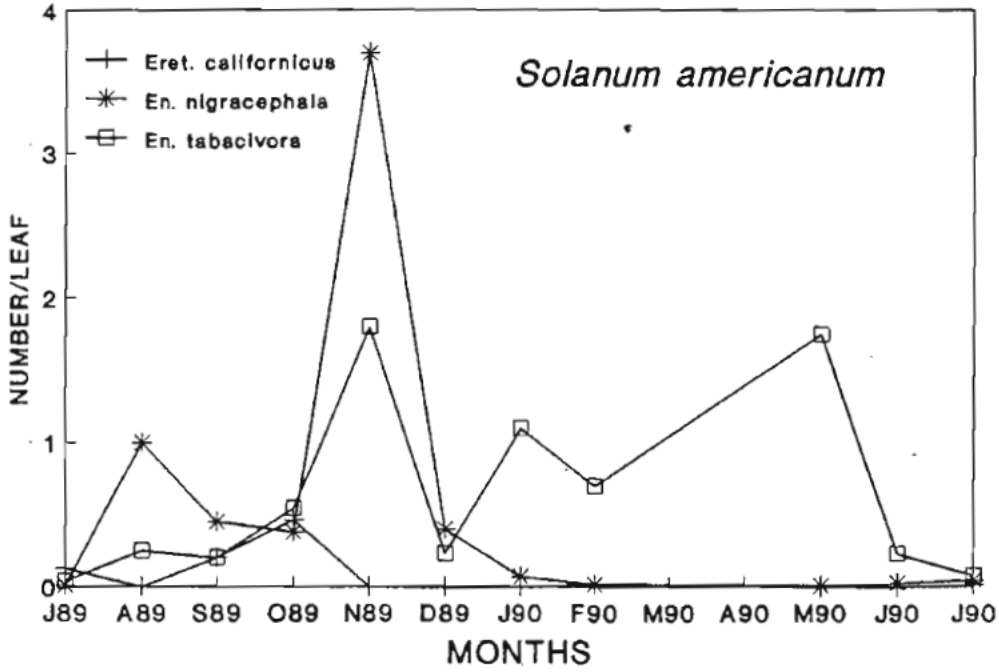

Figure 1. Emergence of hymenopteran parasites from SPWF pupae on nightshade.

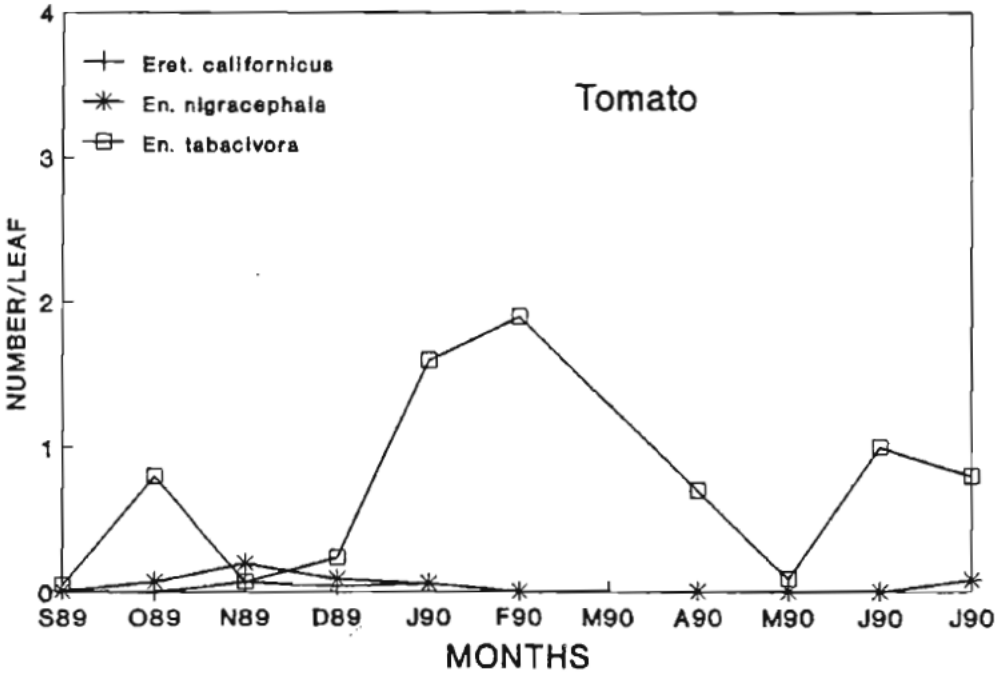

Figure 2. Emergence of hymenopteran parasites from SPWF pupae on tomato.