The Sweetpotato Whitefly and Integrated Pest Management of Tomato

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The explosive entry of sweetpotato whitefly <u>Bemisia tabaci</u> Gennadius (SPWF) into south Florida during the late 80's marked a tuning point for the hitherto successful development of tomato integrated pest management (IPM). The major focus of this program had been an integrated approach to the control of leafminer (Liriomyza spp.) based on monitoring of populations and timing of sprays. Careful management allowed the grower to take advantage of high incidence of leafminer parasitism that often developed in the absence of broad spectrum insecticides. However, increased insecticide use in response to heavy whitefly infestations and consequent losses from irregular ripening and tomato mottle (gemini)virus (TMoV) made this program seem unworkable and irrelevant. Now it appears that a combination of cultural, biological and chemical control has greatly relieved pressure from SPWF, at least in the western half of the region. Once again we may think in terms of true IPM for tomato, this time with SPWF included. Here we describe the whitefly control strategy presently employed, and attempt to chart future directions for extending and integrating the system into a comprehensive plan for all tomato pests.

Sources of SPWF. Yellow sticky traps were used to identify sources of whitefly in Manatee and Hillsburough Counties. A single, yellow sticky trap was placed in the middle of each field and another on the 'weedy' perimeter. Crops included tomato (fresh market and cherry), potato, cabbage (and other crucifers), cucumber (and other cucurbits), pepper and various ornamentals. Traps consisted of two 1 5/8" sticky yellow plastic squares stapled to the top 1" of 12" garden stakes such that the squares 'sandwich' the stake. The stakes were pushed about 2-3" into the soil so that the sticky squares were about 9-10" above and perpendicular to the ground surface. Traps were replaced weekly and the number of SPWF adults counted.

In 1992 as in 1991 (Stansly et al. 1991) the case of cabbage and tomato showed the clearest example of how successive crop hosts can interact to maintain SPWF populations over the season (Fig 1). Results indicated that in Palmetto/Ruskin, cabbage could provide a bridge for whitefly between fall and spring tomato. Potato and

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cherry tomato could also serve as intermediate sources of SPWF during winter months there (Fig. 2), and of TMoV as well in the case of cherry tomato. The fall and spring seasons are not distinct in Homestead and Immokalee so tomato can provide its own bridge for both virus and vector.

In a comparison of SPWF abundance on traps placed in weeds and in adjacent tomato fields (Fig. 3), similar patterns emerged. Fewer whitefly were trapped on weedy margins than within the fields. It is likely that tomato supplied the weeds with whitefly, except perhaps at the beginning of the fall season. The role of weeds as sources of host plants necessary for whitefly survival during the summer is also being evaluated. In a study of 6 tomato fields in Manatee and Hillsburough Counties, 10 leaf samples of 3 weed species were collected on the field margins during August and early September. SPWF nymphs were examined under a stereomicroscope to determine how many had been killed by insect parasites or predators. During the study period the combined effects of parasitism and predation increase from negligible to almost 100% (Fig. 4). Such dramatic results may be exceptional but do illustrate the ability of natural enemies to reduce whitefly populations in weeds free from insecticides.

Field Sanitation and Crop Rotation. The cultural control program for SPWF in South and Central Florida is based on periodically denying whitefly populations access to the crops which provide a concentrated, high quality food source protected by sprays from natural enemies. The period should be at least 3 or 4 consecutive generations at least once a year, or 45-60 days in summer. The longer period would be important where there is no natural winter break between crops. Timely removal of crop residues after the spring harvest and follow-up disking and/or cover crop establishment to discourage growth of volunteers is necessary. An additional benefit of this program is removal of TMoV sources which appear to be largely, if not completely, confined to tomato. Greatly increased mortality and reduced reproductive success of SPWF result from the combined effects of migration and dispersal, poor host plant quality, predation, parasitism and fungal infections. By fall, only a low density, highly dispersed population is available to inoculate new fields. With migration into the field thus reduced, adequate control can be achieved by spraying.

The program was widely adhered to in southwest Florida during the summer of 1990, and numbers of SPWF were greatly reduced that fall compared to the previous year (Stansly et al. 1991). Unfortunately, warm weather and the difficulty of maintaining an effective spray program during harvest fueled a population explosion in old fields during winter which quickly spread to the newly planted spring crop. Growers responded by avoiding close proximity between fall and spring tomato fields during the 1991/92 seasons. Whitefly numbers were low again during the fall and this time did not increase to unmanageable levels during the spring. The physical separation of fall and spring crops not separated in time constitutes the second phase of the cultural control program.

Evidence For Success. No one disputes that fact that SPWF levels in the Immokalee and Palmetto/Ruskin areas were lower during the 1991-92 season than any time since 1987. Some may attribute this to wet weather experienced in the region following 3 years of near drought. We agree that wet weather, particularly in the summer, would decrease SPWF populations by a number of mechanisms: physical attrition, destruction of host plants, increased incidence of fungal pathogens, etc. However, if rain were the only factor, why did whitefly numbers remain high on vegetables in Dade and Palm Beach Counties where raines were even heavier during 1991? We think that hosts such as winter melon, okra, sweet potatoes, malanga, ornamentals and residues from spring crops helped maintain SPWF populations on the East Coast during the summer. Such sources were generally absent from West Coast production areas.

Successful management of SPWF in Southwest Florida should serve as a model, not only for the rest of the state, but also for Texas, California, and more tropical zones where year-round production schedules (often driven by cotton) have allowed infestations of this pest to reach crisis proportions in recent times. Whitefly can be managed when effective spray programs are combined with a minimum 60-day crop-free period at least once a year, or by the spatial separation of successive plantings of host crops during the growing season.

Chemical Control - Resistance management. Insecticides remain an important component of the grower's defense against SPWF. Naturally, dependence solely on insecticides to control whitefly or any pest would be counter-productive, if for no other reason than the rapid appearance of resistance that would surely follow. Insecticide resistance is caused by selective culling of the most susceptible individuals from a population treated with insecticide. This process produces a more resistant population with each generation subjected to insecticide selection. Any practice that reduces the frequency of exposure to insecticides with similar modes of action is likely to slow the development of resistance to those insecticides. One method of achieving this it to skip unnecessary sprays. In addition, materials with different modes of action (organo-phosphates, pyrethroids, chlorinated hydrocarbons, and soaps or detergents) should be rotated to reduce selection against any one type. The practice of tank-mixing insecticides, while possibly providing effective control in the short run, could accelerate selection for resistance against both types of chemical by increasing the frequency of exposure to each. Growers should weigh the pros and cons of tank-mixes and use them only when warranted by otherwise unmanageable infestations.

An integral part of any resistance management program would logically include periodic monitoring of resistance levels in the field. Unfortunately, there is no funding at the present time for such a system, so data from Florida has been gathered in a piece meal way. These data indicate only moderate levels of resistance to pyrethroids and endosulfan to date (Stansly et al. 1991 and G. Leibee 1992, personal communication). The industry would certainly benefit from an organized monitoring program.

Soaps and Detergents Widespread use of surfactants (soaps and detergents) as insecticides continues, despite evidence of some yield loss with repeated applications of moderate to high rates (Vavrina and Stansly 1991, Stansly & Vavrina, 1992). Low cost and sufficient effectiveness to provide control at low levels of infestation probably justify this use. Surfactants are contact insecticides, so good underleaf coverage is essential. They probably work only when wet, and so are most effective with high gallonage and under humid conditions (Butler et al. 1992, Flint et al. 1992).

Field Trials. A nationally replicated trial for insecticidal control of SPWF on vegetable and field crops with standardized protocol was organized through the USDA for the 1992 season. Two of the trials were carried out this spring in Florida on tomato, one in Bradenton and the other Immokalee. Results are given in Tables 1 - 3. Results of an additional insecticide trial carried out at Bradenton can be found in Table 4.

Control of Other Tomato Pests. As the combined effects of cultural controls and natural mortality reduce the need for a blanket of broad-spectrum insecticides to control SPWF, traditional tomato pests such as leafminer, tomato pinworm, and armyworm require renewed attention. Scouting becomes increasingly important as a means of avoiding unnecessary sprays which are both costly and disruptive to biological control. A good scouting program is also necessary to pinpoint specific pest problems to be targeted. For leafminer, we are fortunate in having labels for AgriMek® and Trigard®, both of which provide effective control, are relatively specific, and can be rotated to avoid selection for resistance. BT products do not effect beneficial insects and continue to improve in quality. Used alone, they can provide effective prophylactic control of armyworm, saving chemical treatments for clean-up purposes.

Tomato pinworm. Due to a limited host range (tomato, potato, and eggplant), sanitation and rotation programs aimed at SPWF do much to reduce populations of tomato pinworm (TPW) Keiferia lycopersicella. Nevertheless, it continues to be a stubborn late-season pest whose cryptic habits make insecticidal control difficult. A highly promising control technique is the use of pheromones to disrupt the mating process (Van Steenwyk & Oatman 1983, Jenkins et al. 1990). We cooperated with Nobles Farms Inc., Glades Crop Care and Scentry Inc. (Buckeye Arizona) to demonstrate the use of the product NoMate®, a fiber formulation of TPW pheromone. The product was mixed with 2 parts adhesive and applied to the plastic mulch on 3-6 March in 4 adjacent plots of 60 gross tomato acres at rate of 54 g/ac. A second application covering only 20% of the area was made on 7 Apr. There were two checks, a "near" check of double-cropped melons behind tomatoes, and a "far" check of tomato (10 acres) approximately 1 mile from the treated field. Both checks received weekly or biweekly applications of chemical insecticides including Monitor, Lannate, Ambush, Thiodan, and AgriMek. Wing traps baited with pheromone lures were used to monitor the fields. The number of tomato pinworm moths trapped in the treated field remained below a threshold of 2 to 5 moths/trap/day through early May (Fig. 5), well below both check fields. Numbers of eggs and mines (with or without larvae) were recorded 84 days post-treatment on 20 tomato leaves from each quadrant of the treated and near check fields. By this time pinworms had moved into the pheromone-treated field, although not to the extent of the non-treated (see below).

	Treated	Check
Eggs per leaf.	0.24	0.38
Mines per leaf	0.8	3.0
Leaves w/ mines	51%	81%

New pheromone formulations, including a long-lasting plastic spiral and a sprayable, micro-encapsulated suspension, were evaluated in central and north Florida this year. Both appear to have given excellent results (J. McLaughlin, personal communication).

Future Directions Unforseen developments will undoubtedly cause predictions about future pest control practices to become rapidly outdated. Even the impact of current innovations such as transgenic plants which produce their own BT are difficult to assess. However, IPM will probably continue to serve as a useful guide and model. Biological control, historically a weak component of vegetable IPM, will probably increase in importance. With it will increase the use of control practices compatible with biological control, including insecticides that can be targeted against specific pests and/or which do not interfere with the activities of natural enemies. Additional practices which might be used to enhance biological control are releases of natural enemies and the planting of reservoir crops to increase reproduction and survival of beneficial parasites and predators.

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Table 1. Nymphs and pupae per 10 leaf, (40 cm ^{2}) sample.

Treatment	Rate (lb ai/ac)	Crop Age (days) 29 (precount)	40	54	71	83	Average
Control	--	1.75	3.75ab[1]	8.50a	21.50a	118.25a	38.00a
Amitraz	0.25	1.75	4.50ab	1.50a	13.25bc	19.50b	9.69b
Margozan-0	0.044	0.75	1.25bc	0.75b	10.25bcd	12.25bc	6.12bcd
Buprofizen	0.38	2.50	5.00a	3.00b	6.00cde	1.00c	3.75cd
Brigade	0.1	0.75	2.75abc	0.25b	5.50de	6.25bc	3.69cd
Thiodan	1.0	0.25	2.50abc	0.50b	1.75e	8.50bc	3.31cd
Brigade+ Monitor	0.08 0.75	1.25	2.50abc	0.25b	4.25de	6.00bc	3.25cd
Agridyne	0.044	0.50	3.50abc	1.00b	4.25de	4.25bc	3.25cd
NTN-33893	0.4	0.50	0.50c	0.75b	1.25e	6.50bc	2.25d
Danitol+ Monitor	0.2 0.75	0.50	3.00abc	0.25b	1.00e	3.25bc	1.87d
Karate+ Monitor	0.03 0.75	4.25	2.00abc	0.75b	1.50e	2.50bc	1.69d

[1] Means in the same column followed by the same letter are not statistically different.

Three-row (6 ft centers) by 20 ft plots, 4 replications, planted 23 March, 7 applications from 24 Apr. to 2 June, using tracter-drawn sprayer @ 200 psi 3.4 mph with #3 disks & 25^o cores, 4 nozzles per row minimum (64 gpa) to 6 nozzles maximum (95.5 gpa). Higest fully expanded terminal leaflet (10/plot) sampled for eggs, and highest leaflet containing pupal cases (1) sampled for nymphs at 4, 1 cm2 spots on each leaf.

Table 2. Adult sweetpotato white fly per beat pan sample.

Treatment	Rate (lb ai/ac)	Crop Age (days) 29 (precount)	37	43	57	63	Average
Control	--	1.25a[1]	12.75a	1.25ab	2.75a	6.25a	5.76a
Buprofizen	0.38	0.00b	9.75	0.50ab	2.25ab	0.25bc	3.20b
Agridyne	0.044	1.00ab	6.50ab	0.25ab	1.00bc	1.25bc	2.26bc
NTN-33893	0.4	0.75ab	3.25bc	1.50a	1.75abc	1.50b	2.00cd
Amitraz	0.25	0.25ab	3.75cd	1.00ab	2.50ab	0.25bc	1.88cde
Margosan-o	0.044	0.75ab	4.50dc	0.50ab	1.50abc	0.75bc	1.82cde
Karate+ Monitor	0.03 0.75	0.50ab	6.00bc	0.50ab	0.25c	0.50bc	1.81cde
Aliette	4.0	0.00b	3.50cd	0.00b	1.50abc	1.00bc	1.50cdef
Brigade+ Monitor	0.1 0.75	0.25ab	1.50d	0.50ab	1.00bc	0.75bc	0.95def
Brigade	0.1	0.00b	3.25cd	0.00b	0.25c	0.00c	0.88ef
Danitol+ Monitor	0.2 0.75	0.50ab	1.50d	0.00b	0.25c	0.75bc	0.64f
Thiodan	1.0	0.00b	1.00d	0.25ab	1.25abc	0.00c	0.63f

[1] Means in the same column followed by the same letter are not statistically different.

Adults sampled by beating 5 plants over an oil-covered 10"x13" baking pan.

Table 3. Management of SPWF and TMoV with insecticides, BCREC Bradenton, Spring 1992, a. SPWF and leafmines, b. TMoV incidence, c yield.

Treatment and Rate (AI)/acre		No. sweetpotato whitefly immatures/10 leaflets					No. leafmines/
		Eggs	Crawlers	Sessile nymphs	Pupae	Pupae exuviae	min search
Aliette	4.0 lb	628.2a*	191.0a	287.3a	178.5a	49.3a	118.0a
Align 3% (w/w)	20 gm	239.3ab	127.3ab	110.8ab	63.8ab	37.3ab	123.3a
Ambush 2 EC + Monitor 4 EC	0.2 lb 0.75 lb	11.8e-g	6.5d-f	5.3de	3.0ef	1.8ef	111.0a
Bay NTN 240 FS	0.025 gm	16.3d-g	5.8d-f	17.0de	6.3de	4.8ef	129.5a
Bay NTN 240 FS	0.015 gm	23.0b-e	9.8c-e	8.3cd	12.8cd	6.8de	116.0a
Brigade 10 WP	0.1 lb	4.5e-g	5.8d-f	1.8de	2.3ef	1.5ef	135.0a
Brigade 10 WP + Monitor 4 EC	0.08 lb 0.75 lb	0.0g	0.5f	1.0de	0.5ef	0.3f	120.8a
Danitol 2.4 EC + Monitor 4 EC	0.2 lb 0.75 lb	0.8fg	3.8ef	0.5e	0.3f	0.0f	122.5a
ICIA 0321 1EC + Monitor 4 EC	0.03 lb 0.75 lb	5.7e-g	5.3ef	0.5e	0.8ef	0.3f	112.3a
Margosan-O	20 gm	96.7bc	29.5b-d	46.0bc	33.0bc	12.5b-d	136.5a
Mitac 1.5 EC	0.25 lb	94.7b-d	35.3a-c	44.8b	28.5bc	19.0a-c	127.8a
SN 85292 3.67 SC	0.38 lb	17.0c-f	11.3c-e	3.8de	0.3f	0.8f	122.3a
SN 85292 3.67 SC	0.38 lb**	23.8c-e	9.8d-f	1.8de	0.5ef	0.0f	120.3a
Thiodan 3 EC	1.0 lb	116.2a-c	32.0a-c	58.0bc	35.8bc	10.5cd	121.0a
Check (water)	---	626.7a	206.5a	208.0a	84.5ab	45.3a	134.5a

*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 weekly with Thiodan 3 EC at 1.0 lb AI/acre.

Three row (5 tf centers by 20 ft plots, 4 replications, planted 10 Feb., 13 applications between 6 Mar. & 11 June using high clearance sprayer @ 200 psi 3.4 mph with #3 disks & 25^{o} cores, 4 nozzles per row minimum (60 gpa) to 8 nozzles maximum (120 gpa). Terminal leaflet from leaf from top 1/3 of plant sampled for immature SPWF, all plants examined for TMoV, fruit harvest three times beginning 18 May, 50 ripe fruit graded 1 to 3 for increasing irregular ripening.

Table 3b.

Treatment and lb (AI)/acre		% virus infected plants 20 Mar	27 Mar	3 Apr	10 Apr	17 Apr	24 Apr	1 May	8 May
Aliette	4.0 lb	0.7a*	1.4a	1.4ab	2.0ab	4.1a	6.8ab	8.8a	8.8ab
Align 3% (w/w)	20 gm	0.0a	0.0a	0.0b	1.3ab	2.6a	3.3ab	3.3a	4.0ab
Ambush 2 EC + Monitor 4 EC	0.2 lb 0.75 lb	0.7a	2.0a	3.3ab	2.7ab	2.7a	2.7ab	2.7a	2.7b
Bay NTN 240 FS	0.025 gm	0.6a	0.6a	1.3ab	1.3ab	1.9a	2.6ab	2.6a	2.7b
Bay NTN 240 FS	0.015 gm	0.0a	0.0a	0.7ab	0.7ab	0.7a	0.7a	2.1a	2.1a
Brigade 10 WP	0.1 lb	0.7a	0.7a	1.4ab	2.0ab	2.7a	3.4ab	4.1a	4.1ab
Brigade 10 WP + Monitor 4 EC	0.08 lb 0.75 lb	0.7a	2.0a	4.0ab	5.3a	7.3a	9.4ab	9.4a	10.1ab
Danitol 2.4 EC + Monitor 4 EC	0.2 lb 0.75 lb	1.3a	2.0a	2.0ab	2.6ab	2.6a	3.9ab	3.9a	6.5ab
ICIA 0321 1EC + Monitor 4 EC	0.03 lb 0.75 lb	0.0a	0.0a	2.0ab	2.0ab	3.3a	3.3ab	3.3a	3.3ab
Margosan-O	20 gm	0.0a	1.4a	2.6ab	2.6ab	3.3a	3.9ab	5.9a	10.6ab
Mitac 1.5 EC	0.25 lb	1.3a	2.7a	4.6a	5.3ab	5.9a	7.2ab	7.2a	7.9ab
SN 85292 3.67 SC	0.38 lb	0.0a	0.0a	0.7ab	0.7ab	1.4a	1.4ab	2.0a	2.0b
SN 85292 3.67 SC	0.38 lb**	0.0a	0.0a	0.0b	0.0b	1.5a	2.1ab	2.1a	2.1b
Thiodan 3 EC	1.0 lb	0.7a	0.0a	0.7ab	2.0ab	5.2a	6.6ab	7.9a	14.6a
Check (water)	---	1.4a	1.4a	2.0ab	4.0a	4.7a	10.2a	10.9a	15.0a

*Data were transformed arcsine of the square root of %/100 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 weekly with Thiodan 3 EC at 1.0 lb AI/acre.

Table 3c.

Treatment and Rate (AI)/acre		Fruit yield/10 plants: Extra small No.	Wt (lb)	Small No.	Wt (lb)	Medium No.	Wt (lb)
Aliette	4.0 lb	93.8e**	13.8d	44.8b	8.1c	304.3a	74.3a
Align 3% (w/w)	20 gm	128.5de	17.9cd	59.0ab	10.3a-c	307.8a	77.6a
Ambush 2 EC +Monitor 4 EC	0.2 lb 0.75 lb	200.5a-d	25.4a-c	60.8ab	10.0a-c	240.8a	57.4a
Bay NTN 240 FS	0.025 gm	207.8a-c	27.1ab	62.3ab	11.2a-c	215.8a	51.5a
Bay NTN 240 FS	0.015 gm	149.0b-e	20.9a-d	67.8ab	12.2a-c	267.8a	65.6a
Brigade 10 WP	0.1 lb	177.8a-d	24.7a-c	74.5a	13.9a	312.5a	75.6a
Brigade 10 WP +Monitor 4 EC	0.08 lb 0.75 lb	236.3a	27.7a	73.3a	13.7ab	229.8a	56.1a
Danitol 2.4 EC +Monitor 4 EC	0.2 lb 0.75 lb	190.8a-d	26.4a-c	61.3ab	11.0a-c	236.8a	59.4a
ICIA 0321 1 EC +Monitor 4 EC	0.03 lb 0.75 lb	174.3ab	25.6a-c	62.3ab	11.7a-c	328.5a	81.9a
Margosan-O	20 gm	211.0ab	28.8a	65.3ab	12.0a-c	221.3a	53.0a
Mitac 1.5 EC	0.25 lb	145.8b-e	20.0a-d	57.5ab	10.5a-c	239.8a	55.2a
SN 85292 3.67 SC	0.38 lb	129.8de	17.5cd	50.8ab	8.4bc	232.5a	58.9a
SN 85292 3.67 SC	0.38 lb***	137.5c-e	17.9b-d	47.8ab	8.9a-c	222.0a	53.5a
Thiodan 3 EC	1.0 lb	159.8b-e	21.8a-d	59.5ab	10.6a-c	297.0a	69.2a
Check (water)	---	180.8a-d	23.4a-c	47.5ab	8.7a-c	240.5a	58.2a

Table 3c Con't.

Treatment and lb	(IA)/acre	Fruit yield/10 plants							
		Large		Extra large		Cull		Ber*	
		No.	Wt (lb)	No.	Wt (lb)	No.	Wt (lb)	No.	Wt (lb)
Aliette	4.0 lb	142.3a	51.5a	86.8a	40.9a	39.0ab	10.0a	5.8a	1.6a
Align 3% (w/w)	20 gm	133.8a	44.5a	67.5ab	28.8ab	34.8ab	8.5a	3.5a	0.9a
Ambush 2 EC +Monitor 4 EC	0.2 lb 0.75 lb	99.8a	32.8a	42.5ab	18.7ab	36.0ab	8.2a	58.0a	11.2a
Bay NTN 240 FS	0.025 gm	61.0a	19.6a	23.3b	10.1b	62.8a	12.3a	94.8a	14.2a
Bay NTN 240 FS	0.015 gm	104.5a	34.6a	47.8ab	21.0ab	32.3ab	8.3a	67.0a	13.7a
Brigade 10 WP	0.1 lb	107.0a	35.3a	32.3ab	14.2b	33.3b	8.3a	22.8a	4.8a
Brigade 10 WP +Monitor 4 EC	0.08 lb 0.75 lb	57.5a	18.3a	20.3b	8.2b	35.8ab	7.8a	90.5a	13.6a
Danitol 2.4 EC +Monitor 4 EC	0.2 lb 0.75 lb	80.8a	27.4a	36.3ab	15.4b	44.3ab	12.0a	79.5a	11.9a
ICIA 0321 1 EC +Monitor 4 EC	0.03 lb 0.75 lb	139.8a	47.1a	69.3ab	29.5ab	41.0ab	10.1a	3.8a	0.9a
Margosan-0	20 gm	62.5a	20.2a	21.8b	9.0b	32.5ab	7.1a	74.3a	10.2a
Mitac 1.5 EC	0.25 lb	91.5a	30.0a	40.3ab	17.5ab	35.0ab	8.6a	31.0a	5.5a
SN 85292 3.67 SC	0.38 lb	89.8a	30.9a	45.5ab	20.1ab	33.3ab	8.7a	99.5	12.8a
SN 85292 3.67 SC	0.38lb***	97.3a	33.0a	43.5ab	19.2ab	34.8ab	9.2a	113.0a	18.1a
Thiodan 3 EC	1.0 lb	105.3a	40.7a	39.3ab	18.1ab	37.0ab	9.5a	12.3a	3.0a
Check (water)	---	78.3a	26.0a	37.3ab	16.3b	28.8b	7.3a	44.8a	7.7a

*Fruit affected by blossom end rot.
**Means within a column followed by the same letter are not significantly different at P<0.05 level, Duncan's multiple range test.
***Alternated weekly with Thiodan 3 EC at 1.0 lb AI/acre.

Table 4. Management of SPWF and TMoV with insecticides, GCREC-Bradenton, Spring 1992 - a. SPWF, b. yield, c. TMoV incidence.

		No. sweetpotato whitefly immatures/10 leaflets			
		Eggs		Crawlers	
Treatment and lb (AI)/acre		3 June	18 June	3 June	18 June
Danitol 2.4 EC + Monitor 4 EC	0.2 0.75	1.0c*	3.5c	0.3e	24.5c
Enstar 5 EC	0.22	316.0ab	333.0a	285.8ab	643.2ab
Enstar 5 EC	0.044	115.7b	282.3ab	74.8d	508.8ab
FCI-119	100 ml	343.3ab	402.5a	250.0a-d	697.0a
FCI-119 + Monitor 4 EC	100 ml 0.75	664.0a	495.0a	397.5a	644.0ab
Monitor 4 EC	0.75	150.8b	265.5ab	149.5b-d	387.0ab
Pyrellin EC	2 pts**	148.8b	100.5b	149.0cd	212.5b
RH-0345 2 F	0.25	272.0ab	184.5ab	228.0a-d	322.0ab
RH-2485 2 F	0.25	200.5ab	372.0a	268.3ab	628.0ab
Check (water)	---	175.5ab	261.0ab	253.3a-c	456.0ab

*Data were transformed log10 of X+1 prior to analyses but are presented in the origniani scale. Means within a column followed by the same letter are not significantly different at P<0.05 level, Duncan's multiple range test.
**Amount of product.

Methods as in Table 3. Planting date 10 March, 12 applications from 17 Mar. to 12 June.

Table 4 con't. Management of SPWF and TMoV with insecticides, GCREC-Bradenton, Spring 1992 - a. SPWF, b. yield, c. TMoV incidence.

		No. sweetpotato whitefly immatures/10 leaflets					
		Sessile nymphs		Pupae		Pupae exuviae	
Treatment and lb (AI)/acre		3 June	18 June	3 June	18 June	3 June	18 June
Danitol 2.4 EC + Monitor 4 EC	0.2 0.75	0.3d	5.2d	0.3b	0.8b	0.5c	0.5d
Enstar 5 EC	0.22	138.0a-c	1098.0ab	104.5a	441.0a	*33.0ab	130.0a-c
Enstar 5 EC	0.044	99.5c	466.8bc	94.0a	168.5a	17.8b	57.0c
FCI-119	100 ml	269.0a	1196.5a	98.0a	419.5a	28.5ab	197.0ab
FCI-119 + Monitor 4 EC	100 ml 0.75	193.0a	1339.0a	115.8a	508.5a	65.8a	231.0a
Monitor 4 EC	0.75	114.0bc	861.5ab	72.3a	311.5a	40.3ab	145.3a-c
Pyrellin EC	2 pts**	123.5a-c	299.0c	75.8a	289.5a	42.3ab	158.0a-c
RH-0345 2 F	0.25	166.5a-c	387.0c	84.5a	182.5a	36.5ab	121.5a-c
RH-2485 2 F	0.25	246.0ab	818.5ab	126.5a	412.0a	42.8ab	150.5a-c
Check (water)	---	195.5ab	762.0a-c	130.8a	144.5a	24.3ab	79.0bc

*Data were transformed log10 of X+1 prior to analyses but are presented in the origniani scale. Means within a column followed by the same letter are not significantly different at P<0.05 level, Duncan's multiple range test.
**Amount of product.

Table 4b.

Treatment and lb (AI)/acre		Fruit yield/10 plants No.	Wt (lb)	Lb/fruit	Irregular ripening* Rating	% Marketable
Danitol 2.4 EC + Monitor 4 EC	0.2 0.75	531.3a**	149.4a	0.28c	1.1c	94.3a
Enstar 5 EC	0.22	379.5cd	130.4a	0.35ab	1.8ab	65.3bc
Enstar 5 EC	0.044	470.8ab	146.1a	0.31bc	1.5bc	78.0b
FCI-119	100 ml	420.0b-d	133.1a	0.31bc	1.8ab	64.8bc
FCI-119 + Monitor 4 EC	100 ml 0.75	439.5b-d	133.3a	0.31bc	2.0a	56.6c
Monitor 4 EC	0.75	462.8a-c	146.5a	0.32bc	1.7ab	71.8bc
Pyrellin EC	2 pts***	428.5b-d	127.0a	0.30bc	1.7ab	69.8bc
RH-0345 2 F	0.25	422.3b-d	129.7a	0.31bc	1.8ab	66.0bc
RH-2485 2 F	0.25	367.0d	134.3a	0.37a	1.8ab	64.8bc
Check (water)	---	400.3b-d	131.4a	0.33a-c	1.8ab	64.3bc

*Fruit were rated 1 to 3 for increasing severity of irregular ripening symptoms. Marketable fruit were considered to have ratings of 1 or 2.

**Percent data were transformed arcsine of the square root of %/100 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.

***Amount of product

Table 4c.

Treatment and lb (AI)/acre		% virus infected plants					
		17 Apr	24 Apr	1 May	8 May	21 May	28 May
Danitol 2.4 EC + Monitor 4 EC	0.2 0.75	0.0a*	0.0a	2.6a	2.7a	5.1c	8.3c
Enstar 5 EC	0.22	0.0a	0.6a	1.3a	5.1a	19.9a-c	25.0bc
Enstar 5 EC	0.044	0.0a	0.6a	2.6a	4.5a	9.6bc	17.9bc
FCI-119	100 ml	0.0a	1.9a	1.9a	2.7a	9.6bc	19.2bc
FCI-119 + Monitor 4 EC	100 ml 0.75	0.6a	0.6a	1.3a	3.2a	28.6ab	36.9ab
Monitor 4 EC	0.75	0.0a	0.0a	2.6a	4.5a	15.0a-c	24.7bc
Pyrellin EC	2 pts**	0.0a	1.3	5.2a	5.8a	36.6a	50.7a
RH-0345 2 F	0.25	0.6a	2.6a	3.2a	6.4a	18.7a-c	24.5bc
RH-2485 2 F	0.25	0.0a	0.6a	3.2a	4.5a	10.9bc	16.6bc
Check (water)	---	0.0a	1.3a	1.3a	5.1a	12.8a-c	18.6bc

*Data were transformed arcsine of the square root of %/100 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.
**Amount of product.

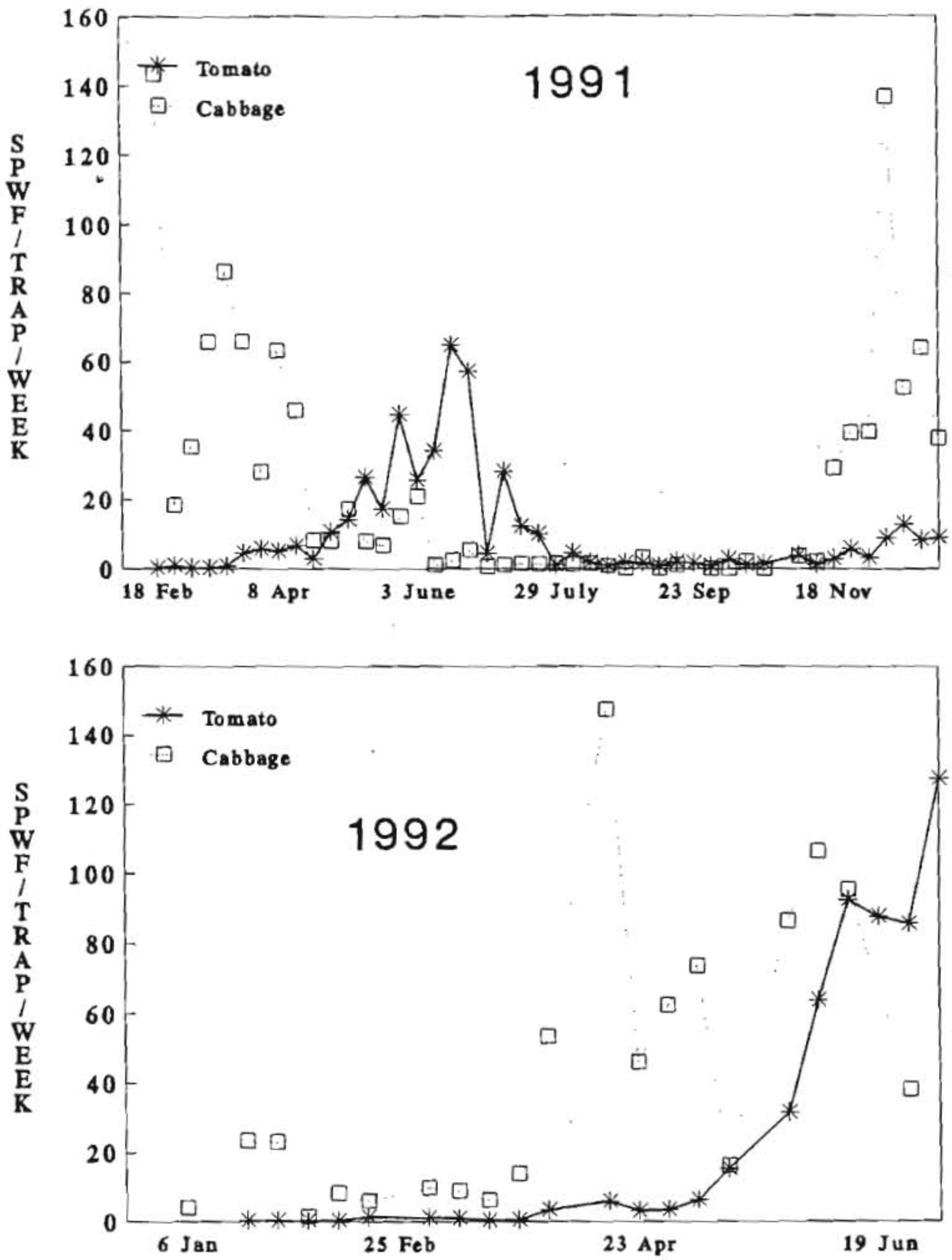

Figure 1. SPWF adults caught on sticky traps in Manatee and Hillsborough Counties. Fields sampled: tomato 1991 = 26, 1992 = 33, cabbage 5 fields each.

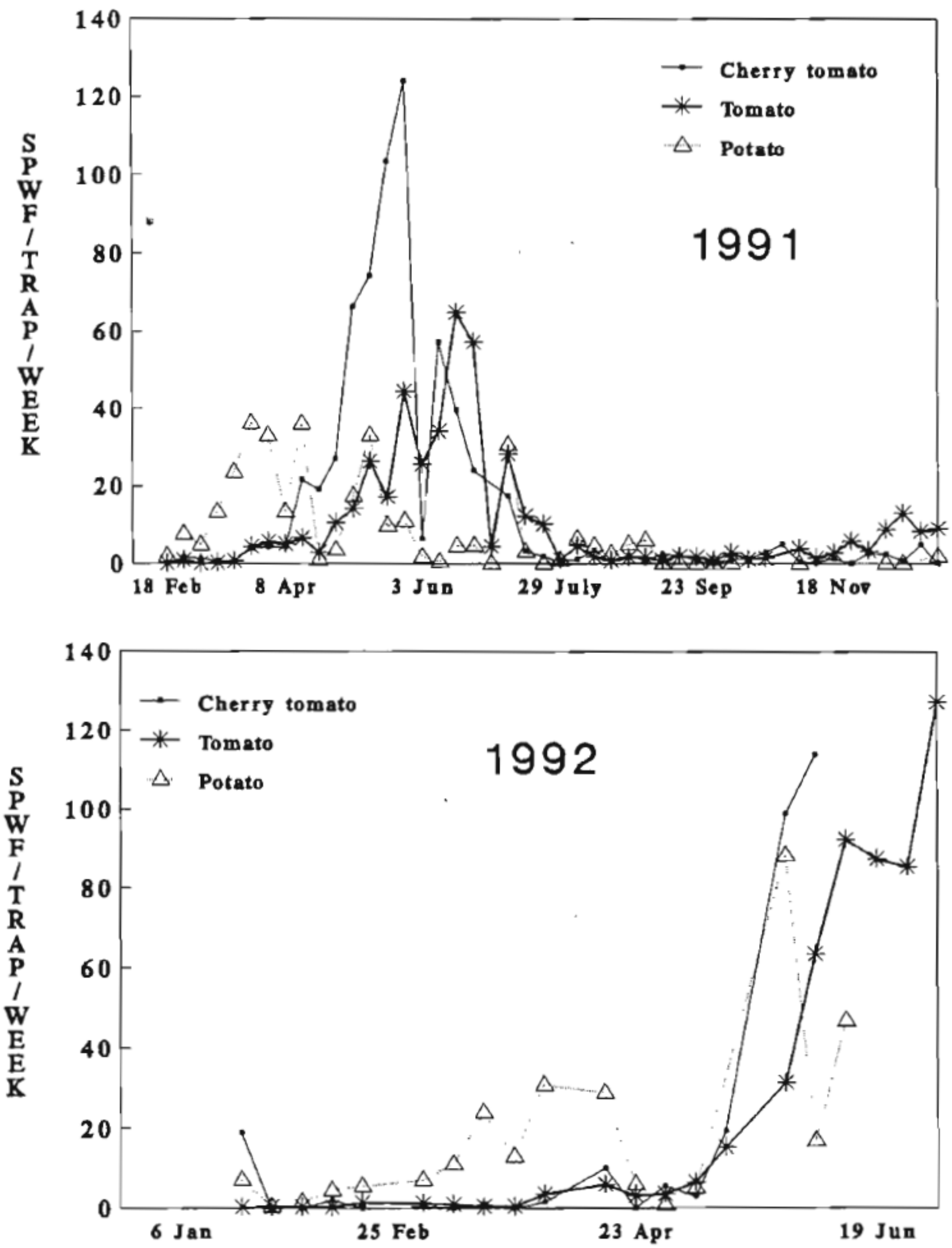

Figure 2. SPWF adults caught on sticky traps in Manatee and Hillsborough Counties. Fields sampled: tomato 1991 = 26, 1992 = 33, cherry tomato 1991 = 4, 1992 = 6, potato 1991 = 6, 1992 = 2.

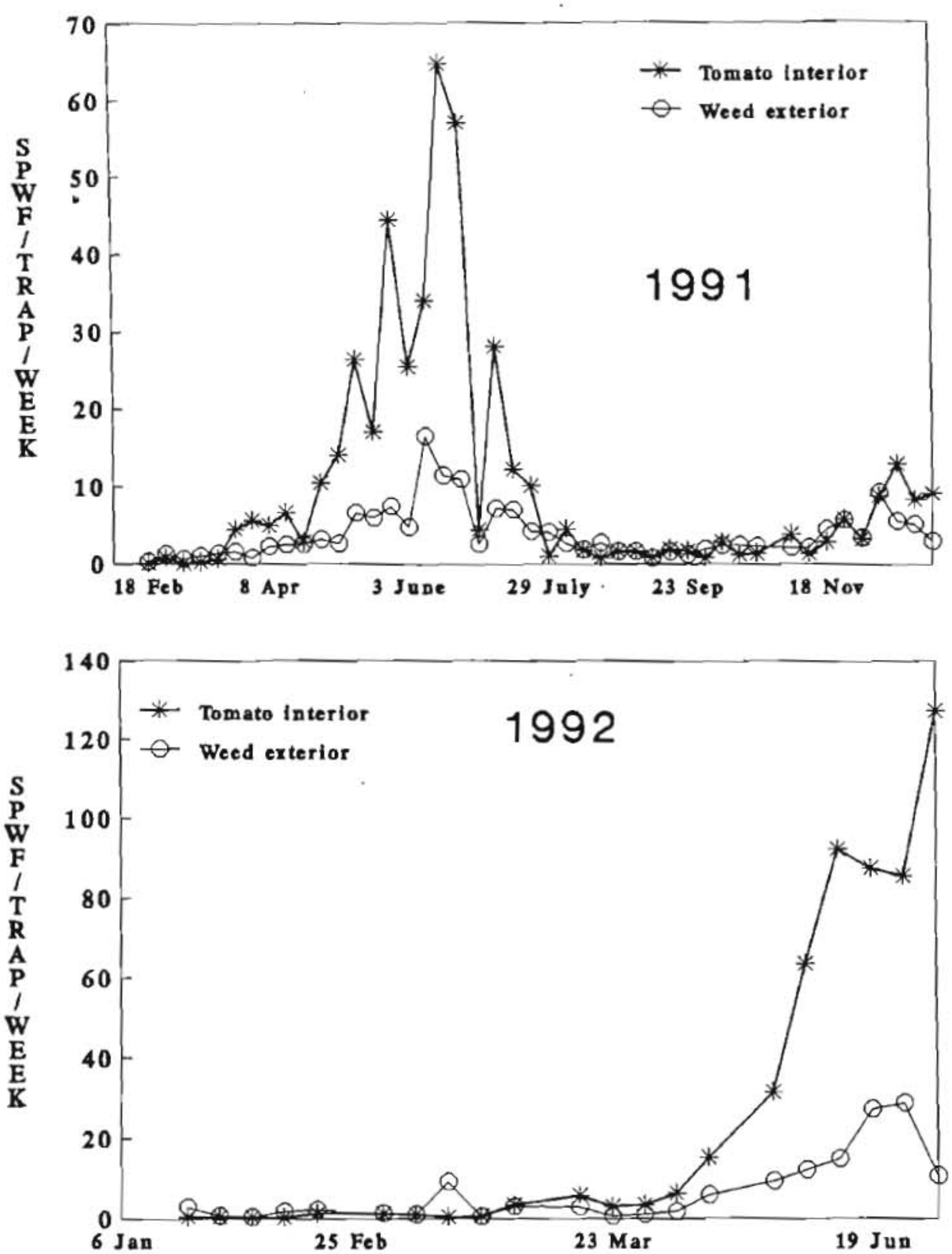

Figure 3. SPWF adults caught on sticky traps in Manatee and Hillsborough Counties in tomato fields and weedy margins. Number of fields as in Fig. 1.

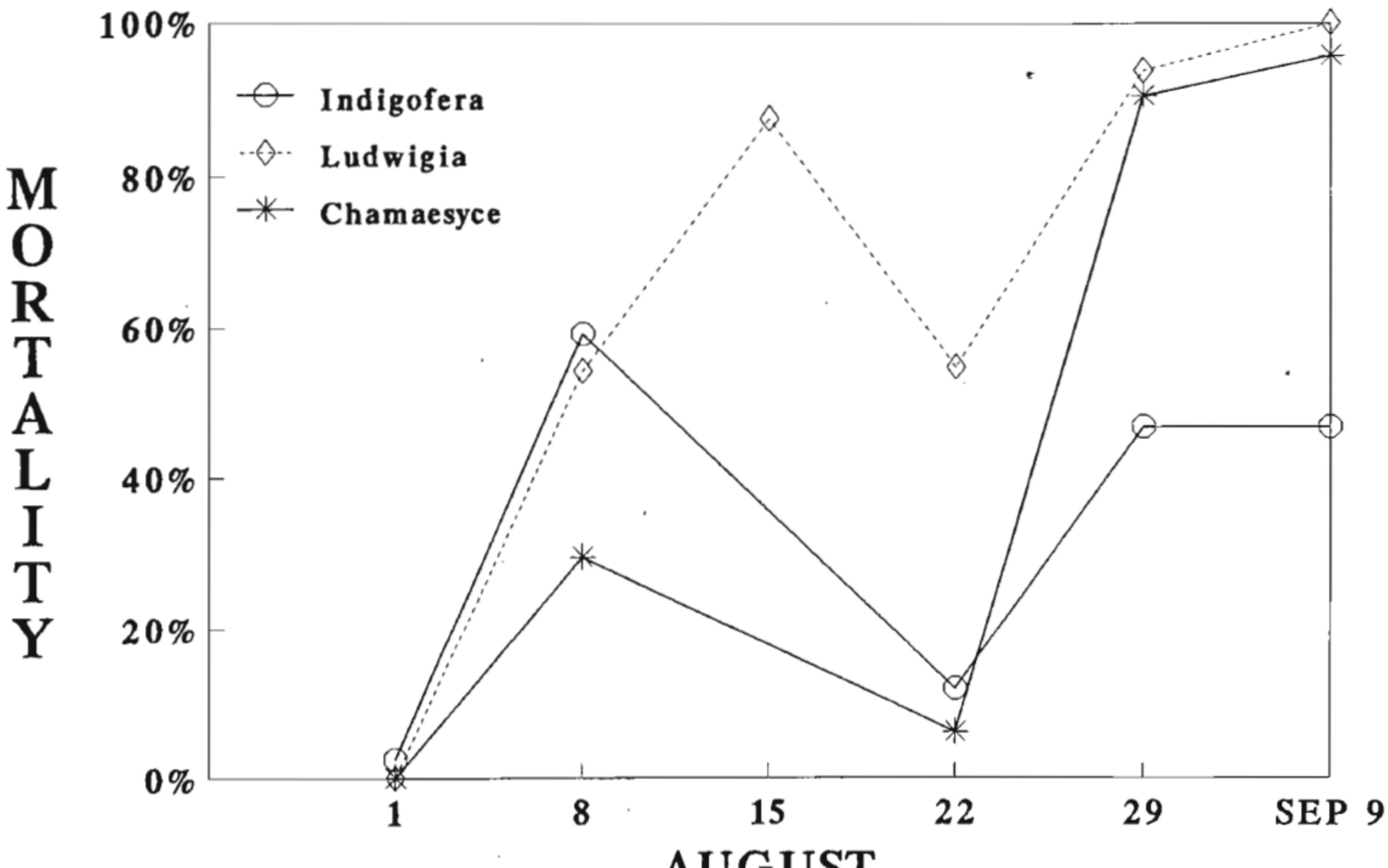

Figure 4. Rate of parasitization plus predation of SPWF nymphs collected on weed hosts in Manatee and Hillsborough counties, 1991.

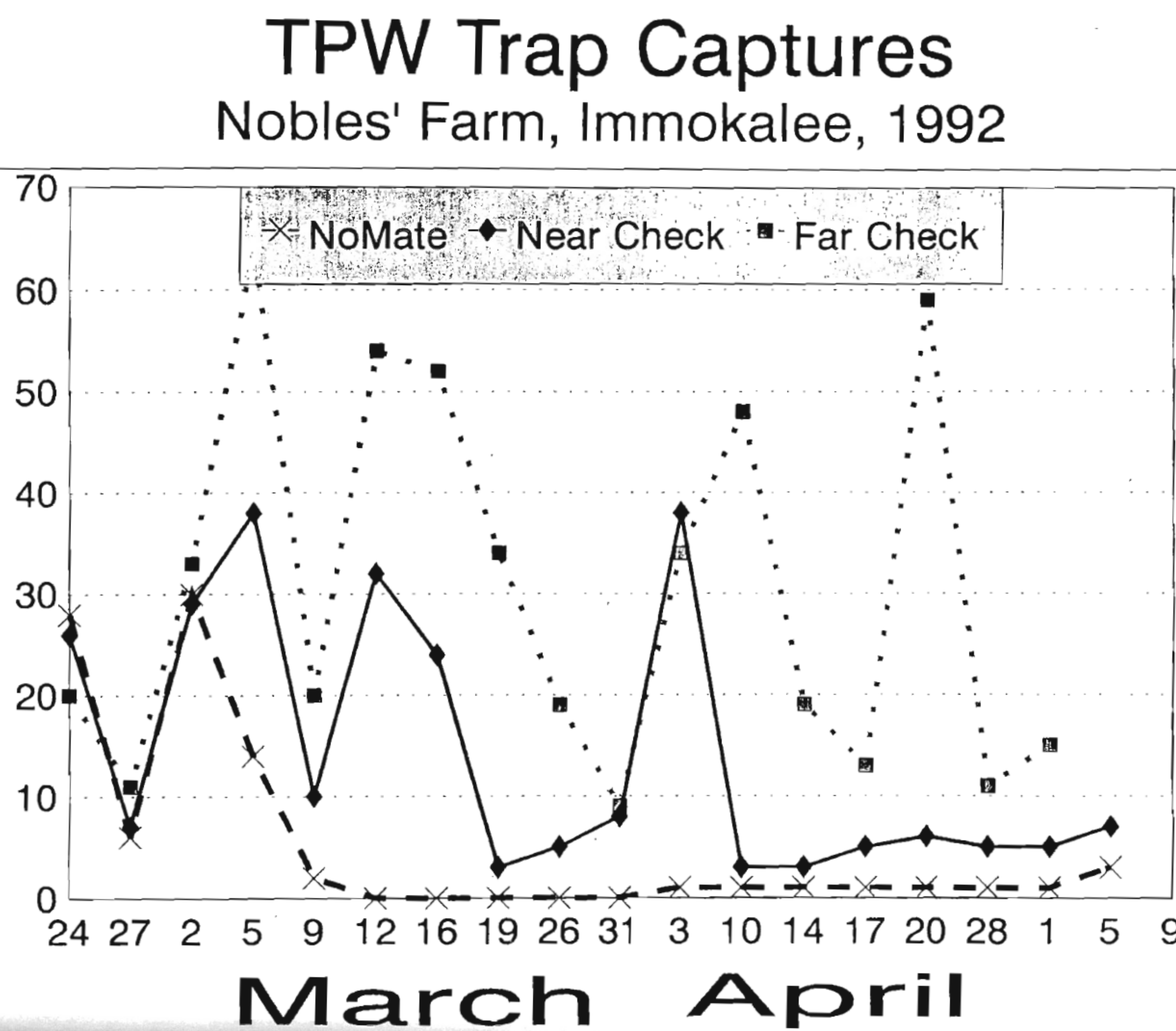

Figure 5. Number of tomato pinworm moths per trap per day in 3 fields in Collier County, 1992.