matoes, providing fruit locular gel maturity is not delayed. After three harvests, the EW III treatment continued to show delayed maturity when compared to MM, FL-O, RU, and EW I (data not shown).

First harvest total fruit weight. Plants grown in the FL-O, EW I, and EW II MSW yielded similarly to the MM treatment, considering total fruit weight at first harvest (Table 1). The RU MSW-produced plants had yields comparable to plants from other MSWs, but lower than those produced by the MM treatment. The EW III lot had significantly lower first harvest output in comparison to all other treatments except RU.

Apparently plants raised in EW I and II were able to compensate for early developmental inadequacies (i.e. smaller plants), since they produced first harvest yields equal to those of plants from the commercial soilless mix. Plants grown in EW III were unable to fully compensate in early stand establishment, perhaps due to other disadvantages inherent to the MSW (e.g. improper maturity or high salts).

Total harvest yields. Over the course of three weeks, three harvests were made from plants in the trial. Overall plant yield was similar with all transplant production treatments except EW III (Table 1). The EW III treatment resulted in a lower total fruit yield than MM, FL-O, and EW II.

Results from this study showed that commercially produced MSW materials can be used successfully as transplant soilless media without detriment to overall tomato yield. Lot variability in MSW physical and/or chemical composition, however, can lead to inconsistencies in the transplants produced, and losses in fruit maturity and yield at first harvest.

Transplant producers will likely find an inconsistent soilless mix difficult to manage for production of a consistent transplant. However, should MSW quality control insure a consistent product and a competitive price with existing soilless mixes, these materials may find favor in the transplant industry.

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SEASONAL ABUNDANCE OF SILVERLEAF WHITEFLY IN SOUTHWEST FLORIDA VEGETABLE FIELDS[1]

PHILIP A. STANSLY
Southwest Florida Research and Education Center
University of Florida, IFAS
P. O. Drawer 5127
Immokalee, FL 33934

Additional index words. *Bemisia argentifolii, Bemisia tabaci,* Homoptera, Aleyrodidae, sampling, imidacloprid.

Abstract. **Yellow sticky traps, beat pan samples for adults, and 10-minute counts of nymphs were used to monitor silverleaf whitefly in vegetable fields in southwest Florida. Traps were placed at canopy level, oriented both horizontally and vertically, inside and outside cultivated areas. Sticky traps were most useful for monitoring whitefly movement, especially when horizontally placed, although vertical traps gave similar results. Beat pan samples taken in the general location of sticky traps proved to be a convenient method of assessing whitefly colonization on a variety of plant types. Beat pan samples confirmed the origin of most whiteflies to be crops rather than weeds. Nymphs were counted for 10 minutes from random samples at each field and gave similar results to pan counts of adults. All counts peaked at harvests and were lowest during summer fallow and fall cropping seasons. Trends in weedy margins followed crop trends but at reduced levels. Counts were lower in 1995 than the two previous years, by all sampling methods, possibly due to widespread use of the insecticide imidacloprid in tomato, although unseasonably high rainfall in autumn and winter may also have impacted whitefly populations. All sampling methods showed whitefly build-up in crops and migration from crop to crop, with weeds serving as poor intermediate hosts. Weeds maintained only few whiteflies over fallow periods. These results supported recommendations to maintain a crop-free period in summer by removal of all crop residues, and of separating fall and *spring crops as much as* possible in time and space to reduce carryover of whitefly populations into successive crop cycles.**

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The silverleaf whitefly (SLWF) *Bemisia argentifolii* Bellows and Perring, was detected first in Florida in 1986 on poinsettia (Hamon and Salguero; 1987, Perring et al., 1993), but soon became a major pest of vegetables in south and central Florida and throughout the tropics and subtropics. Tomato has been the crop most impacted in Florida, first from a disorder induced by nymphal feeding, irregular ripening (Maynard and Cantliffe, 1988; Schuster and Stansly, 1996), then through transmission of tomato mottle geminivirus (TMoV). Yield losses and control costs in Florida tomato were estimated at $141 million for the 1990-91 season (Schuster et al., 1996). The monitoring program described here was initiated in 1992 to provide data to document and predict whitefly populations in and around vegetable fields in southwest Florida. Initially, three sites in Collier county were monitored, but eventually only one was maintained because of similarities between the sites and the logistics of weekly visits. Whiteflies were sampled within the crop and in its weedy margins using sticky traps in two orientations (vertical and horizontal), a beat pan, and a 10-minute count of nymphs. These methods all tracked populations in different ways, each emphasizing different lifecycle stages, so that a relatively complete story of seasonal fluctuation and long term changes in response to patterns of cropping, weather, and management practices could be documented.

Materials and Methods

Four vegetable farms, two in Collier County and two in Hendry County were monitored for whitefly. All fields were fallow in summer. Three large fields at Collier1 were located within the large "Camp Keis" production area. The fields were planted to tomato, potato, or cucumber and were monitored from 11 Nov. 1992 to 12 May 1993. Collier2 was located five miles to the south in the Corkscrew production area, where one large field planted to tomato in fall and cucumber in spring was monitored from 22 Sept. 1992 to 15 Nov. 1995. Tomatoes were planted in late Aug. or early Sept. and harvested in late Nov. or early Dec. Cucumbers were planted in January and harvested in May with June, July and early Aug. fallow. Hendry1 was a farm of intermediate size (800 acres) and located in Felda, relatively isolated from other vegetable production. Blocks of tomato, pepper, and cucumber were planted according to a similar schedule as above. The fourth farm (Hendry2) was small (40 ac) and also located in Felda. The grower planted cherry tomatoes sequentially from Sept. through Nov. and harvested from Dec. through April.

Yellow plastic sticky cards (Olson products Inc., Medina, OH) were cut into 1 3/4-inch squares and attached using Day pinchcock clamps (Fisher Scientific, Pittsburgh, Pa.) to 1/4-inch steel rods 2 ft or 4 ft long depending on crop height. One sticky card, oriented in a vertical position, and one in a horizontal position, were separated at canopy level 6 ft apart at each monitoring location. Monitoring locations were 12 ft inside the crop and about 20 ft outside the crop in weedy margins at 4 cardinal directions midway between corners of each field. Cards were monitored weekly for SLWF adults. Adults were also sampled in the vicinity of monitoring sites using an 8 × 12 inch cake pan painted black and smeared with cooking oil emulsified with 10% liquid detergent. Five beats were made against the crop and the number of adults captured recorded for that site. This was also done on weeds known to be whitefly hosts.

A single nymph count was made on the crop in the vicinity of a sticky trap stake. Leaves were collected at a level in the plant canopy where nymphs and pupal exuviae could both be found, usually at the 6th node for tomato. Leaves were then examined under 10X hand lens and all whitefly nymphs or pupa encountered in 10 minutes were counted. This was done for each location and the growth stage of the crop recorded. Canopy height and width was determined at each crop location with a tape measure and percent canopy cover was visually estimated.

Results and Discussion

Sticky Traps. Sticky trap captures in crops were generally lowest shortly after crop establishment (Oct., Feb.), following a brief peak of activity as whiteflies moved into the crop (Figs. 1, 2). Numbers gradually increased throughout the cropping cycle, peaking at crop termination in Dec. and May when spray programs were curtailed to accommodate harvest operations. Trap captures were almost always higher in crops than in weedy margins during cropping periods, but peaked sharply in weedy margins as whiteflies moved out of senescing crops. The post-harvest peak of airborne whiteflies observed, even where there were no crops (Fig. 2, May-June 1995), indicated a regional as well as local effect. Counts in weeds decreased rapidly thereafter during the summer fallow, due in part to control by natural enemies (Stansly et al., 1994), but probably also to dispersal into widely scattered weeds of poor host quality. Peaks occurred simultaneously on different crop types in Hendry1, even in pepper, a relatively poor whitefly host, indicative perhaps of movement from senescent crops over the entire area (Fig. 3). A general tendency for increased numbers from Sept. 1992 through Dec. 1993 was reversed thereafter with fewer captures through Nov. 1995.

Captures on vertical and horizontally placed traps were similar, although generally higher on horizontal traps, especially during migration periods at crop termination (Figs. 4, 5). Peaks were slightly out of phase: earlier on horizontal traps at crop initiation as whiteflies moved in, earlier on vertical traps at crop termination as they moved out. Greater numbers were seen within a fallow field, where traps were perhaps more visible, than on the weedier margins of the same field where they might have been obscured by vegetation (Fig. 6). A similar phenomenon has been described for aphids (Kennedy et al., 1961).

Beat and Nymph Counts. Trends in beat pan samples of adults followed similar patterns, with peaks in beat samples proceeding peaks in trap captures toward the end of the crop cycle as adult populations built up on crops, then migrated out at crop termination (Figs. 7, 8). The reverse order was observed in new crops, especially those following an earlier crop in the same vicinity. For example, a peak in trap counts seen in January 1993 from whiteflies migrating out of tomato foretold a sharp increase of whiteflies on young cucumbers (Fig. 7). As with sticky card captures, beat samples documented successive peaks of whiteflies on different crop hosts in neighboring fields (Fig. 9).

Beat pan samples showed even more distinct differences between crops and weeds than did sticky traps (Figs. 10, 11). Adults were generally more numerous and peaked earlier in crops than on weedy margins, indicating that whiteflies originating in crops drove the system. An exception might have occurred in fall 1995 when whiteflies were more numerous in

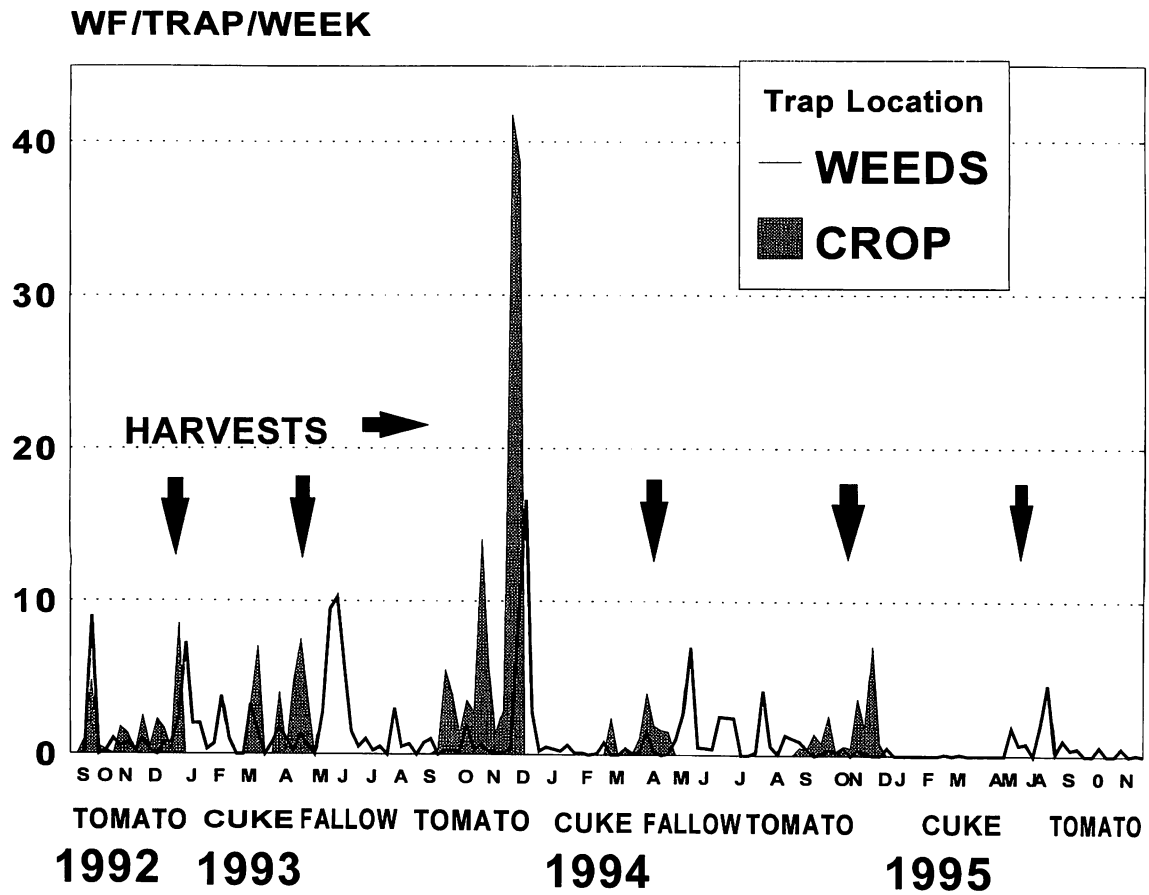

Figure 1. Whitefly captures on yellow sticky traps in crop fields and weedy margins of Collier2 farm.

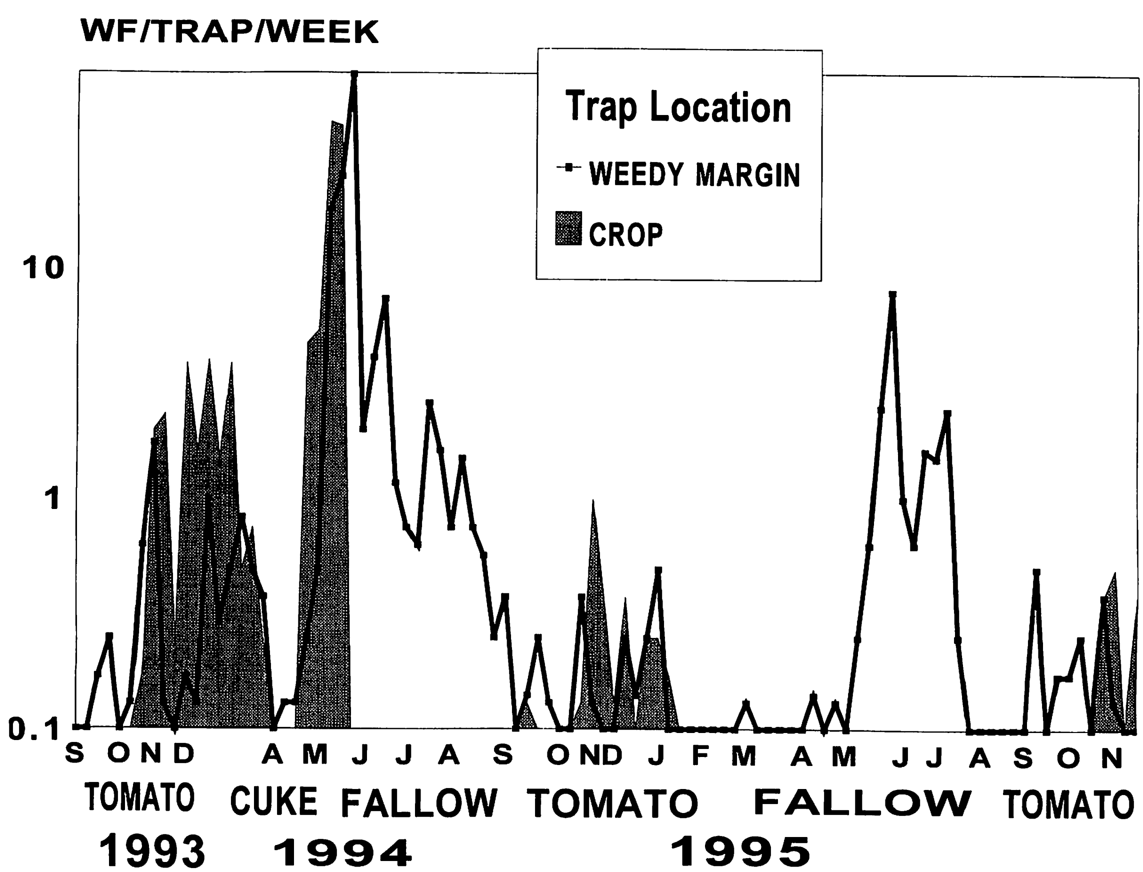

Figure 2. Whitefly captures on yellow sticky traps in crop fields and weedy margins of Hendry2 farm.

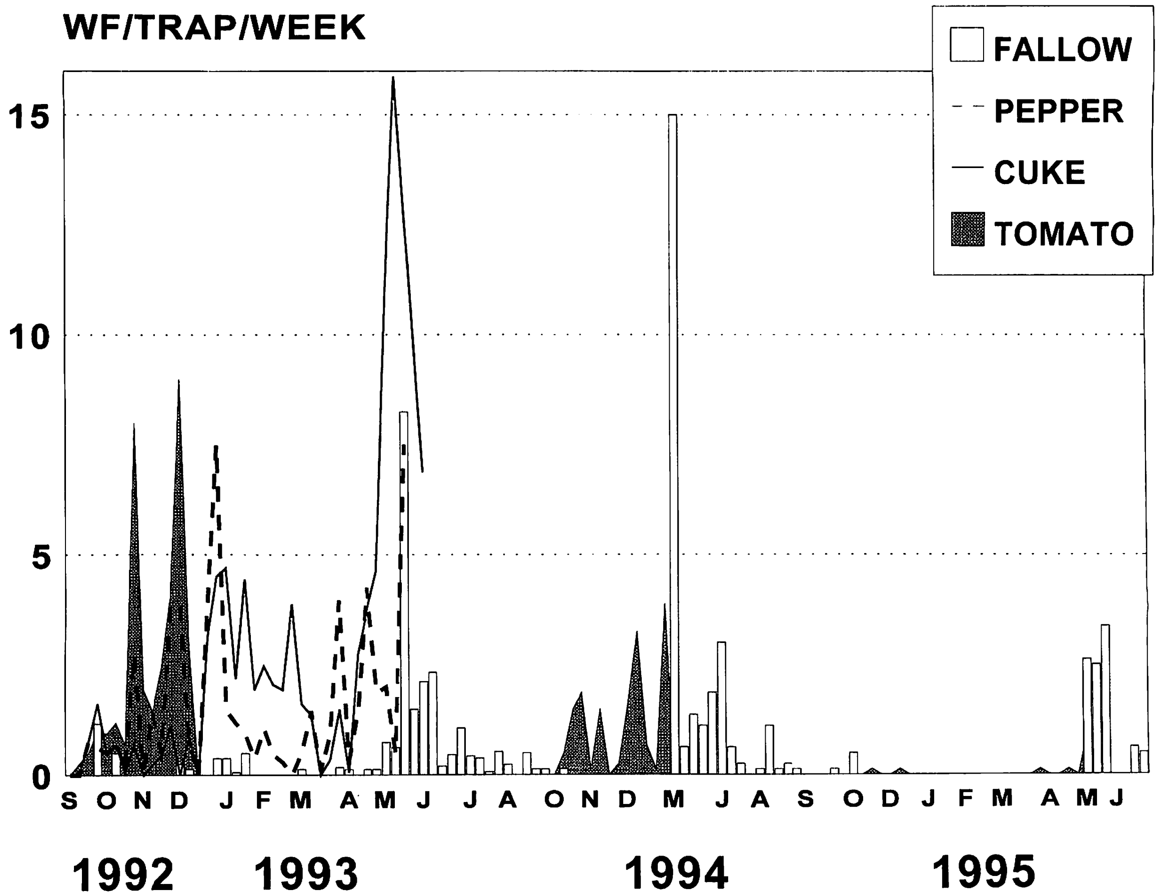

Figure 3. Whitefly captures on yellow sticky traps in adjacent crops on Hendry1 farm.

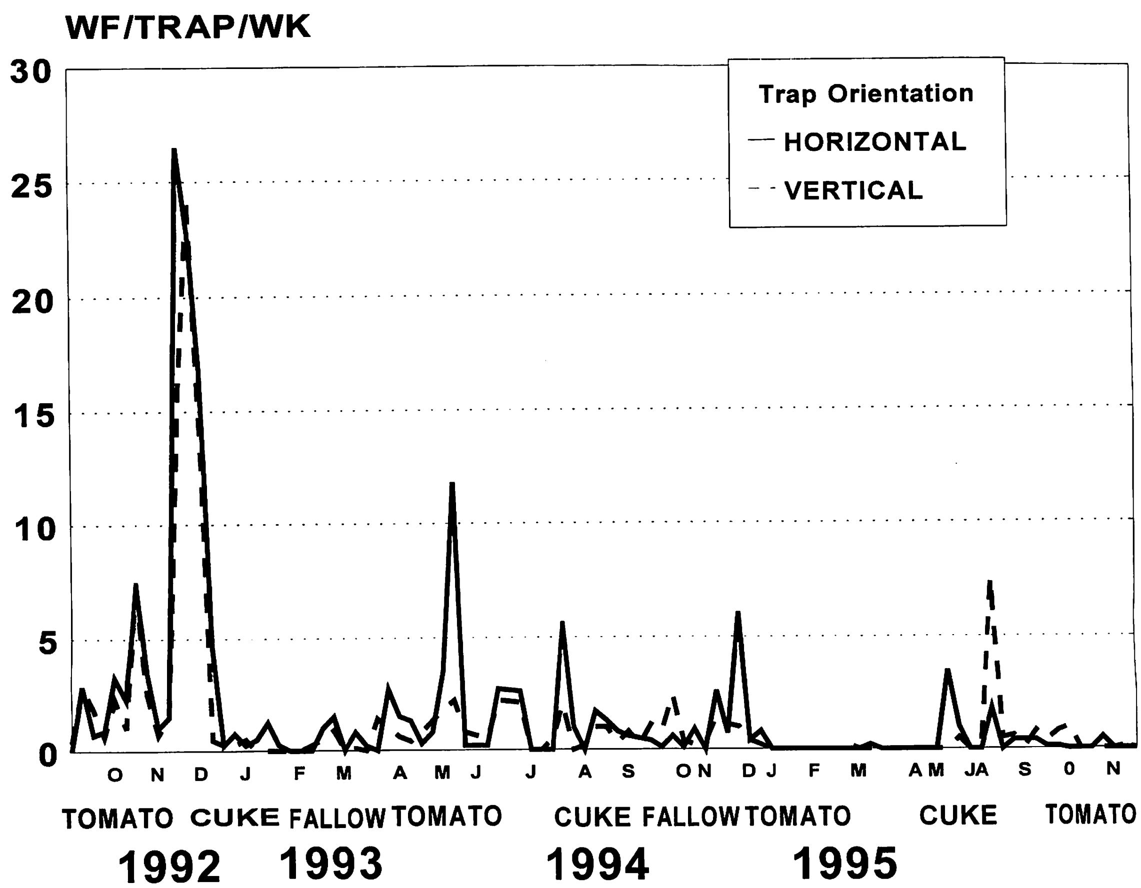

Figure 4. Whitefly captures on horizontally and vertically oriented yellow sticky traps on Collier2 farm.

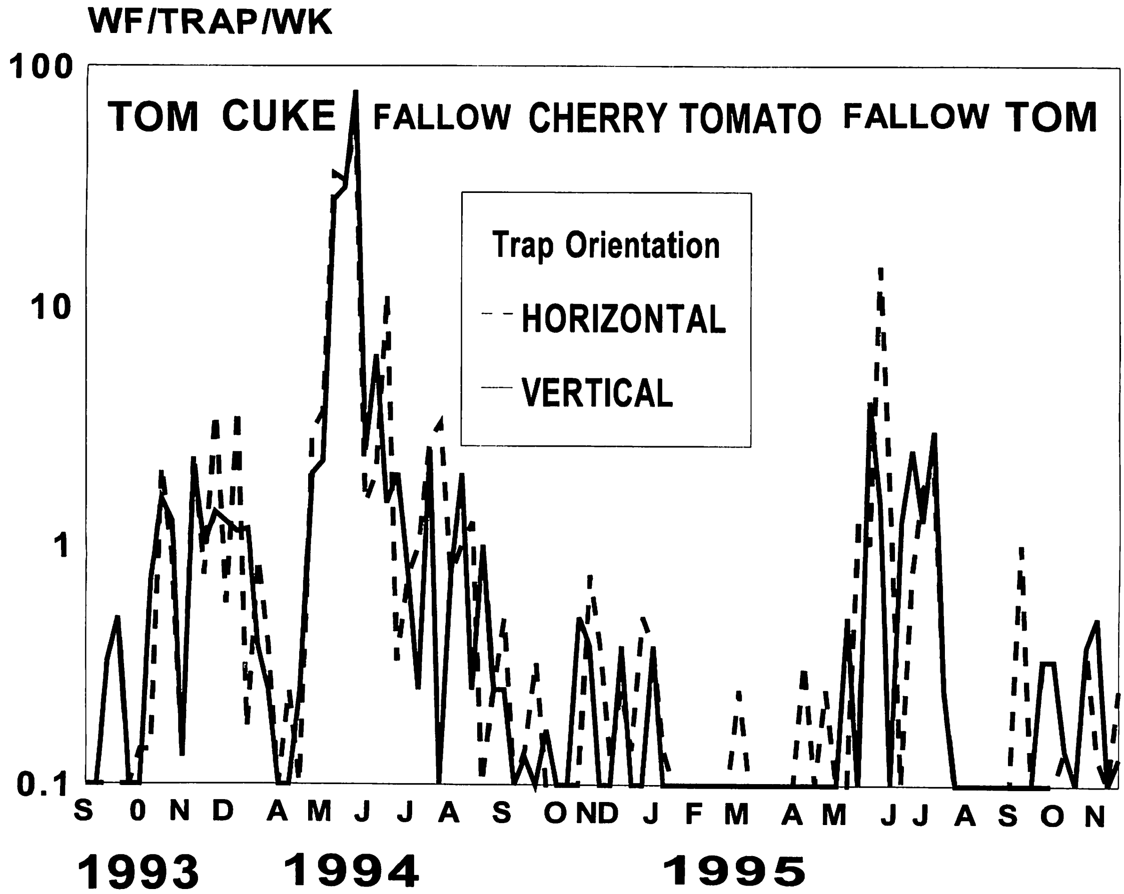

Figure 5. Whitefly captures on horizontally and vertically oriented yellow sticky traps on Hendry2 farm.

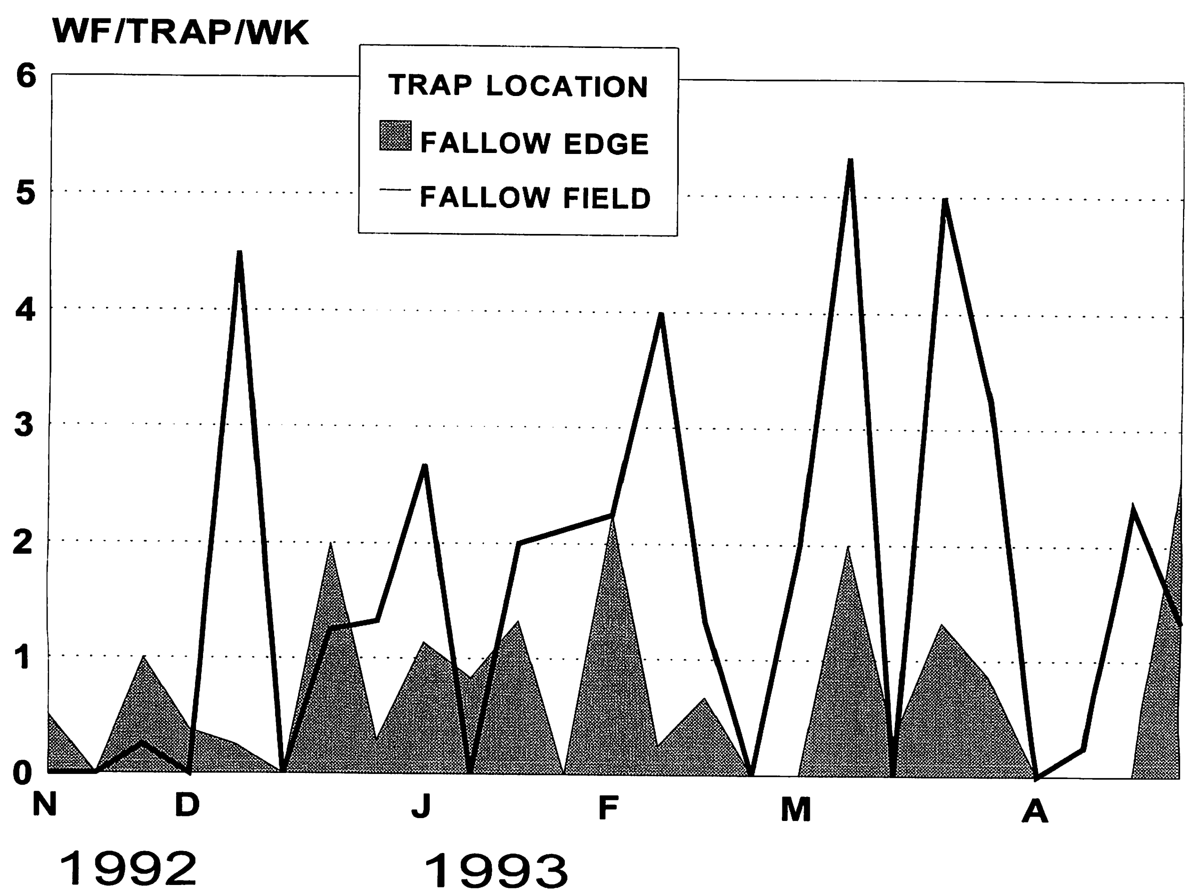

Figure 6. Whitefly captures on yellow sticky traps in fallow field and weedy margin at Collier1 farm.

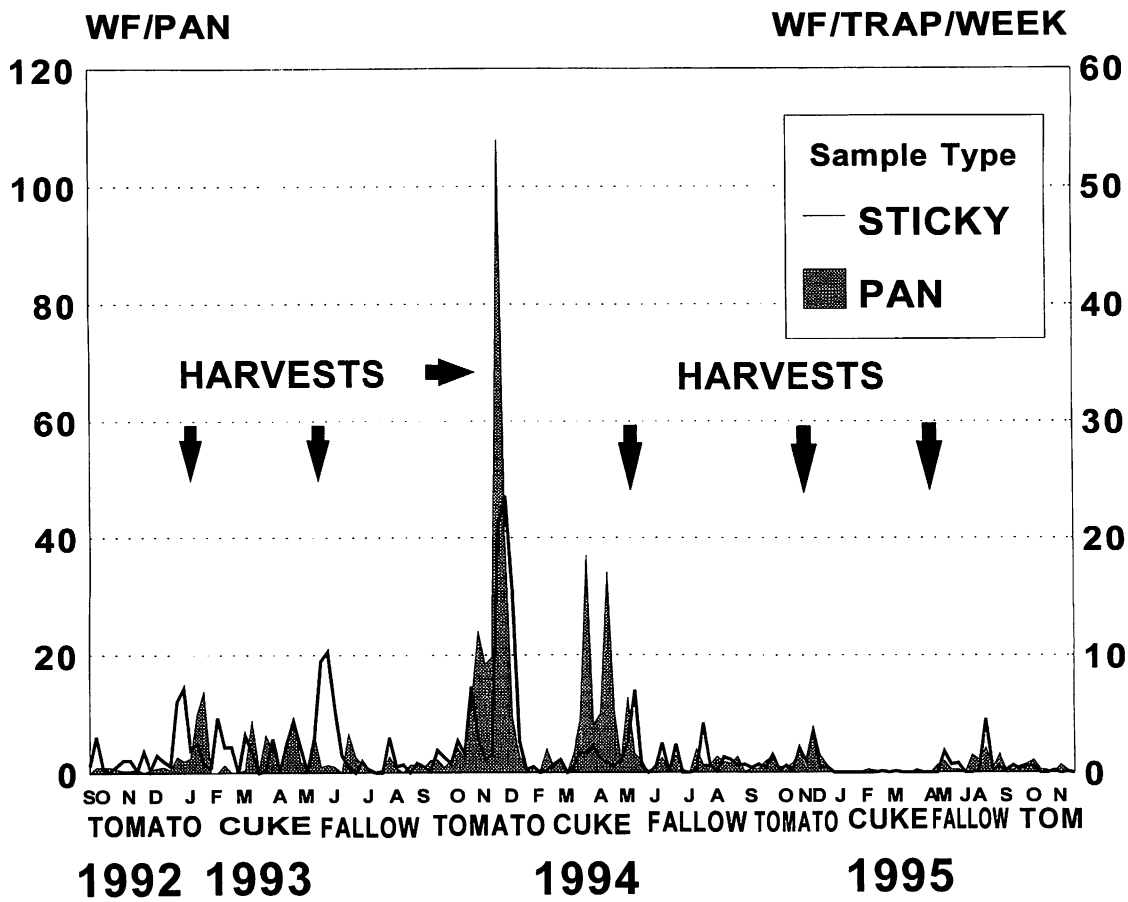

Figure 7. Whitefly captures on yellow sticky traps and in beat pans at Collier2 farm.

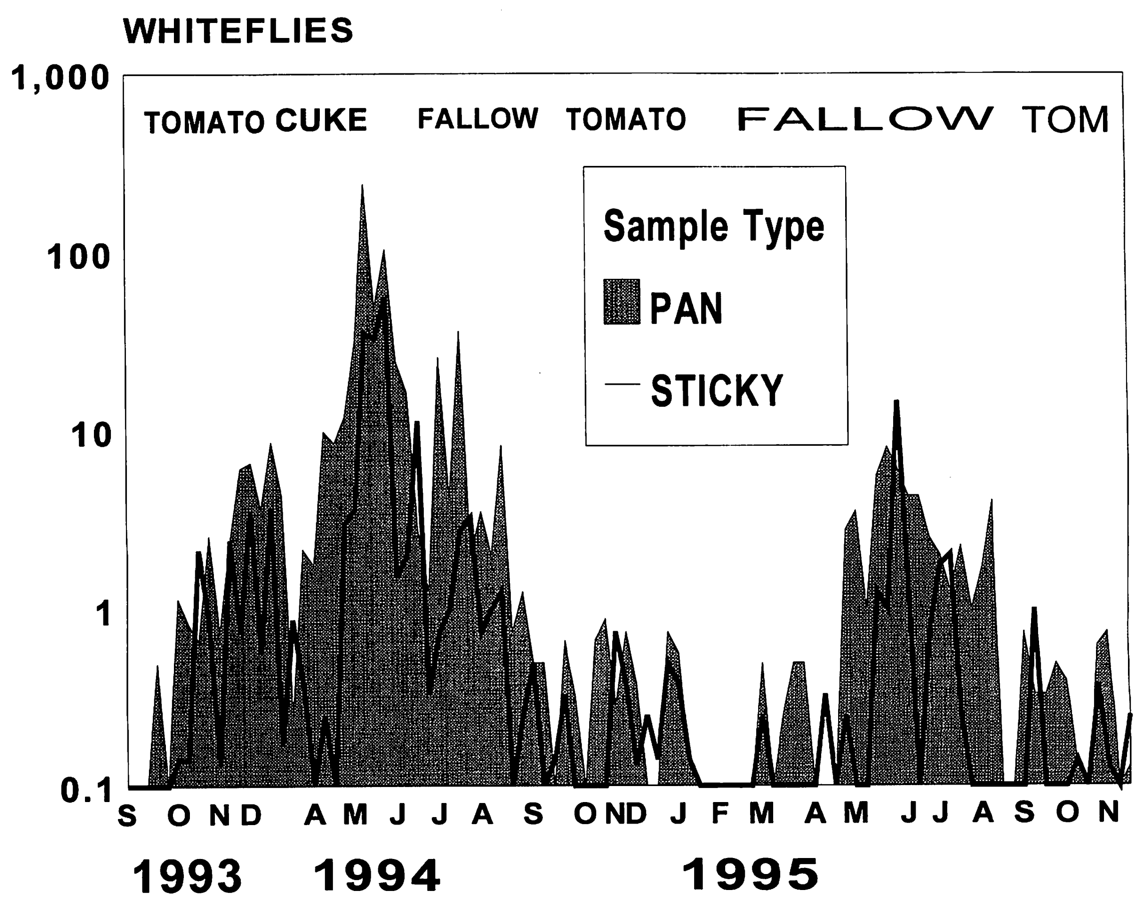

Figure 8. Whitefly captures on yellow sticky traps and in beat pans at Hendry2 farm.

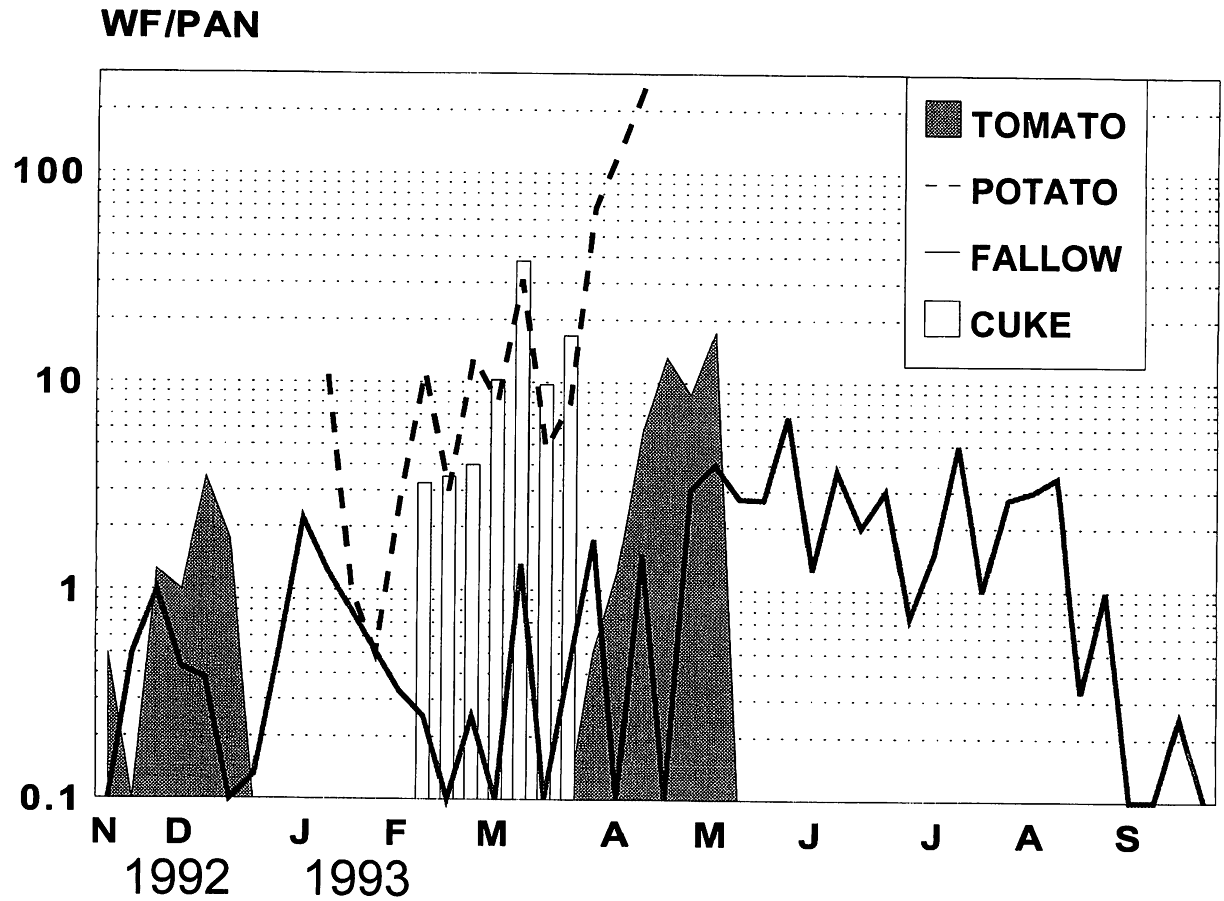

Figure 9. Beat pan samples from adjacent crops on Collier1 farm.

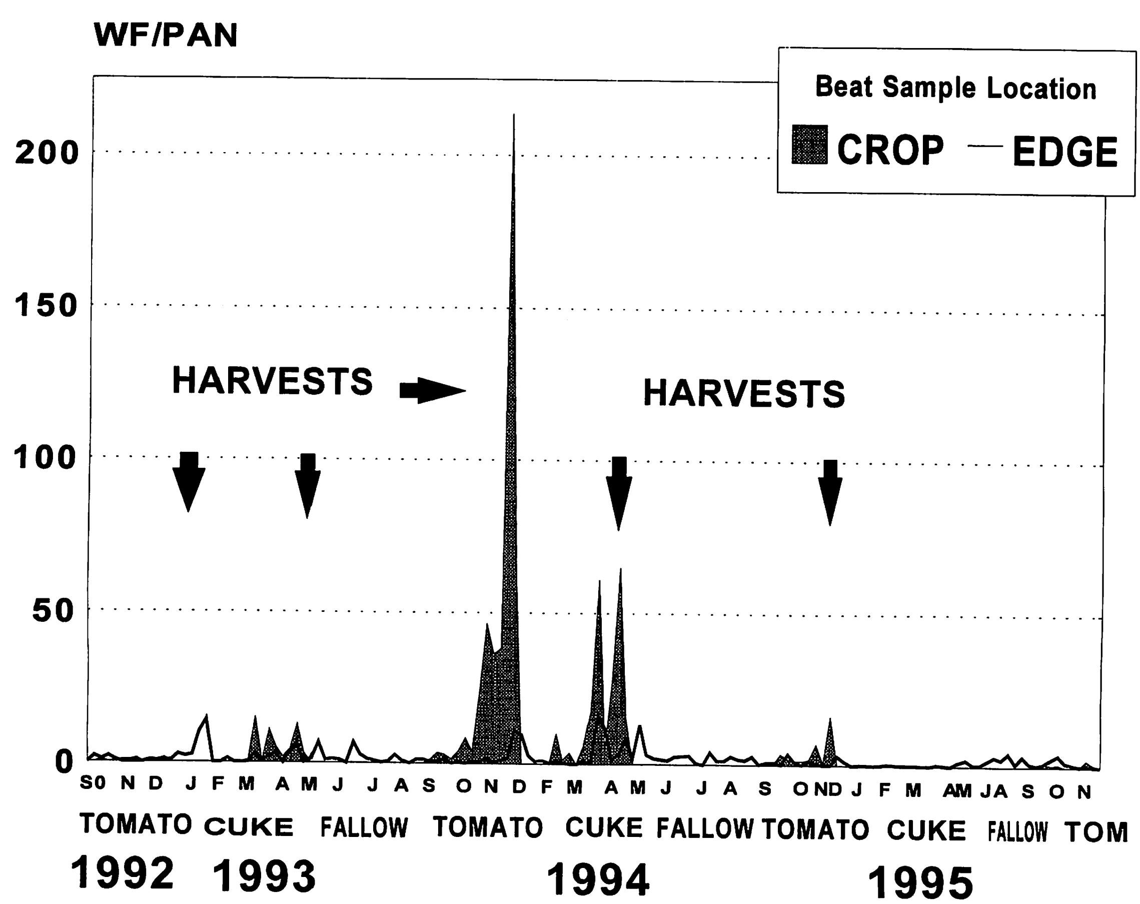

Figure 10. Beat pan samples from crops and weedy margins of Collier2 farm.

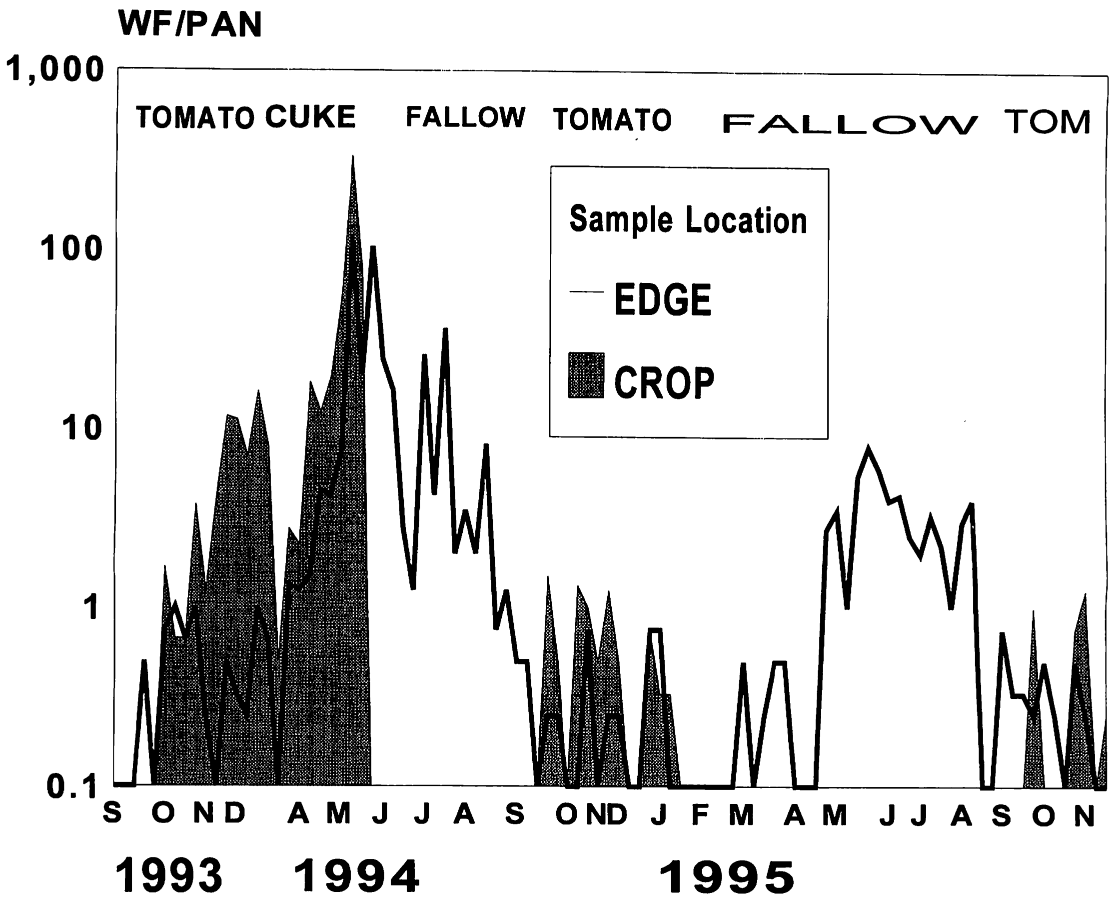

Figure 11. Beat pan samples from crops and weedy margins of Hendry2 farm.

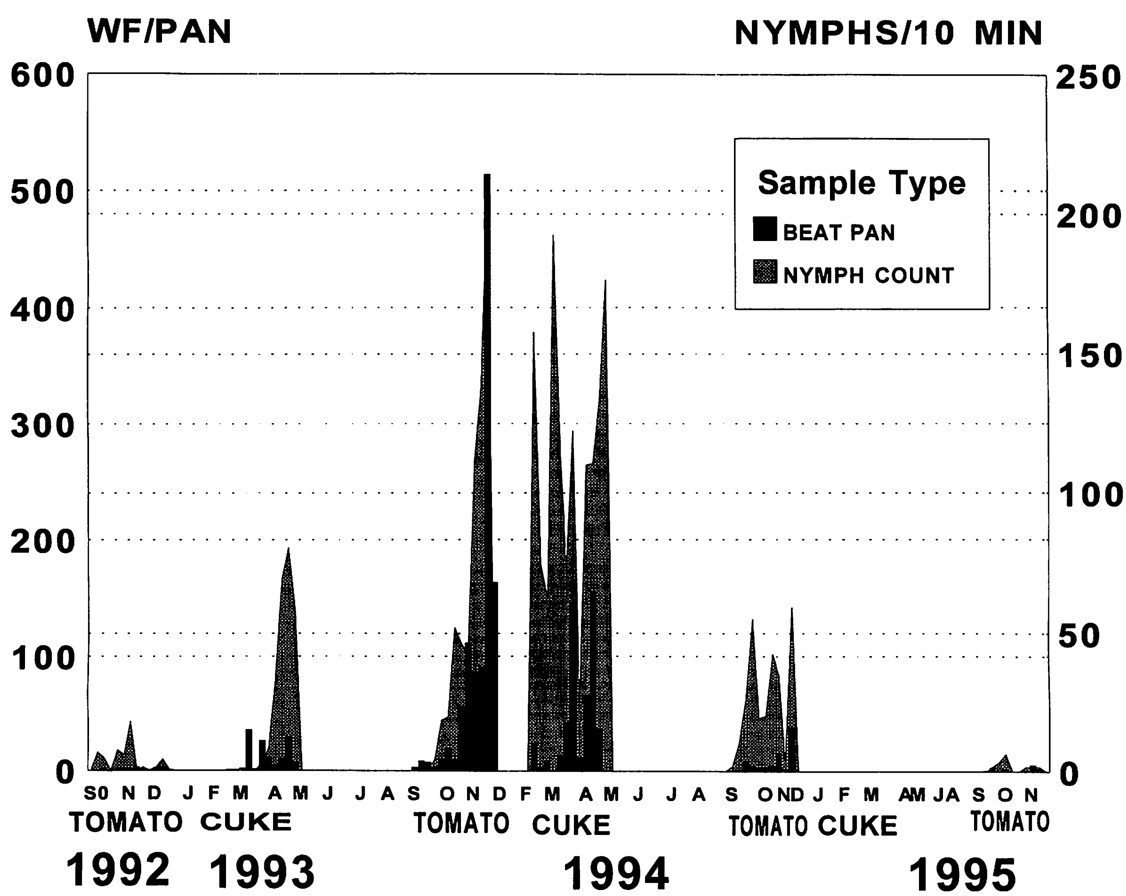

Figure 12. Beat pan samples for adults and 10 minute leaf counts for nymphs at Collier2 farm.

weeds, possibly because widespread use of imidacloprid reduced whitefly on crops below levels observed on weeds (Fig. 10).

In comparing nymph counts with beat pan counts of adults, an expected pattern might be an initial flush of adults as they migrate into the crop, followed by an increase in nymphs and then more adults. Such a pattern was observed in fall 1993, and to a lesser extent in spring the same year (Fig. 12). Insecticide use may have been responsible for obscuring this pattern during other cropping seasons.

In summary, all methods used proved valuable for tracking whiteflies in crops and crop margins. Sticky traps, especially when placed horizontally, proved to be a useful tool for monitoring whitefly movements into and out of crops, and in some cases, could be used to predict outbreaks and guide management decisions. While leaf turns have been shown to be the most efficient sampling method in certain crops (Palumbo et al., 1995), the beat pan provided an efficient and comparable sample of adult whiteflies over many different plant types including erect and recumbent crops and weeds, as did the 10-minute nymph count.

All these sampling methods told a similar story of whiteflies building up on crops and migrating from crop to crop, with weeds serving only as intermediate hosts, ultimately supporting only few whiteflies over fallow periods. These results supported early recommendations (Stansly, 1990; Stansly et al., 1991) emphasizing the importance of a crop-free period during summer requiring removal of all crop residues, and separation of fall and spring crops in time and space to reduce carryover of whitefly populations and TMoV to consecutive plantings. Summer clean-up was quickly adopted and fall whitefly populations have been low ever since as a result. After a disastrous spring crop in 1991, growers redoubled efforts to separate new spring plantings from fall crops with the desired result in 1992. However, the following year brought heavier spring infestations, possibly due to increased winter plantings in response to market incentives. High trap counts at the end of the 1993 season signaled another imminent disaster in spring 1994, avoided by timely appearance of the systemic insecticide, imidacloprid (Admire®). Virtually universal use of this product in tomato since then is probably responsible (together with unusually wet weather) for the dramatic decline in whitefly populations seen over the subsequent 2 years. Hopefully, over-reliance on this powerful tool will not overshadow the importance of crop-free periods as an essential practice for sustained management of SLWF and associated viruses.

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MANAGEMENT OF PICKLEWORM WITH ENTOMOPATHOGENIC NEMATODES

SUSAN E. WEBB
Central Florida Research and Education Center
University of Florida
Leesburg, FL 34748

JOHN L. CAPINERA
Entomology and Nematology Department
University of Florida
Gainesville, FL 32611

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Additional index words. Diaphania nitidalis, Steinernema carpocapsae, Cucurbita pepo, squash.

Abstract. **Entomopathogenic nematodes (*Steinernema carpocapsae*, All strain) were tested for efficacy in controlling pickleworm, *Diaphania nitidalis* Stoll, an important pest of cucurbits in Florida. In 1992, nematodes were applied to squash (*Cucurbita pepo* L.) twice per week, at a rate of three billion nematodes per acre. The percentage of fruit damaged by pickleworm in these plots ranged from 0% on 19 June to a high of 9% on 26 June. Damage in untreated plots ranged from a low of 33% on 16 June to a high of 60% on 12 June. Blossom damage was also significantly reduced with application of nematodes. In 1993, a much lower rate of nematodes was applied once per week (one billion nematodes per acre). Even at this**