Control of Sweetpotato (Silverleaf) Whitefly, *Bemisia Tabaci*, on Cotton in Paloma, Arizona

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Abstract

A large-scale for the control of sweetpotato (silverleaf) whitefly, Bemisia tabaci, (SPW) was carried out in Paloma and Painted Rock near Gila Bend, Arizona, on approximately 6,156 ha of cotton during the 1993 season. Within the program area 40 fields were randomly selected for comparison with 15 fields in each of 2 locations outside the program. They were identified as check east (approximately 11 k northeast of the program) and check west (approximately 3 k west of the program).

Whitefly populations in both check areas were controlled according to individual grower protocol. On a weekly basis, adult counts were taken from all 4 edges and the centers of each field using the oil pan technique. Insecticides were applied aerially in the program area on the full field or edges based on population density recorded from pan samples. Insecticide combinations were rotated weekly in an attempt to reduce the potential for the development of pesticide resistance.

During the 16-week evaluation period SPW adults were significantly higher in check east and check west than the program area by 2- and 6-fold, respectively; eggs were higher by 3- and 39-fold, respectively; and nymphs were also significantly higher in check east and check west by 3- and 60-fold respectively. Ginning records for 1993 indicate approximately a 20% increase in yield in the program area, a 5% increase in check east and a 40% decrease in check west as compared to 1992.

These results demonstrate that an area-wide approach, utilizing edge treatment where possible, based on extensive field sampling regimens represent an important integrated strategy in a successful whitefly control program.

Introduction

The importance of the sweetpotato (silverleaf) whitefly, *Bemisia tabaci* (Gennadius), (SPW), as a vector of plant viruses (Duffus, 1987; Brown & Nelson 1984, 1986), plant diseases (Duffus, 1982), and as a pest has increased

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in various parts of the world in the past decade. In the United States, SPW poses a serious threat to the agriculture systems in the southwestern states and Florida (ARS, USDA, 1992). The feeding behavior of this new pest has a wider range of host plants and is a pest of many new cultivated crops (ARS, USDA, 1992). The reasons for host expansion and increased damage levels are not clear. The more destructive whitefly could be a new strain (Byrne & Miller, 1990) or a new species (Perring et al, 1993). In Arizona, SPW populations often move from weeds and spring vegetable crops to melons where densities increase exponentially until plants begin to senesce, then they move to cotton (Watson et al, 1993). Populations of SPW reached alarming levels in central and western Arizona during the 1992 cotton season. Despite the availability of effective materials that control whiteflies, their high cost, coupled with the need for frequent applications, severely increased production cost. Yields were severely reduced because of the whitefly direct consumption of phloem sap. In addition, whiteflies contaminate lint with honeydew that serves as a medium for sooty mold fungi (Gerling et al, 1980). Honeydew and sooty mold reduce lint quality resulting in a severe economic loss. Beginning in early July 1992, Southwest Boll Weevil Eradication Program personnel sampled 22 cotton fields in central Arizona for both adult and immature whiteflies. Without exception results revealed that, during the early stage of whitefly population development, numbers were highest and escalated faster along field edges.

A field test was conducted during the 1992 season to determine the effect of edge treatment of SPW populations in cotton. Results indicated that the number of adults and immatures can be significantly reduced by treating only the periphery of cotton fields at the onset of their infestations (El-Lissy et al, 1992). It also helped to reduce movement of adults into the interiors of the fields. Further, it minimized the amount of insecticide use since only 15-18% of the total field acreage was treated resulting in a very significant saving (El-Lissy et al, 1992). Treatment of only field edges also preserved the predator and parasite populations in the field centers thus assisting in the control of not only SPW populations but also other harmful cotton insects.

To test this new theory, a large scale demonstration program was conducted in Paloma and Painted Rock near Gila Bend, Arizona, on approximately 6,156 ha of cotton during the 1993 season. This paper reports the results of this program.

Methods and Materials

230 contiguous cotton fields (6,156 ha) in Paloma and Painted Rock near Gila Bend, Maricopa County, Arizona, were selected as a site to implement an area-wide biorational approach to control sweetpotato (silverleaf) whitefly (SPW) populations. Within the program area, 40 fields were randomly selected for the purpose of evaluating the program and comparison with 15 fields in each of 2 locations outside the program. They were identified as check east (approximately 11 k northeast of the program) and check west (approximately 3 k west of the program.). SPW populations in both check areas were controlled according to individual grower protocol. Planting dates in the program and check areas varied from March 20 to April 15. The average field size was approximately 26.4 ha.

SPW population sampling protocol varied slightly in terms of intensity between the evaluation and control segments.

Control:

SPW adults were monitored with yellow sticky traps (30.5 x 15 cm), printed with 72 squares (2.5 x 2.5 cm each), and shaped into cylinders (7.6 cm diameter). Traps were attached vertically to 1.2 m sticks and placed on all four corners of each field about 0.6 m above ground and approximately 1.5 m outside the field edge. Traps were replaced weekly beginning May 3. The number of SPW adults on the traps were counted from 5 randomly selected squares. Trapping was used only to monitor the early movements of the populations to initiate the infield sampling of adults using the oil pan.

Infield adult populations were sampled weekly using 33 x 20 x 5 cm aluminum pans (Butler, USDA, ARS). The pan interiors were painted black and scored with a 2.5 cm grid on the inside bottom surface. A total of 3 samples were taken from each of rows 1, 5, 15 and 25 (or the equivalent distance) from all 4 sides of each field, with an average distance between rows of 96 cm, and from 4 rows (approximately 3.8 m apart) in the center. With the pan near the plant terminal, each sample was taken by tapping the upper 15-20 cm of the plant with a 30 x 4 x 0.5 cm stick using (as much as possible) the same force on each plant to dislodge the SPW adults into the oil coated bottom of the pan. Each sample was comprised of the total number of whiteflies collected from 5 alternating plants in the same row.

Insecticidal applications were made based only on population density as determined by the pan sampling technique. Treatment decisions were made on a field-by-field basis. Applications were made with one swath 21.4 m around the field perimeters (edge treatment) when population density reached the threshold only on the periphery. Full field treatments were initiated when population density in the center of the field reached the threshold. The threshold for treatments was an average of 5 adults/pan/sample from May 20 to June 20, an average of 10 adults/pan/sample from June 21 to July 10, and an average of 30 adults/pan/sample from July 11 to September 3. The first treatment was made on May 20 and the last was made on September 3.

Applications were made from 6:30 to 10:30 a.m. by air using a total of 3 Turbo Thrush (S2R-T34) airplanes with an airspeed of 200 k/h. Each plane was equipped with an 11 m stainless steel boom with a total of 44 CP nozzles installed evenly spaced at a 30° angle from the wind. The pump pressure was 71.7 gm/m^2 producing a swath width of 21.4 m (23 rows) delivering 47.0 liters of finished formula/ha. The wind speed ranged from 3-11 k/h and was generally from the southwest.

Insecticide combinations were rotated weekly in an attempt to reduce the potential for the development of pesticide resistance. Compounds were diluted in water and included the following: Lambda-Cyhalothrin (Karate®) at 34 AI (0.28 l/ha) mixed with Acephate (Orthene® 90S) at 0.57 kg/ha; Tralomethrin (Scout X-tra™) at 27 AI (0.24 l/ha) mixed with Acephate (Orthene® 90S) at 0.57 kg/ha; Mustang™ 1.5EC at 45 AI (0.23 l/ha) mixed with Acephate (Orthene®) at 0.57 kg/ha; Bifenthrin (Capture® 2EC) at 68 AI (0.28 l/ha) mixed with Acephate (Orthene® 90S) at 0.57 kg/ha; Amitraz (Ovasyn®) at 703 AI (1.55 l/ha) mixed with Endosulfan (Thiodan® 3EC) at 1,134 AI (2.36 l/ha); Fenpropathrin (Danitol 2.4EC) at 227 AI (0.78 l/ha) mixed with Acephate (Orthene® 90S) at 0.57 kg/ha; Bifenthrin (Capture® 2EC) at 68 AI (0.28 l/ha) mixed with Endosulfan (Thiodan® 3EC) at 1,134 AI (2.36 l/ha); Fenpropathrin (Danitol 24EC) at 227 AI (0.78 l/ha) mixed with Profenofos (Curacron® 8E) at 1,134 AI (1.18 l/ha); Mustang™ 1.5EC at 45 AI (0.26 l/ha) mixed with Chlorpyrifos (Lorsban 4E) at 567 AI (1.18 l/ha), (AI = g/ha).

Evaluation:

Adult and immature SPW populations were sampled weekly in the 40 randomly selected fields within the program area and the 30 in the check areas.

Adult SPW populations were sampled using the pan technique by taking a total of 5 samples from each of rows 1, 3, 15 and 25 (or the equivalent distance) from all 4 sides of each field and from 4 rows (approximately 10 m apart) in the center.

Immature SPW populations were sampled by collecting the 5th main stem leaf from the top of 5 alternating plants in rows 1, 3, 15 and 25 and from 4 rows (approximately 10 m apart) in the center of each field. Leaves were placed in paper bags and transported to the laboratory. Leaf discs (2.5 cm^2) were punched at the center of the lower part of each leaf. Eggs and all immature SPW were counted on the undersides of the discs.

Data Analysis:

All statistical analyses were carried out using "TABLES", "F", and "t" tests. MSTAT-C statistical software programs (Michigan State University, Copyright 1988).

Results and Discussion

Preliminary analyses indicate that the overall mean number of SPW adults sampled in the program area was significantly different as compared to the check areas, where check east was higher by 2-fold and check west by 6-fold ($F = 3.9$ and 32.0 respectively, $P \leq 0.05$). The overall mean number of SPW eggs in check east and west was higher than the program area by 3- and 39-fold respectively ($F = 17.9$ and 7,378.9, $P \leq 0.05$). The overall mean number of SPW nymphs in check east and west was higher than the program area by 3- and 60-fold respectively ($F = 10.4$ and 13,217.6, $P \leq 0.05$) (Table 1). During the 16 week evaluation period, SPW adults where significantly higher in check east and check west as compared to program area for 5 and 9 weeks respectively ("t" = 2.1 and 3.35) (Figure 1). Eggs were significantly higher for 9 and 11 weeks respectively ("t" = 2.0 and 2.1) (Figure 2). Nymphs were also significantly higher for 10 and 12 weeks respectively ("t" = 2.7 and 2.1) (Figure 3).

Despite the active edge treatments in the program area, and some in the check areas, the overall mean number of adults in row 1 was significantly higher than the center of the fields in all three areas (Figure 4). Eggs were significantly higher only in the check areas (Figure 5), as were as the nymphs (Figure 6), which supports the edge effect theory that SPW population density is highest on the periphery of the fields. Well-timed treatments of field perimeters result in a reduction of both the degree of adult migration and reproductive activity in the periphery and center of fields under control. Although SPW population density was higher on some sides of several fields during the study, the overall mean number of SPW adults by direction was not significant for any week of the study (Figure 7).

Based on the treatment criteria described, SPW populations were successfully controlled with a minimum number of full field insecticide treatments, where 87.4% received only 1-3 full field applications for the entire season (Table 2).

Ginning records for 1993 indicate approximately a 20% increase in yield in the program area, a 5% increase in check east, and a 40% reduction in check west as compared to 1992 (Table 3).

Based on the above, we conclude that an area-wide approach, utilizing edge treatments where possible, based on extensive field sampling regimens represents an important strategy in a successful whitefly control program.

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TABLE 1. Overall mean number of sweetpotato whitefly adults, eggs, and nymphs, Maricopa County, Arizona, 1993

Treatment[a]	$\bar{x}$ Adult/pan[b]	$\bar{x}$ Egg/leaf disc	$\bar{x}$ Nymph/leaf disc
(1)	24.6 a	4.31 a	1.0 a
(2)	57.8 b	11.90 b	3.4 b
(3)	140.0 c	166.30 c	65.4 c

[a] Treatment: (1) program area; (2) check east; (3) check west.
[b] Means in a column not followed by the same letter differ significantly at $P \leq 0.05$ as judged by F test.

TABLE 2. Number of edge and full field insecticide treatments for sweetpotato whitefly control in the program area, Maricopa County, Arizona, 1993.

	Edge Treatment[a]			Full Field Treatment		
No. of Treatments	% of Fields	% of Total Hectares	Number of Hectares	% of Fields	% of Total Hectares	Number of Hectares
1	1.7	0.3	18.5	13.9	12.0	738.7
2	13.0	3.0	369.4	44.1	44.0	5417.3
3	25.2	3.8	701.8	24.7	31.4	5798.9
4	23.9	5.3	1305.1	8.2	7.4	1822.2
5	17.4	3.3	1015.7	4.7	3.9	1200.4
6	16.1	2.9	1071.1	3.4	1.6	590.9

[a] Approximately 20% of the field is treated when edge treatment is implemented.

TABLE 3. Mean cotton lint yield per acre in the program and check areas, Maricopa County, Arizona, 1993.

Year	Paloma[a] lb/ac	Painted Rock lb/ac	Check East lb/ac	Check West lb/ac
1992	1227.3 a	1580.0 a	1324.0 a	1246.7 a
1993	1592.3 b	1937.0 b	1390.0 a	736.2 b

[a] Means in column not followed by the same letter differ significantly at $P \leq 0.05$ as judged by t test.

Figure 1. Mean number of sweetpotato whitefly adults per pan per week and standard error, Maricopa County, Arizona, 1993.

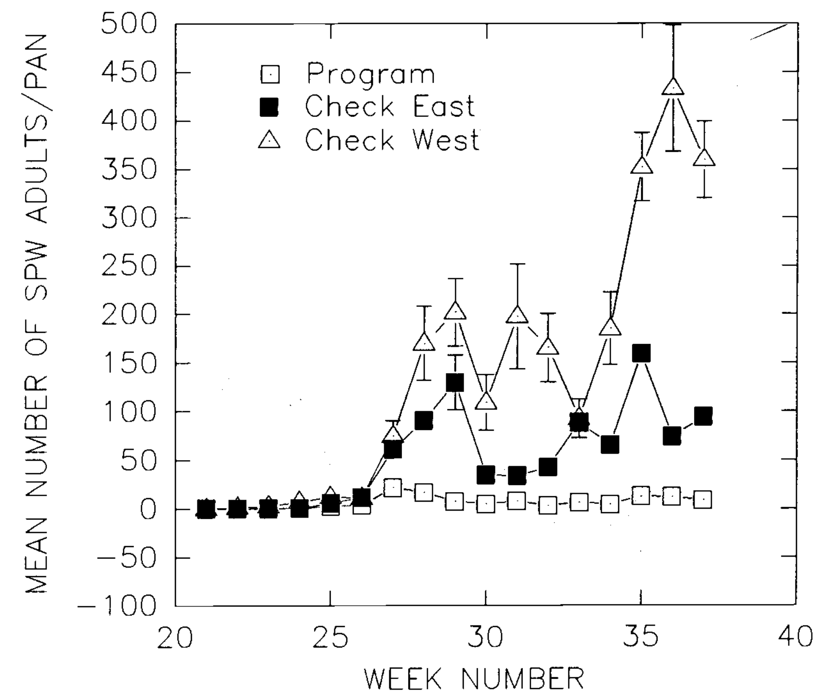

Figure 2. Mean number of sweetpotato whitefly eggs per leaf disc per week and standard error, Maricopa County, Arizona, 1993.

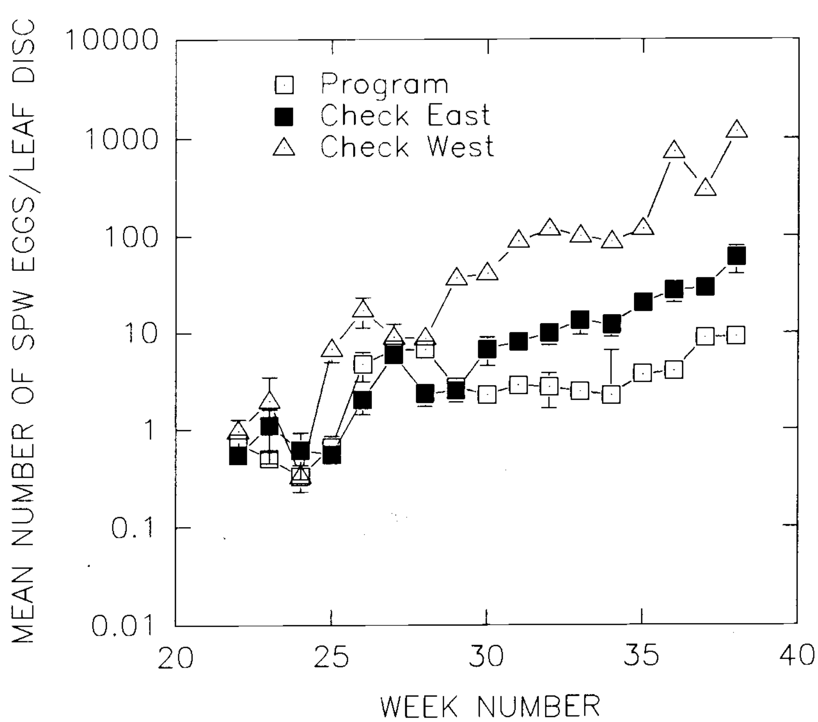

Figure 3. Mean number of sweetpotato whitefly nymphs per leaf disc per week and standard error, Maricopa County, Arizona, 1993.

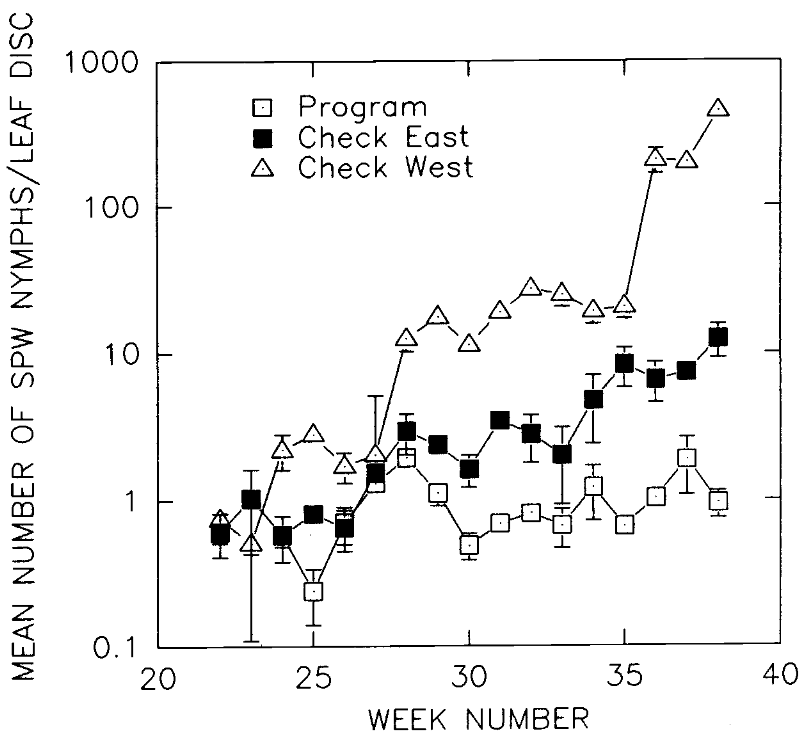

Figure 4. Mean number of sweetpotato whitefly adults per pan and standard error in rows 1,3,15,25 and center of fields, Maricopa County, Arizona, 1993.

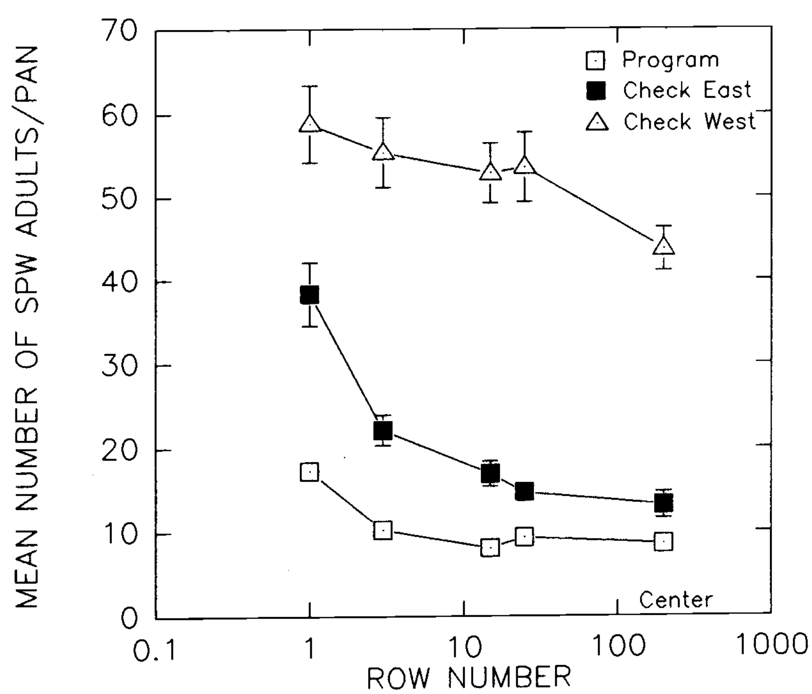

Figure 5. Mean number of sweetpotato whitefly eggs per leaf disc and standard error in rows 1, 3,15,25 and centers of the fields, Maricopa County, Arizona, 1993.

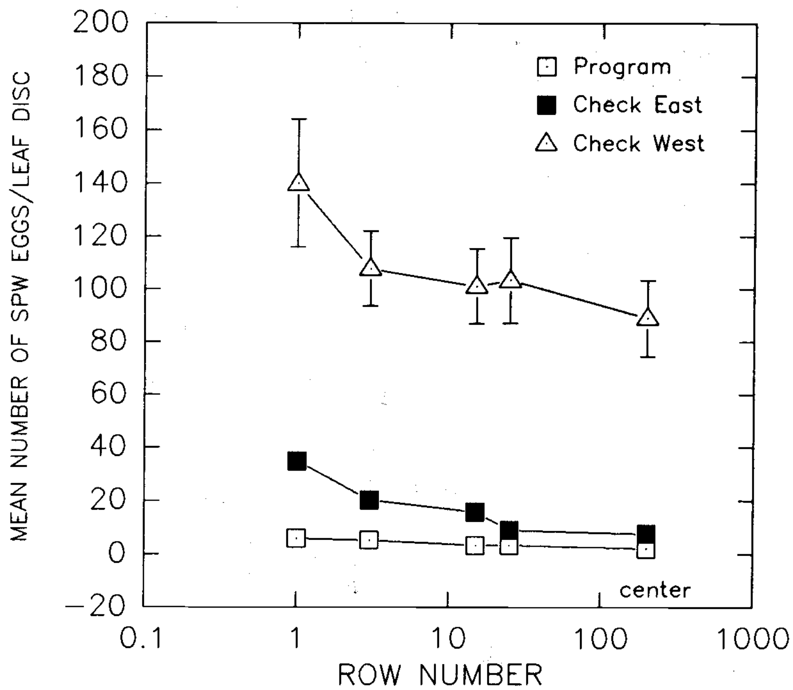

Figure 6. Mean number of sweetpotato whitefly nymphs per leaf disc and standard error in rows 1,3, 15,25 and centers of fields, Maricopa County, Arizona, 1993.

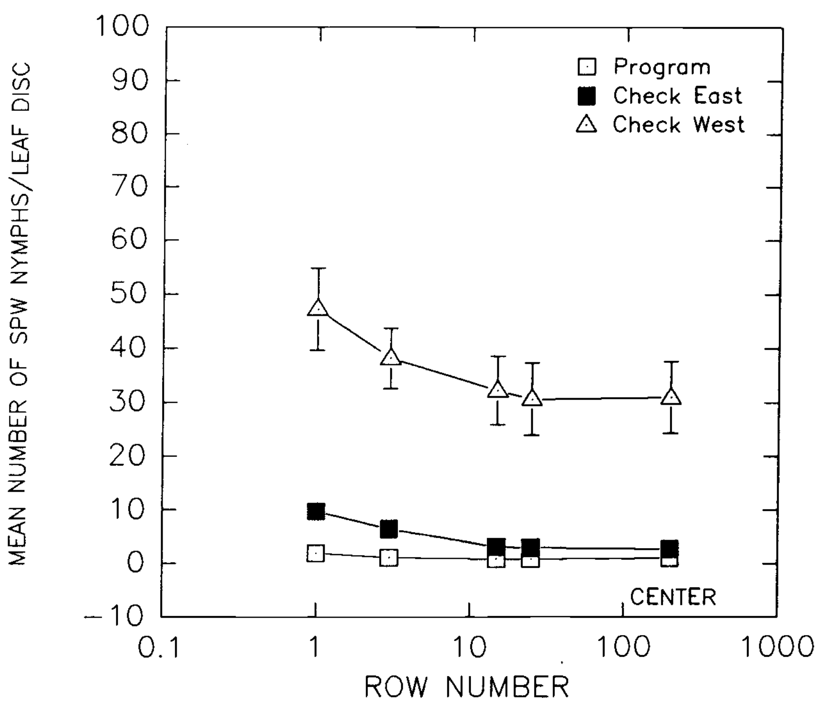

Figure 7. Mean number of sweetpotato whitefliy adults per sampling pan by direction, Maricopa County, Arizona, 1993.