UNIVERSITY OF FLORIDA

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Biological Insect Control in Greenhouse Tomatoes Grown in the Southeastern United States 96-01

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Abstract

Biological control in greenhouse tomatoes in northern climates is a common economical means of managing greenhouse insect pests. Biological control is rarely used in the Florida greenhouse tomato industry. Major Florida pests include: silverleaf whitefly (Bemisia agrentifolii), thrips, aphids, and various armyworm species. Current management of these pests in Florida greenhouses includes routine (often weekly) pesticide applications. This study evaluated the effectiveness of biological control agents in Florida and also provided an economic comparison of their use versus traditional management with pesticides. Effective control of insect pests was achieved with a combination of plastic insect screening materials and the release of biological control agents. The number of a parasitic wasp, Encarsia formosa, required to achieve control of the silverleaf whitefly was much higher than normally required in northern United States greenhouses. The biological control program was much higher in cost than the traditional pesticide programs. Therefore, a much higher price for the tomatoes is needed to offset the higher input costs

Key Words: biological control, greenhouse tomatoes, pest management, whitefly, hydroponics.

Introduction

The greenhouse vegetable industry in Florida expanded during the 1980s. A 1991 survey showed 75 acres of vegetables in production in Florida greenhouses (Hochmuth, 1990a). Most growers in Florida produce tomatoes or cucumbers. Greenhouse tomato producers commonly find several insect pests; however, the silverleaf whitefly (Bemisia argentifolii) is by far the most serious pest. The silverleaf whitefly was first detected in the north Florida production area in the fall of 1989. Since the 1989 season, pest control has required frequent pesticide applications for the control of silverleaf whitefly. Control has been very challenging even with weekly applications of insecticides. Populations build rapidly in the warm greenhouses in Florida. The greenhouse tomato

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season begins with seeding in August, a time of very high silverleaf whitefly populations outdoors. Insect screening has reduced populations but has not eliminated entry into the greenhouses. Prior to 1989, the greenhouse whitefly (Trialeurodes vaporariorum) was very common in Florida greenhouses and was much easier to control with sprays. During the 1990s, the whitefly population in Florida greenhouse vegetable crops has been almost exclusively silverleaf whitefly, making control very difficult.

Biological control programs have been very successful in controlling whitefly in northern United States and Canadian greenhouses (Lieberth, 1991). These control programs were evaluated in north Florida during two seasons from 1994 to 1995. The number of Encarsia formosa and the associated costs for effective control were evaluated.

Materials and Methods

The biological control of silverleaf whitefly using a parasitic wasp, Encarsia formosa, was evaluated during two seasons of greenhouse tomatoes. The trials were conducted in a double-layer polyethylene covered greenhouse at the Suwannee Valley Research and Education Center, University of Florida, near Live Oak, Florida. The greenhouse structure was 18 ft. x 58 ft. with 10 ft. sidewalls. The greenhouse was equipped with an evaporative cooling pad on one end wall and ventilation fans on the opposite end wall. The evaporative cooling pad was covered with a woven monofilament screening material "Antivirus Insect Screen" manufactured by Green-Tek, (Edgerton, WI). The screen covered a wooden box built on the outside of the cooling pad so the surface area covered was approximately twice the opening of the cooling pad. Propane gas heaters provided a minimum temperature of 62 F. Warm air was conveyed by 12" ventilation tubes along the floor between each double row of tomatoes. The same ventilation tubes were used to re-circulate greenhouse air in the crop canopy to minimize free water from forming on the tomato plants. In addition, horizontal air-flow fans were located above the crop and also used as recommended, primarily to reduce moisture on the plants (Bartok, 1994).

Tomatoes, cultivar `Trust', were grown both seasons in a typical rockwool production system (Hochmuth, 1992). Three double rows of tomatoes were planted in the greenhouse, with pairs of rows 5 ft. apart on centers and 50 ft. long, providing approximately 4.5 $ft.^2$ per plant. Tomato seeds were sown in 1½ x 1½ inch rockwool cubes on August 24, 1994 and August 24, 1995. Transplants were planted on the production slabs approximately four weeks after seeding. Nutrient management programs each year followed the five stage program as outlined by the University of Florida, beginning at 70 ppm nitrogen and increasing to 150 ppm according to crop stages of growth (Hochmuth, 1990b). Standard crop maintenance practices were

followed for training, suckering, pruning lower leaves, pollination, and cluster pruning (Hochmuth, 1991). During the winter of the 1994-95 season, the pruned lower leaves were piled on one end of the greenhouse and left for one week. This allowed extra time for Encarsia formosa adults to emerge from parasitized whitefly nymphs. The practice was followed from November to March, but was terminated after March due to concern over increased risk of disease. Tomatoes were harvested 2 to 3 times weekly, graded into marketable and cull categories and the respective number and weights recorded. The first harvest was December 5 in both 1994 and 1995.

A weekly insect scouting and monitoring program was followed in both seasons. Yellow sticky cards were used to help monitor pest populations in the house. One card in three locations was taken down weekly and replaced with a new card. The cards taken down were then surveyed for the pests present. Silverleaf whitefly and thrips populations were recorded from each card. In addition, weekly tomato leaflet samples were taken and examined for pests and beneficial populations. The terminal leaflet from ten random leaves in the greenhouse was used to sample. The leaves chosen were located in the lower plant canopy, approximately one-third of the way up the plant from the lowest leaf.

The results of the scouting reports were sent weekly to project cooperator, G B Systems (Boulder, CO). G B Systems then sent beneficials for release. The beneficial release rate in the 1994-95 season was set to assure control of pests. Encarsia formosa, a parasitic wasp, was used for control of silverleaf whitefly and Amblyseius cucumeris, a predator mite, was used for thrips control.

Results and Discussion

1994-95 Season Summary Very high outdoor populations of silverleaf whitefly and several species of thrips were able to enter the greenhouse at the beginning of the season. Using insect screening reduced but did not eliminate silverleaf whitefly entry. Thrips were able to enter through the screening more easily than the whitefly. Due to the early infestation of whitefly and thrips, biological control programs were initiated in the first month of the season. Both Encarsia formosa and Amblyseius cucumeris were released on September 14, 1994 for whitefly and thrips, respectively. Control of thrips inside the greenhouse was achieved with Amblyseius cucumeris from October to November and cold outdoor temperatures after November eliminated thrips populations outside. As a result, thrips populations were essentially zero from November to March. Thrips increased in the spring season again, however, were not of great concern since the season was near its end.

Silverleaf whitefly populations were maintained at low levels throughout the season by frequent releases at high levels of Encarsia formosa. Releases during March, April, and May were made on a weekly basis. Spring weekly releases of Encarsia formosa

were generally made at a rate of 2.5/ft.^{2} (28/meter^2). This rate of release is 6 to 7 times the rate recommended for control of the greenhouse whitefly in northern greenhouses. Even at these high levels of Encarsia formosa, silverleaf whitefly populations were frequently 1 to 3 per leaflet (Table 1).

There was a total of 54,000 Encarsia formosa released in the 1000 ft.^{2} greenhouse during the season on 22 different releases. The approximate cost for these releases would have been $418 for the season plus shipping charges. The seasonal marketable yield for this crop was 21 lbs per plant. The cost of the biological control program is perhaps best understood on the basis of the cost per pound of tomato yield. The cost of Encarsia formosa in the 1994-95 evaluation would have been 11.1 cents per pound of tomato (Table 2). The thrips biological control program using Amblyseius cucumeris would have cost $110.75 for the season or 2.9 cents per pound of marketed tomatoes. Based on actual charges for this program, the shipping charges for a typical 1 to 2 bay greenhouse operation in north Florida would add 5.0 cents per pound.

1995-96 Season Summary Due to the extremely high costs associated with the biological control program implemented in 1994-95, the biological control program in 1995-96 was set to reduce costs if possible. The early season control program for silverleaf whitefly included nearly weekly sprays of soaps. Whitefly populations on tomato leaflets varied from 0 to 15 per leaflet during October and early November. Whitefly nymph populations were reduced with soap sprays to nearly zero, based on leaflet counts on November 11, 1995. The first Encarsia formosa release for the season was made on November 17, 1995. The rate of Encarsia formosa released in 1995-96 was lowered to determine if a lower release rate would be effective.

Release rates were 1.3/ft.^{2} (14/meter^2), one-half of the rate from the 1994-95 season. During the period of Encarsia formosa releases (November 17 to December 8) the silverleaf whitefly nymph counts increased each subsequent week from 0 to 18 per leaflet. The releases of Encarsia formosa were terminated and a spray program initiated to bring the population of whitefly in control. The adult whitefly counts were two per card on November 16 and increased to a high of over 350 per card on December 8, 1995.

Another indication of the high silverleaf whitefly population was the presence of the tomato fruit disorder known as irregular ripening. This disorder is known to be associated with silverleaf whitefly feeding (Maynard and Cantliffe, 1994). The exact mechanism is yet unknown, however, the irregular ripening is known to subside when the silverleaf whitefly populations are brought under control.

Conclusions

Biological control programs using Encarsia formosa for silverleaf whitefly in the southern United States will be very challenging and expensive. Biological control of this

pest was achieved during the 1994-95 season. A good yield (21 lbs/plant), for Florida greenhouses, of very high quality tomato fruit was harvested. The associated costs with the 1994-95 biological control program was 17 cents/lb of tomato. This figure did not include the time or labor required to conduct the scouting and record keeping program. These tasks would require approximately two hours per week. The biological control program costs should be compared to a traditional spray program. The current insect control spray programs of small north Florida growers is estimated to be 3 to 4 cents per pound. This would include the amortized cost of a motorized backpack sprayer plus the insecticide costs. The higher cost for biological control programs would have to be offset by higher tomato prices. Current markets do not justify the higher costs of biological control found in this study.

Reduced releases of Encarsia formosa below the 1994-95 trial levels of 2.5/ft.^{2} should be evaluated in Florida with caution. Important factors requiring the high levels of Encarsia formosa appear to include: 1) primary Florida pest species is silverleaf whitefly, not greenhouse whitefly, 2) extremely high outdoor silverleaf whitefly populations at the beginning of the season, 3) problems created by irregular ripening due to even moderately low silverleaf whitefly populations, and 4) minimum greenhouse temperatures in Florida are generally maintained at 62^o F, higher minimum temperature may increase parasite effectiveness.

Literature Cited

1. Bartok, J. L. 1994. Don't overlook benefits of horizontal air flow fans. Greenhouse Manager. February, 1994. p. 90-92.

2. Hochmuth, G. J. 1990a. Florida...A leader in greenhouse vegetable production. Citrus and Vegetable Magazine. October, 1990.

3. Hochmuth, G. J. 1990b. Nutrient solution formulation for hydroponic (rockwool and NFT) tomatoes in Florida. Fla. Coop. Ext. Serv. Special Series SS-VEC- 44.

4. Hochmuth, G. J. 1991. Greenhouse vegetable production handbook Vol. 3. Greenhouse vegetable crops production guide. Fla. Coop. Ext. Serv. SP-48.

5. Hochmuth, G. J. 1992. Production of Florida greenhouse vegetables in rockwool. Greenhouse design and crop management. Fla. Coop. Ext. Serv. SP-110.

6. Lieberth, J. A. 1991. Yes, you can win the war on whiteflies. Meister Publ. Co. Willoughby, OH.

7. Maynard, D. N., and D. J. Cantliffe. 1990. Squash silverleaf and tomato irregular ripening: new vegetable disorders in Florida. Fla. Coop. Ext. Serv. Fact Sheet VC-37.

8. Osborne, L. S., K. Hoelmer, and D. Gerling. 1991. Prospects for biological control of sweetpotato whitefly. Resh. Rept. No. 030. Bedding Plant Foundation, Inc. Lansing, MI.

Table 1. Summary of average monthly pest populations from scouting reports for silverleaf whitefly during the 1994-95 season in Live Oak, FL.

Month	Card counts[z]	Whitefly per leaflet[y]	Parasitized whitefly per leaflet[x]
October	6	8	1
November	8	3	4
December	13	2	1
January	5	.5	.5
February	5	3	1
March	8	3	.5
April	5	2	1
May	1	.5	.1
June	1	.2	.2

[z]Yellow sticky cards were 3 x 5 inches and counts included the total number of adult silver-leaf whitefly from both sides of the card.

[y]Counts represent average number of silverleaf whitefly nymphs per terminal leaflet from leaves in the lower one-third of the plant canopy.

[x]Parasitized whitefly per leaflet were those parasitized by Encarsia formosa.

Table 2. Associated costs for biological control agents and shipping for the 1994-95 season.

Control agent	Cost/lb tomato (¢/lb)[z]
Encarsia formosa	11.1
Amblyseius cucumeris	2.9
Shipping	5.0
Total	17.0