LATE SEASON BIOLOGICAL CONTROL OF WHITEFLIES IN FALL CANTALOUPE USING FORMULATIONS OF BEAUVERIA BASSIANA

Tim C. Knowles, Stefan T. Jaronski, and Jerry McGuire

Abstract

Beauveria bassiana is a naturally occurring fungal disease of insects that has been shown to be an effective biological control against whiteflies in cotton and vegetable crops. Six treatments were initiated in drip irrigated fall cantaloupe on October 2, and repeated on October 9 and 23. The six treatments consisted of: 1) a check or unsprayed plot; 2) 0.5 lb. Mycotrol WP/acre; 3) 1 lb. Mycotrol WP/acre; 4) 1 pt. Mycotrol ES/acre; 5) 0.5 lb. Mycotrol WP/acre + pyrethroid tank mix; and 6) 12 oz. Naturalis-L/acre. Under moderate to light sweetpotato whitefly pressure, the Mycotrol formulations provided significant control (68-79%) compared to unsprayed check plots, and were superior to Naturalis-L formulation whose effects were relatively short lived. Mycotrol WP applied in three applications at the labeled rate of 1 lb. product/acre had the cumulative effect of maintaining adult whitefly leaf counts below the currently recommended economic threshold of 3 per leaf at 28 days after treatment initiation, under the conditions of this study.

Introduction

The silverleaf whitefly (Bemisia argentifoli) has become a serious economically damaging pest of fall cantaloupe. Whitefly damage to fall melons can consist of reduced plant vigor due to adults and nymphs feeding on plant phloem, the development of plant disorders including silverleaf symptoms as seen in squash, and irregular ripening of fruit, excretion of honeydew which promotes sooty mold, the transmission of plant viruses, and yield losses exceeding 15% (Palumbo, 1995). Whiteflies are often abundant in fall melons and can be difficult to suppress even with repeated applications of effective insecticides and insecticide combinations. The whitefly has the ability to rapidly become resistant to insecticides, which stresses the importance of effective integrated pest/crop management (IPM/ICM) strategies to maintain whitefly populations below economically damaging levels.

An important component of IPM is to utilize biological controls as a component of an ICM program. Beauveria bassiana is a naturally occurring insect specific fungus that has been shown to provide effective control of the silverleaf whitefly in cotton grown in southern Arizona (Akey and Henneberry, 1994; Yuster, 1994). Two commercial formulations of the Beauveria fungus are currently available for whitefly control, Naturalis-L which has been tested primarily in cotton, and Mycotrol which has been tested extensively in vegetable crops.

Thorough, uniform coverage of the underside of leaves is essential for the Beauveria fungus to be effective. Spores must directly contact the insect, germinate, and grow through the insect cuticle. The fungus grows rapidly within the insect killing it within 3 to 7 days. Speed of control depends on the number of spores contacting the insect, insect age, and ambient temperature. Repeat applications are necessary at 4 to 8 day intervals as many times as necessary while the pest pressure persists. Repeat applications are cumulative in effect. The fungus is compatible when tank mixed with pyrethroids which provide quick knockdown of adult whiteflies while the fungus acts on nymphs. It should not be tank mixed with herbicides or fungicides, and it is important that an interval of at least 2 days should be followed between the use of the Beauveria fungus and a fungicide.

Admire (imidacloprid) is used at or near planting to effectively control whitefly in melon crops grown in Arizona. Since whitefly pressure can be especially intense on fall grown melons, the University of Arizona does not recommend that Admire be used on fall melons without augmenting control with foliar adulticides later in the season (Kerns and Palumbo, 1996). Little research has been done to determine the efficacy of biological controls such as the Beauveria fungus applied in fall to whiteflies in cantaloupe. Thus, a field experiment was conducted in western Arizona to determine the effectiveness of fall applications of Mycotrol, Mycotrol plus pyrethroid (Pounce), and Naturalis-L for late season control of silverleaf whitefly in fall cantaloupe previously treated with Admire at planting.

Materials and Methods

Drip irrigated "Durango" cantaloupe were planted in slant beds on 80 inch centers in August, 1995 near Vicksberg, AZ (located in eastern La Paz County). All plots received an application of imidacloprid at the full label rate (16 oz./acre Admire 2F) injected through the drip irrigation system in August. Additionally, all plots received applications of endosulfan (1.3 qt./acre Thiodan EC) on October 6, abamectin (8 oz./acre Agri-mek) + permethrin (2 oz./acre Pounce) on October 9 for leafminer control, and sulfur (9.9 lb. Golden Dew/acre) on October 16 and 26.

Individual plots were nine 80 inch beds wide by 1200 feet long (1.65 acres). The six treatments were replicated twice in randomized complete blocks. Treatments were initiated on October 2 when whitefly numbers had reached 30 nymphs per 1 inch leaf disc, and repeated on October 9 and 23. High air temperature on the afternoon of each application was 92, 91, and 76 F, respectively, and daily solar radiation accumulated was 533, 491, and 447 Langleys, respectively. Treatments consisted of: 1) a growers standard practice of Admire injected at stand establishment without further control (control); 2) 0.5 lb. Mycotrol WP/acre with Kinetic wetting agent (4 oz./100 gal. solution); 3) 1.0 lb. Mycotrol WP/acre with Kinetic wetting agent; 4) 1 pt. Mycotrol ES/acre; 5) 0.5 lb. Mycotrol WP/acre with Kinetic wetting agent, plus pyrethroid (0.1 lb. a.i. Pounce 3.2 EC); and 6) 12 oz. Naturalis-L/acre. Applications were made with an FMC air blast sprayer at 30 gal./acre broadcast rate. Water used to prepare each spray solution was buffered at a pH of 6.0.

Spray coverage on October 2 and 23 was monitored by the use of water-sensitive spray cards, and fungal spores were collected and counted on microscope coverslips. Adult whitefly (primarily silverleaf) counts on the first mature leaf by the leaf turn method (Palumbo et al., 1994) on October 2 (day 0), October 13 (day 11), October 16 (day 14), October 23 (day 21), and October 30 (day 28). The seventh to ninth leaf from the crown of the plant was sampled for immature whitefly counts. Whitefly immatures were counted on 1 inch diameter discs from 40 leaves collected from each plot on days 0, 14, 21 and 28 using leaves having mixed populations of small (1st and 2nd instar) and large (3rd and 4th instar) nymphs. Statistical analyses were performed on square root transformations of the data using ANOVA and Tukey's HSD test at the 0.05 level of probability to separate means when appropriate. No yield estimated were made.

Results and Discussion

Spray coverage on the cantaloupe leaf undersides with the air blast equipment was light and very variable. Spore clumping due to incompatibility of the Mycotrol plus Pounce tank mix was very pronounced. The other Mycotrol treatments had well dispersed spores in the droplet residues. Droplet counts on spray cards ranged from 2.5 to 48 droplets per square inch, with C.V.'s exceeding 60% (data not shown). Mean Beauvaria bassiana spore counts per square inch were: 7,130 spores for the 0.5 lb. rate of Mycotrol WP; 12,120 spores for the 1 lb. rate of Mycotrol WP; 9,510 spores for the 1 pt. rate of Mycotrol ES; and 6,460 for the 0.5 lb. rate of Mycotrol WP plus Pounce. These rates are somewhat low for optimum control, and C.V.'s ranged from 50 to 100% indicating high variability in spore counts within and among treatments.

Silverleaf whitefly numbers in all plots plummeted during the first seven days of the trial, probably because of the Thiodan application on October 6, which may have been applied to all plots (data not shown). Furthermore, by October 16, heavy lacewing (Chrysopa spp.) populations were observed in all plots. Since the Beauvaria fungus is specific to the whitefly, it has minimal impact on non-target beneficial insects. When present in large numbers, these natural predators of the silverleaf whitefly provide effective biological control. Adult and immature whitefly numbers remained relatively low for fall melons for the duration of the study. Nevertheless, there were significant differences in adult whitefly numbers among treatments for all sampling dates (Table 1). In general, the Mycotrol treatments were associated with the lowest adult numbers, compared to the control and Naturalis-L treatment. The suggested application interval for Naturalis-L is 3 to 5 days until control is achieved. It seems that the 7 day application interval for treatments applied in this study exceeded the duration of effective whitefly control normally achieved with Naturalis-L.

According to Palumbo et. al. (1994), the University of Arizona recommends that whitefly populations not be allowed to exceed three adults per leaf to prevent large numbers of whiteflies from infesting plants later in the season. At 14 days after the first application, adult whitefly numbers exceeded this threshold in all plots (Table 1). Although the Mycotrol treatments resulted in significant control (68-72%) compared to the check plots, adult whitefly numbers still exceeded the economic threshold of three per leaf. At 21 days after initiation of treatments (following 2 applications of Beauvaria fungus) the Mycotrol treatments still showed significant control (69-79%) of whitefly adults compared to the check plots, however adult whitefly leaf counts still exceeded the defined threshold of 3 per leaf. By 28 days after initiation of the treatments (following 3 applications of the Beauvaria fungus) Mycotrol WP at the 1 lb./acre rate and Mycotrol WP at the 0.5 lb./acre rate plus Pounce gave effective control (64-78%) of whitefly adults compared to check plots, and adult whitefly leaf counts were below the defined economic threshold of 3 per leaf. Therefore, based on adult whitefly counts, Mycotrol WP at the 1 lb./acre rate resulted in adequate whitefly control following 3 weekly applications, when adult whitefly numbers did not exceed 7 to 18 adults/leaf in untreated plots.

In terms of whitefly nymph numbers, none of the treatment regimes were significantly different from the check plots (Table 1). Generally, there was a trend for lower numbers of whitefly immatures on leaf dics sampled from plots treated with the Beauvaria fungus compared to check plots, although this was not statistically significant at the 0.05 level. With only one degree of freedom resulting from the two replications used in this study, the slight differences observed between treatments were less than the variability between replicates. Total whitefly immature counts at all sample dates following initiation of treatments were too low to show any significant differences, and were too low to have any impact on cantaloupe fruit quality and yields.

Although Beauvaria bassiana in the Mycotrol formulations gave significant control of the silverleaf whitefly compared to unsprayed check plots, the degree of control ranged from 68 to 79% which may not provide adequate control under heavy infestations. Although whitefly pest pressure was relatively light in fall cantaloupe grown in this study, three applications of Mycotrol WP at the 1 lb./acre rate had a cumulative effect of maintaining adult whitefly counts below the currently recommended economic threshold of 3 adults/leaf.

References

Akey, D.H., and T.J. Henneberry. 1994. Sweetpotato whitefly control by Naturalis-L, the fungus Beauveria bassiana in furrow and sub-drip irrigated upland cotton. 1994 Proceedings Beltwide Cotton Conferences, National Cotton Council, Memphis, TN. p. 1089-1091.

Kerns, David L., and John C. Palumbo. 1996. Using Admire on desert vegetable crops. University of Arizona Cooperative Extension IPM Series Number 4. Tucson, AZ.

Palumbo, J.C. 1995. Impact of sweetpotato whitefly infestation on yield and quality of cantaloupe. 1994-1995 Vegetable Report. College of Agriculture Report, Series P-100. University of Arizona. Tucson, AZ. p. 104-106.

Palumbo, J.C., A. Tonhasca, Jr., and D.N. Byrne. 1994. Sampling plans and action thresholds for whiteflies on spring melons. University of Arizona Cooperative Extension IPM Series Number 1. Tucson, AZ.

Yuster, Jane. 1994. Strategies for the use of Naturalis-L for control of cotton pests. 1994 Proceedings Beltwide Cotton Conferences, National Cotton Council, Memphis, TN. p. 1113-1114.

Table 1. Mean number of whitefly immatures per 1 inch diameter leaf disc on the seventh to ninth leaf from the crown and the mean number of whitefly adults on the first mature terminal leaf (third to fifth node) on fall cantaloupe sampled at 0, 14, 21, and 28 days after initiation (DAA) of Beauvaria fungus applications. Small nymphs refer to first and second instars, while large nymphs refer to third and fourth instars (red-eyed nymphs).

Treatment	Rate/Acre	DAA	Whitefly Nymphs			Whitefly Adults
			Small	Large	Total	
			--- #/1 inch leaf disc ---			#/leaf
Control		0	29 a	3 a	32 a	69 b
Mycotrol WP	0.5 lb form.	0	32 a	4 a	36 a	63 bc
Mycotrol WP	1.0 lb form	0	17 a	3 a	20 a	40 c
Mycotrol ES	1 pt form.	0	18 a	6 a	24 a	102 a
Mycotrol WP + Pounce	0.5 lb + 0.1 lb (AI)	0	19 a	6 a	25 a	59 bc
Naturalis-L	12 oz form.	0	14 a	3 a	17 a	57 bc
Control		14	7.8 a	1.9 a	9.7 a	18.0 a
Mycotrol WP	0.5 lb form.	14	4.8 a	0.8 a	5.6 a	5.6 c
Mycotrol WP	1.0 lb form.	14	7.5 a	1.7 a	9.2 a	5.7 c
Mycotrol ES	1 pt form.	14	7.2 a	1.0 a	8.2 a	5.4 c
Mycotrol WP + Pounce	0.5 lb + 0.1 lb. (AI)	14	6.7 a	3.0 a	9.7 a	5.0 c
Naturalis-L	12 oz form.	14	6.0 a	1.1 a	7.1 a	10.0 b
Control		21	3.0 a	1.6 a	4.6 a	15.0 b
Mycotrol WP	0.5 lb form.	21	1.0 a	0.7 a	1.7 a	4.7 bc
Mycotrol WP	1.0 lb form.	21	0.9 a	0.6 a	1.5 a	3.3 c
Mycotrol ES	1 pt form.	21	1.9 a	1.4 a	3.3 a	4.2 c
Mycotrol WP + Pounce	0.5 lb + 0.1 lb (AI)	21	2.3 a	2.0 a	4.3 a	3.2 c
Naturalis-L	12 oz form.	21	1.3 a	1.0 a	2.3 a	18.0 ab
Control		28	3.0 a	6.6 a	9.6 a	7.2 a
Mycotrol WP	0.5 lb form.	28	1.9 a	4.9 a	6.8 a	5.2 ab
Mycotrol WP	1.0 lb form.	28	1.0 a	3.7 a	4.7 a	1.6 c
Mycotrol ES	1 pt form.	28	1.5 a	2.4 a	3.9 a	5.2 ab
Mycotrol WP + Pounce	0.5 lb + 0.1 lb (AI)	28	1.5 a	3.8 a	5.3 a	2.6 bc
Naturalis-L	12 oz form.	28	1.5 a	4.0 a	5.5 a	6.8 a

Means within a column and sample date followed by the same letter are not significantly different at the 0.05 level of probability according to Tukey's HSD test.