Evaluating Two Neonicotinoid Insecticides Against Silverleaf Whitefly (Homoptera: Aleyrodidae) on Spring Melons in South Texas

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ABSTRACT

Efficacy of nicotinyl insecticides, imidacloprid and thiamethoxam, was tested against the silverleaf whitefly, *Bemisia argentifolii* Bellows & Perring, on cantaloupe (*Cucumis melo* L.) in 1999. A soil formulation of imidacloprid (Admire) and a soil formulation of thiamethoxam (Platinum) were applied through a drip irrigation system at transplanting, at mid-season, or at transplanting and at mid-season; and a foliar formulation of thiamethoxam was sprayed using a tractor-mounted sprayer. Thiamethoxam applied once at transplanting and thiamethoxam(Actara) sprayed three times were as effective against silverleaf whitefly as imidacloprid applied once at transplanting and two times (at transplanting and at mid-season) during the season. Imidacloprid applied once only at mid-season was as effective as imidacloprid applied once (at transplanting) or twice (at transplanting and mid-season). Applications of these insecticides significantly reduced whitefly population and foliage damage by sooty mold, and increased melon yield and quality. Whitefly populations and cantaloupe yields were not significantly different between imidacloprid applied twice at transplanting and mid-season and only once at transplanting.

RESUMEN

Se probó la eficacia de los insecticidas nicotinílicos imidacloprido y tiametoxamo sobre la mosquita blanca, *Bemisia argentifolii* Bellows y Perring, en melón (*Cucumis melo* L.) en 1999. Se aplicaron formulaciones para el suelo de imidacloprido (Admire) y tiametoxamo (Platinum) a través del sistema de riego por goteo durante el trasplante, a la mitad de la temporada, o al tiempo del transplante y también a la mitad de la temporada. También se aplicó una formulación foliar de tiametoxamo usando un aspersor montado en tractor. Una aplicación de tiametoxamo al momento del transplante así como de tiametoxamo (Actara) asperjado 3 veces fueron tan efectivos contra la mosquita blanca como la aplicación de imidacloprido aplicado una sola vez durante el trasplante o aplicado dos veces, durante el trasplante y a la mitad de la temporada. Imidacloprido aplicado una vez solamente a la mitad de la temporada fue tan efectivo como el imidacloprido aplicado una vez al tiempo del transplante o dos veces, durante el transplante y a la mitad de la temporada. Las aplicaciones de estos insecticidas redujeron significativamente las poblaciones de mosquita blanca así como el daño foliar debido al moho oscuro e incrementaron el tamaño y calidad de la cosecha. Las poblaciones de mosquita blanca y la cantidad de cosecha de melón no fueron significativamente diferentes entre las aplicaciones de imidacloprido aplicadas 2 veces, durante el trasplante y a la mitad de la temporada, o aplicado solo una vez durante el trasplante.

Additional index words. Imidacloprid, thiamethoxam, sweetpotato whitefly, cantaloupe, whitefly

The silverleaf whitefly, *Bemisia argentifolii* Bellows & Perring, continues to be one of the most important pests of vegetable and field crops in the southern United States and the tropical and subtropical areas of the world (Henneberry et al., 2000). In south Texas, silverleaf whitefly can be especially severe on cucurbits (Riley and Sparks 1993). Although cultural practices and whitefly resistant varieties are taken into consideration by the local growers when managing silverleaf whitefly on melon in south Texas, chemical control is still the most widely used measure.

Imidacloprid (Bayer Corporation, Kansas City, MO), a systemic neonicotinoid insecticide, has offered highly effective control of whiteflies, aphids and other insects for several years in the United States (Mullins 1993, Stansly et al. 1998). It has been used extensively in Texas and elsewhere, and is still effective against the whitefly (Riley 1994, Stansly 1996). Growers and scientists are concerned that the whitefly may become resistant to imidacloprid. Another neonicotinoid compound, thiamethoxam (Syngenta, Greensboro, NC), has potential for use on vegetables for management of whiteflies, aphids, thrips, leafhoppers and certain species of beetles (Gobel et al. 1999).

The objectives of this study were to determine the efficacy of imidacloprid (Admire) and thiamethoxam (Platinum and Actara) for controlling silverleaf whitefly on spring cantaloupe in south Texas, and to determine the optimal timing of applications of these two insecticides.

MATERIALS AND METHODS

Field experiment design. The experiment was conducted at the Texas Agricultural Experiment Station at Weslaco. Small seedlings (2-3 true leaves) of cantaloupe melon, *Cucumis melo* L. (variety lmPac) were transplanted in the field on 22 Feb. 1999. Each plot was 30 ft long with two separate rows (80 inches wide each), and 30 plants each. All plots were arranged in a randomized complete block design with 4 replications. The plants were irrigated, fertilized and treated with fungicides using the standard cultural practices for south Texas.

Insecticides and applications. A soil formulation of imidacloprid, Admire 2F (21.4% active ingredient or AI) and a soil formulation of thiamethoxam, Platinum 2SC (21.6% AI) were used through drip irrigation system. A foliar formulation of thiamethoxam, Actara 25WG (25% AI), was sprayed using a tractor-mounted sprayer with 1 overhead and 2 lateral TXSS18 hollow-cone nozzles at 300 psi (2068 kPa) and a 468 liter ha^{-1} delivery rate. There were seven treatments: (1). Imidacloprid at 14.4 oz product/acre (252 g AI/ha) dripped at transplanting (22 Feb.); (2). Imidacloprid at 7.2 oz product/ac (126 g AI/ha)) dripped at transplanting (22 Feb.) and dripped at mid-season (13 April); (3). Imidacloprid at 7.2 oz product/ac dripped at mid-season (13 April); (4). Thiamethoxam (Platinum) at 5.88 oz product/ac (103 g AI/ha), dripped at transplanting (22 Feb.); (5). Thiamethoxam (Platinum) at 4.2 oz product/ac (74 g AI/ha) dripped at transplanting (22 Feb.); (6). Thiamethoxam (Actara), sprayed at 2.5 oz product/ac (44 g AI/ha) on three occasions (24 March, and 7 and 22 April); and (7) nontreated plots were used as controls.

Whitefly sampling. Adult sampling was initiated four weeks (on 8 March) after transplanting. Thereafter, adults were sampled seven times at 7-d intervals. Ten plants per plot were randomly selected, and the whitefly adults from the third leaf from the apical meristem were counted by turning the leaves gently. Whitefly eggs and nymphs (including red-eyed nymphs or pupae) were sampled weekly starting on 31 March for six weeks, and were recorded separately. When plants had <6, the oldest leaf was detached from the plant. Four leaf-disks (each 2 cm in diameter or 3.14 cm^2 leaf area in total) from the lower surface of each leaf were randomly selected, and eggs and nymphs were counted. When plants had >6 leaves, the 4th~5th leaf proximal to the base of the plant was collected from each plant, and eggs and nymphs were counted. A total of 10 leaves, one from each plant, were collected from each plot.

Damage-quality evaluation. At termination, leaves covered by sooty mold were visually ranked in the following categories: 0-no sooty mold, 1-minor (1% leaf area), 2-minor to moderate (2 to 5% leaf area), 3-moderate (6 to10% leaf area), 4-moderate to heavy (11 to 30% leaf area), and 5-heavy (>30% leaf area). Cantaloupes were picked from each plot when ripe. The size of each cantaloupe was weighed, and graded based on the number of melons held in a standard 18.14 kg (40 lb) shipping box, normally referred to as N9 (9 melons per box, ?15.5 cm in diam), N12 (14.6-15.5 cm in diam), N15 (13.6-14.6 cm in diam), N18 (12.7-13.6 cm in diam), N23 (11.7-12.7 cm in diam), and N30 (<11.7 cm in diam). Percentage of soluble sugar from the top and bottom portion of each of five randomly selected cantaloupes from each plot was measured and averaged for each treatment.

Data analysis. Numbers of whitefly adults per leaf and eggs and nymphs per leaf disk, and damage and yields from each plot were analyzed using a 2-way analysis of variance (time x treatment), and the means were separated using the least significant difference test (LSD) at $P = 0.05$ after a significant F-test (SAS Institute, 2000).

RESULTS AND DISCUSSIONS

Whitefly adults. During early season, adult whitefly populations were high in untreated plots (Fig. 1A). Silverleaf whitefly populations were significantly different among the treatments (F = 5.46-33.36; df = 6,21; P = 0.0031-0.0001) except for the first sampling date on 8 March (F = 3.86; df = 6,21; P = 0.0150). The number of adults was lower on the plants treated with thiamethoxam (both rates, dripped at transplanting) and imidacloprid (dripped at transplanting). Imidacloprid applied at mid-season through drip irrigation on 13 April, and

Table 1. Effects of applications of imidacloprid and thiamethoxam for management of *Bemisia argentifolii* on melon size and yield (Weslaco, Spring 1999).

Treatment	Melons	Weight	Melon size (no./box)					
			30	23	18	15	12	9
	no./plot	kg/plot						
Imidacloprid: planting	52.0±1.9a[z]	215.0±5.0ab	4.0	6.1	10.2	12.5	11.6	11.0
Imidacloprid: mid-season	51.0±1.8a	203.0±4.8b	2.8	5.8	4.8	17.0	10.0	10.8
Imidacloprid: planting + mid-season	56.0±3.4a	209.7±22.6ab	4.3	6.3	10.5	12.3	11.5	11.3
Thiamethoxam: 5.88 oz/ac	54.8±2.5a	236.0±9.5a	3.3	3.3	3.5	13.3	13.0	18.5
Thiamethoxam: 4.25 oz/ac	51.3±2.1a	232.6±10.0a	1.3	2.3	4.8	9.5	13.8	19.8
Thiamethoxam: foliar spray	51.0±2.6a	214.7±14.1ab	2.6	4.5	5.3	12.3	12.5	13.8
Untreated	55.8±3.6a	170.2±10.9c	6.8	10.8	12.8	16.5	7.5	3.5

[z]means followed by the same letter in each column are not significantly different.

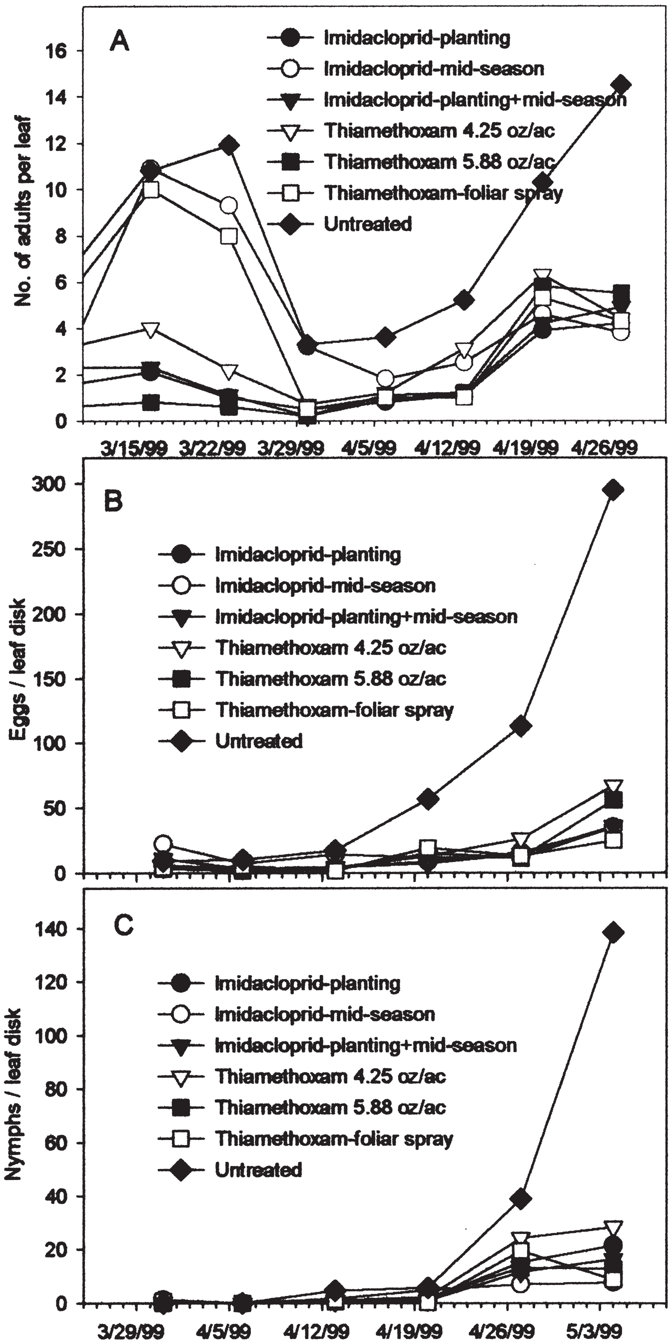

Fig. 1. Numbers of *Bemisia argentifolii* on cantaloupe after applications of imidacloprid, thiamethoxam (Weslaco, Spring 1999).

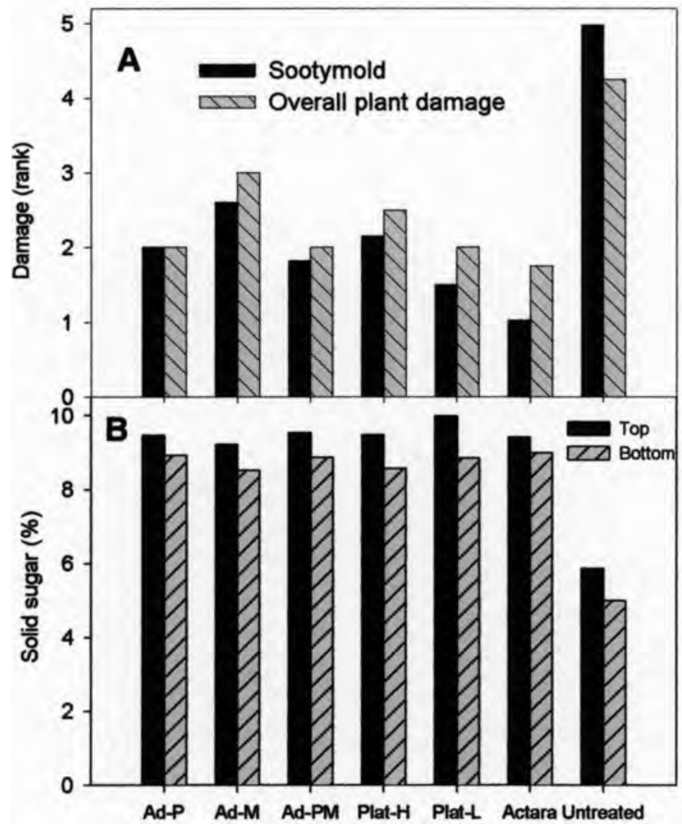

Fig. 2. Damage and quality of cantaloupe after applications of imidacloprid and thiamethoxam for management of *Bemisia argentifolii* (Weslaco, Spring 1999). A. Sooty mold on melon leaves; B. Sugar contents of harvest melons. IMP, imidacloprid at transplanting; IMM, imidacloprid at mid-season; IMPM, imidacloprid at transplanting and mid-season; TPH, thiamethoxam at 5.88 oz/acre; TPL, thiamethoxam at 4.25 oz/acre; TA, thiamethoxam (Actara) at 39 g/acre.

thiamethoxam sprayed on 23 March had a similar number of whitefly adults because insecticides in these two treatments were not applied until mid-season and 13 April, respectively. In the thiamethoxam foliar-sprayed plots, after the first application on 23 March, whitefly populations were reduced immediately to a very low level (about one adult per leaf) in one week, and maintained a low population level throughout the season. All insecticide-treated plants had significantly lower whitefly population than those on nontreated plants after 29 March.

Whitefly immatures. The numbers of whitefly eggs on nontreated plants were significantly greater than that on all insecticide-treated plants from mid-season (19 April) to the end of season, but there were no significant differences among the insecticide treatments (F = 5.37-22.58; df = 6,21; P = 0.0038-0.0001) (Fig. 1B). The numbers of nymphs (including red-eyed nymphs or pupae) of silverleaf whitefly on all plants varied greatly during the season (F = 5.36-25.75; df = 6,21; P = 0.00068-0.0001). The numbers of nymphs increased at a relatively slow pace before the mid-season (Fig. 1C), but those on nontreated plants increased rapidly beginning 26 April, whereas those on insecticide-treated plants increased slowly and maintained at a low level.

Later in the season, only the insecticide-treated plants had green foliage. Both whitefly adults and immatures on all insecticide-treated plants were often greater than those on the nontreated plants. One possible explanation is that because the nontreated plants had many leaves that were dead or chlorotic, and the whiteflies on those plants were forced to relocate to more suitable hosts.

Damage, quality and yield. Sooty mold growth on melon leaves varied significantly among the treatments (F = 33.64; df = 6, 21; P = 0.0001); damage level was lowest on the plants treated with foliar-applied thiamethoxam (three sprays), followed by drip-applied thiamethoxam at transplanting at the lower rate, drip-applied imidacloprid at transplanting, drip-applied imidacloprid dripped at transplanting and at mid-season, drip-applied thiamethoxam at transplanting at higher rate, and imidacloprid at mid-season (Fig. 2A). In the nontreated plots, almost all leaves and melons were covered by sooty mold and honeydew, and the leaves were desiccated at the end of the season. All insecticide treatments resulted in higher percentage of sugar than those in the nontreated plants (F = 24.94; df = 6, 23; P = 0.0001) (Fig. 2B).

Total numbers of cantaloupes harvested among the treatments were not significantly different (F = 1.11; df = 6, 23; P = 0.3896), however, plots treated with drip-applied thiamethoxam at transplanting (both rates) had a greater number of large melons than the other treatments, followed by thiamethoxam sprayed three times, and all imidacloprid treatments (Table 1). In contrast, the untreated plots had the most number of small melons. Total weights were significantly different among the treatments (F = 3.01; df = 6, 23; P = 0.0383), with both rates of the thiamethoxam dripped at transplanting having the greatest weight, followed by imidacloprid dripped at transplanting, at mid season and at both transplanting and mid-season, thiamethoxam foliar-sprayed, and the untreated control having the lowest.

Application of thiamethoxam (Platinum and Actara) and imidacloprid significantly reduced silverleaf whitefly populations and damage caused by the whiteflies, and increased yield and quality of the melons over nontreated melons. However, imidacloprid applied at transplanting and in mid-season did not result in significantly lower whitefly populations and higher yield and quality compared to when imidacloprid was applied once, either at transplanting or in mid-season.

Because both imidacloprid and thiamethoxam are neonicotinoids, growers need to apply one or the other but not both to avoid potential cross-resistance by *B.argentifolii*. It has been known that *B. argentifolii* are resistant to organophosphorous and pyrethroid insecticides and other newer compounds (Cahill et al. 1995, Denholm et al. 1996). It is for this reason that once an efficacious insecticide has been found, such as imidacloprid or thiamethoxam, its potency should be maintained through appropriate use in insecticide resistance management program.

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