Corresponding author: J. A. LaMondia
Department of Plant Pathology and Ecology
The Connecticut Agricultural Experiment Station
Valley Laboratory, 153 Cook Hill Road
P. O. Box 248, Windsor, CT 06095
Phone: (860) 683-4982
Fax: (860) 683-4987
E-mail: lamondia@caes.state.ct.us

EFFECT OF APPLICATION TECHNIQUE ON IMIDACLOPRID EFFICACY AGAINST TOBACCO APHIDS ON CONNECTICUT CIGAR WRAPPER TOBACCO.

J. A. LaMondia[1] and T. M. Rathier[2]

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[1] Plant Pathologist/Nematologist, Department of Plant Pathology and Ecology,
[2] Assistant Soil Scientist, The Connecticut Agricultural Experiment Station Valley Lab. P. O. Box 248, Windsor, CT 06095. E-mail: lamondia@caes.state.ct.us

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ABSTRACT

The effects of imidacloprid (Admire 2F) and application technique on efficacy of tobacco aphid management in Connecticut cigar wrapper tobacco were investigated from 1995 to 1998. Imidacloprid was efficacious as a greenhouse transplant treatment, as a soil broadcast or drench before or at transplanting, as a band application at cultivation, and as a foliar spray. Imidacloprid applied at or before transplanting resulted in long but not full season control of tobacco aphids. Control with a single soil application of imidacloprid was as good as or better than oxamyl (Vydate L) or multiple applications of acephate (Orthene). Foliar applications of imidacloprid were less effective than soil or transplant applications, and multiple applications were required to extend control. Aphid infestations are most damaging in mid to late season in Connecticut. Imidacloprid efficacy was extended by increasing the rate from 0.19 to 0.38 kg (AI)/ha, or by band application adjacent to plants at the last cultivation. Successful band treatment required adequate soil moisture and irrigation to move the insecticide into the root zone. Band treatment did not confer an advantage over a transplant soil drench in 1997, when soils were dry and irrigation was not applied. Conversely, band treatment at the last cultivation extended efficacy in 1998, and irrigation further increased the efficacy of the band treatment to season-long control.
Additional key words: acephate, Admire, *Myzus nicotianae*, *Nicotiana tabacum*, oxamyl, Vydate.

INTRODUCTION

The tobacco aphid, *Myzus nicotianae* Blackman, is a serious pest of tobacco in the Connecticut River Valley (5) and throughout the world (2, 3). While a number of insecticides are registered for insect control, a combination of preplant oxamyl (Vydate L, Dupont, Wilmington, DE) and acephate (Orthene, Valent, Walnut Creek, CA) was commonly used for aphid and flea beetle until the label rate of Vydate was reduced to levels which reduced the efficacy against aphids and no longer controlled tobacco cyst nematodes. Acephate is a widely used, effective insecticide, but control failures in flue-cured tobacco have been reported (6). Aphid control with acephate may be difficult to achieve without adequate plant coverage, challenging at best in shade-grown cigar wrapper tobacco.

Imidacloprid (Admire, Bayer Corp., Kansas City, MO) is a systemic chloronicotinyl insecticide effective against aphids and whiteflies (4, 9, 10). Imidacloprid may be applied to tobacco transplants in greenhouse trays, to soil, to transplant water, or to foliage. The systemic nature of this insecticide confers a great advantage in shade-grown tobacco. However, Connecticut shade tobacco is a long season crop, approximately 105 days, and aphid control needs to maintained over the entire season. The objectives of this research were i) to evaluate different application techniques for aphid control under Connecticut conditions, and ii) to determine the effect of application technique on the longevity of aphid control.

MATERIALS AND METHODS

Experiments were conducted at the CT Agricultural Expt. Station Valley Laboratory in Windsor CT. Shade-grown cigar wrapper tobacco was grown in a cloth-covered shade tent. The soil was an Entic Haplorthod (Windsor fine sandy loam, 71.8% sand, 23.0% silt , 5.2% clay, pH = 6.0 and OM = 4.0%). Broadleaf dark air-cured cigar wrapper tobacco was grown in the same soils in a location adjacent to the shade tent.

Experiment 1: 1995. Ten insecticide treatments were evaluated for tobacco aphid control in a cloth-covered shade tent. There were 4 replicate 4-row plots of each treatment (5 m by 5 m), each with 2 replicate treated rows in the center and 2 adjacent untreated rows. Admire 2F (NTN 33893) greenhouse-drenches were applied on 30 May to two-month-old 'O-40' plants in 128-cell flats (25-cm^3 mix per cell). Admire 2F was applied at 0.13, 0.26, and 0.54 kg (AI)/ha in 1 ml/plant (26,690 plants per hectare). On 31 May, Vydate L (2.24 kg (AI)/ha in 1,000 l/ha water) was broadcast in a 1 m swath using a 8004E (TeeJet, Spraying Systems Co., Wheaton, IL) nozzle and raked to incorporate. Tobacco was transplanted on 1 June to rows 1 m apart with plants 0.3 m apart within rows. Vydate was also band applied (2.24 kg (AI)/ha) on 2 June to 10 cm on either side of rows using a TG-3 nozzle and incorporated by hoeing. Admire 2F was applied on 2 June as a soil drench (0.13, 0.26, and 0.54 kg (AI)/ha) using a TeeJet TG-3 at 103.4 kPa to apply 20 ml/plant in 2 10-ml applications 2-cm to either side of plants. Foliar Orthene or Admire 2F was applied using a TG-3 nozzle at 103.4 kPa on 12 July and 4 August at rates of 0.84 and 0.06 kg (AI)/ha, respectively, in 1,900 l/ha water. One leaf each from 10 plants per row was removed on 24 July, 8 August, and 21 August (1600 leaves per date), and rated for apterous aphids (scale: 0 = no aphids or winged only; 1 = 1 aphid per leaf; and 10 = more than 1 aphid per leaf). Ratings from the 10 plants were added and treatments compared to adjacent untreated

rows by the nonparametric Wilcoxon Matched Pairs Test. Treatment means within dates were compared by the nonparametric Kruskal-Wallis Test.

Experiment 2: 1996. Insecticide treatments were evaluated for tobacco aphid control in a cloth-covered shade tent at the CT Agricultural Expt. Station Valley Laboratory in Windsor CT. On 28 May, plots were fertilized with 141 kg N/ha of cottonseed meal-based 10-8-10, broadcast treated with Lorsban 4E at 1.7 kg (AI)/ha and Ridomil 2E at 1.1 kg (AI)/ha and spiked to incorporate. On 5 June, Vydate L (2.24 kg (AI)/ha in 1,000 l/ha water) was broadcast to appropriate plots in a 1 m swath using a TeeJet KCL-5 nozzle and raked to incorporate. Tobacco was transplanted on 6 June to rows 1 m apart with a 0.3 m spacing within rows. There were 20 replicate 4-row plots of each treatment (5 m by 5 m), each with 2 treated pick rows in the center and 2 adjacent treated border rows. Plots were separated by an additional untreated border row. Vydate was band applied at 2.24 kg (AI)/ha to appropriate plots on 7 June to 15 cm on either side of rows using a backpack sprayer with a TeeJet 8004-E nozzle and incorporated by hoeing. Admire 2F was applied on 6 June as a soil drench at 0.19 kg (AI)/ha (26,690 plants/ha) using a backpack sprayer with a TeeJet TG-3 nozzle at 103.4 kPa to apply 20 ml/plant in 2 10-ml applications 2-cm to either side of plants. Foliar Orthene at 0.84 kg (AI)/ha, in 1,900 l/ha water, was applied on 8 July to previously untreated plots and on 16 August to plots previously sprayed with Orthene or Vydate using a TG-3 nozzle at 103.4 kPa. One leaf each from 15 plants per row was removed on 16 August, 21 August, 30 August, and 6 September (60 leaves per plot), and rated for apterous aphids (scale: 0 = no aphids or winged only; 1 = 1 aphid per leaf; 2 = 2-10 aphids 3 = 11-100 aphids and 4 = more than 100 aphids per leaf). Ratings from 15 plants per plot were recorded and treatments compared within dates by the nonparametric Kruskal-Wallis Test. Plants were picked at weekly intervals over six weeks (29 July, 6 August, 15 August, 20 August and 28 August) to remove 18 leaves.

Experiment 3: 1997, broadleaf tobacco. Preplant broadcast, transplant drench or band application at cultivation of Admire 2F (imidacloprid) treatments were evaluated for tobacco aphid control. Admire 2F was applied at 0.12 kg (AI)/ha (28.3 g per 1000 plants based on 16,800 plants/ha) for all treatments. On 29 May, plots were fertilized with 162.6 kg N/ha of cottonseed meal-based 10-8-10. On 2 June, plots were treated with Lorsban 4E at 1.7 kg (AI)/ha and Ridomil 2E at 1.12 kg (AI)/ha and spiked. On 9 June, preplant Admire was broadcast to appropriate plots in a 1 m swath using a TeeJet 8004E nozzle at 124 to 138 kPa and spiked to incorporate. Tobacco was transplanted on 10 June to rows 1 m apart with a 0.3 m spacing within rows. There were 6 replicate 2-row plots of each treatment (3 m by 6 m). Plots were separated by an unplanted border row. Plots were irrigated 10 June and 15 June with 1.25 and 1.0 cm water. Admire 2F was applied on 11 June as a soil drench using a backpack sprayer with a TeeJet TG-3 nozzle at 103.4 kPa to apply 20 ml/plant in 2 10-ml applications 2-cm to either side of plants. Admire 2F was band applied at sidedress in 654 l water/ha to appropriate plots on 20 June (with 66 kg N/ha) or 30 Jun (with 77 kg N/ha) to 15 cm on either side of rows using a backpack sprayer with a TeeJet 8004-E nozzle and incorporated by mechanical cultivation. One leaf each from 10 plants per row was rated for apterous tobacco aphids on 23 July, 29 July, 7 August, and 14 August (scale: 0 = no aphids or winged only; 1 = 1 aphid per leaf; 2 = 2-10 aphids 3 = 11-100 aphids and 4 = more than 100 aphids per leaf). Treatments were compared within dates by the nonparametric Kruskal-Wallis Test and the Bonferroni Test. Ten plants per plot were stalk cut and weighed on 19 August.

Experiment 4: 1997, shade tobacco. Preplant broadcast, transplant drench or band application treatments of Admire 2F (imidacloprid) were evaluated for tobacco aphid control in a cloth-covered shade tent. Admire 2F was applied at 0.19 kg (AI)/ha for all treatments. On 29 May, plots were fertilized with 162 kg N/ha of cottonseed meal-based 10-8-10. On 2 June, plots were broadcast with Lorsban 4E at 1.7 kg (AI)/ha and Ridomil 2E at 1.1 kg (AI)/ha and spiked to incorporate. On 3 June, preplant Admire 2F in 934 l/ha water was broadcast to appropriate plots in a 1 m swath using a TeeJet 8004E nozzle at 124 to 138 kPa and spiked. Tobacco was transplanted on 4 June to rows 1 m apart with a 0.3 m spacing within rows. There were 5 replicate 4-row plots of each treatment (20 5 m by 5 m plots). Plots were separated by an untreated border row. Plots were irrigated 5 June with 1.0 cm water. Admire 2F was applied on 6 June as a soil drench using a backpack sprayer with a TeeJet TG-3 nozzle at 103.4 kPa to apply 20 ml/plant in 2 10-ml applications 2-cm to two sides of each plant. Admire 2F was band applied at sidedress in 654 l water/ha to appropriate plots on 20 June (with 66 kg N/ha) or 30 Jun (with 77 kg N/ha) to 15 cm on either side of rows using a backpack sprayer with a TeeJet 8004E nozzle and incorporated by mechanical cultivation and hoeing. One leaf each from 10 plants per row was removed on 29 July, 7 August, 14 August, and 22 August and rated for apterous tobacco aphids (scale: 0 = no aphids or winged only; 1 = 1 aphid per leaf; 2 = 2-10 aphids 3 = 11-100 aphids and 4 = more than 100 aphids per leaf). Treatments were compared within dates by the nonparametric Kruskal-Wallis Test and the Bonferroni Test.

Experiment 5: 1998, shade tobacco. Admire 2F (imidacloprid) application methods, rates and the effects of irrigation were evaluated for tobacco aphid control in a cloth-covered shade tent. Admire 2F was applied at 0.19 or 0.38 kg (AI)/ha for all treatments. On 26 May, plots were fertilized with 123 kg N/ha of cottonseed meal-based 10-8-10, plots were broadcast with Lorsban 4E at 1.7 kg (AI)/ha and Ridomil 2E at 1.1 kg (AI)/ha and spiked to incorporate. Tobacco was transplanted on 27 May to rows 1 m apart with a 0.3 m spacing within rows. There were 5 replicate single-row plots of each treatment. Every third row was an untreated border row. Plots were irrigated 27 May with 0.6 cm water. Admire 2F was applied on 29 May as a soil drench using a backpack sprayer with a TeeJet TG-3 nozzle at 103.4 kPa to apply 20 ml/plant in 2 10-ml applications 2-cm to two sides of each plant. Plots were sidedressed with 78.5 kg N/ha of cottonseed meal-based 10-8-10 and cultivated on 18 June. Admire 2F was band applied at the last cultivation on 23 June in 654 l water/ha to appropriate plots (with 93 kg N/ha) to 15 cm on either side of rows using a backpack sprayer with a TeeJet 8004-E nozzle and incorporated by mechanical cultivation and hoeing. Appropriate plots were irrigated with 1.25 cm water. One leaf each from 10 plants per row was removed on 30 July, 4 August, 17 August, 27 August, and 3 September, and rated for apterous tobacco aphids (scale: 0 = no aphids or winged only; 1 = 1 aphid per leaf; 2 = 2-10 aphids 3 = 11-100 aphids and 4 = more than 100 aphids per leaf). Treatments were compared within dates by the nonparametric Kruskal-Wallis Test and the multiple comparison Z-Test.

RESULTS

Experiment 1: 1995. On 24 July, all treatments resulted in fewer aphids than adjacent untreated plants (Table 1). The foliar Orthene treatment was free of aphids, and Admire soil and transplant treatments were not different from Orthene. Vydate and foliar Admire resulted in less aphid control. By 8 August, broadcast Vydate was similar to untreated plants. Orthene and the

higher rates of Admire again resulted in the best control. By 21 August, Vydate had no effect on aphids. Foliar Orthene and the higher rates of Admire resulted in the best aphid control. The aphid ratings of 61.8 to 68.1 reflect that 33.8 to 37.5% of plants in the best treatments had 0 or 1 aphid per leaf, excellent control compared with the heavy infestations on untreated plants.

Experiment 2: 1996. Aphids were first observed on 1 July on untreated plants (Table 2). On 8 July, aphids were not present in treated plots. Aphids were transferred to 1 leaf of each plant in the center untreated border row. Untreated border rows became heavily infested by 30 July and acted as a strong aphid source for insecticide-treated rows. All untreated border plants were heavily infested (rating of 4.0) by 15 August. At that time, plots treated with soil-applied Admire had fewer aphids than plots treated with either a single Orthene application or with preplant band or broadcast Vydate. Aphid populations increased in Admire plots after the middle of August, similar to previous results. There were no differences in aphid infestation between preplant Vydate band or broadcast application. After a second Orthene application, aphid numbers were reduced to below levels in Admire-treated plots. Vydate resulted in good aphid control 4 wk after transplanting, but aphid numbers rebounded by 10 wk after transplanting. Fresh weight leaf yields were greater for Vydate treated plots than Admire or Orthene due to non-target tobacco cyst nematode control, but there were no differences between Admire or Orthene or between band or broadcast Vydate.

Experiment 3: 1997, broadleaf tobacco. Aphids were first observed on 8 July on untreated plants. Untreated border rows acted as an aphid source for insecticide-treated rows. At the 29 July, 7 August and 14 August dates, all plots treated with Admire except the band application applied at the last cultivation had fewer aphids than control plots without insecticides (Table 3). Aphid populations increased in all plots throughout August. There were no differences in aphid infestation between preplant broadcast, transplant drench or band application at the first cultivation after 29 July. Plots were not irrigated after sidedress/cultivation band treatments, and no rain occurred within 24 hr. Admire application resulted in 60 to 70 days of aphid control, and sidedress/cultivation band treatments without irrigation did not extend control.

Experiment 4: 1997, shade tobacco. Aphids were first observed on 8 July on untreated plants. Aphids were transferred to 1 leaf of each plant in the center untreated border row. These border rows were strong aphid sources for insecticide-treated rows. At the 29 July and 7 August dates, all plots treated with Admire except the band application applied at the first cultivation had fewer aphids than control plots without insecticides (Table 4). Aphid populations increased in all plots throughout August. There were no differences in aphid infestation between preplant broadcast, transplant drench or band application after 7 August. Plots were not irrigated after sidedress/cultivation band treatments, and no rain occurred within 24 hr. Admire application resulted in 60 to 70 days of aphid control. Sidedress/cultivation band treatments applied without supplemental irrigation did not extend control.

Experiment 5: 1998, shade tobacco. Aphids were first observed on 8 July on untreated plants. Aphids were transferred to 1 leaf of each plant in the untreated border rows. These border rows were strong aphid sources for insecticide-treated rows. Aphid populations increased in all plots throughout August (Table 5). At all of the evaluation dates, all plots treated with Admire had fewer aphids than control plots without insecticides (P=0.001). The higher rate of Admire application resulted in better aphid control than the low rate at the last 2 evaluation dates when applied as a transplant drench (P=0.05). Application of Admire at the last cultivation resulted in the best efficacy from 17 August to 3 September (P=0.001), and irrigation

immediately after application at the last cultivation increased Admire efficacy at 27 August and 3 September (P=0.001) regardless of previous transplant drench application.

No phytotoxicity was observed for any treatment in any of the experiments.

DISCUSSION

The environment of shade-grown tobacco is very favorable for tobacco aphid populations, and both shade and broadleaf wrapper tobaccos have very low tolerances for aphid infestation (5). Late season aphid infestations can be damaging and difficult to control. Good spray coverage can be difficult to achieve in high density shade tobacco plantings, particularly late in the season after each plant has been tied to wires under the cloth that are arranged over each row of tobacco.

Low rates of imidacloprid (0.13 to 0.26 kg (AI)/ha Admire 2F) applied at or before transplanting resulted in long but not full season control of tobacco aphids over the four years of this study. Control with a single application of imidacloprid was as good as or better than oxamyl or multiple applications of acephate. Imidacloprid efficacy was extended by increasing the preplant application rate from 0.19 to 0.38 kg (AI)/ha, or by application of the low rate to a band adjacent to plants at the last cultivation. Foliar applications of imidacloprid resulted in significant aphid control, but repeat applications were required and more aphids and aphid damage was evident compared to soil or transplant applied imidacloprid. Soil application results in better plant uptake and protects imidacloprid from photodegradation.

Aphid infestations typically occur in mid to late season, with higher aphid populations and the bulk of damage done late. We observed the first occurrence of tobacco aphids in early July. Band treatment at the last cultivation was investigated as a means of delaying application time to extend efficacy throughout the season. However, band treatment at cultivation may be dependent on soil moisture and irrigation to move the insecticide into the root zone. Band treatment did not confer an advantage over a transplant soil drench in 1997, when soils were dry and irrigation was not applied. Soil moisture was greater in 1998, and band application at the last cultivation extended control into September. Irrigation further increased the efficacy of the band treatment in 1998. These results are similar to the findings of Palumbo et al (7) which indicated that the placement or hydrological movement of imidacloprid into the soil around plant roots was optimal for absorption, translocation, and insecticide efficacy.

Hydrological movement by irrigation may be important for several reasons, including soil adsorption, photodegradation, and root uptake. Insect control by imidacloprid in potted poinsettia was similar for top or subsurface irrigation through 84 days, but top irrigation was superior in extending control beyond that period (1). Irrigation may be even more important in tobacco when imidacloprid is banded with a meal fertilizer and cultivated to incorporate. Simultaneous fertilization or the addition of organic matter may increase the adsorption and persistence of imidacloprid in soils, resulting in immobilization or a mechanism of slow release (7). Fertilization may also influence microbial activity and subsequent breakdown of active ingredient into other compounds. Irrigation may be important in moving the insecticide from the soil surface to the root zone prior to soil adsorption.

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Table 1. Evaluation of insecticides and application methods for control of the tobacco aphid in Connecticut shade tobacco, 1995.

Treatment/ formulation	Application method[b]	Rate kg (AI)/ha	Tobacco Aphid Rating[a] 24 July Treatment		Control	P[c]	8 August Treatment		Control	P	21 August Treatment		Control	P
Vydate L	broadcast	2.24	7.6	A	90.3	0.01	92.8	A	100.0	NS	100.0	A	100.0	NS
Vydate L	banded	2.24	15.3	A	96.5	0.01	75.4	A	100.0	0.04	100.0	A	100.0	NS
Admire 2F	soil drench	0.13	1.8	AB	87.8	0.01	7.6	BC	100.0	0.01	86.5	B	100.0	0.03
Admire 2F	soil drench	0.26	0.1	B	73.0	0.01	17.0	BC	88.9	0.01	74.6	B	100.0	NS
Admire 2F	soil drench	0.54	2.6	AB	97.6	0.01	4.1	BC	100.0	0.01	68.1	C	100.0	0.01
Admire 2F	transplant	0.13	4.1	AB	88.8	0.01	24.1	B	100.0	0.01	96.3	A	100.0	NS
Admire 2F	transplant	0.26	2.9	AB	97.6	0.01	22.1	B	100.0	0.01	82.8	B	100.0	0.04
Admire 2F	transplant	0.54	1.9	AB	98.8	0.01	2.8	BC	100.0	0.01	61.8	C	100.0	0.01
Admire 2F	foliar spray	2 @ 0.06	12.1	AB	78.9	0.01	21.1	B	100.0	0.01	97.8	A	100.0	NS
Orthene 75SP	foliar spray	2 @ 0.84	0.0	B	91.4	0.01	3.1	BC	100.0	0.01	62.3	C	100.0	0.01
Kruskal-Wallis Prob (T > Chi-square)			0.05				0.001				0.001			

[a] Aphid rating: 0 = no apterous aphids; 1 = one aphid per leaf; 10 = more than one aphid, totaled over 10 samples per row.

[b] Broadcast = soil applied preplant incorporated; banded = soil applied to 10 cm band on either side of transplants and incorporated; soil drench = applied to soil in a 5-cm-d area to the sides of the transplant; transplant application = applied to the root ball in a transplant flat in 1-ml water; and foliar = applied to foliage using a backpack sprayer on 12 Jul and 4 Aug.

[c] Probability that means of adjacent treated and untreated control rows are equal based on the nonparametric Wilcoxon Matched Pairs Test.

Table 2. Evaluation of insecticides and application methods for control of the tobacco aphid in Connecticut shade tobacco, 1996.

Treatment / formulation	Application method[b]	Rate kg (AI)/ha	Tobacco Aphid Rating[a] (30 plants per plot) 15 Aug	21 Aug	30 Aug	6 Sep	Yield (leaf wt (g) / plant)
Admire 2F	soil drench	0.17	1.3 A	2.0 C	2.4 C	2.5 C	610.7 A
Orthene 75SP	foliar spray	2 @ 0.84	3.0 B	0.7 B	0.9 B	1.4 B	618.8 A
Vydate L / Orthene 75SP	broadcast / foliar	2.24 / 0.84	3.2 B	1.2 A	1.2 A	1.6 A	675.9 AB
Vydate L / Orthene 75SP	banded / foliar	2.24 / 0.84	3.2 B	1.2 A	1.3 A	1.8 A	742.8 B
Kruskal-Wallis Prob (T > Chi-square)			0.001	0.001	0.001	0.001	ANOVA (P) = 0.02

[a] Aphid rating: 0 = no apterous aphids; 1 = one aphid; 2 = 2 to 10 aphids, 3 = 11 to 100, and 4 = > 100 aphids per leaf.

[b] Broadcast = soil applied preplant incorporated; banded = soil applied to 15 cm band on either side of transplants and incorporated; soil drench = applied to soil in a 5-cm-d area to the sides of the transplant, and foliar = applied to foliage using a backpack sprayer on 8 Jul and 16 Aug for Orthene alone or 16 Aug for Vydate / Orthene.

Table 3. Effect of imidacloprid (Admire 2F) application method on control of the tobacco aphid in Connecticut broadleaf tobacco, 1997.

Treatment / formulation	Application method[b]	Rate kg (AI)/ha	Tobacco Aphid Rating[a] (10 plants per plot) 23 Jul	29 Jul	7 Aug	14 Aug	Yield (g per plant)
None (control)		0.00	0.2 A	1.1 A	1.9 A	2.4 A	248.1 A
Admire 2F	preplant broadcast	0.12	0.0 B	0.2 B	0.5 B	0.8 B	254.2 A
Admire 2F	soil drench	0.12	0.0 B	0.0 B	0.0 B	0.2 B	253.7 A
Admire 2F	band at first cultivation	0.12	0.1 A	0.5 B	0.5 B	1.0 B	239.4 A
Admire 2F	band at last cultivation	0.12	0.3 A	1.2 A	1.6 A	2.5 A	242.8 A
Kruskal-Wallis Prob (T > Chi-square)				0.001	0.001	0.001	0.001	ns

[a] Aphid rating: 0 = no apterous aphids; 1 = one aphid; 2 = 2 to 10 aphids, 3 = 11 to 100, and 4 = > 100 aphids per leaf.

[b] Broadcast = soil applied preplant incorporated; banded = soil applied to 15 cm band on either side of transplants and incorporated; soil drench = applied to soil in a 5-cm-d area to two sides of the transplant.

Table 4. Effect of imidacloprid (Admire 2F) application method on control of the tobacco aphid in Connecticut shade tobacco, 1997.

Treatment / formulation	Application method[b]	Rate kg (AI)/ha	Tobacco Aphid Rating[a] (10 plants per plot) 29 Jul	7 Aug	14 Aug	22 Aug
None (control)		0.0	0.6 A	2.1 A	3.3 A	3.7 A
Admire 2F	preplant broadcast	0.19	0.0 B	0.9 B	2.0 B	2.6 B
Admire 2F	soil drench	0.19	0.0 B	0.7 B	1.6 B	2.3 B
Admire 2F	band at first cultivation	0.19	0.6 A	1.7 A	2.2 B	2.6 B
Admire 2F	band at last cultivation	0.19	0.1 B	0.9 B	1.7 B	2.1 B
Kruskal-Wallis Prob (T > Chi-square)			0.001	0.001	0.001	0.001

[a] Aphid rating: 0 = no apterous aphids; 1 = one aphid; 2 = 2 to 10 aphids, 3 = 11 to 100, and 4 = > 100 aphids per leaf.

[b] Broadcast = soil applied preplant incorporated; banded = soil applied to 15 cm band on either side of transplants and incorporated; soil drench = applied to soil in a 5-cm-d area to two sides of each transplant.

Table 5. Effect of imidacloprid (Admire 2F) application method and irrigation on control of the tobacco aphid in Connecticut shade tobacco, 1998.

Treatment	Application method[b]	Rate kg (AI)/ha	Irrigation	Tobacco Aphid Rating[a] (10 plants per plot) 30 Jul	8 Aug	17 Aug	27 Aug	3 Sep
None (control)		0.0	no	1.3	2.2	4.0	4.0	4.0
Admire 2F	transplant drench	0.19	no	0.0	0.0	1.5	2.8	3.0
Admire 2F	transplant drench	0.38	no	0.0	0.0	1.7	1.8	1.8
Admire 2F	drench/band at cultivation	0.19 + 0.19	yes	0.0	0.0	1.3	1.5	1.5
Admire 2F	drench/band at cultivation	0.19 + 0.19	no	0.0	0.0	1.3	1.4	1.6
Admire 2F	band at last cultivation	0.19	yes	0.0	0.1	1.3	1.5	1.5
Admire 2F	band at last cultivation	0.19	no	0.0	0.1	1.2	1.7	1.9
Kruskal-Wallis Prob (T > Chi-square)				0.001	0.001	0.001	0.001	0.001

[a] Aphid rating: 0 = no apterous aphids; 1 = one aphid; 2 = 2 to 10 aphids, 3 = 11 to 100, and 4 = > 100 aphids per leaf.

[b] Transplant drench = soil applied 20 ml/plant in 2 10-ml applications 2-cm to two sides of each plan and incorporated; band at cultivation = band applied at the last cultivation on 23 Jun in 654 l water/ha to 15 cm on either side of rows and incorporated by mechanical cultivation and hoeing.