Arizona Department of Agriculture
AILRC Grants Program – Final Report for 2007
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Whitefly and Aphid Management For Desert Lettuce

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Introduction

Desert lettuce production remains highly dependant on the availability of effective and economical insecticides. The implementation of FQPA has begun and will likely result in the reduced availability of many important compounds. Consequently, development of new IPM alternatives for insect management has become especially important. Recent product registrations have resulted in important IPM tools for desert lettuce growers that provide excellent control of worms, *leafminers*, and whiteflies. There are several additional chemistries currently under development that will be available for insect management in the next few years. Research to evaluate and develop these products for desert lettuce IPM programs has been supported through funding provided by AILRC and the Agrochemical industry over the past several years.

However, thrips and aphids still remain key pests of spring lettuce in the desert and represent the most important insect problems currently facing the industry. Several new promising insecticides that are in early stages of development are being evaluated for their control. However, the presence of a new aphid species, the currant-lettuce aphid, *Nasonovia ribisnigri*, and the foxglove aphid, *Aulacorthum solani*, presents some new challenges. We are still uncertain how this new species will behave under desert growing conditions. Research to learn more about its damage potential and control in the desert needs to continue. Furthermore, western flower thrips remain a very difficult pest to control and no compounds are being developed specifically for its management. Many of the compounds currently used for controlling thrips (Lannate, Orthene, Dimethoate) are directly threatened by FQPA. The intention of this proposal is to continue evaluation of new chemistries and management approaches under local growing conditions and generate new information that will allow Arizona growers to cost-effectively manage these pests.

Aphids are one of the most important insect problems in head lettuce grown in Arizona. A new aphid species, the foxglove aphid, *Aulacorthum solani*, was found infesting commercial lettuce

fields in the Yuma area for the first time this past growing season. It has been known to occur in California since at least 1940, and along with the lettuce aphid, *Nosanovia ribis-nigri*, has caused problems for lettuce growers in Salinas area for the past several years. Although, the lettuce aphid is the more important of the two in Salinas, studies last spring suggest that foxglove aphid may be a more important pest in the desert. Foxglove aphids are thought to occur throughout the U.S and Canada, but its effect is generally greatest in the eastern regions of the continent. It is also found worldwide, but is probably of European origin.

The foxglove aphid appears to be similar to the lettuce aphid in that the alates (winged forms) are difficult to differentiate, both aphids have short life cycles that allow populations to build up rapidly, and both tend to prefer to colonize the youngest tissue near the terminal growing point of the plant. Apterae (wingless forms) foxglove aphid are also often confused with the green peach aphid, *Myzus persicae*. Both aphids are usually yellow-green to all green but the green peach aphid may also be somewhat pink or red, as is the lettuce aphid. The foxglove aphid is slightly larger (maximum length is 3.0 mm) than the green peach aphid (max. length is 2.3 mm). One way to distinguish these two aphids is by the dark joints found on legs and antennae of the foxglove aphid, and the dark tips of the cornicles. The green peach aphid also has pale-colored legs and antennae but without dark joints. Foxglove aphids are also unique in that they have a bright green or dark colored spot at the base of each cornicle. Alates have a pattern of transverse dark bars on the dorsal abdomen.

The foxglove aphid was not previously thought to occur in Arizona. It is principally considered a serious pest of potatoes and is also found on ornamental and greenhouse plants. It is considered an occasional pest of lettuce and leafy vegetables grown in Canada. Unlike the lettuce aphid which was first found in Yuma five years ago, the foxglove aphid is known to colonize a much broader range of plant hosts, including a wide variety of weeds, ornamentals and crops. This large availability of hosts and apparent adaptation to our winter and spring growing conditions suggests that foxglove aphids might present growers with some new challenges.

There is much uncertainty surrounding this new species, and its ability to thrive within our desert growing conditions. We are not sure how or when the foxglove aphid moved into the Yuma area, but it seems likely that it may have arrived via transplants or harvest equipment, much like we suspect with the lettuce aphid. Because this species is polyphagus and utilizes a number of known host plants grown in the desert, we are concerned that foxglove aphids may become an established pest on our winter/spring crops. In terms of management, control with foliar aphicides appears to be more difficult because the aphids preference for the protected terminal growth. We have had the opportunity to conduct a considerable amount of field research over the past two growing seasons to learn more about this pest. Because of the importance of the foxglove as a contaminant of lettuce and other leafy vegetables, we designed several studies to its examine its population growth, distribution, and damage potential.

Objective 1. To continue monitoring for a 15th consecutive year the commercial field performance of Admire soil treatments for control of whiteflies in the Yuma

Methods and Materials : Several commercial lettuce fields planted in the Dome Valley, Gila Valley and Yuma Valley were used for these studies from 1993-2006. A total of 6-9 monitoring sites were established for each season (7 in 2006). (Table 1). Lettuce fields were planted within a week in early September (Sep 9-17) in each year. Admire was evaluated on 'empire' type lettuce varieties each year. Two treatments were evaluated in each growers field: (1) growers standard application of Admire throughout the field, and (2) an untreated check plot where Admire was not applied in a randomly selected area in the field measuring 4 beds * 100 ft. The commercial standard field received 16 oz of Admire (or 7 oz of Admire Pro in 2006) at planting in a total volume of 20 gallons/acre. Admire was injected at a depth of ~ 2" below the seed line just prior to seeding.

Lettuce plants were sampled for immature whitefly densities three times each season, based on crop phenology. Twenty basal leaves from the center rows of each plot were collected randomly from ten lettuce plants at: thinning stage (4-leaf stage; 21 days after planting), heading or "rosette" stage (leaves begin to cup inward to form heads; 50 days after planting), and harvest (mature heads; 69-77 days after planting). Samples were taken to the laboratory where two 1-cm^2 areas were selected randomly on each leaf, and the numbers of all immature stages of whiteflies were counted using a stereo microscope and recorded. Since 1998, studies similar to above were initiated in commercial broccoli and melon fields in the Yuma and Gila valleys. Broccoli plots were established in early September similar to the lettuce trials described above. Admire was applied similar to the lettuce trials. Leaf samples were collected from basal leaves at 20 , 40 and 60 days after planting and immature densities were assessed as above..

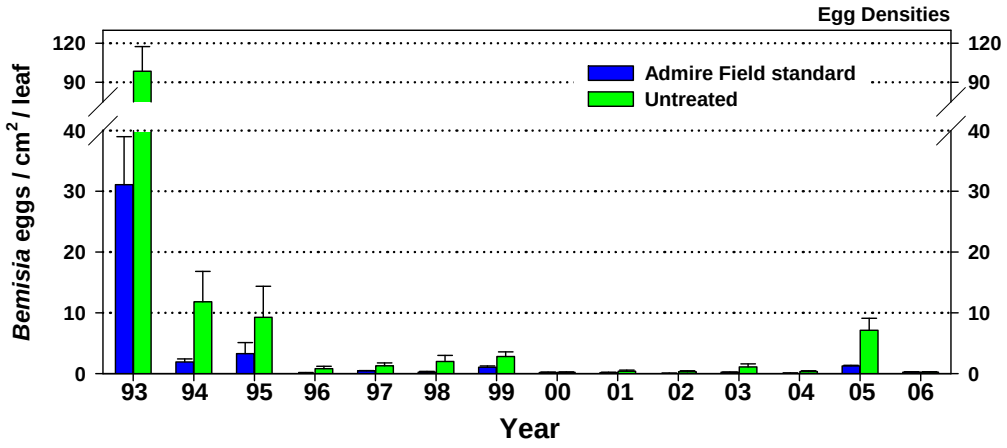
Results : Evaluations of Admire field efficacy in lettuce for the 2006 growing season are found in Figure 1. Over the past 14 years, silverleaf whitefly densities in lettuce fields have declined dramatically. Numbers were greatest in 1993 and 1994 when Admire was first introduced (Fig 1). We observed a small outbreak in 2005, but numbers declined to low levels again the past season. Untreated lettuce plots had significantly greater whitefly densities throughout the season than the Admire treated field plots . During the past 10 years, whitefly densities have overall been considerably lower. Although, in most years, whitefly numbers were significantly greater in the untreated plots, immature densities at thinning and heading were not great enough to cause differences in yield. A trend of low whitefly abundance and immigration during September in Yuma growing regions has been observed in particular the past 3 years, and can be seen more directly from trap catches in our trap network . In my estimation, this is largely a reflection of the area-wide use of Admire on fall and spring vegetable crops and the suppressive effects it has had on whitefly populations. In addition , the implementation of the

IGR's, Knack and Applaud, in cotton and the additional impact that natural mortality has had whitefly populations has undoubtedly had an impact on regional whitefly activity, particularly as it relates to adult movement form cotton to fall lettuce crops.

In general, our data suggests that Admire continues to provide exceptional field efficacy over the past 14 years. Thus, as of the fall 2006 our initial conclusion is that Admire remains efficacious. However, the fact that densities on lettuce have been very low (2 nymphs/cm^2) in most years since 1995, and lettuce is a marginal host for whitefly development and colonization, suggests that these data may not truly reflect Admire efficacy against whitefly populations in Yuma. Because of this concern, untreated test sites were established in commercial broccoli fields beginning in the fall 1998 to measure differences in whitefly colonization in these highly preferred host crops. Results from the broccoli trials clearly show that Admire provided excellent efficacy of whitefly adults and small nymphs (Figure 2) . No significant colonization was observed in any of the Admire treated fields. In contrast, several of untreated plots experienced stunted growth, and chlorosis of leaf and stem tissue. Result in the melon plots showed a similar response . Field plots left untreated, resulted in significantly higher whitefly densities at each sampling interval. These results are consistent with results from our 1998 studies, suggesting that growers could expect ~ 45days of residual efficacy following soil application of Admire on fall vegetables.

Figure 1.

Head Lettuce (Yuma, Dome and Gila Valleys) 1993-2006



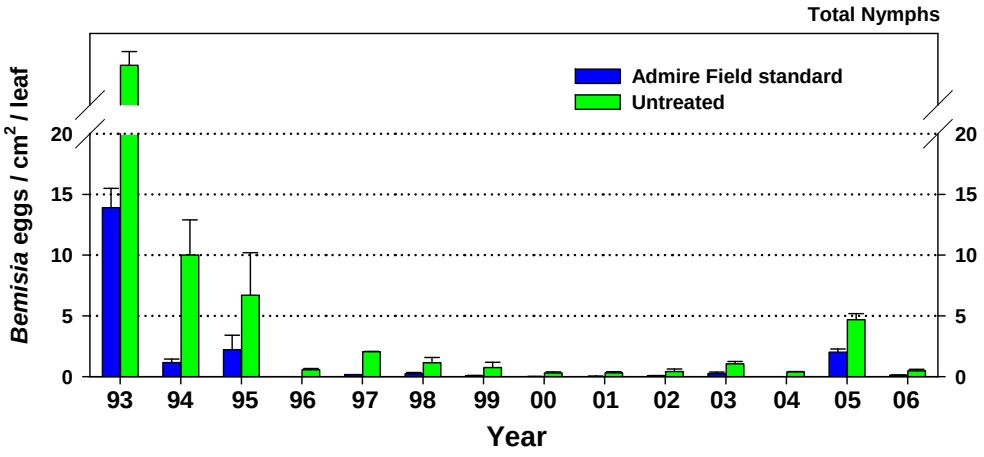


Figure 2

Broccoli (Yuma, Dome and Gila Valleys) 1998-2005

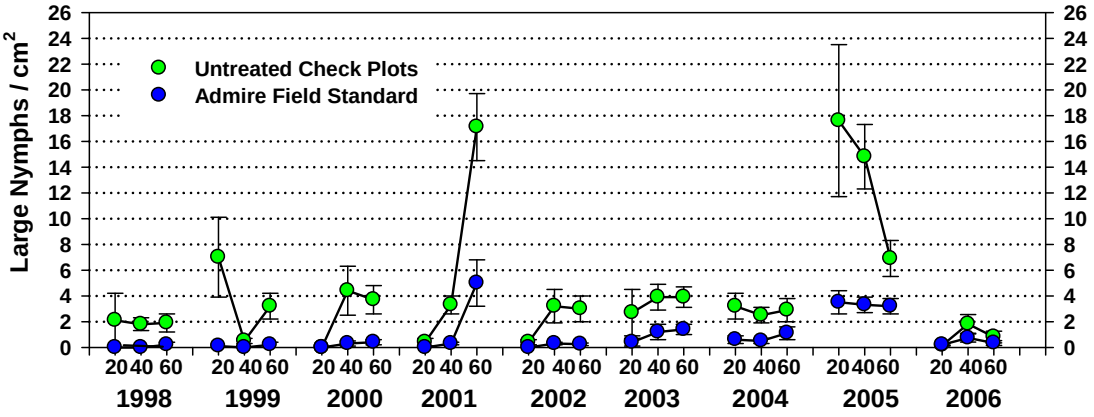


Fig. 1. Broccoli leaf samples collected 25 September 2006 from four commercial fields.

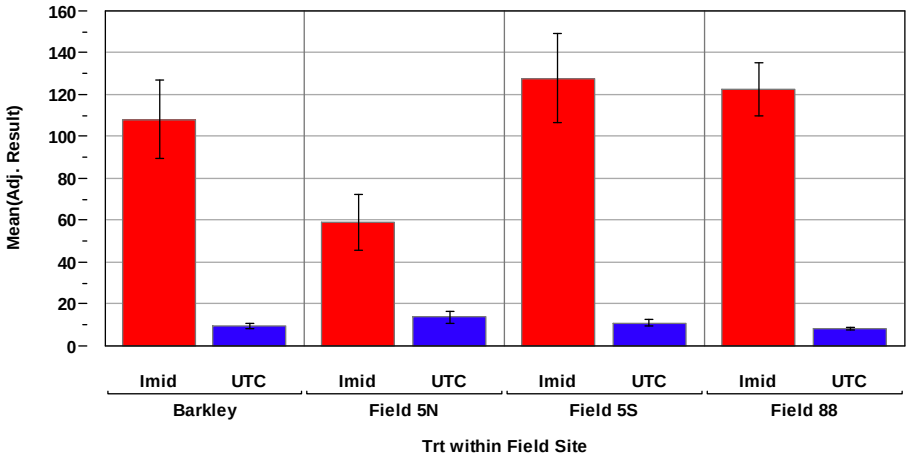


Fig. 2. Broccoli leaf samples collected 16 October 2006 from the same four commercial fields as in fig. 1. The UTC samples had elevated readings in three of the four fields .

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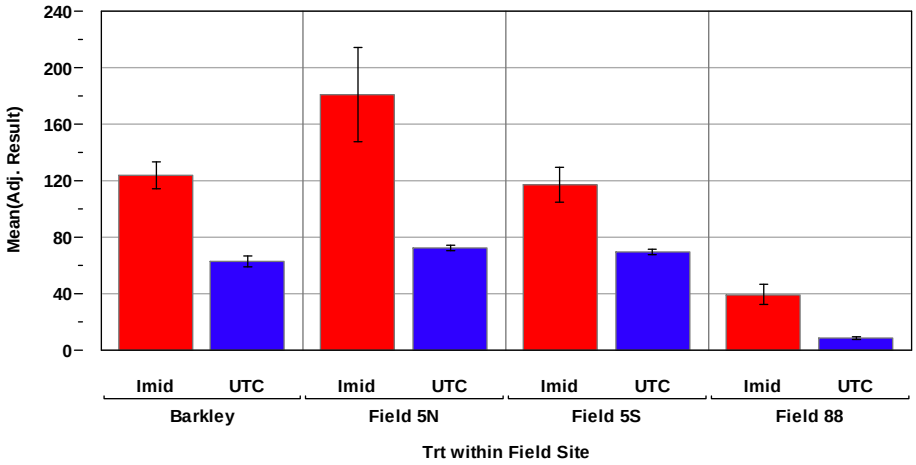
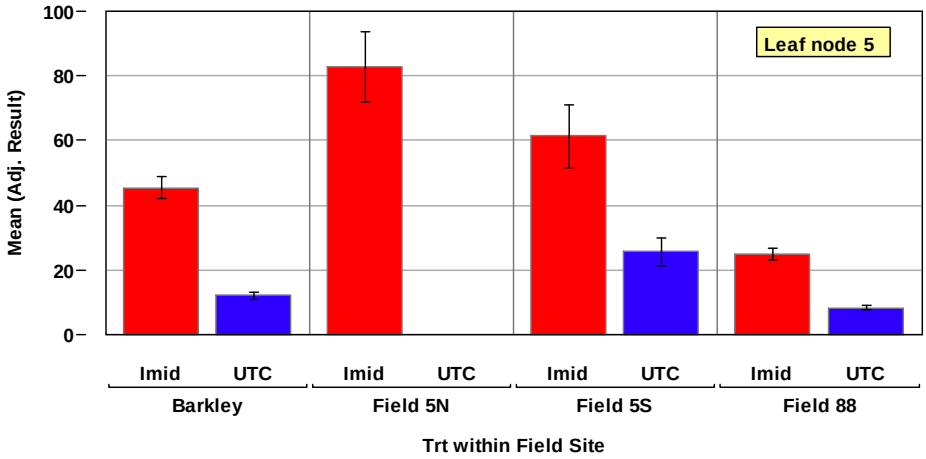


Fig. 3. Differences in imidacloprid concentrations according to leaf node position in broccoli plants from four commercial fields collected 7 November 2006 (UTC sample from field 5N was lost).



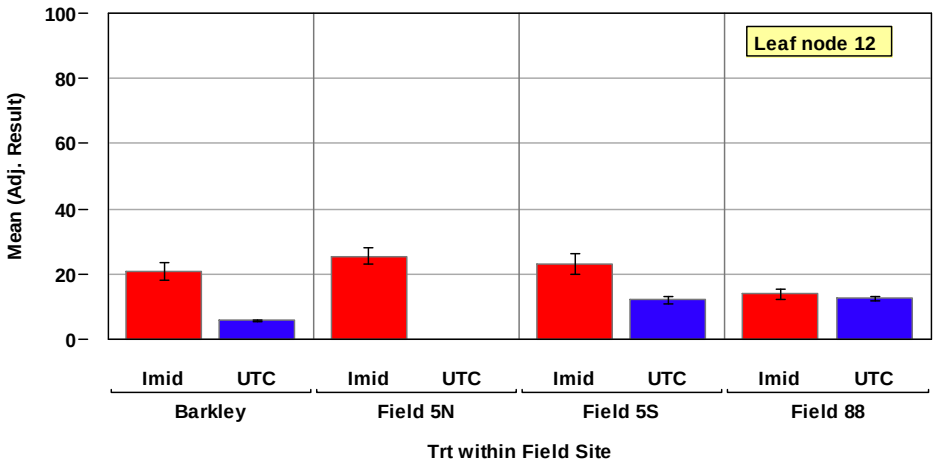


Fig. 4. Broccoli leaf samples collected 4 October 2006.

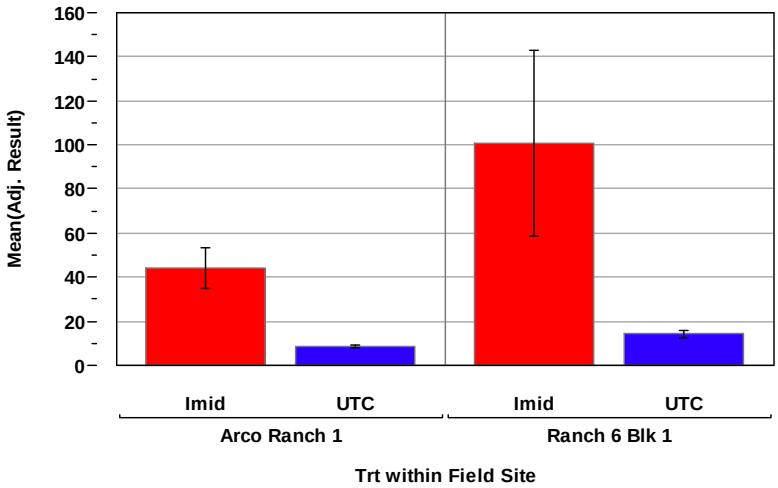
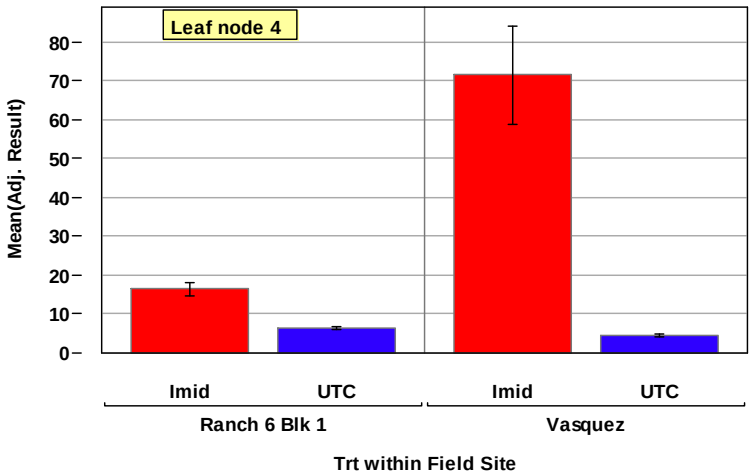


Fig. 5. Differences in imidacloprid concentrations according to leaf node position in broccoli plants from two commercial fields collected 26 October 2006.



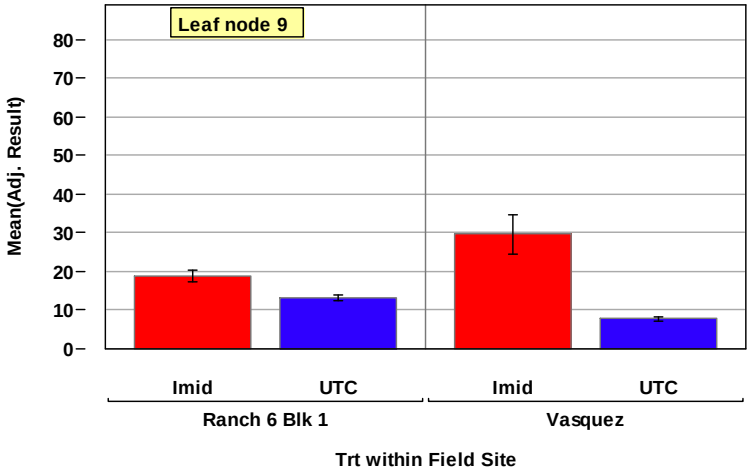
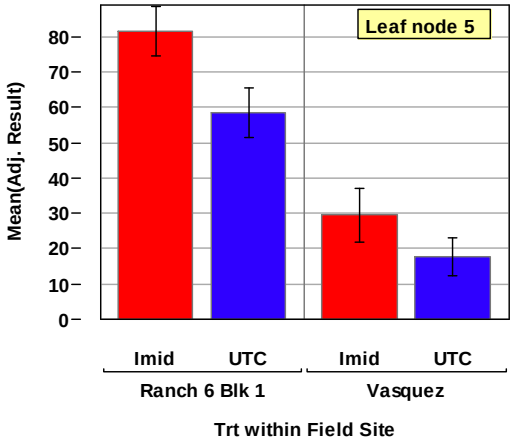
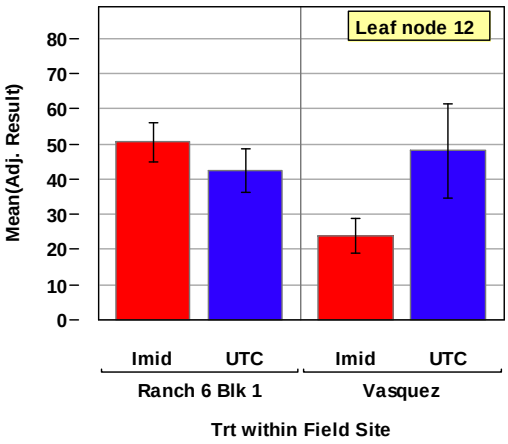


Fig. 6. Differences in imidacloprid concentrations according to leaf node position in broccoli plants from two commercial fields collected 18 November 2006. No explanation for the UTC levels (but check about foliar trts).





Objective 2. To evaluate and compare the efficacy of Admire Pro® and several new Generic Imidacloprid products with Admire 2F® for control of whiteflies and aphids in fall and spring head lettuce.

Objective 3. To evaluate and compare the efficacy of several new experimental compounds that have aphid efficacy in spring lettuce

Introduction

Similarly, aphids continue to be a serious economic pest of head lettuce. Preventative, at-plant applications of Admire (imidacloprid) provide consistent, season long control of green peach aphids in spring lettuce. Certainly the question of whether the generic imidacloprid products will control this aphid similarly to Admire is applicable. We expect them to be equally effective, but again we need to scientifically demonstrate this. However, the foxglove aphid on lettuce is another issue. It has become well established on desert lettuce during the past 5 years, particularly in the Yuma and Gila Valleys. Surprisingly, Admire has not been as consistent against foxglove aphids, often allowing aphids to infest plants later in the season (75-80 days after planting). We are not sure why this occurs.

We initially assumed that foxglove aphids were inherently less susceptible to Admire than green peach aphids, but we now hypothesize that these differences in control may also be related to aphid behavior, in association with uptake and distribution of Admire in the lettuce plant. Based on previous research on cantaloupes (Castle and Palumbo, Fig 6), we have found that upon uptake by the roots Admire tends to initially move to young leaf tissue in high concentrations when plants are small, accumulating in older leaf tissue as the season progress, and resulting in progressively lower imidacloprid concentrations in the terminal growth beyond 70 days. This suggests to us that perhaps the reason Admire is so effective against green peach aphid is that the aphids preferentially colonize the older frame leaves on the lettuce plants (hypothetically coming in contact with high imidacloprid residues and thus preventing colonization). In contrast, foxglove aphids tend to colonize new leaf tissue near developing heads and wrapper leaves (hypothetically with low imidacloprid residue levels during the heading stage. Below are several trials we conducted in 2006-2007 to meet these objectives.

APHID CONTROL WITH IMIDACLOPRID FORMULATIONS IN SPRING HEAD LETTUCE

Small-plot, field studies were conducted at the University of Arizona, Yuma Agricultural Center in the spring 2007 growing season. Head Lettuce '*Desert Spring'* was direct seeded into double row beds on 42 inch centers on 16 Dec, 2006. Plots for each trial consisted of 2 beds, 45' long and were arranged in a randomized complete block design with 4 replications. Formulations and rates for each compound are provided in the tables. The imidacloprid soil treatments were applied as a shank injection at a depth of 2" below the seed line during planting in a total water volume of 21 GPA. Foliar sprays of Movento were applied on 9 and 19 Mar with a CO_2 operated boom that delivered a broadcast application at at 50 psi and 28 gpa through three TX-18 ConeJet nozzles per bed. An adjuvant, DyneAmic (Helena Chemical Co.), was applied at 0.75% v/v to the Movento treatments. Aphid populations were assessed by estimating the number of aphids / plant in whole plant, destructive samples. On each sampling date, 5 plants were randomly selected from each plot and placed individually into large 5-gal tubs. Each plant was sampled by visually examining all plant foliage and counting the number of apterous aphids present. At harvest (Mar 28), infestation levels of apterous aphids were estimated by randomly selecting 10 plants within each replicate, visually counting all aphids only on heads and two wrapper leaves. Data were analyzed as a 1-way ANOVA using a protected LSD F test to distinguish treatment mean differences.

Aphid pressure was light at the beginning of the trial and peaked at moderately heavy pressure at harvest. GPA was present in low numbers and was not a contaminant factor at harvest (Table 1). However, differences in GPA numbers among the imidacloprid formulations were not observed throughout the trial. LA numbers were low during the first half of the season, but increased to high numbers at harvest. All of the imidacloprid treatments significantly reduced LA numbers compared with the UTC at harvest (Table 2). However, head contamination with LA was high and would have rendered all of the imidacloprid treatments unacceptable for commercial markets. The foliar sprays of Movento applied 19- and 9- d prior to harvest significantly reduced LA numbers in lettuce heads at harvest. Heads in these plots were considered commercially acceptable. No phytotoxicity was observed.

Table 1.

		Mean GPA / Plant				
Treatment	Rate	20-Jan	5-Feb	26-Feb	13-Mar	Harvest 28-Mar
Admire Pro	10.5 oz	0.03 b	0.05 b	0.5 b	0.0 c	0.1 a
Admire 2F	24 oz	0.0 b	0.05 b	0.8 b	0.0 c	0.0 a
Admire Pro	7 oz	0.05 b	0.08 b	0.1 b	0.5 c	0.0 a
Admire 2F	16 oz	0.0 b	0.0 b	0.3 b	0.2 c	0.0 a
Alias 2F-16 oz	16 oz	0.08 b	0.4 b	0.7 b	0.3 c	0.0 a
Nuprid 2F-16 oz	16 oz	0.08 b	0.3 b	0.5 b	0.6 bc	0.0 a
Widow 2F-16 oz	16 oz	0.08 b	0.3b	0.9 b	0.6 bc	0.0 a
Admire Pro + Movento 2SC	7 oz + 5 oz	0.05 b	0.08 b	0.1 b	0.0 c	0.0 a
Movento 2SC	5 oz	0.5 a	1.2 a	11.4 a	1.2 b	0.0 a
UTC	-	0.5 a	1.2 a	11.4 a	2.4 a	0.0 a

Mean imidacloprid concentrations in spring lettuce samples collected on 3 dates at YAC.

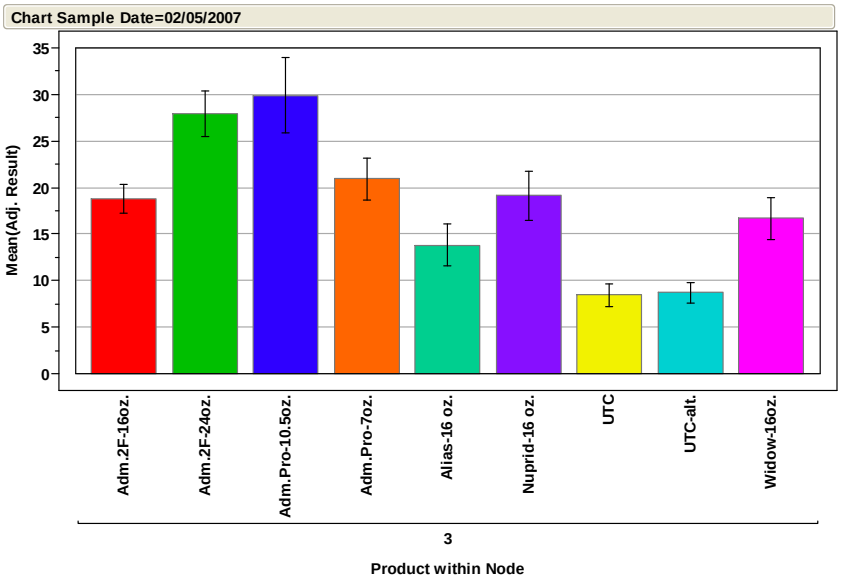
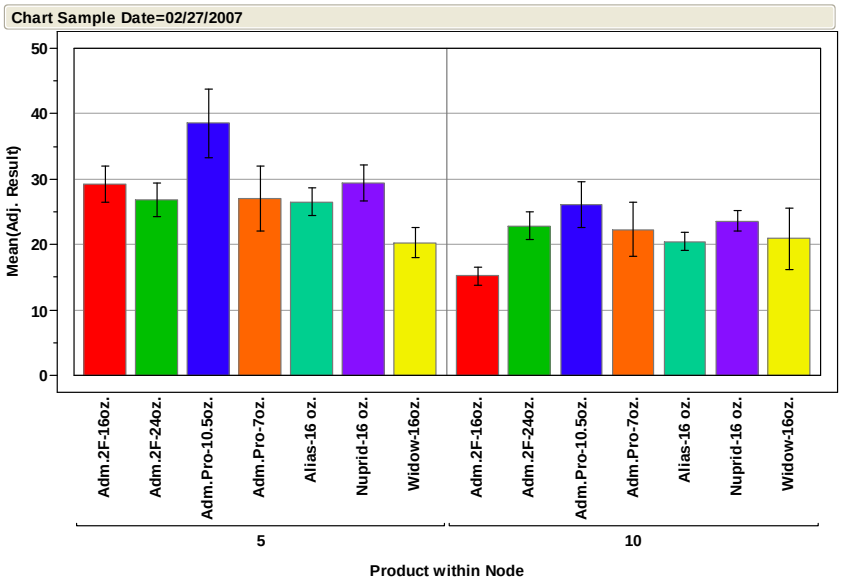


Chart Sample Date=02/05/2007
Mean(Adj. Result)
35
30
25
20
15
10
5
0
Adm.2F-16oz.
Adm.2F-24oz.
Adm.Pro-10.5oz.
Adm.Pro-7oz.
Alias-16 oz.
Nuprid-16 oz.
UTC
UTC-alt.
Widow-16oz.
3
Product within Node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40
30
20
10
0
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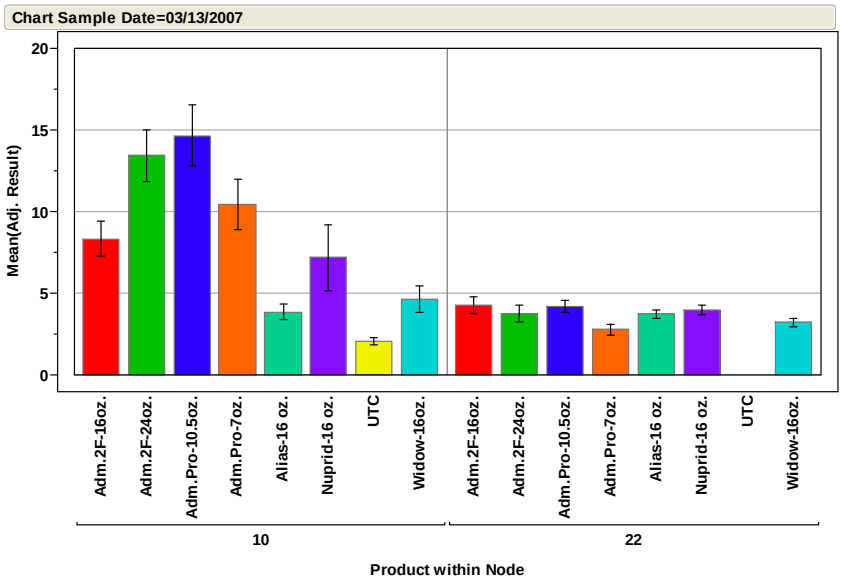
Adm.2F-24oz.
Adm.Pro-10.5oz.
Adm.Pro-7oz.
Alias-16 oz.
Nuprid-16 oz.
Widow-16oz.
Adm.2F-16oz.
Adm.2F-24oz.
Adm.Pro-10.5oz.
Adm.Pro-7oz.
Alias-16 oz.
Nuprid-16 oz.
Widow-16oz.
5
10
Product within Node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Mean(Adj. Result)
20
15
10
5
0
Adm.2F-16oz.
Adm.2F-24oz.
Adm.Pro-10.5oz.
Adm.Pro-7oz.
Alias-16 oz.
Nuprid-16 oz.
UTC
Widow-16oz.
Adm.2F-16oz.
Adm.2F-24oz.
Adm.Pro-10.5oz.
Adm.Pro-7oz.
Alias-16 oz.
Nuprid-16 oz.
UTC
Widow-16oz.
10
22
Product within Node

Table 2.

		Mean LA / Plant				
Treatment	Rate	20-Jan	5-Feb	26-Feb	13-Mar	Harvest 28-Mar
Admire Pro	10.5 oz	0.0 a	0.0 a	1.5 b	26.2 def	57.8 cd
Admire 2F	24 oz	0.0 a	0.0 a	1.2 b	22.6 ef	63.1 cd
Admire Pro	7 oz	0.0 a	0.0 a	3.4 ab	59.8 bc	101.8 bcd
Admire 2F	16 oz	0.0 a	0.0 a	1.5 b	35.3 cdef	105.1 bcd
Alias 2F-16 oz	16 oz	0.0 a	0.0 a	3.7 ab	50.0 cde	145.8 bc
Nuprid 2F-16 oz	16 oz	0.0 a	0.0 a	2.9 ab	87.8 b	198.5 b
Widow 2F-16 oz	16 oz	0.0 a	0.0 a	2.5 b	56.8 bcd	138.5 bc
Admire Pro + Movento 2SC	7 oz + 5 oz	0.0 a	0.0 a	3.4 ab	11.0 f	1.6 d
Movento 2SC	5 oz	0.0 a	0.0 a	7.1 a	12.2 f	1.8 d
UTC	-	0.0 a	0.0 a	7.1 a	156.3 a	381.5 a

APHID CONTROL WITH FOLIAR AND SOIL APPLIED NEONICOTINOIDS IN HEAD LETTUCE

Small-plot, field studies were conducted at the University of Arizona, Yuma Agricultural Center in the spring 2007 growing seasons. Head Lettuce 'Westland' was direct seeded into double row beds on 42 inch centers on 16 Nov, 2007. Plots for each trial consisted of 2 beds , 45' long. Plots were arranged in a randomized complete block design with 4 replications. Formulations and rates for each compound are provided in the tables. The Admire Pro and Platinum treatments were applied at a depth of 2" below the seed line during planting in a total water volume of 21 GPA . Foliar sprays were applied on 10 Jan, 27 Jan and 17 Feb with a CO_2 operated boom sprayer at 50 psi and 28 gpa. A broadcast application was delivered through 3 TXVS-12 ConeJet nozzles per bed. An adjuvant, DyneAmic (Helena Chemical Co.), was applied at 0.25% to all treatments. The Movento treatment was applied only once on Feb 17 on lettuce plots treated with Admire Pro at planting. Extremely cold weather was recorded from Jan 15-17 (below freezing temperatures recorded for several hours). At harvest (Mar 7), infestation levels of apterous aphids were estimated by randomly selecting 10 plants within each replicate, visually counting all aphids on frame/wrapper leaves and heads separately and documenting the percentage of heads with aphid infestations of >5 and > 10 aphids/head. Data were analyzed as a 1-way ANOVA using a protected LSD F test to distinguish treatment mean differences.

Aphid pressure was moderate-heavy during the study. FGA aphid infestation levels at harvest varied significantly among the soil and foliar spray treatments. The Platinum (8 oz) and Admire Pro soil treatments, and the low-rate Actara (3 oz) foliar treatment did not significantly reduce the number of FGA/head compared with the UTC. Furthermore, because the USDA marketing standard for U.S. No.1 lettuce does not accept lettuce shipments that exceed 12% of the heads with 5 or or more aphids, these same treatments would not have been commercially acceptable.

LA infestation levels were much higher at harvest than for FGA. All the foliar spray treatments and the Platinum (8oz) treatment had significantly fewer LA than the UTC. However, only the Movento spray treatment applied 18 d before harvest to Admire Pro soil-treated plots provided lettuce heads that were commercially acceptable based on USDA marketing standards.

			% Heads infested with				% Heads infested with
	Rate	FGA / head	> 5 FGA	> 10 FGA	LA/ head	> 5 LA	> 10 LA
Platinum 2SC	8 oz	4.2 ab	18.0 b	10.8 a	35.6 bc	78.8 abc	71.5 ab
Platinum 2SC	11 oz	1.6 b	10.8 b	0.0 a	77.1 ab	82.0 abc	64.3 b
Admire Pro	8 oz	4.4 ab	25.3 ab	17.8 a	52.1 abc	89.3 ab	82.3 ab
Admire Pro + Movento 2SC	8 oz +8 oz	0.5 b	0.0 b	0.0 a	1.0 c	0.0 d	0.0 d
Actara 25WG	3 oz	3.9 ab	14.3 b	14.3 a	20.5 c	85.8 ab	57.3 bc
Actara 25WG	4 oz	0.4 b	0.0 b	0.0 a	16.9 c	67.8 bc	53.8 bc
Belaf 50SG	2.8 oz	0.04 b	0.0 b	0.0 a	19.9 c	71.3 bc	60.8 b
Assail 30SG	4 oz	1.5 b	10.8 b	3.5 a	21.6 c	60.5 c	28.5 cd
UTC	-	6.8 a	49.8 a	25.0 a	100.1 a	100 a	100 a

APHID CONTROL WITH MOVENTO IN SPRING HEAD LETTUCE

Small-plot, field studies were conducted at the University of Arizona, Yuma Agricultural Center in the spring 2007 growing season. Head Lettuce 'Desert Spring' was direct seeded into double row beds on 42 inch centers on 7 Nov, 2006. Plots for each trial consisted of 2 beds , 45' long. Plots were arranged in a randomized complete block design with 4 replications. Formulations and rates for each compound are provided in the tables. Foliar sprays were applied on 9 Jan, 25 Jan and 16 Feb with a CO_2 operated boom sprayer at 50 psi and 28 gpa. A broadcast application was delivered through 3 TXVS-18 ConeJet nozzles per bed. An adjuvant, Dyne-Amic (Helena Chemical Co.), was applied at 0.375% to all treatments. The high rate of Movento (8 oz) was only applied twice (9 Jan and 25 Jan). The 6 oz rate of Movento was applied twice (9 Jan and 25 Jan) and applied at 4 oz in combination with Capture at 6 oz on Feb 16. Aphid populations were assessed by estimating the number of aphids / plant in whole plant, destructive samples. On each sampling date, 5 plants were randomly selected from each plot and placed individually into large 5-gal tubs. Each plant was sampled by visually examining all plant foliage and counting the number of apterous (non-winged) aphids present. At harvest (Feb 23), infestation levels of apterous aphids were estimated by randomly selecting 10 plants within each replicate, visually counting all aphids on frame/wrapper leaves and heads separately. Data were analyzed as a 1-way ANOVA using a protected LSD F test to distinguish treatment mean differences.

Aphid pressure was light at the beginning of the trial and peaked at moderately heavy pressure at harvest. Following the first application, only Assail and Beleaf significantly reduced GPA numbers relative the UTC (Table 1). Temperatures in January were quite cold (~10 degrees below normal) and may have negatively influenced the systemic activity of the Movento treatments after the first spray. Following the second and third applications, all treatments provided significant control of GPA and head contamination at harvest was negligible in all spray treatments. Differences in LA numbers among treatments were not evident until harvest (Table 2). All treatments significantly reduced LA numbers compared to the UTC except for Assail. Averaged across all evaluations, the Movento treatments provided the most consistent LA control.

Table 1.

		Mean GPA / Plant							
Treatment	**Rate/ac**	7-Jan	16-Jan	24-Jan	1-Feb	8-Feb	15-Feb	Harvest 23-Feb	Season Avg
Movento 150 OD[1]	6 oz	2.3 a	6.6 a	9.0 ab	4.6 b	5.0 b	2.2 b	0.5 b	4.6 b
Movento 150 OD[2]	8 oz	2.0 a	7.0 a	5.6 abc	5.5 b	2.7 b	2.0 b	0.4 b	3.9 b
Beleaf	2.8 oz	1.9 a	5.5 a	4.3 bc	2.5 b	2.2 b	3.9 b	0.8 b	3.2 b
Assail	4 oz	1.0 a	4.3 a	3.6 bc	1.6 b	4.3 b	3.5 b	0.2 b	2.9 b
Provado	6.2 oz	2.2 a	7.0 a	6.8 abc	2.6 b	2.0 b	2.6 b	0.6 b	3.6 b
UTC	-	1.8 a	10.7 a	11.2 a	20.0 a	39.8 a	31.7 a	9.2 a	20.4 a

Means followed by the same letter are not significantly different, ANOVA; protected LSD *(p>0.05)*

[1] Movento (6 oz) was tank-mixed with Capture (6 oz) on the third applications, 16 Feb.

[2] The Movento 8 oz treatment was only applied on 9 and 25 Jan.

Table 2.

		LA / Plant							
Treatment	**Rate/ac**	7-Jan	16-Jan	24-Jan	1-Feb	8-Feb	15-Feb	Harvest 23-Feb	Season Avg
Movento 150 OD[1]	6 oz	0.0 a	0.0 a	0.0 a	1.0 a	0.4 a	2.3 a	0.4 b	0.6 c
Movento 150 OD[2]	8 oz	0.0 a	0.0 a	0.0 a	0.1 a	0.1 a	0.6 a	2.1 b	0.5 c
Beleaf	2.8 oz	0.0 a	0.0 a	0.04 a	0.1 a	0.5 a	6.7 a	3.4 b	1.8 bc
Assail	4 oz	0.0 a	0.1 a	0.7 a	0.1 a	0.2 a	12.9 a	54.9 ab	11.5 ab
Provado	6.2 oz	0.0 a	0.0 a	0.5 a	0.1 a	1.6 a	16.9 a	3.8 b	3.8 bc
UTC	-	0.0 a	0.0 a	1.3 a	1.0 a	7.9 a	13.2 a	97.8 a	20.2 a

Means followed by the same letter are not significantly different, ANOVA; protected LSD *(p>0.05)*

[1] Movento (6 oz) was tank-mixed with Capture (6 oz) on the third applications, 16 Feb.

[2] The Movento 8 oz treatment was only applied on 9 and 25 Jan.

EVALUATION OF MOVENTO FOR APHID CONTROL IN HEAD LETTUCE

The objective of this study was to evaluate the residual efficacy of a new active ingredient, Movento (spirotetramat), as a foliar spray for control of aphids on spring head lettuce under desert growing conditions. Lettuce was direct seeded on 1 Dec, 2005 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, furrow irrigated thereafter. Plots were two beds wide by 45 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a randomized complete block design. Formulations and rates for each compound are provided in the tables. Foliar applications were made with a CO^2 operated boom sprayer operated at 60 psi and 21.0 GPA. A broadcast spray was delivered through 2 TX-18 ConeJet nozzles per bed. An adjuvant, DyneAmic (Helena Chemical Co.), was applied at 0.5% v/v on the first application and an MSO (Destiny) at 0.5% on the second application to the Movento 5 oz and Beleaf treatments only. Sprays were applied on Jan 30 and Feb 20. No other pesticides were applied. Aphid populations were assessed by estimating the number of aphids /plant in whole plant, destructive samples. On each sample date, 10 plants were randomly selected from each plot and placed individually into large 3-gal tubs. Each plant was sampled by visually examining all plant foliage and counting the number of apterous aphids present. At harvest, infestation levels of apterous aphids were estimated by randomly selecting 10 plants within each replicate, visually counting all aphids on frame/wrapper leaves and heads separately. Data were analyzed as a 1-way ANOVA using a protected LSD F test to distinguish treatment mean differences

Aphid pressure was light at the beginning of the trial and peaked at moderately heavy pressure at harvest. GPA was present in low numbers and was not a factor at harvest (Table 1). GPA numbers were significantly lower in the Movento treatments than in the untreated control on each post-treatment sample. FGA numbers were low following the 1st application and did not differ among the spray treatments and the untreated control (Table 2). At 16 and 24 days following the 2nd spray, the Movento at 5 oz did not significantly reduce FGA numbers. However, the addition of DyneAmic to the Movento 5 oz treatment resulted in significantly fewer FGA than the untreated control. At harvest (30-DAT #2), all treatments except Beleaf significantly reduced FGA numbers. LA numbers were highest at harvest, and all treatments had significantly fewer LA than the untreated check (Table 3). Total aphid numbers were also highest at harvest and were lowest in the Movento treatments (Table 4). The results of this study suggest that the addition of an adjuvant (DyneAmic) can significantly improve Movento performance against aphis in lettuce.

Table 1.

Treatment	Rate/ac	Mean GPA / Plant						
		6-Feb	13-Feb	20-Feb	28-Feb	8-Mar	16-Mar	Harvest 22-Mar
Movento 150OD	5 oz	0.5 b	0.5 b	1.2 b	0.6 b	0.1 b	0.2 b	0.4 b
Movento 150OD	8 oz	0.7 b	0.3 b	1.0 b	0.2 b	0.1 b	0.1 b	0.0 b
Movento 150OD+DyneAmic	5 oz + 0.5%	0.2 b	0.2 b	0.8 b	0.2 b	0.3 b	0.1 b	0.1 b
Beleaf+Dyneamic	2.3 oz + 0.5%	0.2 b	0.2 b	1.2 b	0.2 b	0.3 b	0.1 b	0.2 b
UTC	-	4.9 a	2.2 a	5.0 a	3.2 a	2.4 a	5.6 a	2.2 a

Table 2.

Treatment	Rate/ac	Mean FGA / Plant						
		6-Feb	13-Feb	20-Feb	28-Feb	8-Mar	16-Mar	Harvest 22-Mar
Movento 150OD	5 oz	0.0 a	0.0 a	0.5 a	0.6 a	0.5 ab	2.6 ab	14.7 bc
Movento 150OD	8 oz	0.0 a	0.0 a	0.1 a	0.8 a	0.2 b	0.8 bc	1.2 c
Movento 150OD + DyneAmic	5 oz + 0.5%	0.0 a	0.0 a	0.0 a	0.1 a	0.1 b	0.1 c	1.4 c
Beleaf +Dyneamic	2.3 oz + 0.5%	0.0 a	0.0 a	0.1 a	0.1 a	0.3 b	0.4 bc	21.8 ab
UTC	-	0.0 a	0.0 a	1.0 a	0.9 a	1.3 a	5.2 a	35.6 a

Table 3.

		Mean LA / Plant						
Treatment	Rate/ac	6-Feb	13-Feb	20-Feb	28-Feb	8-Mar	16-Mar	Harvest 22-Mar
Movento 150OD	5 oz	0.0 a	0.0 a	0.0 a	0.4 a	0.6 a	0.9 b	3.3 b
Movento 150OD	8 oz	0.0 a	0.0 a	0.0 a	0.1 a	0.0 a	1.2 b	0.5 b
Movento 150OD+DyneAmic	5 oz + 0.5%	0.0 a	0.0 a	0.4 a	0.1 a	0.0 a	1.1 b	2.4 b
Beleaf+Dyneamic	2.3 oz + 0.5%	0.0 a	0.0 a	0.0 a	0.1 a	0.4 a	19.0 ab	34.2 b
UTC	-	0.0 a	0.0 a	0.4 a	0.7 a	2.9 a	30.2 a	86.1 a

Table 4.

		Mean Total Aphids / Plant						
Treatment	Rate/ac	6-Feb	13-Feb	20-Feb	28-Feb	8-Mar	16-Mar	Harvest 22-Mar
Movento 150OD	5 oz	0.5 b	0.5 b	1.7 b	1.6 b	1.2 b	3.6 b	18.3 b
Movento 150OD	8 oz	0.7 b	0.3 b	1.1 b	1.0 b	1.3 b	2.1 b	1.7 b
Movento 150OD+DyneAmic	5 oz + 0.5%	0.2 b	0.2 b	0.9 b	0.4 b	0.3 b	1.2 b	3.9 b
Beleaf+Dyneamic	2.3 oz + 0.5%	0.2 b	0.2 b	1.2 b	0.4 b	0.9 b	19.5 ab	46.5 b
UTC	-	4.9 a	2.2 a	6.4 a	4.8 a	6.6 a	41.0 a	123.9 a

MOVENTO AS A PRE-HARVEST TREATMENT FOR APHID CONTROL IN ROMAINE HEARTS

The objective of this study was to evaluate the efficacy of Movento (spirotetramat), when applied as a pre-harvest spray to romaine lettuce hearts heavily infested with aphids. Small-plot, field studies were conducted at the University of Arizona, Yuma Agricultural Center in the spring 2007 growing season. Romaine 'Fresh Heart' was direct seeded into double row beds on 42 inch centers on 7 Nov, 2006. Plots for each trial consisted of 2 beds, 40' long. Plots were arranged in a randomized complete block design with 4 replications. Treatments consisted of foliar sprays of Movento applied alone, and sprays of Movento, Beleaf and Assail applied in combination with Thionex on the first application (4 Mar, 17 d before harvest) and Capture on the second application (14 Mar, 7 d before harvest). Sprays were applied with a CO_2 operated boom sprayer at 50 psi and 28 gpa. A broadcast application was delivered through 3 TXVS-18 ConeJet nozzles per bed. An adjuvant, DyneAmic (Helena Chemical Co.), was applied at 0.75% to all treatments. Aphid populations were assessed by estimating the number of aphids /plant in whole plant, destructive samples. On each sampling date, 6 plants were randomly selected from each plot and placed individually into large 5-gal tubs. Each plant was sampled by visually examining all plant foliage and counting the number of apterous (non-winged) aphids present. Data were analyzed as a 1-way ANOVA using a protected LSD F test to distinguish treatment mean differences.

Aphid pressure was very heavy when the spray was applied, well above the recommended action threshold for aphids in lettuce. GPA and FGA numbers were relatively low compared to LA which was found infesting the terminal growing points hidden within the cupped-over romaine hearts. At 10 DAT-1 (7 d pre-harvest), all treatments had significantly reduced aphid numbers compared with the untreated control, but the Movento treatments provided much better control than either the Assail or Beleaf combinations. At harvest (7 DAT-2), again all treatments had significantly reduced total aphid numbers compared with the untreated control. However, only the two Movento treatments were capable of cleaning up aphid-contaminated plants sufficient enough to be acceptable for the fresh romaine market. The combination of Thionex and Capture with the Movento sprays did not significantly improve performance at harvest.

Date	Treatment	Rate	Mean Aphids / Plant			
			FGA	GPA	LA	Total
4-Mar (pre-spray)	Movento 2SC	8 oz	2.1 a	3.0 a	179.0 a	184.1 a
	Movento 2SC + Thionex 3EC	8 oz +32 oz	0.8 a	3.1 a	199.5 a	203.4 a
	Beleaf 50SG + Thionex 3EC	2.8 oz+32 oz	0.9 a	3.1 a	155.3 a	159.3 a
	Assail 30SG + Thionex 3EC	4 oz + 32 oz	1.5 a	2.4 a	156.3 a	160.3 a
	UTC	-	1.6 a	3.0 a	178.5 a	183.1 a
14-Mar (10 DAT-1) *7 d preharvest*	Movento 2SC	8 oz	9.8 b	3.6 b	12.4 c	25.9 c
	Movento 2SC + Thionex 3EC	8 oz +32 oz	1.7 b	3.8 b	9.8 c	15.3 c
	Beleaf 50SG + Thionex 3EC	2.8 oz+32 oz	3.1 b	6.5 ab	511.71 b	521.3 b
	Assail 30SG + Thionex 3EC	4 oz + 32 oz	2.8 b	2.9 b	333.2 b	338.9 b
	UTC	-	33.4 a	13.5 a	850.8 a	897.7 a
21-Mar (7 DAT-2) *Harvest*	Movento 2SC	8 oz	6.3 b	0.2 c	2.2 c	8.7 c
	Movento 2SC + Capture 2EC	8 oz + 5 oz	0.7 b	0.5 bc	2.1 c	3.3 c
	Beleaf 50SG + Capture 2SC	2.8 oz+ 5 oz	1.4 b	4.4 a	224.7 b	230.6 b
	Assail 30SG + Capture 2SC	4 oz + 5 oz	2.7 b	1.1 abc	293.7 b	297.5 b
	UTC	-	35.0 a	3.8 ab	942.7 a	981.5 a

Means followed by the same letter for each date are not significantly different, ANOVA; protected LSD *(p>0.05)*

EVALUATION OF NOVEL APHICIDES FOR APHID CONTROL IN SPRING LETTUCE

The objective of this study was to evaluate the residual efficacy of a new active ingredient, Movento (spirotetramat), when applied as a pre-harvest spray to lettuce heavily infeted with aphids. Romaine was direct seeded on 1 Dec, 2004 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, furrow irrigated thereafter. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a randomized complete block design. Formulations and rates for each compound are provided in the tables. A single foliar application was made on 24 Feb (~ 4 weeks pre-harvest) with a CO_2 operated boom sprayer operated at 60 psi and 26.5 GPA. A broadcast spray was delivered through 2 TX-18 ConeJet per bed. An adjuvant, DyneAmic (Helena Chemical Co.), was applied at 0.125%v/v to all spray applications. Aphid populations were assessed by estimating the number of aphids in whole plant, destructive samples at 12 and 27 d intervals following treatment (DAT). The final sample coincided with crop harvest of romaine hearts. On each sample date, 10 plants were randomly selected from each plot and placed individually into large 3-gal plastic tubs. Each plant was sampled by visually examining all plant foliage and counting the number of apterous aphids present. Insect data were summed for each sample date and subjected to a 1-way analysis of variance. The mean values were then subjected to a protected LSD $_{(p<0.05)}$ F test to distinguish significant differences among treatment means.

Aphid pressure was very heavy when the spray was applied (>35 aphids/plant) which is well above the recommended action threshold. FGA were the dominant aphid species present throughout the trial, and were found infesting the terminal growing points hidden within the cupped-over romaine hearts. At 12 DAT (~2 wk pre-harvest), all treatments had significantly reduced total aphid numbers compared with the untreated control, and only Assail had not significantly reduced FGA numbers compared with the control. Although mean LA numbers were much higher in the untreated compared to the Movento treatment, between-plant variation was very high in each treatment and differences among treatments were not detected. At harvest (27 DAT), again all treatments had significantly reduced total aphid numbers compared with the untreated control. FGA and LA numbers were lowest in the Beleaf and Movento treatments, but only the Movento application provided what would be considered economic aphid control for romaine hearts.

			Mean Aphids / Plant				
Date	Treatment	Rate	GPA	AL	FGA	LA	Total
24-Feb (pre-spray)	Assail 30SG	4.0 oz	9.8 a	14.0 a	14.6 a	2.1 a	40.5 a
	Beleaf 50SG	2.3 oz	11.0 a	14.4 a	18.5 a	2.3 a	46.2 a
	Provado 1.6F	6.3 oz	8.8 a	12.0 a	13.2 a	0.8 a	36.8 a
	Movento 150OD	8 oz	10.5 a	14.8 a	17.6 a	2.0 a	44.9 a
	Untreated	-	9.0 a	13.1 a	15.0 a	2.3 a	39.4 a
8-Mar (12 DAT)	Assail 30SG	4.0 oz	1.9 a	10.4 a	51.9 ab	15.8 a	80.0 b
	Beleaf 50SG	2.3 oz	0.4 a	14.4 a	31.2 bc	13.7 a	59.7 b
	Provado 1.6F	6.3 oz	0.1	0.3 a	13.0 c	5.2 a	18.8 cd
	Movento 150OD	8 oz	1.0 a	1.0 a	5.9 c	1.0 a	8.9 d
	Untreated	-	8.2 a	22.2 a	75.6 a	38.0 a	144.0 a
23-Mar (27 DAT) *Harvest*	Assail 30SG	4.0 oz	0.7 b	1.0 b	77.6 b	10.2 a	89.4 b
	Beleaf 50SG	2.3 oz	0.3 b	0.3 b	8.8 c	11.4 a	20.9 c
	Provado 1.6F	6.3 oz	0.7 b	0.3 b	44.3 bc	5.6 a	50.9 bc
	Movento 150OD	8 oz	0.0 b	0.0 b	2.6 c	0.6 a	3.1 c
	Untreated	-	6.3 a	2.7 a	133.7 a	9.6 a	152.2 a

Means followed by the same letter for each date are not significantly different, ANOVA; protected LSD *(p>0.05)*

LETTUCE APHID CONTROL WITH MOVENTO IN SPRING ROMAINE LETTUCE

The objective of this study was to evaluate the residual efficacy of Movento (spirotetramat), when applied with different rates of adjuvant and used in combination with contact insecticides. Small-plot, field studies were conducted at the University of Arizona, Yuma Agricultural Center in the spring 2007 growing season. Romaine 'Fresh Heart' was direct seeded into double row beds on 42 inch centers on 16 Dec, 2007. Plots for each trial consisted of 2 beds, 45' long. Plots were arranged in a randomized complete block design with 4 replications. Formulations and rates for each treatment are provided in the tables. Foliar sprays were applied on 16 Feb, 8 Mar and 19 Mar with a CO_2 operated boom sprayer at 50 psi and 28 gpa. A broadcast application was delivered through 3 TXVS-18 ConeJet nozzles per bed. An adjuvant, DyneAmic (Helena Chemical Co.), was added to all treatments at various rates (see table). The Movento 8 oz treatments were only applied on Feb 16 and Mar 8.
LA populations were assessed by estimating the number of aphids / plant in whole plant, destructive samples. On each sampling date, 6 plants were randomly selected from each plot and placed individually into large 5-gal tubs. Each plant was sampled by visually examining all plant foliage and counting the number of apterous (non-winged) LA present. At harvest, hearts were sampled for aphid contamination by selecting 10 plants per plot, removing the frame and wrapper leaves and counting the number of LA on and within individual hearts. Data were analyzed as a 1-way ANOVA using a protected LSD F test to distinguish treatment mean differences.

LA pressure was very light early in the season, but reached economically damaging numbers at harvest in the UTC. Following the first application, all treatments except the Beleaf tankmix significantly reduced LA numbers compared to the UTC. Following the 2nd application, the Movento treatments applied alone provided significant control until harvest (25 d). Although not significantly different at harvest, the Movento treatment applied with the higher rate of Dye-Amic (0.75%) provided more consistent control across all replicates that the Movento treatment with the low rate of Dyne-Amic (0.375%). The Movento (6 oz) tank mix treatment also provided significant LA control at harvest, but was applied an additional time at 14 d before harvest. The Beleaf treatments did not provide as consistent LA control following the 2nd and 3rd sprays as the any of the Movento treatments. No phytotoxicty was observed.

			LA / Plant					
Treatment	**Rate/ac**	**Spray Dates**	15-Feb	27-Feb	6-Mar	19-Mar	27-Mar	*Harvest* 2- Apr
Movento 150SC [1]	5 oz	16 Feb, 8 Mar	0.1 a	1.1 a	5.5 b	8.1 c	27.1 c	32.9 cd
Movento 150SC [2]	5 oz	16 Feb, 8 Mar	0.5 a	0.6 a	4.0 b	6.8 c	11.3 c	11.2 d
Movento Tankmix [3]	3 oz+	16 Feb, 8 Mar, 19 Mar	0.0 a	1.0 a	8.1 b	8.0 c	8.0 c	3.3 d
Beleaf [1]	2.8 oz	16 Feb, 8 Mar, 19 Mar	0.0 a	6.3 a	12.8 b	166.2 b	271.8 b	233.7 b
Beleaf Tankmix [3]	2.3 oz+	16 Feb, 8 Mar, 19 Mar	0.4 a	4.6 a	20.5 ab	122.5 b	179.7 bc	131.8 bc
UTC	-	-	0.5a	5.2 a	35.3 a	546.7 a	1117.0 a	766.0 a

Means followed by the same letter for each date are not significantly different, ANOVA; protected LSD *(p>0.05)*

[1] Dyne-Amic added to these treatments at a rate of 0.375% v/v

[2] Dyne-Amic added to this treatment at a rate of 0.75% v/v

[3] Lannate SP (0.5 lb) was combined with Movento and Beleaf on the 16 Feb spray; Thionex 3EC (32 oz) was combined on the 8 Mar and 19 Mar sprays ; Dyne-Amic added to these treatments at a rate of 0.375% v/v

WESTERN FLOWER THRIPS AND APHID CONTROL WITH NOVEL INSECTICIDES ON LETTUCE

The objective of the study was to compare the efficacy of several new insecticides with industry standards for control of western flower thrips and aphids on romaine lettuce under desert growing conditions. Lettuce was direct seeded on 20 Jan, 2005 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a randomized complete block design. Formulations and rates for each compound are provided in the tables. Foliar sprays were applied on 25 Feb, 7 Mar and 17 Mar with a CO_2 operated boom sprayer at 60 psi and 21.5 gpa. A broadcast application was delivered through 2 TX-18 ConeJet nozzles per bed. An adjuvant, DyneAmic (Helena Chemical Co.), was applied at 0.06 - 0.125% to all treatments. Numbers of WFT from 5 plants per replicate were recorded on each sample date. Relative WFT numbers were measured by removing plants and beating them vigorously against a screened pan (12 in. x 7 in. x 2 in) for a predetermined time (15 sec). A 6 in. by 6 in. sticky trap was placed inside of the pan to catch the dislodged WFT. Sticky traps were then taken to the laboratory where adult and larvae were counted. Aphid populations were assessed by estimating the number of aphids in whole plant, destructive samples at 10-11 d intervals following treatment (DAT). On each sample date, 10 plants were randomly selected from each plot and placed individually into large 3-gal plastic tubs. Each plant was sampled by visually examining all plant foliage and counting the number of apterous aphids present. Data were analyzed as a 1-way ANOVA with means compared where appropriate using a protected LSD *F* test $_{(p<0.05)}$.

WFT population pressure was heavy during this trial. Several new active ingredients were compared to Lannate +Mustang for control of WFT. None of the compounds tested provided consistent knockdown of adult WFT (Table 1). In some cases, WFT adult numbers were statistically higher in the sprayed treatments than in the untreated check. It is not uncommon to measure poor efficacy against adults in the spring due to the daily immigration of WFT adults this time of the year, particularly in small plots trials. In addition, the lettuce plants treated with Radiant, Lannate and Tesoro may have also been more attractive to migrating adults as feeding damage to leaves was light due to excellent control of the larvae populations (Table 2). Radiant was particularly consistent in significantly reducing larvae populations, providing as good or better control than the standard Lannate +Mustang Max tank mixture. The significant reduction in larvae numbers on the Radiant treated plants was clearly evident following the 3rd application (Table 2). Aphid pressure was similarly heavy during the trial. Although four aphid species were recorded from plant samples during each sample, LA accounted for about 85% of the toal aphid population. Movento provided the most significant reduction in aphid numbers considering that it was only applied twice (Table 3). The Beleaf and Mustang Max combination provided comparable aphid control following 3 applications. Neither Tesoro nor Radiant significantly reduced aphid numbers relative to the untreated control. Provado applied at an almost 2X rate provided inconsistent aphid control. No phytotoxicty was observed.

Table 1

		Mean WFT Adults / Plant								
Treatment	Rate/ac	1-Mar	4-Mar	7-Mar	11-Mar	14-Mar	17-Mar	21-Mar	24-Mar	28-Mar
Mustang Max+Lannate SP	4 oz + 0.8 lb	6.3 c	13.1 cd	19.1 cd	49.4 c	90.7 bcd	66.6 a	42.6 cd	60.0 bc	104.0 a
Beleaf 50SG +Mustang Max	2.3 + 4 oz	28.5 ab	27.5 a	28.3 ab	36.4 c	80.7 d	84.0 a	42.0 cd	62.3 bc	138.0 a
Tesoro 4EC [1]	6.5 oz	13.9 c	12.7 d	18.9 cd	49.2 c	67.1 d	57.3 a	26.0 d	48.7 c	96.7 a
Radiant 1SC	5 oz	13.9 c	16.7 cd	23.1 bcd	94.8 ab	109.9 abc	81.3 a	90.7 a	78.7 bc	119.3 a
Provado 1.6F	6.5 oz	35.9 a	26.5 a	22.6 bcd	121.6 a	129.8 a	85.3 a	82.0 ab	124.7 a	156.7 a
Movento 150 OD [2]	8 oz	24.5 b	25.6 ab	24.7 abc	90.1 b	111.9 ab	85.3 a	84.0 ab	89.3 b	130.7 a
Untreated	-	23.9 b	19.7 bc	18.2 d	53.0 c	82.2 cd	70.0 a	64.7 bc	79.3 bc	142.7 a

[1] Warrior (3.8 oz) was combined with Tesoro on the final application (Mar 17)

[2] Movento received sprays on 25 Feb and 17 Mar only . All other treatments were sprayed 3 times (Feb 25, Mar 7 and Mar 17).

Table 2.

		Mean WFT Larvae / Plant								
Treatment	Rate/ac	1-Mar	4-Mar	7-Mar	11-Mar	14-Mar	17-Mar	21-Mar	24-Mar	28-Mar
Mustang Max+Lannate SP	4 oz + 0.8 lb	6.1 de	5.1 c	4.3 bcd	6.0 b	33.2 cd	59.3 d	30.7 d	100.0 cd	60.0 cd
Beleaf 50SG +Mustang Max	2.3 + 4 oz	8.1 cd	8.9 ab	7.8 a	16.8 b	70.4 c	72.0 d	75.3 d	94.7 cd	98.7 bcd
Tesoro 4EC [1]	6.5 oz	5.1 de	4.7 c	3.6 cd	8.4 b	39.2 cd	62.3 d	78.0 d	138.0 bc	61.3 cd
Radiant 1SC	5 oz	2.7 e	1.3 d	1.2 d	2.3 b	10.6 d	24.7 d	25.3 d	18.0 d	4.7 d
Provado 1.6F	6.5 oz	16.2 ab	8.5 b	5.4 abc	74.0 a	156.6 a	252.7 ab	204.7 c	233.3 ab	172.7 abc
Movento 150 OD [2]	8 oz	17.7 a	10.7 ab	5.1 abc	13.2 b	111.7 b	182.7 c	304.7 ab	250.7 ab	119.3 bcd
Untreated	-	17.5 ab	8.8 ab	5.4 abc	83.6 a	170.7 a	204.0 bc	255.3 bc	165.3 abc	210.7 ab

[1] Warrior (3.8 oz) was combined with Tesoro on the final application (Mar 17)

[2] Movento received sprays on 25 Feb and 17 Mar only . All other treatments were sprayed 3 times (Feb 25, Mar 7 and Mar 17).

Table 3.

		Mean Aphids / Plant		
Treatment	Rate/ac	7-Mar	17-Mar	28-Mar
Mustang Max+Lannate SP	4 oz + 0.8 lb	116.7 a	43.4 c	59.4 cd
Beleaf 50SG +Mustang Max	2.3 + 4 oz	32.8 c	34.4 c	25.8 d
Tesoro 4EC [1]	6.5 oz	103.6 a	166.0 ab	248.8 ab
Radiant 1SC	5 oz	110.2 a	193.8 a	268.2 a
Provado 1.6F	6.5 oz	49.7 bc	12.6 c	52.7 cd
Movento 150 OD [2]	8 oz	12.9 c	62.1 bc	13.6 d
Untreated	-	140.3 a	131.1 abc	215.7 abc

[1] Warrior T (3.8 oz) was combined with Tesoro on the final application (Mar 17)

[2] Movento received sprays on 25 Feb and 17 Mar only . All other treatments were sprayed 3 times (Feb 25, Mar 7 and Mar 17).