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Insect Management For Desert Lettuce Production

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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.

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

Methods and Materials : Several commercial lettuce fields planted in the Dome Valley, Gila Valley and Yuma Valley were used for these studies from 1993-2007. 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 2007 growing season are found in Figure 1. Over the past 15years, silverleaf whitefly densities in lettuce fields have declined dramatically, but have begun to show reduced residual efficacy in the past few years. 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 higher.

In general, our data suggests that Admire is beginning to lose residual efficacy. Thus, as of the fall 2007 our initial conclusion is that although Admire remains efficacious, resudial efficacy appears to eroding. This can be further observed in our broccoli data. Because lettuce is a marginal host for whitefly development and colonization, suggests 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 reduced residual efficacy of whitefly large nymphs (Figure 2) . This figure shows whitefly population responses (3^{rd} and 4^{th} instars) on imidacloprid treated and untreated plants sampled from sentinel plots in commercial broccoli fields in the Yuma Valley at 20, 40 and 60 days after planting from the fall of 1998 through 2007. Graph A shows the actual densities of large nymphs over the 10 year period; Graph B shows the % reduction in nymphs in the field compared to the untreated sentinel plots over the same period of time; and Graph C shows a negative trend in whitefly population reduction with exposure to imidacloprid through time.

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.

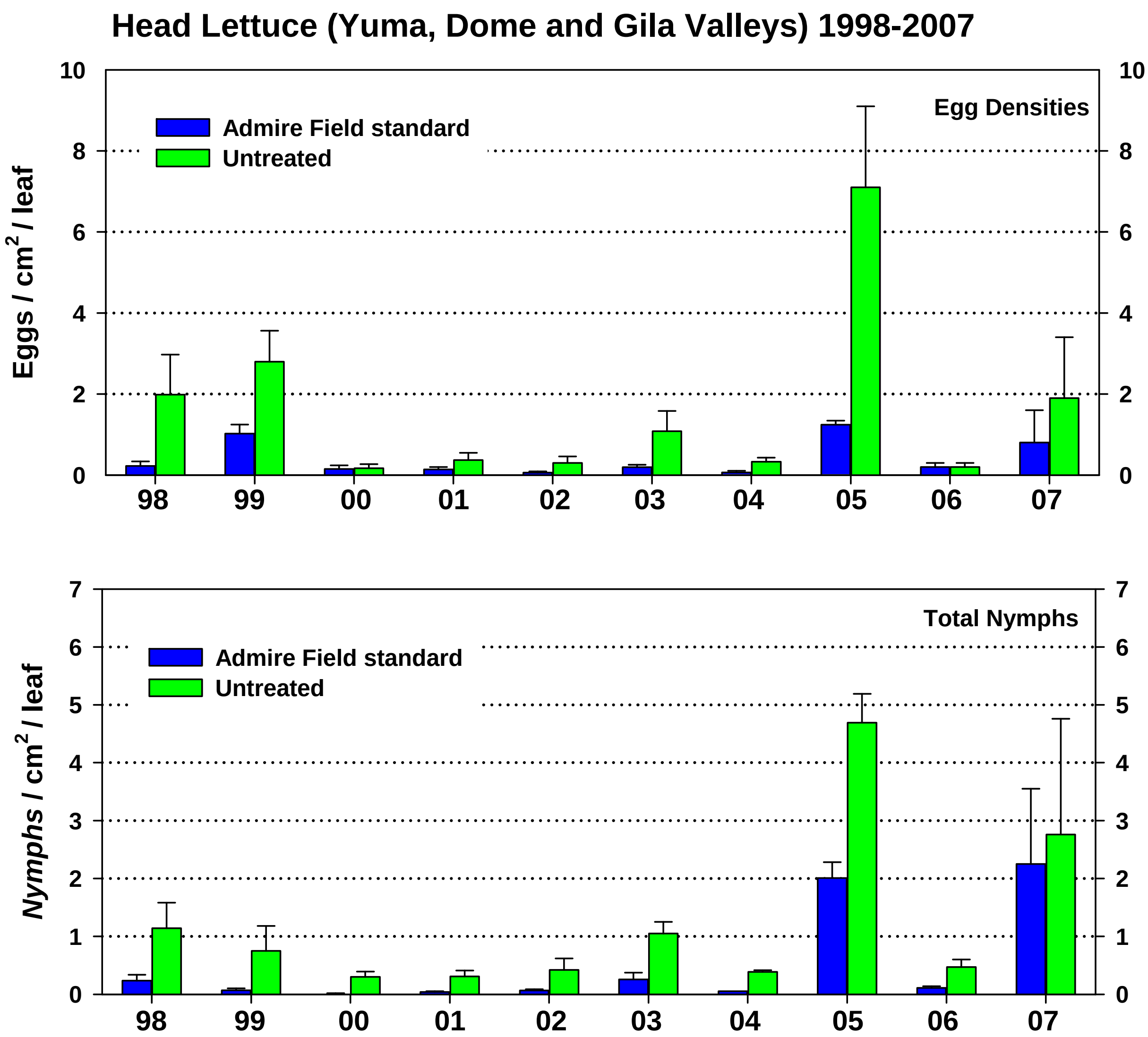

Figure 1.

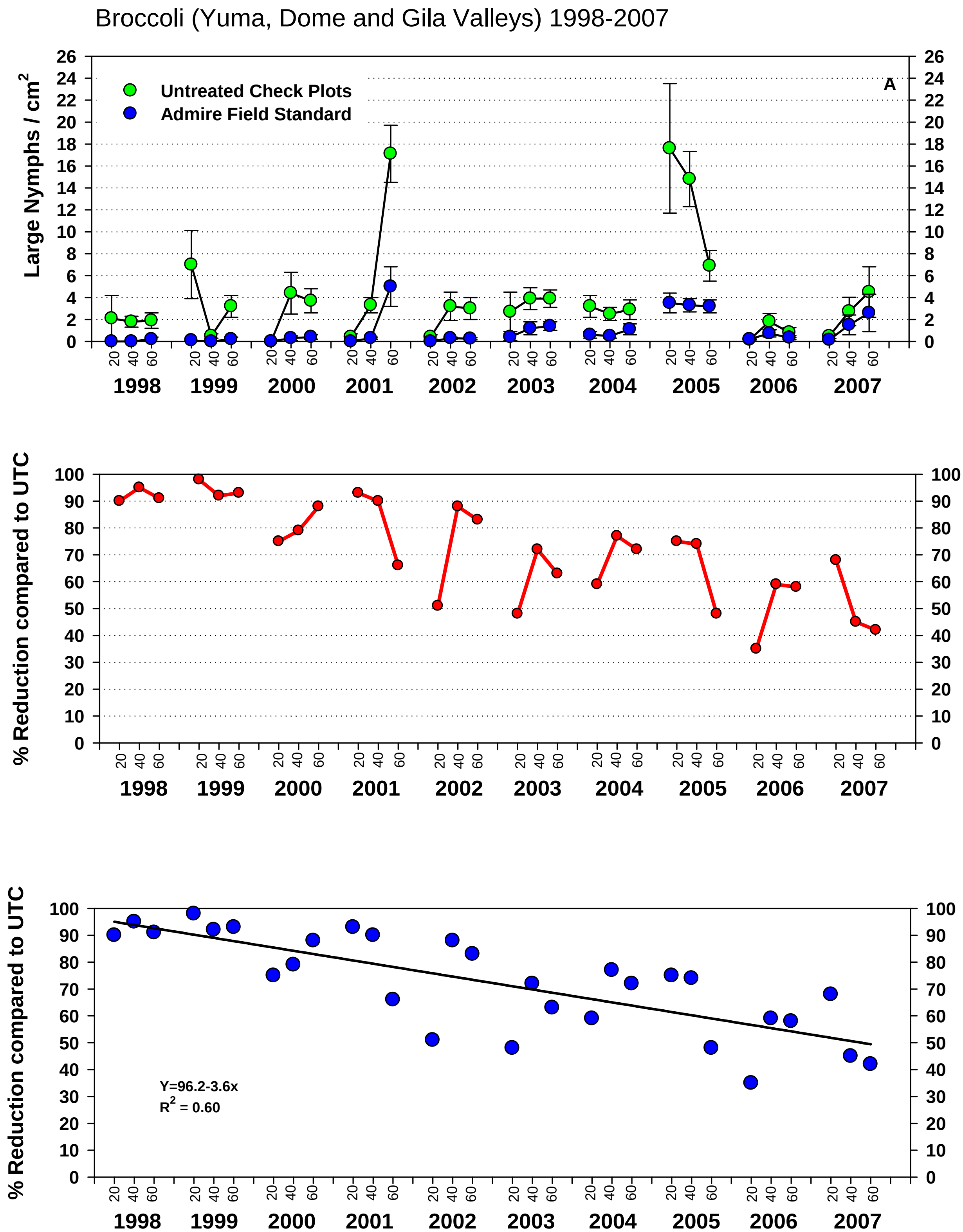
Broccoli (Yuma, Dome and Gila Valleys) 1998-2007
Large Nymphs / cm2
Untreated Check Plots
Admire Field Standard
A
% Reduction compared to UTC
Y=96.2-3.6x
R2 = 0.60
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007

Figure 2.

<u>Objective 2.</u> **Systemic Efficacy Of Rynaxypyr Applied Through Drip Irrigation On Fall Lettuce**

The objective of the study was to evaluate the systemic efficacy of the new compound rynaxypyr when applied to lettuce using drip irrigation relative to standard materials used against lepidopterous larvae on head lettuce under desert growing conditions. Lettuce was direct seeded on Sep 14, 2007 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 thereafter using a sub-surface irrigation system with emitters at 8” spacing; tape was placed 6” below the soil surface. Plots were four beds wide by 55 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. Soil applications were made by diluting formulated material in 2 gal of water and metering the total volume into the plots using a Venturi type injection system Drip chemigations were made over a 10 hour period by allowing the system to run for 1 hr, injecting each material through the system for 45 min duration and then flushing the system for a 8 hr period. A subsequent irrigation was made 4 days following each injection. Applications were made on Oct 6, Oct 14 and Oct 23. Rynaxypyr treatments were buffered down to a pH of 4.7 by adding New Balance at 0.25% v/v to each solution before each injection. Evaluation of lepidopterous larvae efficacy was based on the number of live larvae per plant. Ten plants per replicate were destructively sampled on each sample date. The sample unit consisted of examination of whole plants for presence of small and large BAW, CL and CEW . For BAW, larvae were considered small if <5 mm in length, large if >5mm in length. For CL and CEW , larvae were considered small if <10 mm, large if > 10 mm. At harvest, 20 mature plants per plot were randomly selected and assessed for feeding damage and presence of frass on the heads as well as presence of larvae. A damage assessment of leafminer activity was conducted by counting all the visible mines present on leaves on Nov 22. Assessments were made from 6 randomly selected plants and counting mines on 5 leaves / plant from the basal node positions 5-10. Treatment means were analyzed using a 1-way ANOVA and means separated by a protected LSD $_{(P<0.05)}$.

Initially we had planned to measure rynaxypyr efficacy against swwetpotato whiteflies but the population were very low during the study. However, BAW and CL pressure was moderate. Pre-application counts for BAW were 1.3 small and 1.3 large larvae per 10 plants, and for CL were 3.3 small and 3.8 large larvae per 10 plants. In general, treatment differences for BAW and CL control were consistent following each application. BAW efficacy was comparable among the DPX-E2Y45 treatments where significant post-treatment reduction of large BAW was similar for all rates applied compared to the untreated check (Table 1). The DPX-E2Y45 treatments also reduced large BAW larvae numbers comparable to the industry standards of Avaunt and Success. Trends were similar for CL where DPX-E2Y45 treatments provided significant reductions of large CL larvae comparable to the industry standards following each spray application (Table 2). In general, DPX-E2Y45 appeared to provide the most consistent efficacy at higher rates. The lack of significant differences in small CL and BAW among the spray treatments and the untreated control following sprays did not reflect a lack of control because many of the small larvae had hatched 2-3 days following each application. However, differences in feeding damage among treatments (Table 3) may in part reflect the effects of residual efficacy of some of the treatments on small larvae. These results suggest that DPX-E2Y45, when applied at comparable rates, should provide commercially acceptable control of BAW and CL in head lettuce.

Table 1.

		Mean larvae / 10 plants								
		13-Oct			20-Oct			30-Oct		
Treatment	Rate /acre	CL	BAW	CEW	CL	BAW	CEW	CL	BAW	CEW
Rynaxypyr 1.6 SC	3.4 oz	16.3 a	0.9 a	0.3 a	12.5 b	0.9 b	0.0 a	0.6 b	0.0 a	0.0 a
Rynaxypyr 1.6 SC	5.1 oz	12.2 a	1.8 a	0.6 a	2.5 b	0.0 b	0.0 a	0.0 b	0.0 a	0.0 a
Admire Pro	7 oz	24.1 a	0.6 a	0.0 a	28.1 a	4.3 a	0.3 a	15.9 a	0.3 a	0.0 a
UTC	-	17.8 a	0.6 a	0.0 a	25.6 a	4.7 a	0.3 a	17.5 a	0.3 a	0.0 a

Table 1 cont.

		Mean larvae / 10 plants								
		6-Nov			15-Nov			22-Nov		
Treatment	Rate /acre	CL	BAW	CEW	CL	BAW	CEW	CL	BAW	CEW
Rynaxypyr 1.6 SC	3.4 oz	0.4 b	0.4 a	0.0 a	0.0 b	0.0 a	0.0 a	0.0 b	0.0 a	0.0 a
Rynaxypyr 1.6 SC	5.1 oz	0.0 b	0.0 a	0.0 a	0.0 b	0.0 a	0.0 a	0.0 b	0.0 a	0.0 a
Admire Pro	7 oz	21.7 a	0.0 a	0.0 a	10.8 a	0.5 a	0.8 a	5.8 a	0.0 a	0.4 a
UTC	-	19.2 a	0.0 a	0.0 a	11.2 a	0.8 a	1.0 a	4.8 a	0.0 a	0.0 a

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

Table 2.

Treatment	Rate /acre	Leafminer Damage (mines/leaf)	Lep Feeding Damage		% Heads Infested with Larvae			
			% Damaged Heads	% Heads with Frass	CL	BAW	CEW	Total
Rynaxypyr 1.6 SC	3.4 oz	0.06 b	2.5 b	0.0 b	0.0 b	0.0 a	0.0 b	0.0 b
Rynaxypyr 1.6 SC	5.1 oz	0.01 b	2.5 b	0.0 b	0.0 b	0.0 a	00 b	0.0 b
Admire Pro	7 oz	1.72 a	72.5 a	75.0 a	12.5 a	0.0 a	7.5 a	20.0 a
UTC	-	1.94 a	75.0 a	82.5 a	7.5 a	0.0 a	10.0 a	17.5 a

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

Systemic Efficacy Of Coragen Applied Through Drip Irrigation On Romaine Lettuce

The objective of the study was to evaluate the systemic efficacy of the new compound Coragen (rynaxypyr) when applied to romaine lettuce using drip irrigation under desert growing conditions. Lettuce was direct seeded on Sep 12, 2007 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 thereafter using a sub-surface irrigation system with emitters at 8” spacing; tape was placed 5” below the soil surface. Large plots were used in this study and consisted of a single bed 600’ long. Four replications of each treatment were arranged in a randomized complete block design. Formulations and rates for each compound are provided in the tables. Treatments were applied through the drip irrigation system by diluting formulated material in 3000 ml of water and metering the total volume into the plots using a CO_2 injection system. Drip chemigations were made over a 4 hour period by allowing the system to run for 1/2 hr, injecting each material through the system for a 1.5 hr duration and then flushing the system for a 2 hr period. A subsequent irrigation (6 hr) was made 4 days following each injection. Two applications were made on 8 and 19 Oct. Rynaxypyr treatments were buffered down to a pH of 4.7 by adding New Balance at 0.25% v/v to each solution before each injection. Evaluation of lepidopterous larvae efficacy was based on the number of live larvae per plant. Ten plants per replicate were destructively sampled on each sample date. The sample unit consisted of examination of whole plants for presence of small and large BAW and CL. At harvest (28 Nov), 20 mature plants per plot were randomly selected and assessed for presence of feeding damage and frass on the heads as well as presence of live larvae. A damage assessment of leafminer activity was conducted by counting all the visible mines present on leaves on Nov 18. Assessments were made from 6 randomly selected plants and counting mines on 10 leaves / plant from the basal node positions 11-20. Treatment means were analyzed using a 1-way ANOVA and means separated by a protected LSD $_{(P<0.05)}$.

BAW and CL pressure was light-moderate. Pre-application counts were 2.0 larvae per 10 plants. At 5 d following the first chemigation, no significant differences were observed between the Coragen treatments and the untreated control (Table 1). By 10 DAA-1, the Coragen treatments had significantly reduced larval numbers. Following the second application, larva were not detected in the Coragen treated plants and remained very low until harvest. At harvest (40 DAA-2), damage and larval contamination of romaine hearts was negligible in the Coragen treatments compared with the Alias and untreated check which were considerably higher than the USDA grading standards for marketable head lettuce (Table 2). In addition, assessments made at 30 DAA-2 showed that Coragen provided highly significant protection from LM (Table 3). The results of this trial further suggest that Coragen has acceptable systemic activity against key lepidopterous larvae and leafminers in lettuce when applied via sub-surface chemigation in desert growing conditions. No phytotoxicity was observed.

Table 1.

Treatment	Rate	Larvae / 10 Plants							
		5 DAA-1 **Oct 13**	*10 DAA-1* **Oct 18**	*8 DAA-2* **Oct 27**	*14 DAA-2* **Nov 2**	*21 DAA-2* **Nov 9**	*30 DAA-2* **Nov 18**	*40 DAA-2* **Nov 28**	**Avg.**
Coragen 1.6 SC	3.5 oz	2.5 a	2.5 b	0.0 b	0.0 b	1.0 b	1.3 b	0.0 b	1.0 b
Coragen 1.6 SC	5 oz	3.5 a	0.7 b	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0.6 b
Coragen 1.6 SC	6.7 oz	2.1 a	0.8 b	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0.4 b
Coragen 1.6 SC	7.7 oz	1.5 a	0.7 b	0.0 b	0.0 b	0.0 b	0.0 b	0.9 b	0.4 b
Alias 2F	16 oz	3.3 a	6.5 a	6.3 a	5.3 a	10.0 a	12.5 a	4.1 a	6.8 a
UTC	-	4.8 a	7.4 a	5.3 a	4.4 a	10.0 a	13.0 a	4.4 a	6.9 a

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

Table 2.

Treatment	Rate	Heart contamination (% infested)		
		Feeding Damage	Frass	Larvae
Coragen 1.6 SC	3.5 oz	9.4 b	3.1 b	0.0 b
Coragen 1.6 SC	5 oz	0.0 b	0.0 b	0.0 b
Coragen 1.6 SC	6.7 oz	0.0 b	0.0 b	0.0 b
Coragen 1.6 SC	7.7 oz	9.4 b	6.3 b	6.3 b
Alias 2F	16 oz	84.5 a	81.5 a	46.9 a
UTC	-	81.5 a	84.0 a	43.8 a

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

Table 3.

Treatment	Rate	Avg mines / leaf at each basal node position										Avg mines / plant
		11	12	13	14	15	16	17	18	19	20	
Coragen 1.6 SC	3.5 oz	0.2 b	0.4 b	0.4 b	0.3 b	0.2 b	0.4 ab	0.3 b	0.1 b	0.1 b	0.1 b	2.3 b
Coragen 1.6 SC	5 oz	0.2 b	0.3 b	0.1 b	0.2 b	0.1 b	0.3 b	0.2 b	0.1 b	0.1 b	0.3 ab	1.7 b
Coragen 1.6 SC	6.7 oz	0.1 b	0.2 bc	0.2 b	0.3 b	0.2 b	0.35 b	0.1 b	0.1 b	0.0 b	0.0 b	1.3 b
Coragen 1.6 SC	7.7 oz	0.0 b	0.0 c	0.1 b	0.2 b	0.1 b	0.1 b	0.2 b	0.1 b	0.0 b	0.0 b	0.6 b
UTC	-	2.9 a	2.1 a	1.8 a	1.5 a	1.7 a	0.9 a	1.0 a	0.6 a	0.7 a	0.5 a	13.7 a

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

Objective 3. 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. 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 sprayed 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 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 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 until harvest (Table 2). All treatments significantly reduced LA numbers compared to the UTC except for Assail. Averaged across the season, the Movento trea tments provided the most consistent LA control.

Table 1.

Treatment	Rate/ac	Mean GPA / Plant							
		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

Table 2.

Treatment	Rate/ac	LA / Plant							
		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	0.04 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.

Aphid Control With Generic Imidacloprid Formulations And Movento In 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 6 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 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 applications of Movento just prior to harvest (19 and 9 days pre-harvest), both on Admire Pro treated and untreated plants, significantly reduced LA numbers in lettuce heads at harvest. Heads in these plots were considered commercially acceptable.

		Mean Green Peach Aphid / 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 Lettuce Aphid / 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

Movento As A Pre-Harvest Treatment For Lettuce Aphid Control In Lettuce

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 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). Foliar sprays were applied with a CO_2 operated boom sprayer at 50 psi and 28 gpa. A broadcast application was delivered through 3 TX-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 total 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 Movento treatments were capable of cleaning up contaminated hearts and provided what would be considered economic aphid control for the fresh romaine market.

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)*

Objective 4. Efficacy of Radiant (XDE-175) Against Western Flower Thrips in Lettuce

Materials and Methods

Spring 2005 –Trial I: The field trial was conducted at the University of Arizona Yuma Agricultural Center. Romaine lettuce 'Fresh heart' was direct seeded 1 Dec 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. Each treatment was replicated four times and arranged in a randomized complete block design. Insecticide treatments and rates used in the trial are found in Tables1 and 2. The foliar applications were made with a CO_2 operated boom sprayer operated at 60 psi and 20.5 GPA. A broadcast spray was delivered through 2 TX-18 ConeJet nozzles per bed. An adjuvant, DyneAmic, was applied at 0.125%v/v with all spray applications. Sprays were applied on Feb 9, 15 and 25. No other pesticides were applied.

Spring 2005 –Trial II: The field trial was conducted at the University of Arizona Yuma Agricultural Center. Romaine lettuce 'PIC 715'was direct seeded 20 Jan 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 30 ft long and bordered by two untreated beds. Each treatment was replicated four times and arranged in a randomized complete block design. Insecticide treatments and rates used in the trial are found in Tables 3-5. The foliar applications were made with a CO_2 operated boom sprayer operated at 60 psi and 20.5 GPA. A broadcast spray was delivered through 2 TX-18 ConeJet nozzles per bed. An adjuvant, DyneAmic, was applied at 0.125%v/v with all spray applications. Sprays were applied on Feb 25, Mar 7 and Mar 17. No other pesticides were applied.

Fall 2005 –Trial I: The field trial was conducted at the University of Arizona Yuma Agricultural Center. Romaine lettuce 'Rubicon' was direct seeded 8 Sep 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. Each treatment was replicated four times and arranged in a randomized complete block design. Insecticide treatments and rates used in the trial are found in Tables 6-7. The foliar applications were made with a CO_2 operated boom sprayer operated at 60 psi and 20.5 GPA. A broadcast spray was delivered through 2 TX-18 ConeJet nozzles per bed. An adjuvant, DyneAmic, was applied at 0.125%v/v with all spray applications. Sprays were applied on Oct 9, 16 and 22. No other pesticides were applied.

Fall 2005 –Trial II: The field trial was conducted at the University of Arizona Yuma Agricultural Center. Romaine lettuce 'PIC 715' was direct seeded 20 Sep 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. Each treatment was replicated four times and arranged in a randomized complete block design. Insecticide treatments and rates used in the trial are found in Tables 8-9. The foliar applications were made with a CO_2 operated boom sprayer operated at 60 psi and 20.5 GPA. A broadcast spray was delivered through 2 TX-18 ConeJet nozzles per bed. An adjuvant, DyneAmic, was applied at 0.125%v/v with all spray applications. Sprays were applied on Oct 31, Nov 8 and 17. No other pesticides were applied.

Spring 2006: The field trial was conducted at the University of Arizona Yuma Agricultural Center. Romaine lettuce 'PIC 715' was direct seeded 18 Jan 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 33 ft long and bordered by two untreated beds. Each treatment was replicated four times and arranged in a randomized complete block design. Insecticide treatments and rates used in the trial are found in Tables 10-11. The foliar applications were made with a CO_2 operated boom sprayer operated at 60 psi and 20.5 GPA. A broadcast spray was delivered through 2 TX-18 ConeJet nozzles per bed. An adjuvant, DyneAmic, was applied at 0.125%v/v with all spray applications. Sprays were applied on Mar 6, 13 , 20 and 31. On the third (Mar 20) and fourth (Mar 31) applications, the rate of Lannate was increased to 0.75 lb/ac and Mustang Max was applied at 4 oz/ac instead of Renounce. Also on the fourth application, the Success–only treatment was increased to 9 oz/ac and the rate of XDE-175 was increased to 7 oz/ac. No other pesticides were applied.

Sampling and Statistical Analysis: Evaluation of WFT control in each study was based on the number of live adults and nymphs per plant sampled from the center 2 rows of each replicate at intervals following each application. Numbers of WFT adults and larvae from 5 plants per replicate were recorded on each sample. Samples were taken by removing plants and beating them vigorously against a screened pan for a predetermined duration. Inside of the pan was a sticky trap to catch the dislodged WFT. Sticky traps were then taken to the laboratory where adult and larvae were counted. WFT adult and larvae numbers were subjected to a two-way analysis of variance using the SAS statistical software. When analysis of variance was significant ($p<0.05$), the mean values were subjected to a protected LSD $_{(p<0.05)}$ F test to distinguish treatment differences.

Results and Discussion

In each study we conducted, RADIANT performed statistically comparable to or better than Success and at lower use rates. This was most evident in the spring 2005–Trial I where RADIANT applied at rates as low as 2 oz /acre provided the same level of adult and larval WFT control as Success applied at 6 oz (Table 1 and 2). This is particularly important since the RADIANT formulation used in these trials was a 1 lb ai/gal material versus the 2 lb ai/gal Success 2SC formulation. Although the spinosyn class of chemistry is inherently weaker on adult WFT, RADIANT provided adult control comparable to the Lannate +Warrior standard on several post-treatment samples. In the spring 2005–Trial II, RADIANT was compared to Lannate +Mustang and Beleaf (an aphicide with marginal WFT activity) + Mustang. Adult pressure was much heavier and RADIANT did not provide consistent knockdown of adult WFT (Tables 3-5). In some cases, WFT adult numbers were statistically higher in the RADIANT than in the untreated check. It is not uncommon to measure poor efficacy against adults in late spring trials due to the daily movement of WFT adults from field to field this time of the year, particularly in small plots. The lettuce plants treated with RADIANT may have also been more attractive to migrating adults as very little feeding damage was observed on treated plants, a result of the excellent larval control. The highly significant reduction in larvae numbers was clearly evident following the 3rd application (Table 5).

In the Fall 2005 Trial I, RADIANT provided as good or better control of WFT adult and larvae than Success, which was again applied at a higher rate (Table 6 and 7). In the Fall 2005 Trial II, RADIANT provided larval WFT control comparable to the standard Lannate+Mustang under higher population pressure (Table 8 and 9). In most cases, RADIANT provided statistically similar suppression of adults as well. Measurement of adult efficacy is generally much more accurate in fall trials as adult numbers are lower and not moving a great deal between plots.

In the final trial (Spring 2006), RADIANT again showed excellent control of WFT larvae, comparable to its sister compound Success, and statistically superior to Lannate+Renounce in many post-spray evaluations (Table 10-11). We also included a Success + Renounce treatment and it did not provide significantly better control of WFT larvae than RADIANT. The addition of the pyrethroid to both Success and Lannate did provide statistically better efficacy against WFT adults, however by the end of the trial adult numbers were high in all the treatments, even with the use of higher rates on the last application. Again, the lack of measurable adult control was probably somewhat masked by the daily inter-plot movement of adults.

In summary, application of RADIANT to romaine lettuce showed significant activity against WFT comparable to Success, but at lower use rates. This is important as many consider that Success is presently used in produce production at low rates. It appears to provide better residual activity against larvae than the standard compounds presently used, but does not appear to provide any additional adult efficacy. We plan to further evaluate RADIANT in combination with pyrethroids and other active ingredients to determine if adult activity can be significantly enhanced. RADIANT also has excellent residual activity against our lepidopterous larvae complex in lettuce (JCP, unpublished data), and will be an excellent addition to our IPM programs. Because of its enhanced residual activity at low use rates against WFT and Lep larvae, it will likely replace Success uses in produce crops. Unfortunately, because it has the same mode-of-action as Success, it will not provide an additional rotational partner for our resistance management programs.

Table 1. Adult WFT numbers on spring romaine lettuce, 2005 – Trial I

		Mean WFT adults / Plant						
Treatment	**Rate**	**9-Feb**	**14-Feb**	**17-Feb**	**21-Feb**	**25-Feb**	**28-Feb**	**4-Mar**
Radiant	7 oz	3.0a	2.7 bc	3.6 b	2.5 bc	5.1 a	8.3 b	13.7 b
Radiant	5 oz	3.5a	3.7 bc	3.5 b	2.7 bc	6.0 a	7.6 bc	16.7 b
Radiant	3 oz	4.5a	2.9 bc	3.1 b	2.3 bc	7.0 a	8.8 b	16.5 b
Radiant	2 oz	2.5a	3.8 bc	3.5 b	3.5 bc	5.9 a	9.3 ab	19.2 b
Success 2SC	6 oz	3.1a	4.3 b	3.3 b	3.7 b	4.3 a	7.3 bc	17.1 b
Lannate+Warrior	0.8 lb+ 3.8 oz	3.1a	1.9 c	0.8 c	1.7 c	4.3 a	3.6 c	13.3 b
Untreated	--	3.0a	7.3 a	7.1 a	6.3 a	6.8 a	13.9 a	29.7 a

Means followed by the same letter are not significantly different, SAS ANOVA, protected $LSD_{(p>0.05)}$

Table 2. Larvae WFT numbers on spring romaine lettuce, 2005 – Trial I

		Mean WFT larvae/ Plant						
Treatment	**Rate**	**9-Feb**	**14-Feb**	**17-Feb**	**21-Feb**	**25-Feb**	**28-Feb**	**4-Mar**
Radiant	7 oz	10.2a	8.5 bc	6.7 bc	2.0 b	1.5 b	2.0 b	0.5 b
Radiant	5 oz	11.2a	5.8 c	7.1 bc	3.7 b	1.3 b	1.7 b	0.2 b
Radiant	3 oz	13.0a	8.0 bc	12.6 b	2.3 b	2.5 b	1.7 b	0.3 b
Radiant	2 oz	12.3a	10.8 bc	11.5 bc	3.7 b	2.7 b	2.9 b	0.4 b
Success 2SC	6 oz	12.8a	11.9 b	11.9 bc	3.5 b	2.5 b	2.0 b	0.7 b
Lannate+Warrior	0.8 lb+ 3.8 oz	13.0a	7.9 bc	5.2 c	4.1 b	2.9 b	1.6 b	0.9 b
Untreated	--	13.2a	18.9 a	25.9 a	20.8 a	23.1 a	13.7 b	4.8 a

Means followed by the same letter are not significantly different, SAS ANOVA, protected $LSD_{(p>0.05)}$

Table 3. Adult and Larvae WFT numbers following the first application on spring romaine lettuce, 2005 – Trial II.

Application # 1		**Mean WFT / Plant**					
		1-Mar		**4-Mar**		**7-Mar**	
Treatment	**Rate/ac**	**Adult**	**Larvae**	**Adult**	**Larvae**	**Adult**	**Larvae**
Mustang+Lannate	4 oz + 0.8 lb	6.3 b	6.1 bc	13.1 b	5.1 b	19.1 cd	4.3 ab
Mustang+Beleaf	4 oz+2.3 oz	28.5 a	8.1 b	27.5 a	8.9 a	28.3 ab	7.8 a
Radiant	5 oz	13.9 b	2.7 c	16.7 b	1.3 c	23.1 bc	1.2 b
Untreated	--	23.9 a	17.5 a	19.7 b	8.8 a	18.2 d	5.4 a

Table 4. Adult and Larvae WFT numbers following the second application on spring romaine lettuce, 2005 – Trial II.

Application # 2		**Mean WFT / Plant**					
		11-Mar		**14-Mar**		**17-Mar**	
Treatment	**Rate/ac**	**Adult**	**Larvae**	**Adult**	**Larvae**	**Adult**	**Larvae**
Mustang+Lannate	4 oz + 0.8 lb	49.4 b	6.0 b	90.7 b	33.2 b	66.6 a	59.3 b
Mustang+Beleaf	4 oz+2.3 oz	36.4 b	16.8 b	80.7 b	70.4 b	84.0 a	72.0 b
Radiant	5 oz	94.8 a	2.3 b	109.9 a	10.6 b	81.3 a	24.7 b
Untreated		53.0 b	83.6 a	82.2 b	170.7 a	70.0 a	204.0 a

Table 5. Adult and Larvae WFT numbers following the second application on spring romaine lettuce, 2005 – Trial II.

Application # 3		**Mean WFT / Plant**					
		21-Mar		**24-Mar**		**28-Mar**	
Treatment	**Rate/ac**	**Adult**	**Larvae**	**Adult**	**Larvae**	**Adult**	**Larvae**
Mustang+Lannate	4 oz + 0.8 lb	42.6 b	30.7 b	60.0 a	100.0 a	104.0 a	60.0 c
Mustang+Beleaf	4 +2.3 oz	42.0 b	75.3 b	62.3 a	94.7 a	138.0 a	98.7 b
Radiant	5 oz	90.7 a	25.3 b	78.7 a	18.0 b	119.3 a	4.7 d
Untreated		64.7 b	255.3 a	79.3 a	165.3 a	142.7 a	210.7 a

Means followed by the same letter are not significantly different, SAS ANOVA, protected $LSD_{(p>0.05)}$

Table 6. Adult WFT numbers on fall romaine lettuce, 2005 – Trial I.

		Mean WFT adults / plant							
Treatment	**Rate/ac**	**7-Oct**	**11-Oct**	**15-Oct**	**19-Oct**	**22-Oct**	**27-Oct**	**3-Nov**	**8- Nov**
Success	6 oz	0.8 a	1.8 ab	5.3 a	1.8 b	3.3 c	5.2 ab	4.1 ab	6.3 a
Radiant	5 oz	0.9 a	1.0 b	5.3 a	1.9 b	2.8 b	3.4 b	3.8 b	4.5 a
UTC	.	0.7 a	3.8 a	4.9 a	4.2 a	5.3 a	5.8 a	5.7 a	7.0 a

Table 7. Larvae WFT numbers on fall romaine lettuce, 2005 – Trial I.

		Mean WFT larvae / plant							
Treatment	**Rate/ac**	**7-Oct**	**11-Oct**	**15-Oct**	**19-Oct**	**22-Oct**	**27-Oct**	**3-Nov**	**8-Nov**
Success	6 oz	0.9 a	2.9 a	1.1 b	0.2 b	1.0 b	0.4 b	0.9 b	2.7 b
Radiant	5 oz	1.0a	2.7 a	1.0 b	0.2 b	0.3 b	0.1 b	0.3 b	1.0 b
UTC	.	1.0 a	8.4 a	3.4 a	1.6 a	2.4 a	3.2 a	6.6 a	7.0 a

Means followed by the same letter are not significantly different, SAS ANOVA, protected $LSD_{(p>0.05)}$

Table 8. Adult WFT numbers on fall romaine lettuce, 2005 – Trial II.

		Mean WFT adults / plant					
Treatment	**Rate**	**27-Oct**	**3-Nov**	**7-Nov**	**11-Jan**	**16-Nov**	**23-Nov**
Lannate+Mustang	0.5 lb+ 4 oz	9.7a	2.6 c	3.8 b	2.2 c	3.8 c	1.5 b
Success	6 oz	9.9a	5.1 a	4.3 b	4.8 b	7.0 b	4.3 b
Radiant	5 oz	9.9a	3.9 b	5.5 ab	3.4 bc	4.2 bc	3.1 b
UTC	.	7.0a	6.2 a	7.0 a	10.7 a	11.3 a	9.3 a

Table 9. Larvae WFT numbers on fall romaine lettuce, 2005 – Trial II.

		Mean WFT larvae / plant					
Treatment	**Rate**	**27-Oct**	**3-Nov**	**7-Nov**	**11-Jan**	**16-Nov**	**23-Nov**
Lannate+Mustang	0.5 lb+ 4 oz	82.4a	26.4 bc	16.1 bc	4.1 c	0.7 c	0.9 b
Success	6 oz	75.7a	25.3 bc	12.8 c	3.6 c	2.8 b	1.7 b
Radiant	5 oz	71.7a	14.0 c	10.5 c	1.9 c	0.8 c	1.5 b
UTC	.	88.0a	46.3 a	37.9 a	18.1 a	11.2 a	10.0 a

Means followed by the same letter are not significantly different, ANOVA, protected $LSD_{(p>0.05)}$

Table 10. Adult WFT numbers on spring romaine lettuce, 2006.

Treatment	Rate	Mean WFT adults / plant									
		3-Mar	9-Mar	13-Mar	17-Mar	20-Mar	24-Mar	29-Mar	6-Apr	10-Apr	13-Apr
Lannate+Renounce	0.5 lb+3.5 oz	12.8a	2.0c	6.2c	5.1b	8.5a	12.7c	60.0a	28.5bc	43.5a	133.8a
Success+Renounce	5 oz + 3.5 oz	12.0a	2.0c	8.2b	6.0b	12.0a	15.5c	51.9a	21.0c	61.8a	105.6a
Success	6 oz	12.1a	3.3bc	7.3bc	10.0a	14.8a	23.4b	63.0a	33.3ab	56.1a	79.2b
Radiant	5 oz	11.8a	3.8b	5.7c	12.3a	14.2a	25.2b	56.7a	29.7b	46.8a	75.0b
UTC	-	12.0a	9.1a	14.6a	11.8a	10.2a	31.6a	40.9a	39.9a	63.0a	75.6b

Table 11. Larvae WFT numbers on spring romaine lettuce, 2006.

Treatment	Rate	Mean WFT larvae / plant									
		3-Mar	9-Mar	13-Mar	17-Mar	20-Mar	24-Mar	29-Mar	6-Apr	10-Apr	13-Apr
Lannate+Renounce	0.5 lb+3.5 oz	1.6a	4.2c	16.0c	18.5b	15.8b	11.1b	25.2b	24.0b	97.2a	70.5b
Success+Renounce	5 oz + 3.5 oz	3.1a	9.6b	22.5b	24.0b	16.4b	8.7b	33.6b	17.7bc	37.5bc	44.4bc
Success	6 oz	2.4a	7.4bc	12.1c	6.6c	8.7bc	5.9bc	43.8b	13.5c	41.4b	35.1cd
Radiant	5 oz	2.2a	4.3c	5.9d	3.6c	2.8c	1.4c	15.3b	8.7c	15.3c	21.6d
UTC	-	2.6a	16.8a	35.7a	60.7a	63.5a	77.3a	92.7a	53.1a	52.2b	166.6a

Means followed by the same letter are not significantly different, SAS ANOVA, protected $LSD_{(p>0.05)}$