Arizona Department of Agriculture
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Project title: **Economic Insect Management in Desert Lettuce**

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Location of Research: Yuma Valley Agricultural Center

Rationale:

The number of new insecticides available for insect control in head lettuce has increased considerably in the past few years. This is extremely important given the impending reductions in a number of important insecticides (ie., diazinon, dimethoate and endosulfan). As FQPA continues to be implemented, restrictions in the uses of pyrethroids and other older products may soon follow. Although most of the newly registered products are very effective against pests such as worms and aphids, they tend to be very expensive. Thus, it is critical that growers continue to explore how to use these products more cost-effectively. In addition, there are several new, unregistered insecticides that are under development that may eventually provide activity against on many of the key pests that infest lettuce.

The continual occurrence of several key insect pests further justifies the need to explore new insecticides and their cost-effective use patterns for local growers and PCAs. A complex of aphid species are well established in desert lettuce, and thrips have become increasingly difficult and expensive to control in spring and fall lettuce. Many of the compounds currently used for controlling thrips (Lannate, Orthene, Endosulfan) are directly threatened by FQPA. Finally, worm pests such as beet armyworm and cabbage looper remain the most economically important pest in fall lettuce and typically require 3-4 foliar sprays throughout the season to prevent losses.

Newer insecticides currently available for management of key insect pests (**Appendix: *Table 1).*** They offer many favorable attributes to lettuce growers because they are very selective, environmentally friendly, and very effective against certain insect pests. Products such as Radiant and Proclaim have been the standards for worm control the past few years, but the recent registration of a Coragen, Voliam xpress , Synpase and Vetica have recently provided more options. Interestingly, recent research has shown that these products provide similar control of worms in lettuce, yet their costs to the grower can vary widely. Similarly, Movento is clearly the most commonly used product for aphid control, and other foliar alternative products are available. Use of Admire and generic imidacloprid products as soil insecticides remains about the same, but their cost to the grower has dropped significantly. Finally, a number of new compounds with different modes of action are presently being developed that provide a wide spectrum of activity against many key insect pests **(Appendix: *Table 2).*** To date, we have only limited research experience with them to determine how they might best fit in desert lettuce management programs.

Objective 1. Evaluating the Economic Efficacy and Performance of Key Insecticides in Fall Head Lettuce .

The objective of this study was to compare the knockdown and residual efficacy of new foliar applied diamide insecticide products against lepidopterous larvae on head lettuce at rates based on: (1) manufacture and University of Arizona recommendations; and (2) at product rates based on a fixed cost per acre ($20/ac). Three separate field trials were conducted in the fall of 2010.

Trial I Head lettuce, *Lactuca sativa* var. *capitata* L. 'Diamondback' was direct seeded on 9 Sep, 2010 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, with furrow irrigation used thereafter. Plots were two beds wide by 45 ft long and bordered by a single untreated bed. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each compound are shown in the table below. In this trial, efficacy was compared among treatments when applied at the manufacture/University recommended rate. Two foliar spray applications were made on 28 Sep and 14 Oct with a CO_2 operated boom sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 21.5 GPA. An adjuvant, Dyne-Amic (Helena Chemical Co.), was applied at 0.125% v/v with all treatments.

Treatment	Rate/ac
Radiant 2SC	5 oz
Proclaim 5SG	3.6 oz
Intrepid 2F	10 oz
Avaunt 30WG	5 oz
Coragen 1.67SC	5 oz
Voliam Xpress	8 oz
Synapse 24WG	3 oz
Vetica SC	17 oz

Trial II In this trial, head lettuce ' Diamondback' was direct seeded into plots adjacent to those in Trial I on the same date (9 Sep, 2010). Stand establishment, plot size and experimental design were the same as Trial I. However, rates for each treatment compound were different and are shown in the table below. In Trial II, we set the cost of control at a fixed price for each product ($ 20/acre based on estimates provided by 2 independent consultants) and compared efficacy among products at the calculated rates / acre for this price. Similar to trial I, two foliar spray applications were made on 28 Sep and 14 Oct with a CO_2 operated boom sprayer that delivered 21.5 GPA. Dyne-Amic was applied at 0.125% v/v with all treatments.

Treatment	Estimated Price ($ / oz)	Applied Rate (oz/ac) at $20/ac
Radiant	**4.60**	**4.3**
Proclaim	**6.00**	**3.3**
Intrepid	**1.90**	**10.5**
Avaunt	**5.00**	**4**
Coragen	**5.85**	**3.5**
Voliam Xpress	**3.35**	**6**
Synapse	**5.30**	**3**
Vetica	**1.20**	**16**

Trial III This trial was essentially the same as Trial I , with the exception that head lettuce 'Diamondback' was direct seeded into plots two weeks later on 23 Sep, 2010 in plots about 0.5 mile away, and only a single application was made on 21 Oct using the same spray volume and equipment.

Treatment Evaluations: In each trial, evaluation of efficacy was based on the number of live larvae per plant. Six-ten plants per replicate were destructively sampled at several days after application (DAA) following each spray. The sample unit consisted of examination of whole plants for presence of Cabbage looper (CL) *Trichoplusia ni* (Hubner), and Beet armyworm (BAW) *Spodoptera exigua* (Hubner) larvae. Data for each species was recorded by instar, but only live larvae that were 2nd instar or older were used in the analysis. The number of neonate-1st instar larvae were not included in the analysis because of the difficulty in measuring treatment effects (mortality) on newly eclosed larvae. Data were pooled across instars, averaged and converted to the number of larvae per 10 plants for each post-treatment evaluation. Data were subjected to ANOVA and means were separated using an *F*-protected LSD ($P \leq 0.05$).

Summary: In general, CL and BAW pressure was moderate during the trials. Treatment differences among the spray treatments for CL and BAW efficacy were consistent following each application. CL efficacy was comparable among the Diamides and the industry standards (Proclaim and Radiant) at several days following application (DAA) where significant post-treatment reduction of CL larvae was similar for all spray treatments compared to the untreated check. Trends in BAW efficacy were similar in each trial and both BAW and CL larvae numbers were significantly lower than the untreated check at 10-14 d following each application. In conclusion, the results of these trials strongly suggest that the new diamide insecticide products can cost-effectively control CL and BAW populations comparable to the industry standards presently used in desert lettuce production. Economic evaluations from Trial I show that cost effectiveness of compounds varies with timing and compouond.

Trial I

Treatment	Rate/ac	Cabbage Looper larvae / 10 Plants 1-DAA1 29-Sep	3-DAA1 1-Oct	7-DAA1 5-Oct	10-DAA1 8-Oct	14-DAA1 12-Oct	1-DAA2 15-Oct	3-DAA2 17-Oct	7-DAA2 21-Oct	14-DAA2 28-Oct	21-DAA2 4-Nov	Trial Avg.
Radiant 2SC	5 oz	0.0a	0.0 b	0.0a	0.0 b	0.6a	0.0 b	0.0 b	0.0 b	0.0 b	0.0a	0.1 b
Proclaim 5SG	3.6 oz	0.0a	0.0 b	0.3a	0.0 b	0.9a	0.8 b	0.0 b	0.0 b	0.5 b	1.5a	0.4 b
Intrepid 2F	10 oz	0.0a	0.0 b	0.3a	0.3 b	0.0a	0.4 b	0.0 b	0.0 b	0.5 b	0.0a	0.2 b
Avaunt 30WG	5 oz	0.0a	0.0 b	0.0a	0.0 b	0.0a	0.4 b	0.0 b	0.0 b	0.0 b	0.5a	0.1 b
Coragen 1.6SC	5 oz	0.0a	0.0 b	0.3a	0.0 b	0.3a	0.4 b	0.0 b	0.0 b	0.0 b	0.5a	0.2 b
Voliam Xpress	8 oz	0.0a	0.0 b	0.0a	0.0 b	0.9a	0.0 b	0.0 b	0.0 b	0.0 b	0.5a	0.1 b
Synapse 24WG	3 oz	0.0a	0.0 b	0.0a	0.6 b	0.0a	0.4 b	0.0 b	0.0 b	0.0 b	1.5a	0.3 b
Vetica SC	17 oz	0.0a	0.0 b	0.0a	0.6 b	0.6a	1.7 ab	0.0 b	0.0 b	0.0 b	0.5a	0.3 b
Untreated	-	0.0a	0.6 a	2.5a	2.8 a	1.5a	3.3 a	2.9 a	1.3 a	3.0 a	3.0a	2.1 a

Treatment	Rate/ac	Beet armyworm larvae / 10 Plants 1-DAA1 29-Sep	3-DAA1 1-Oct	7-DAA1 5-Oct	10-DAA1 8-Oct	14-DAA1 12-Oct	1-DAA2 15-Oct	3-DAA2 17-Oct	7-DAA2 21-Oct	14-DAA2 28-Oct	21-DAA2 4-Nov	Trial Avg.
Radiant 2SC	5 oz	0.0 b	0.0 b	0.0 b	0.3 b	1.6 b	0.0a	0.0 b	0.8 b	0.0 c	0.5a	0.3 b
Proclaim 5SG	3.6 oz	0.2 b	0.0 b	0.0 b	0.0 b	1.3 b	1.7a	0.0 b	0.0 b	0.0 c	1.0a	0.4 b
Intrepid 2F	10 oz	2.3 b	0.6 b	0.6 b	0.6 b	0.6 b	1.7a	0.4 b	0.0 b	0.0 c	2.0a	0.9 b
Avaunt 30WG	5 oz	1.0 b	0.9 b	0.0 b	0.9 b	0.6 b	0.8a	1.3 b	0.0 b	2.0 b	1.0a	0.9 b
Coragen 1.6SC	5 oz	0.4 b	0.0 b	0.3 b	0.0 b	0.6 b	0.4a	0.0 b	0.0 b	0.0 c	1.0a	0.3 b
Voliam Xpress	8 oz	0.0 b	0.0 b	0.0 b	0.0 b	0.3 b	2.1a	0.0 b	0.0 b	0.0 c	0.0a	0.2 b
Synapse 24WG	3 oz	0.3 b	0.0 b	0.0 b	0.3 b	0.3 b	1.3a	0.0 b	0.4 b	1.5 bc	1.0a	0.5 b
Vetica SC	17 oz	0.3 b	0.0 b	0.3 b	0.0 b	1.3 b	0.4a	0.4 b	0.8 b	0.0 c	0.5a	0.4 b
Untreated	-	9.6 a	11.6 a	5.3 a	3.4 a	4.4 a	5.0a	14.6 a	8.3 a	5.5 a	2.5a	7.0 a

Means in a column followed by the same letter are not significantly different ($P > 0.05$, *F*-protected LSD).

Trial I - Economic Evaluation - 1st Spray (thinning stage)

			Total Worms - 1st Spray *(thinning stage)*		
Treatment	**Rate/ac**	**Estimated Cost $ /ac**	**Avg. larvae / 10 plants**	**Days of control > 90%**	**Control cost ($ /day)**
Radiant	5 oz	23.00	0.5	10.0	2.30
Proclaim	3.6 oz	21.60	0.5	10.0	2.16
Intrepid	10 oz	19.00	1.1	7.0	2.71
Avaunt	5 oz	25.00	0.7	7.0	3.57
Coragen	5 oz	29.25	0.4	10.0	2.93
Voliam Xpress	8 oz	26.80	0.3	10.0	2.68
Synapse	3 oz	15.90	0.3	10.0	1.59
Vetica	17 oz	20.40	0.6	10.0	2.04
Untreated	-	-	8.5	-	-

Trial I - Economic Evaluation- 2nd Spray (cupping stage)

			Total Worms - 2nd Spray *(cupping stage)*		
Treatment	**Rate/ac**	**Estimated Cost $ /ac**	**Avg. larvae / 10 plants**	**Days of control > 90%**	**Control cost ($ /day)**
Radiant	5 oz	23.00	0.3	21.0	1.10
Proclaim	3.6 oz	21.60	1.1	14.0	1.54
Intrepid	10 oz	19.00	1.0	14.0	1.36
Avaunt	5 oz	25.00	1.2	10.0	2.50
Coragen	5 oz	29.25	0.5	14.0	2.09
Voliam Xpress	8 oz	26.80	0.5	21.0	1.28
Synapse	3 oz	15.90	1.2	10.0	1.59
Vetica	17 oz	20.40	0.9	21.0	0.97
Untreated	-	-	9.9	-	-

Trial II

Treatment	Rate/ac	Cabbage Looper larvae/ 10 Plants 2-DAA1 30-Sep	4-DAA1 2-Oct	7-DAA1 5-Oct	10-DAA1 8-Oct	14-DAA1 12-Oct	2-DAA2 16-Oct	4-DAA2 18-Oct	7-DAA2 21-Oct	14-DAA2 28-Oct	21-DAA2 4-Nov	Trial Avg.
Radiant 2SC	4.3 oz	0.0 a	0.0 a	0.0 b	0.0 a	0.0 a	0.0 b	0.0 b	0.0 b	0.0 b	0.5 bc	0.05 b
Proclaim 5SG	3.3 oz	0.1 a	0.0 a	0.0 b	0.0 a	0.4 a	0.0 b	0.0 b	0.8 b	1.0 ab	3.5 ab	0.5 b
Intrepid 2F	10.5 oz	0.0 a	0.0 a	0.0 b	0.0 a	0.0 a	0.0 b	0.0 b	0.0 b	1.5 ab	1.0 bc	0.2 b
Avaunt 30WG	4.0 oz	0.0 a	0.0 a	0.0 b	0.0 a	0.0 a	0.0 b	0.0 b	0.0 b	0.0 b	3.5 ab	0.3 b
Coragen 1.6SC	3.5 oz	0.0a	0.0 a	0.0 b	0.0 a	0.8 a	0.0 b	0.0 b	0.4 b	0.0 b	0.5 bc	0.2 b
Voliam Xpress	6.0 oz	0.0 a	0.0 a	0.0 b	0.0 a	0.4 a	0.0 b	0.0 b	0.0 b	0.0 b	0.0 c	0.03 b
Synapse 24WG	3.0 oz	0.0 a	0.0 a	0.0 b	0.0 a	0.0 a	0.0 b	0.0 b	0.0 b	0.0 b	0.0 c	0.0 b
Vetica SC	16.0 oz	0.0 a	0.0 a	0.0 b	0.0 a	0.8 a	0.0 b	0.0 b	0.0 b	0.0 b	2.0 abc	0.3 b
Untreated	-	0.0 a	0.6 a	0.9 a	0.3 a	1.7 a	3.75 a	4.2 a	2.9 a	2.5 a	5.0 a	2.0 a

Treatment	Rate/ac	Beet armyworm larvae/ 10 Plants 2-DAA1 30-Sep	4-DAA1 2-Oct	7-DAA1 5-Oct	10-AA1 8-Oct	14-DAA1 12-Oct	2-DAA2 16-Oct	4-DAA2 18-Oct	7-DAA2 21-Oct	14-DAA2 28-Oct	21-DAA2 4-Nov	Trial Avg.
Radiant 2SC	4.3 oz	2.3 b	0.0 b	0.0 b	0.0 b	0.8 a	0.0 b	0.0 b	0.0 b	0.5 a	1.0 a	0.6 bc
Proclaim 5SG	3.3 oz	1.4 b	0.0 b	0.0 b	0.0 b	0.8 a	0.0 b	0.0 b	0.0 b	0.5 a	1.0 a	0.5 bc
Intrepid 2F	10.5 oz	0.5 b	0.0 b	0.0 b	0.0 b	0.0 a	0.0 b	0.8 b	0.0 b	0.5 a	1.0 a	0.3 c
Avaunt 30WG	4.0 oz	1.0 b	0.0 b	0.0 b	0.0 b	0.4a	0.8 b	4.6 a	0.0 b	1.5 a	2.5 a	1.1 b
Coragen 1.6SC	3.5 oz	0.9 b	0.0 b	0.0 b	0.0 b	0.0 a	0.0 b	0.0 b	0.0 b	1.0 a	0.5 a	0.3 c
Voliam Xpress	6.0 oz	0.9 b	0.0 b	0.0 b	0.3 b	0.0 a	0.0 b	0.0 b	0.0 b	0.0 a	0.5 a	0.2 c
Synapse 24WG	3.0 oz	0.6 b	0.0 b	0.0 b	0.3 b	0.0 a	0.0 b	0.0 b	0.0 b	1.0 a	0.0 a	0.2 c
Vetica SC	4.3 oz	1.3 b	0.0 b	0.0 b	0.0 b	0.0 a	0.0 b	0.4 b	0.0 b	0.0 a	0.0 a	0.3 c
Untreated	-	7.1 a	8.1 a	1.9 a	1.9 a	0.4 a	2.5 a	4.2 a	1.3 a	2.0 a	3.5 a	3.6 a

Means in a column followed by the same letter are not significantly different (*P* > 0.05, *F*-protected LSD).

Trial III

Treatment	Rate/ac	Cabbage Looper larvae/ 10 Plants 2-DAA1 23-Oct	4-DAA1 25-Oct	7-DAA1 28-Oct	11-DAA1 1-Nov	15-DAA1 5-Nov	21-DAA1 11-Nov	Trial Avg.
Radiant 2SC	5 oz	0.0 a	0.0 b	0.0 b	0.0 b	0.0 a	0.0 a	0.0 b
Proclaim 5SG	3.6 oz	0.0 a	0.0 b	0.8 ab	0.0 b	0.0 a	0.5 a	0.2 b
Intrepid 2F	10 oz	0.9 a	0.3 b	0.0 b	0.4 b	0.5 a	0.0 a	0.4 b
Avaunt 30WG	5 oz	0.0 a	0.0 b	0.0 b	0.0 b	0.5 a	0.0 a	0.1 b
Coragen 1.6SC	5 oz	0.0 a	0.0 b	0.4 b	0.0 b	0.0 a	0.0 a	0.1 b
Voliam Xpress	8 oz	0.0 a	0.0 b	0.0 b	0.0 b	0.0 a	0.5 a	0.1 b
Synapse 24WG	3 oz	0.0 a	0.0 b	0.8 ab	0.0 b	1.5 a	0.0 a	0.4 b
Vetica SC	17 oz	0.3a	0.6 b	0.0 b	0.0 b	0.5 a	0.5 a	0.3 b
Untreated	-	0.0 a	3.4 a	1.7 a	3.3 a	2.0 a	1.5 a	1.9 a

Treatment	Rate/ac	Beet armyworm larvae/ 10 Plants 2-DAA1 23-Oct	4-DAA1 25-Oct	7-DAA1 28-Oct	11-DAA1 1-Nov	15-DAA1 5-Nov	21-DAA1 11-Nov	Trial Avg.
Radiant 2SC	5 oz	0.3 c	0.0 b	0.0 b	0.4 b	1.0 b	0.0 a	0.3 b
Proclaim 5SG	3.6 oz	0.6 c	0.3 b	0.0 b	0.8 b	0.0 b	0.0 a	0.3 b
Intrepid 2F	10 oz	6.3 b	0.3 b	0.8 b	0.4 b	0.0 b	0.0 a	1.3 b
Avaunt 30WG	5 oz	5.3 b	0.3 b	0.0 b	1.3 ab	1.0 b	0.0 a	1.3 b
Coragen 1.6SC	5 oz	0.6 c	0.3 b	0.4 b	0.0 b	0.0 b	0.0 a	0.2 b
Voliam Xpress	8 oz	1.6 c	0.0 b	0.8 b	0.0 b	0.5 b	0.0 a	0.5 b
Synapse 24WG	3 oz	0.9 c	0.9 b	0.8b	0.4 b	0.0 b	0.0 a	0.5 b
Vetica SC	17 oz	1.9 c	0.0 b	0.0 b	0.0 b	0.0 b	0.0 a	0.3 b
Untreated	-	11.6 a	4.7 a	11.7 a	2.9 a	4.0 a	0.5 a	5.9 a

Means in a column followed by the same letter are not significantly different ($P > 0.05$, F-protected LSD).

Objective 2. Evaluating New Insecticides for Worm, Aphid and Thrips Control in Fall and Spring Head Lettuce

I. Worms:

Foliar And Soil Applied Insecticides For Beet Armyworm Larvae On Head Lettuce

The objective of the study was to evaluate the efficacy of two new numbered compounds against beet armyworm (BAW) on head lettuce when applied as a foliar spray and as a sub-surface, soil injection (SSI) under desert growing conditions. Head lettuce was direct seeded on 23 Sep, 2010 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, with furrow irrigation used 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 RCB design. Formulations and rates for each treatment compound are provided in the table. The SSI treatments were injected 2" directly below each seed line with a fertilizer shank just prior to planting in a total water volume of 20.5 GPA. Two foliar sprays were applied on 14 and 30 Oct with a CO_2 operated boom sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 21.5 GPA. An adjuvant, Dyne-Amic (Helena Chemical Co.), was applied at 0.125% v/v with all treatments. Evaluation of efficacy was based on the number of live BAW larvae per plant. Ten plants per replicate were destructively sampled at several intervals following each spray applications. The sample unit consisted of examination of whole plants for presence of large (2nd or > instar) BAW. Data were subjected to ANOVA and means were separated using an *F*-protected LSD ($P \leq 0.05$).

BAW pressure was moderate during the study. A16901 and A16971 applied as SSI systemic treatments significantly reduced BAW larvae compared to the untreated control on each sample during the trial. Larvae were not detected on plants in the A16901 treatment until 34 d after planting and in the A16971 treatments until 44 d following planting. Similarly, A16901 and A16971 applied as foliar sprays provided excellent control of BAW following each application. When averaged across all sample dates, differences in BAW numbers were not detected among any of the foliar and soil treatments. The results of this trial suggest that these two new compounds can effectively control BAW comparable to the currently registered products presently used in desert lettuce production.

Table 1.

			Mean BAW / 10 plants			
Treatment	**Application**	**Rate /ac**	**13-Oct**	**20-Oct**	**27-Oct**	**6-Nov**
Cyazypyr 40WG	Soil	14.3 oz	0.0 b	0.0 b	0.3 b	0.5 b
Cyazypyr 40WG	Soil	7.2 oz	0.0 b	0.0 b	0.0 b	1.0 b
Durivo	Soil	13 oz	0.0 b	0.0 b	0.3 b	4.0 b
Cyazypyr 40WG	Foliar	7.2 oz	3.5 a	0.3 b	0.3 b	1.0 b
Cyazypyr 40WG	Foliar	3.6 oz	3.9 a	0.0 b	0.3 b	0.0 b
Voliam Flexi	Foliar	7 oz	3.8 a	0.0 b	0.6 b	0.0 b
Untreated	-	-	4.1 a	9.4 a	8.4 a	13.5 a

Table 1. continued.

Treatment	Application	Rate /ac	Mean BAW / 10 plants			
			12-Nov	19-Nov	23-Nov	Avg.
Cyazypyr 40WG	Soil	14.3 oz	0.0 b	0.5 b	0.5 b	0.3 b
Cyazypyr 40WG	Soil	7.2 oz	0.0 b	1.0 b	0.0 b	0.3 b
Durivo	Soil	13 oz	2.5 b	0.0 b	2.5 b	1.3 b
Cyazypyr 40WG	Foliar	7.2 oz	0.0 b	0.0 b	1.0 b	0.4 b
Cyazypyr 40WG	Foliar	3.6 oz	0.0 b	0.0 b	0.0 b	0.1 b
Voliam Flexi	Foliar	7 oz	1.0 b	0.0 b	0.5 b	0.4 b
Untreated	-	-	15.5 a	4.5 a	6.5 a	8.7 a

Means in a column followed by the same letter are not significantly different ($P > 0.05$, F-protected LSD).

II. Aphids:

Lettuce Aphid Control On Head Lettuce With Soil And Foliar Insecticides

The objective of this study was to evaluate the efficacy of several foliar- and soil-applied insecticides against LA in head lettuce under desert growing conditions. Head lettuce was direct seeded into double row beds on 42 inch centers on 9 Feb 2010. Plots were two beds wide by 45 ft long and bordered by two untreated beds. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each compound are provided in the table. Sub-surface, soil injection (SSI) treatments were applied by placing the insecticides 2" directly below each seed line with a fertilizer shank just prior to planting in a total water volume of 20.5 GPA. Foliar treatments received spray applications on 21 Mar and 6 Apr as a broadcast application delivered through 2 TXVS-18 ConeJet nozzles per bed at 21.5 GPA @ 40 psi. Evaluations of LA populations were assessed by estimating the number of aphids per plant in whole plant, destructive samples. On each sample date, five 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 live apterous aphids present. Data were log transform (mean+1) and subjected to ANOVA; means were separated using an F-protected LSD ($P \leq 0.05$). Actual non-transformed means and LSD values are presented in the tables.

LA pressure was light early in the study, but by 50 days following planting aphid numbers began to increase steadily in the untreated check. Among the SSI systemic treatments evaluated, Durivo and Admire Pro significantly reduced LA numbers throughout the trial relative to the untreated control. The Cyazypyr soil treatment did not provide significant aphid control on any of the sample dates. Among the foliar treatments, Movento consistently provided significant reductions in LA numbers following each spray application. When averaged across all sample dates, all treatments except Cyazypyr had significantly lower LA numbers than the untreated control. No phytotoxicity was observed.

Treatment	Rate/ac	Application	Mean Lettuce aphids / Plant						
			20-Mar	25-Mar	29-Mar	5-Apr	14-Apr	22-Apr	Avg.
Durivo	13.0 oz	Soil	0.1	0.0	0.0	4.9	6.1	13.0	4.5
Admire Pro	7 oz	Soil	0.2	0.1	0.0	2.8	8.6	47.3	9.8
Cyazypyr 20 SC	10.4 oz	Soil	0.1	0.6	2.2	18.6	71.3	126.5	36.3
Voliam Xpress	9 oz	Foliar	0.2	0.8	2.7	13.7	22.4	68.8	18.1
Voliam Flexi	7 oz	Foliar	0.2	0.0	0.2	10.2	12.1	54.2	12.8
Assail 30SG	4 oz	Foliar	0.2	0.3	2.1	10.3	14.5	111.7	23.1
Movento 2SC	5 oz	Foliar	0.1	0.0	1.1	3.2	1.3	4.1	1.6
Untreated	-	-	0.2	0.3	0.6	20.9	108.3	142.2	45.3

Means in a column followed by the same letter are not significantly different ($P > 0.05$, F-protected LSD).

Aphid Control With Sivanto In Head Lettuce

The objective of this study was to evaluate the residual efficacy of a new active ingredient, Sivanto (flupyradifurone), as a foliar spray for control of aphids on spring head lettuce under desert growing conditions. Head lettuce 'Navajo' was direct seeded into double row beds on 42 inch centers on 7 Jan, 2011. Plots were two beds wide by 45 ft long and bordered by two untreated beds. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each compound are provided in the tables. Foliar sprays were applied on 22 Mar and 13 Apr with a CO_2 operated boom sprayer at 40 psi and 21.5 gpa. A broadcast application was delivered through 2 TXVS-18 ConeJet nozzles per bed. An adjuvant, Dyne-Amic (Helena Chemical Co.), was applied at 0.25% to all treatments. Aphid populations were assessed by estimating the number of aphids / plant in whole plant, destructive samples following each application. On each sampling date, 5 plants were randomly selected from each plot and placed individually into large 5-gal tubs. At harvest (27 Apr; 14-DAT2), 10 plants were randomly selected from each plot and sampled by visually examining all foliage within a harvested head and recording the number of live aphids present in each individual head. Mean aphids per head (species combined) and the percentage of heads contaminated with greater than 1 and 5 live aphids were calculated at harvest. Aphid data were log transform (mean+1) and percent contaminated hearts were acrsine transformed prior to the ANOVA and an F-protected LSD ($P \leq 0.05$) to distinguish treatment mean differences. Actual non-transformed means are presented in the tables.

Lettuce aphid (LA) and *A. lactucae* population pressures were moderate during the trial. Two days prior to the beginning of the trial, pre-spray estimates for LA and *A. lactucae* were 12.5 and 5.3 aphids / plant, respectively. Following the first application, none of the spray treatments significantly reduced numbers of either aphid species at 3-DAT (Table 1 and 2). By 6-DAT1, aphid numbers in all spray treatments were significantly reduced compared to the untreated check. This trend continued for the remainder of the trial except for the Assail treatment, which did not significantly reduce LA numbers beginning 10-DAT1 and *A. lactucae* numbers after 14-DAT1. Overall, each rate of Sivanto provided control of both aphid species comparable to the industry standard, Movento. At harvest, aphid numbers and percent head contamination were significantly lower in the Sivanto treatments relative to the untreated check. Although, head contamination did not differ among the Movento and Sivanto treatments, contamination levels would have only been commercially unacceptable in the Sivanto treatments under normal market conditions. These results suggest that Sivanto may be a viable early season, rotational alternative with Movento for aphid control in desert romaine lettuce.

Table 1

		Lettuce aphids / plant					
		3-DAT1	**6-DAT1**	**10- DAT1**	**14-DAT1**	**21-DAT1**	**7-DAT2**
Treatment	**Rate/ac**	**25-Mar**	**28-Mar**	**1-Apr**	**5-Apr**	**12-Apr**	**20-Apr**
Sivanto 200SL	5.2 oz	2.5 a	0.6 c	1.2 bc	0.9 b	5.7 b	1.3 b
Sivanto 200SL	8.6 oz	6.2 a	0.3 c	0.2 c	0.2 c	6.0 b	1.8 b
Movento 2SC	5 oz	9.1 a	2.4 b	1.3 bc	1.3 b	3.1 b	1.5 b
Assail 30SG	3 oz	11.8 a	3.5 b	10.2 ab	20.1 a	28.5 a	22.3 a
Untreated	-	10.3 a	16.1 a	21.4 a	34.7 a	55.7 a	15.7 a

Means in a column followed by the same letter are not significantly different (*P* > 0.05, *F*-protected LSD).

Table 2

		A. lactucae **aphids/ plant**					
		3-DAT1	**6-DAT1**	**10- DAT1**	**14-DAT1**	**21-DAT1**	**7-DAT2**
Treatment	**Rate/ac**	**25-Mar**	**28-Mar**	**1-Apr**	**5-Apr**	**12-Apr**	**20-Apr**
Sivanto 200SL	5.2 oz	6.0 a	0.7 cd	0.7 cd	0.1 c	0.4 b	0.0 b
Sivanto 200SL	8.6 oz	9.3 a	0.2 d	0.4 d	0.1 c	1.4 b	0.1 b
Movento 2SC	5 oz	21.1 a	2.5 bc	1.3 bc	0.6 c	1.0 b	0.1 b
Assail 30SG	3 oz	8.6 a	4.6 b	3.8 b	9.2 b	13.8 a	11.0 a
Untreated	-	18.9 a	14.8 a	24.1 a	38.0 a	24.8 a	16.4 a

Means in a column followed by the same letter are not significantly different (*P* > 0.05, *F*-protected LSD).

Table 3

Foliar Treatment	Rate/ac	Total aphids per head	% Contaminated Head > 1 aphid	% Contaminated Head > 5 aphids
Sivanto 200SL	5.2 oz	1.9 bc	30.0 bc	15.0 bc
Sivanto 200SL	8.6 oz	2.4 bc	50.0 bc	20.0 bc
Movento 2SC	5 oz	0.3 c	10.0 c	0.0 c
Assail 30SG	3 oz	4.4 ab	65.0 ab	37.5 ab
Untreated check	-	11.3 a	95.0 a	60.0 a

Means in a column followed by the same letter are not significantly different ($P > 0.05$, *F*-protected LSD).

Aphid Control With Closer In Head Lettuce, 2011

The objective of this study was to evaluate the residual efficacy of a new active ingredient, Closer (sulfoxaflor), as a foliar spray for control of aphids on spring head lettuce under desert growing conditions. Head lettuce 'Navajo' was direct seeded into double row beds on 42 inch centers on 7 Dec, 2010. Plots were two beds wide by 45 ft long and bordered by two untreated beds. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each compound are provided in the tables. Foliar sprays were applied on 12 and 28 Feb with a CO_2 operated boom sprayer at 40 psi and 28 gpa. A broadcast application was delivered through 2 TXVS-18 ConeJet nozzles per bed. An adjuvant, Dyne-Amic (Helena Chemical Co.), was applied at 0.25% to all 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. Data were log transform (mean+1) and subjected to ANOVA; means were separated using an *F*-protected LSD ($P \leq 0.05$). Actual non-transformed means are presented in the tables.

Green peach aphid (GPA) pressure was light during the trial. Following the first application, all Closer treatments provided significant suppression of GPA comparable to the industry standards (Movento, Assail and Beleaf) (Table 1). A similar trend was observed at 7 DAT 2, but by 15-DAT 2 the GPA population had declined to insignificant levels in all treatments. In contrast, *A. lactucae* aphid pressure was moderate during the trial (Table 2). No differences in *A. lactucae* numbers were observed among all treatments at 7 DAT-1, but thereafter all the Closer treatments significantly reduced *A. lactucae* numbers relative to the untreated check. Among the industry standards, Assail failed to provide significant control of *A. lactucae* following the second application. These results suggest that Closer may be a viable rotational alternative for aphid control in desert head lettuce.

Table 1

Treatment	Rate/ac	Green peach aphids / plant 19-Feb 7-DAT1	26-Feb 14-DAT1	7-Mar 7-DAT2	15-Mar 15-DAT2	22-Mar 22-DAT2	Avg.
Closer 2SC	1.43 oz	0.4 b	0.6 b	0.1 b	0.1 a	0.0 a	0.2 b
Closer 2SC	2.14 oz	0.2 b	0.4 bc	0.0 b	0.0 a	0.0 a	0.1 b
Closer 2SC	2.85 oz	0.1 b	0.3 bc	0.2 b	0.4 a	0.0 a	0.2 b
Movento 2SC	5 oz	0.3 b	0.7 b	0.1 b	0.3 a	0.0 a	0.3 b
Assail 30SG	4 oz	0.3 b	0.6 b	0.4 b	0.4 a	0.0 a	0.3 b
Beleaf 50SG	2.8 oz	0.3 b	0.0 c	0.3 b	0.3 a	0.0 a	0.2 b
Untreated check	-	2.8 a	5.7 a	2.9 a	1.2 a	0.1 a	2.5 a

Means in a column followed by the same letter are not significantly different (*P* > 0.05, *F*-protected LSD).

Table 2

Treatment	Rate/ac	*A. lactucae* aphids / plant 19-Feb 7-DAT1	26-Feb 14-DAT1	7-Mar 7-DAT2	15-Mar 15-DAT2	22-Mar 22-DAT2	Avg.
Closer 2SC	1.43 oz	0.3 a	2.0 b	0.4 cd	2.8 b	0.6 cd	1.3 b
Closer 2SC	2.14 oz	0.5 a	2.3 b	0.1 d	2.1 b	1.0 cd	1.2 b
Closer 2SC	2.85 oz	0.1 a	1.5 b	0.1 d	2.3 b	0.9 cd	1.0 b
Movento 2SC	5 oz	4.7 a	2.9 b	1.0 c	1.9 b	0.2 d	2.2 b
Assail 30SG	4 oz	3.8 a	3.8 b	4.1 b	19.5 a	6.4 a	8.1 a
Beleaf 50SG	2.8 oz	1.1 a	2.6 b	0.7 c	4.7 b	2.0 bc	2.2 b
Untreated check	-	6.8 a	16.5 a	46.3 a	56.9 a	4.8 ab	26.2 a

Means in a column followed by the same letter are not significantly different (*P* > 0.05, *F*-protected LSD).

II. Thrips:

Western Flower Thrips Control With Torac On Head Lettuce

The objective of the trial was to evaluate the efficacy of the new insecticide Torac (tolfenpyrad) when applied alone and in a mixture with an industry standard for control of western flower thrips (WFT) on spring head lettuce under desert growing conditions. Head lettuce was direct seeded on 7 Jan, 2011 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 RCB design. Formulations and rates for each compound are provided in the tables. Foliar sprays were applied on 6 and 20 Mar with a CO_2 operated boom sprayer that delivered a broadcast application at 40 psi and 21.5 gpa through 2 TXVS-18 ConeJet nozzles per bed. An adjuvant, Dyne-Amic (Helena Chemical Co.), was applied at 0.25% to all treatments. Numbers of WFT from 5 plants per replicate were recorded at various sample date following each application (DAT). 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 (10 sec). A 6 in. by 6 in. sticky card was placed inside of the pan to catch the dislodged WFT. Sticky cards were then taken to the laboratory where adult and larvae were counted. Data were subjected to ANOVA and means were separated using an *F*-protected LSD ($P \leq 0.05$).

WFT population levels were moderate during this trial. Following the first application, adult WFT numbers did not differ between the Torac+Lannate and Torac alone treatments (Table 1). However, by 3 DAT2 the Torac+Lannate treatment provided significantly better control than the Torac alone. None of the spray treatments in this trial provided residual control of WFT adults beyond 5 - 6 days following application. When averaged across all sample dates, WFT adult numbers in the Torac-only treatment did not differ from Lannate, Warrior or the Torac+Lannate treatments, but were significantly higher than the Radiant and Lannate+Warrior standards. The Torac+Lannate treatment provided more consistent control of WFT larvae relative to the Torac treatment applied alone (Table 2). When averaged across all sprays and sample dates, the Torac-alone treatment had significantly higher WFT larvae numbers than all other treatments except the Warrior II treatment. As a stand-alone treatment Torac provides significant activity against adult WFT comparable to the pyrethroid. However, when used in combination with Lannate, Torac provided enhanced control of WFT larvae comparable to the standard Lannate+Warrior II mixture presently used by desert lettuce growers.

Table 1.

		Avg. Adults / Plant						
Treatment	**Rate/ ac**	**2-DAT1**	**5-DAT1**	**9-DAT1**	**3-DAT2**	**6-DAT2**	**10-DAT2**	**Avg.**
Lannate+Warrior II	0.75 lb + 1.9 oz	1.5 b	3.4 c	15.6 a	9.1 c	18.1 cd	27.1 a	12.5 cd
Lannate+Torac	0.75 lb + 21 oz	1.0 b	2.7 c	16.1 a	11.8 c	23.3 bc	42.2 a	16.2 b
Lannate SP	0.75 oz	1.5 b	5.1 bc	21.0 a	9.7 c	20.7 bcd	30.7 a	14.7 bc
Warrior II	1.9 oz	2.3 b	7.0 ab	16.9 a	12.9 c	24.0 b	26.9 a	15.0 b
Torac 15EC	21 oz	2.6 b	4.2 bc	18.0 a	18.4 b	24.5 b	32.3 a	16.6 b
Radiant SC	7 oz	1.0 b	3.9 c	14.9 a	11.9 c	15.6 d	22.9 a	11.7 d
Untreated	-	6.6 b	9.7 a	15.5 a	26.9 a	32.4 a	31.3 a	20.4 a

Means in a column followed by the same letter are not significantly different ($P > 0.05$, *F*-protected LSD).

Table 2

Treatment	Rate/ ac	Avg. Larvae / Plant						
		2-DAT1	5-DAT1	9-DAT1	3-DAT2	6-DAT2	10-DAT2	Avg.
Lannate+Warrior II	0.75 lb + 1.9 oz	9.5 d	22.9 c	26.5 bc	5.9 c	9.1 d	34.4 cd	18.0 d
Lannate+Torac	0.75 lb + 21 oz	11.6 cd	20.5 c	19.8 cd	4.5 c	7.5 d	23.8 de	14.6 d
Lannate SP	0.75 oz	14.5 bcd	21.4 c	18.4 cd	7.1 c	13.2 d	41.4 bcd	19.3 d
Warrior II	1.9 oz	20.5 b	36.9 b	38.0 b	32.3 b	53.5 b	58.8 ab	39.9 b
Torac 15EC	21 oz	17.6 bc	28.3 bc	22.0 c	17.6 c	27.3 c	43.9 bc	26.1 c
Radiant SC	7 oz	10.5 d	9.1 d	8.2 d	4.3 c	4.4 d	6.5 e	7.2 e
Untreated	-	34.9 a	46.9 a	51.1 a	79.4 a	73.0 a	73.1 a	59.7 a

Means in a column followed by the same letter are not significantly different (*P* > 0.05, *F*-protected LSD).

Western Flower Thrips Control With Radiant On Romaine Lettuce

The objective of the trial was to evaluate the efficacy of the Radiant applied at several rates and in combination with a biorational insecticide against western flower thrips (WFT) on head lettuce under desert growing conditions. Romaine lettuce was direct seeded on 25 Sep, 2010 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 RCB design. Formulations and rates for each compound are provided in the tables. Foliar sprays were applied on 30 Oct and 10 Nov with a CO_2 operated boom sprayer that delivered a broadcast application at 40 psi and 21.5 gpa through 2 TXVS-18 ConeJet nozzles per bed. An adjuvant, Penetrator Plus (1% v/v), was added to each spray mixture. The addition of the Penetrator Plus dropped the pH from 7.8 to 6.2. 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 card was placed inside of the pan to catch the dislodged WFT. Sticky cards were then taken to the laboratory where adult and larvae were counted separately. Data were subjected to ANOVA and means were separated using an *F*-protected LSD ($P \leq 0.05$).

WFT numbers were light during this fall trial. All spray tretments significantly reduced WFT adult and larval numbers realtive to the untreated control on each sampling interval following both applications (Tables 1 and 2). Furthermore, following each spray, no differences in WFT adult or larval numbers were detected among the Radiant treatments, regardless of rate applied. The Radiant+Aza-Direct treatment appeared to have some antagonsitic activity on WFT adults at 7-1 DAA, where it contained significantly highre WFT numbers than the 6 and 8 oz Radiant treatments. On two other sample dates (9 and 13 Nov) it had significantly higher WFT adult numbers than the Lannate+Mustang Max standard. Overall, increasing Radiant rates did not appear to significantly improve efficacy when applied on romaine lettuce in this trial. No phytotoxicity was observed.

Table 1.

		WFT adults / plant						
Treatment	**Rate/ac**	**3-DAA1 2-Nov**	**7-DAA1 6-Nov**	**10-DAA1 9-Nov**	**3-DAA2 13-Nov**	**7-DAA2 17-Nov**	**10-DAA2 20-Nov**	**14-DAA2 24-Nov**
Radiant 1SC	4 oz	0.4 b	0.9 bc	0.8 cd	0.9 bc	2.0 b	1.8 b	2.0 c
Radiant 1SC	6 oz	0.4 b	0.5 c	1.2 c	1.2 bc	1.6 b	1.8 b	2.5 bc
Radiant 1SC	8 oz	0.8 b	0.4 c	1.0 cd	1.1 bc	1.1 b	1.7 b	2.2 c
Radiant+Aza-Direct	4 oz+ 8 oz	0.4 b	1.5 b	1.4 bc	1.8 b	1.1 b	2.2 b	2.5 bc
Lannate+Mustang Max	0.5 lb+4 oz	0.2 b	0.7 bc	0.5 d	0.7 c	1.9 b	2.9 b	4.8 b
Untreated		3.1 a	3.2 a	3.2 a	7.7 a	6.7 a	8.8 a	11.3 a

Means in a column followed by the same letter are not significantly different (*P* > 0.05, *F*-protected LSD).

Table 2.

		WFT larvae / plant						
Treatment	**Rate/ac**	**3-DAA1 2-Nov**	**7-DAA1 6-Nov**	**10-DAA1 9-Nov**	**3-DAA2 13-Nov**	**7-DAA2 17-Nov**	**10-DAA2 20-Nov**	**14-DAA2 24-Nov**
Radiant 1SC	4 oz	1.9 b	2.2 b	1.9 b	0.5 b	0.4 b	0.6 b	0.6 b
Radiant 1SC	6 oz	1.7 b	2.8 b	2.0 b	0.6 b	0.2 b	0.4 b	0.2 b
Radiant 1SC	8 oz	2.6 b	1.4 b	1.7 b	0.5 b	0.4 b	0.3 b	0.2 b
Radiant+Aza-Direct	4 oz+ 8 oz	1.2 b	2.3 b	1.8 b	0.6 b	0.4 b	0.5 b	0.4 b
Lannate+Mustang Max	0.5 lb+4 oz	2.3 b	4.2 b	2.2 b	0.9 b	0.6 b	0.7 b	0.8 b
Untreated		10.9 a	12.0 a	15.6 a	24.6 a	13.5 a	12.4 a	10.4 a

Means in a column followed by the same letter are not significantly different (*P* > 0.05, *F*-protected LSD).

Western Flower Thrips Control with Torac and Exirel On Fall Head Lettuce

The objective of the trial was to evaluate the efficacy of several insecticides for control of western flower thrips on fall head lettuce under desert growing conditions. Head lettuce 'Diamondback' was direct seeded on 15 Sep, 2011 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 RCB design. Formulations and rates for each compound are provided in the tables. Foliar sprays were applied on 24 Oct and 1 Nov with a CO_2 operated boom sprayer that delivered a broadcast application at 40 psi and 25 gpa through 2 TXVS-18 ConeJet nozzles per bed. An adjuvant, Dyne-Amic (Helena Chemical Co.), was applied at 0.25% to all but the M-Pede and Aza-Direct treatments. Numbers of WFT from 5 plants per replicate were recorded at various sample date following each application (DAT). 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 (10 sec). A 6 in. by 6 in. sticky card was placed inside of the pan to catch the dislodged WFT. Sticky cards were then taken to the laboratory where adult and larvae were counted. Data were subjected to ANOVA and means were separated using an *F*-protected LSD ($P \leq 0.05$).

WFT population levels were light during this fall trial. Following each application, the industry standards (Lannate+Brigade and Radiant) and Lannate+Torac significantly reduced adult WFT numbers relative to the untreated check (Table 1), with the exception of the 14-DAT2 sample when none of the spray treatments provided residual control of WFT adults. The Exirel, M-Pede, and M-Pede+Aza-Direct did not provide consistently significant adult control and when averaged across all sample dates, WFT adult numbers in these treatments did not differ from the untreated check. All the treatments appeared to be more active against the WFT larvae (Table 2). The industry standards and Lannate+Torac provided the most consistent control of WFT larvae. When averaged across all sample dates, WFT larvae numbers in the Exirel, M-Pede, and M-Pede+Aza-Direct treatments were significantly lower the untreated, but not as low as the industry standards.

Table 1.

		Avg. Adults / Plant					
Treatment	**Rate/ ac**	**3-DAT1**	**7-DAT1**	**3-DAT2**	**7-DAT2**	**14-DAT2**	**Avg.**
Lannate +Brigade	0.8 lb + 5 oz	2.1 d	6.2 cd	1.3 c	1.9 d	3.6 a	3.0 c
Lannate +Torac	0.8lb + 21 oz	2.6 cd	5.6 d	2.7 bc	3.1 cd	3.4 a	3.5 bc
Radiant SC	7 oz	2.9 cd	9.2 bc	4.3 b	4.0 cd	2.3 a	4.5 b
Exirel	13.5 oz	4.8 bc	13.0 a	9.2 a	5.0 bc	4.6 a	7.3 a
M-Pede	2% v/v	5.7 ab	11.3 b	7.5 a	7.0 ab	3.9 a	7.0 a
M-Pede + Aza-Direct	2% v/v + 2 pt	7.1 a	12.0 ab	7.5 a	7.8 ab	5.3 a	7.9 a
UTC	-	5.9 ab	12.3 a	8.2 a	8.1 a	4.2 a	7.4 a

Means in a column followed by the same letter are not significantly different ($P > 0.05$, *F*-protected LSD).

Table 2

Treatment	Rate/ ac	Avg. Larvae / Plant					
		3-DAT1	7-DAT1	3-DAT2	7-DAT2	14-DAT2	Avg.
Lannate +Brigade	0.8 lb + 5 oz	2.5 c	3.5 d	0.9 cde	0.4 a	0.7 c	1.6 d
Lannate +Torac	0.8lb + 21 oz	2.7 c	1.7 d	0.7 de	0.3 a	0.6 c	1.2 d
Radiant SC	7 oz	2.9 c	2.7 d	0.2 e	0.3 a	1.2 c	1.5 d
Exirel	13.5 oz	5.4 bc	8.3 c	3.5 ab	0.9 a	2.0 c	4.0 c
M-Pede	2% v/v	5.4 bc	7.8 c	2.7 bc	1.2 a	6.8 ab	4.8 bc
M-Pede + Aza-Direct	2% v/v + 2 pt	7.4 ab	12.7 ab	2.6 bcd	1.2 a	4.8 b	5.7 b
UTC	-	10.1 a	15.2 a	4.7 a	3.1 a	7.7 a	8.1 a

Means in a column followed by the same letter are not significantly different (*P* > 0.05, *F*-protected LSD).

APPENDIX

Table 1. Primary insecticides currently used for insect management in head lettuce.

Product	Chemical Name	IRAC MOA group [1]	Effective Insect Spectrum on Desert Lettuce				
			Worms	Leaf miner	Whitefly	Thrips	Aphid
*Primarily considered **Worm** compounds*							
Radiant	Spinetoram	5	●	●		●	
Proclaim	Emamectin	6	●				
Intrepid	Methoxyfenozide	18A	●				
Coragen	Rynaxypyr	28	●	●			
Voliam xpress	Rynaxypyr+ pyrethroid	28+3	●	●			
Synapse	Flubendiamide	28	●				
Vetica	Flubendiamide	28+16	●		●		
*Primarily considered **Aphid** compounds*							
Movento	Spirotetramat	23			●		●
Admire, Alias	Imidacloprid	4A			●		●
Assail	Acetamiprid	4A			●		●
Venom	Dinotefuron	4A			●		●
Fulfill	Pymetrozine	9B					●
Beleaf	Flonicamid	9C					●

[1] Numbers correspond to a group of insecticides that has a separate and unique mode of action from other compounds used in lettuce. These numbers can be found on the front of each insecticide label to identify its MOA.

Table 2. New insecticides currently in development for insect management

Active ingredient	IRAC MOA group	Presumed Spectrum of Insect Activity				
		Worms	Leaf miner	Whitefly	Thrips	Aphid
Cyazypyr	28	●	●	●		
Pyrifluquinazon	Unknown			●	●	●
Sulfoxaflor	Unknown			●		●
Tolfenpyrad	21				●	●
Clothianidin	4A					●

[1] Numbers correspond to a group of insecticides that has a separate and unique mode of action from other compounds used in lettuce. These numbers can be found on the front of each insecticide label to identify its MOA.