Arizona Department of Agriculture
AILRC Grants Program – Final Report for 2017
Project 17-04

Project title: **Evaluation of New Insecticides for Insect Management in Desert Head Lettuce**

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Location of Research: Yuma Valley Agricultural Center

Objective: *To continue to compare the knockdown and residual efficacy of several new insecticides for* thrips, aphid, and worm *control relative to the industry standards currently used in desert head lettuce production.*

Cost-effective insecticides are very important in the production of desert lettuce. New insecticides continue to be developed that have a fit for insect control in desert head lettuce, albeit at a slower rate than 5 years ago. Although most of the newly developed products that growers use are very effective against the key lettuce insect pests, they tend to be very expensive. Thus, it is critical that PCAs continue to explore how to use newer products more cost-effectively. In addition, there are several new, unregistered insecticides that are under development that will likely provide activity against on many of the key pests that infest lettuce. We continue to explore use patterns for existing products as well initiate research to determine how these new chemistries fit into existing insect management programs in our unique desert cropping system.

Key insecticides currently available for control of lettuce insect pests 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, Exirel, and Besiege have recently provided more options. 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 have recently been or are currently under development that provides a wide spectrum of activity against many key insect pests**.** Based on trials conducted last year, we are gaining important information on their activity and how they might best fit in desert lettuce management programs.
With the growth in organic lettuce production in desert lettuce, we have begun to study organically approved products for insect control and particularly for aphids. Although numerous organically-allowed (OMRI approved) biopesticides are registered for insect control, there is much uncertainty among growers and PCAs whether the products will actually control insects as advertised. Many of the biopesticide manufacturer’s claim that their organic products will safely

provide broad spectrum insect control that is “as good as or better” than conventional pesticides. Many local PCAs and organic growers are skeptical of these claims because local scientific information to support the manufactures claims is not currently available. In 2016-2017, we focussed on determining the relative performance of key organic products (Entrust, Pyganic, M-Pede, Aza-Direct, Azera, Grandevo and Captiva) against worms, aphids and thrips.

This project is an on-going project and a continuation of the proposal submitted to the AILRC in 2015. Below are the results of a number of field trials conducted in fall of 2016 and spring 2017 that evaluated the efficacy of the new insecticide active ingredients shown in the figure above including lepidopterous larvae (beet armyworm and cabbage looper), sweet potato whiteflies, thrips and aphids, both for conventional and organic head lettuce.

I. Organically-Allowed Insecticide Alternatives for Beet Armyworm and Cabbage Looper Control in Head Lettuce

Objective**:** To compare the efficacy of foliar insecticide alternatives currently allowed for use in organic lettuce production under fall growing conditions.

Methods: Head lettuce 'El Guapo' was direct seeded into double row beds on 42-inch centers on 7 Sep, 2016. 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. Three foliar applications were made with a CO_2 operated sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 22.5 GPA. An adjuvant, Nufilm P, was applied @ 0.125% vol/vol with each treatment on applications 1 and 3, Silwet was applied as an adjuvant @ 0.125% for application 2.

At various intervals after treatment (DAT), 10 plants were randomly selected from each replicate and destructively sampled for the presence of beet armyworm (BAW) and cabbage looper (CL). Control was based on the examination of whole plants for presence of large (2^{nd} or > instar) larvae. Because of heterogeneity of mean variances, BAW and CL data were transformed using a $\log_{10}(x + 1)$ function before analysis and subjected to ANOVA; means were compared using Turkey's HSD test ($P \leq 0.05$). Means from non-transformed data are presented in the tables.

Summary: Entrust was clearly the most consistently efficacious product for BAW and CL in this trial (Table 1 and 2). In most cases, efficacy with Entrust at 3 oz/ac was comparable to the higher 5 oz rate. Averaged across all samples, BAW and CL efficacy did not differ significantly between the two Entrust rates. Among the two Bt products, Xentari provided significantly more consistent control of BAW, but both provided significant control of CL compared to the untreated check. The azadirachtin product AzaGuard, provided control of CL comparable to the Bts, but did not significantly control BAW relative to the intreated check. Grandivo and Venerate did not provide control of either BAW or CL.

This trial provides important information to PCAs. First, Entrust can be used a lower rates (<5 oz) and still provide acceptable control of BAW and CL. Second, Xentari, Dipel and in some cases Azaguard can be rotational partners for Entrust. Finally, Grandivo and Venerate do not appear to provide acceptable control of BAW and CL in lettuce under fall growing conditions in the desert.

Table 1.

Treatment	Rate/ac	*Beet armyworm larvae / 10 Plants*							
		3 DAA-1	***6 DAA-1***	***4 DAA-2***	***8 DAA-2***	***5 DAA-3***	***10 DAA-3***	***15 DAA-3***	***Avg.***
Entrust	5 oz	0.0b	0.0b	0.0b	0.0b	1.0a	0.5a	0.0a	0.2d
Entrust	3 oz	0.3ab	0.0b	0.0b	0.8ab	1.0a	0.0a	0.0a	0.3cd
Azagard	16 oz	1.9ab	0.9b	0.9b	3.3ab	3.5a	1.5a	0.4a	2.1ab
Dipel	2 lbs	0.6ab	1.3ab	1.3ab	4.2a	6.5a	1.0a	0.0a	2.2abc
Xentari	2 lbs	0.0b	0.6b	0.6b	1.3ab	1.0a	0.5a	0.4a	0.5bcd
Grandivo	2 lbs	1.6ab	4.0a	4.0a	3.8ab	6.0a	1.0a	0.8a	3.0a
Venerate	2 qts	1.3ab	1.3ab	1.3ab	5.8a	7.0a	1.5a	0.4a	3.0a
Untreated	-	2.5a	1.3ab	1.3ab	4.2a	8.0a	1.0a	0.4a	3.0a
	F	*3.73*	*5.92*	*5.92*	*4.53*	*3.97*	*0.82*	*0.68*	*9.91*
	P>F	*0.009*	*0.0007*	*0.0007*	*0.003*	*0.007*	*0.58*	*0.68*	*<.0001*

Means within a column followed by same letter are not statistically different (Turkey's HSD test, P>0.05).

Table 2.

Treatment	Rate/ac	*Cabbage looper larvae / 10 Plants*							
		3 DAA-1	***6 DAA-1***	***4 DAA-2***	***8 DAA-2***	***5 DAA-3***	***10 DAA-3***	***15 DAA-3***	***Avg.***
Entrust	5 oz	0.0d	0.0c	0.0d	0.4c	0.5b	0.0c	0.0a	0.1d
Entrust	3 oz	0.3cd	0.6bc	0.0d	2.1bc	0.5b	0.5bc	0.4a	0.6d
Azagard	16 oz	4.7ab	3.8ab	5.0abc	4.6ab	4.0ab	3.0abc	0.8a	3.7bc
Dipel	2 lbs	1.9abc	6.3a	3.4bc	4.6ab	2.5ab	3.0abc	0.8a	3.2c
Xentari	2 lbs	1.8bcd	4.1ab	2.2c	3.3ab	3.5ab	4.0abc	0.8a	3.2c
Grandivo	2 lbs	5.3a	7.8a	6.3ab	7.9a	7.5a	7.0a	1.3a	6.1ab
Venerate	2 qts	5.6a	9.4a	8.4ab	8.8a	8.0a	4.0abc	1.7a	6.6ab
Untreated	-	5.6a	9.1a	10.3a	7.5a	8.0a	6.5ab	2.5a	7.1a
	F	*15.75*	*13.84*	*22.84*	*9.44*	*4.56*	*4.15*	*1.06*	*36.31*
	P>F	*<.0001*	*0.009*	*<.0001*	*<.0001*	*0.003*	*0.005*	*0.42*	*<.0001*

Means within a column followed by same letter are not statistically different (Turkey’s HSD test, P>0.05).

II. Reduced-risk Insecticide Alternatives for Beet Armyworm and Cabbage Looper Control In Conventional Head Lettuce

Objective: The objective of this trial was to evaluate whether the addition of a pyrethroid would enhance the activity of several key insecticides for control of Beet Armyworm and Cabbage Looper on Conventional Lettuce under fall growing conditions.

Methods: Head lettuce 'PYB7101A' was direct seeded into double row beds on 42-inch centers on 7 Sep, 2016. 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. Product formulations and rates for each compound are provided in the tables.

Two foliar sprays were applied on 13 and 30 Oct with a CO^2 pressurized boom sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 22.5 gpa. An adjuvant, Dyne-Amic (Helena Chemical Co.), was applied at 0.125% vol/vol with these spray treatments. Beet armyworm (BAW) and CL (cabbage looper) control was based on the examination of 10 whole plants at 7 d intervals following each application (DAA) for the presence of large (2nd instar or older) larvae. Because of heterogeneity of mean variances, data were transformed using a log10 (x + 1) function before analysis and subjected to ANOVA (Proc GLM; SAS Institute 2009). Means were compared means using Turkey's HSD test ($P \leq 0.05$). Means from non-transformed data are presented in the tables.

Summary: Worm pressure was moderate prior to the first application, but declined rapidly following the second spray. Against BAW, the addition of the Sniper appeared to provide enhanced residual activity for Coragen following the first application. However, when averaged across both applications, the addition pyrethroid (Sniper) did not significantly enhance insecticideal activity of Exirel, Radiant, or Coragen. Similarly, against cabbage looper, all treatments provided significant kncodwon and residual control.

Table 1.

Treatment	Rate/ac	*Beet armyworm larvae / 10 Plants*							
		4 DAA-1	***8 DAA-1***	***12 DAA-1***	***15 DAA-1***	***3 DAA-2***	***7 DAA-2***	***10 DAA-2***	***Avg.***
Exirel	16 oz	0.0b	0.0b	0.0b	0.4b	0.0b	0.0a	0.0a	0.1b
Exirel+Sniper	16 oz+5 oz	0.0b	0.0b	0.0b	0.4b	0.0b	0.0a	0.0a	0.1b
Radiant	5 oz	0.0b	0.0b	1.7ab	0.4b	0.0b	0.5a	0.0a	0.4b
Radiant+Sniper	5 oz + 5 oz	0.0b	0.0b	0.4b	0.8b	0.5b	0.0a	0.0a	0.3b
Coragen	4.5 oz	0.4b	0.0b	0.0b	1.3ab	0.0b	0.0a	0.0a	0.2b
Coragen + Sniper	5 oz + 5 oz	0.0b	0.0b	0.0b	0.0b	0.0b	0.0a	0.0a	0.1b
Voliam Xpress	9 oz	0.0b	0.0b	1.3ab	0.8b	0.0b	0.5a	0.0a	0.4b
Proclaim + Sniper	4.5 + 1.9 oz	0.0b	0.0b	0.4b	1.3ab	0.0b	0.0a	0.0a	0.2b
Intrepid + Sniper	10 oz + 1.9 oz	1.3ab	0.5b	0.0b	0.4b	0.0b	0.0a	0.0a	0.4b
UTC	-	2.9a	8.5a	3.3a	5.8a	2.5a	1.0a	0.5a	3.5a
	F	*4.61*	*12.11*	*3.664*	*3.46*	*5.97*	*1.43*	*1.01*	*19.11*
	P>F	*0.001*	*<.0001*	*0.004*	*0.006*	*0.0001*	*0.22*	*0.46*	*<.0001*

Means within a column followed by same letter are not statistically different (Turkey's HSD test, P>0.05).

Table 2.

Treatment	Rate/ac	*Cabbage Looper larvae / 10 Plants*							
		4 DAA-1	***8 DAA-1***	***12 DAA-1***	***15 DAA-1***	***3 DAA-2***	***7 DAA-2***	***10 DAA-2***	***Avg.***
Exirel	16 oz	0.0b	0.5b	0.4b	0.4b	0.0a	0.0b	0.0b	0.2b
Exirel+Sniper	16 oz+5 oz	0.0b	0.0b	0.0b	0.0b	0.0a	0.0b	0.0b	0.0b
Radiant	5 oz	0.4b	0.0b	0.4b	0.8b	1.5a	0.0b	0.0b	0.4b
Radiant+Sniper	5 oz + 5 oz	0.0b	0.0b	0.0b	0.0b	0.0a	0.0b	0.0b	0.0b
Coragen	4.5 oz	0.4b	1.5b	0.0b	0.0b	0.5a	0.0b	0.0b	0.3b
Coragen + Sniper	5 oz + 5 oz	0.0b	0.0b	0.0b	0.0b	0.0a	0.0b	0.0b	0.0b
Voliam Xpress	9 oz	0.0b	2.0b	0.0b	0.0b	0.0a	0.0b	0.0b	0.3b
Proclaim + Sniper	4.5 + 1.9 oz	0.4b	0.0b	0.4b	0.0b	0.0a	0.0b	0.0b	0.1b
Intrepid + Sniper	10 oz + 1.9 oz	0.8ab	0.5b	0.0b	0.0b	0.0a	0.0b	0.0b	0.2b
UTC	-	3.8a	12.5a	3.8a	3.8a	1.0a	1.0a	2.0a	4.0a
	F	*3.27*	*18.04*	*9.95*	*5.27*	*1.82*	*3.01*	*3.02*	*37.21*
	P>F	*0.008*	*<.0001*	*<.0001*	*0.0004*	*0.11*	*0.01*	*0.01*	*<.0001*

Means within a column followed by same letter are not statistically different (Turkey's HSD test, P>0.05).

III. Organically-Allowed Insecticide Alternatives for Thrips Control in Fall Head Lettuce

Objective: The objective of this trial was to evaluate the efficacy of several organically allowed products against bean thrips and western flower thrips (WFT) in fall head lettuce.

Methods: Head lettuce 'PYB7101A' was direct seeded into double row beds on 42 inch centers on 29 Sep, 2016. 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. Product formulations and rates for each compound are provided in the tables.

Two foliar sprays were applied on 1 and 11 Nov with a CO_2 pressurized boom sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 22.5 gpa. An acidifier (Neutralizer) was applied to Aza-Direct, AzaGuard, Azera and Pyganic at 0.1% vol/vol to adjust the pH to 5.5. No adjuvants were applied with any of the sprays.

Numbers of WFT from 5 plants per replicate were recorded at various sample dates following each application (DAT). Relative WFT numbers were measured by removing plants and beating them vigorously against a screened pan (12 inch x 7 inch x 2 inch) for a predetermined time (10 s). A 6 inch by 6 inch 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. Because of heterogeneity of mean variances, data for all insect were transformed using a log10 (x+1) function before analysis. All data were subjected to ANOVA; means were compared using Turkey's HSD test (P=0.05). Means from nontransformed data are presented in the tables.

Summary:

The bean thrips population was high and the WFT population was moderate for fall lettuce. The only treatments that provided significant bean thrips control were Entrust at 7 oz, and the Entrust, 5 oz+M-Pede, 2% combination. Both treatments provided similar activity which is important since this provided PCAs with the option of redcuing the Entrust rate and not losing activity. Against WFT, the Entrust treatments similarly provided significant reduction of both adult and larvae compared with the untreated check. The only other treatment that provided significant control of WFT was Veritran-D, although not at the same level as the Entrust treatments. Unfortunately, Veritran-D is not labeled on lettuce at this time. It was disappointing that none of the other treatments provided significant thrips activity as a rotational partner for Entrust is sorely needed.

Table 1.

Treatment	Rate	Bean Thrips / Plant						
		3 DAA-1	**7 DAA-1**	**3 DAA-2**	**7 DAA-2**	**10 DAA-2**	**18 DAA-2**	**Trial Avg.**
Entrust	7 oz	10.4bc	7.5cd	5.4c	3.0bc	0.9c	0.0c	4.5b
Entrust+M-Pede	5 oz + 2%	6.7c	5.1d	3.6c	0.0d	1.5bc	0.3bc	2.9b
Aza-Direct	3.5 pts	37.0a	41.4a	21.9a	12.3a	8.4a	5.7a	21.1a
AzaGuard	16 oz	27.3ab	47.9a	22.5a	9.0a	13.5a	3.3abc	20.6a
Azera	3 pts	36.0a	36.3ab	22.2a	6.0ab	13.8a	3.0abc	19.6a
Azera+Pyganic	3 pts + 17 oz	28.1a	44.1a	24.6a	5.1abc	14.4a	4.2abc	20.1a
Pyganic	17 oz	27.9a	41.4a	18.0ab	6.3ab	9.9a	2.7abc	17.7a
Veratran-D	10 lbs	33.6a	32.4ab	20.7a	8.7a	11.7a	3.6abc	18.5a
Untreated	-	33.3a	46.5a	27.9a	9.0a	15.6a	7.5ab	23.3a
	F value	*11.89*	*19.77*	*8.35*	*31.56*	*11.81*	*3.85*	*58.84*
	P>F	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*0.003*	*<.0001*

Means within a column followed by same letter are not statistically different (Turkey's HSD test, P>0.05).

Table 2.

Treatment	Rate	Western Flower Thrips – Adult / Plant						
		3 DAA-1	**7 DAA-1**	**3 DAA-2**	**7 DAA-2**	**10 DAA-2**	**18 DAA-2**	**Trial Avg.**
Entrust	7 oz	4.0cd	9.6ab	4.8bc	6.0a	4.8a	3.9a	5.5bc
Entrust+M-Pede	5 oz + 2%	4.8bcd	3.6b	3.0c	0.9b	3.9a	1.5a	2.9c
Aza-Direct	3.5 pts	10.9abc	16.8a	9.3ab	10.8a	4.8a	5.1a	9.6ab
AzaGuard	16 oz	12.5a	17.1a	13.2a	5.7a	5.7a	6.0a	10.1ab
Azera	3 pts	12.0ab	12.3a	7.2abc	7.8a	6.6a	6.6a	8.8ab
Azera+Pyganic	3 pts + 17 oz	10.4abc	19.8a	11.4ab	9.0a	7.8a	8.7a	11.2a
Pyganic	17 oz	13.3a	14.7a	10.5ab	11.7a	7.5a	5.4a	10.5ab
Veratran-D	10 lbs	7.5abcd	11.1ab	4.8bc	4.2a	3.3a	4.8a	6.0bc
Untreated	-	15.9a	18.6a	10.2ab	9.0a	6.6a	6.0a	11.0ab
	F value	*7.33*	*4.45*	*5.62*	*5.26*	*1.53*	*1.56*	*9.81*
	P>F	*<.0001*	*0.001*	*0.0002*	*0.0004*	*0.18*	*0.17*	*<.0001*

Means within a column followed by same letter are not statistically different (Turkey's HSD test, P>0.05).

Table 3.

Treatment	Rate	Western Flower Thrips – Larvae / Plant						
		3 DAA-1	**7 DAA-1**	**3 DAA-2**	**7 DAA-2**	**10 DAA-2**	**18 DAA-2**	**Trial Avg.**
Entrust	7 oz	12.0b	8.4b	3.0cd	1.5b	2.4b	2.1b	4.9c
Entrust+M-Pede	5 oz + 2%	9.4b	4.2b	1.8c	0.9b	1.5b	0.0b	3.0c
Aza-Direct	3.5 pts	53.1a	52.5a	30.3ab	20.7a	18.3ab	9.6a	30.8ab
AzaGuard	16 oz	42.6a	53.4a	25.5ab	24.3a	14.4ab	10.2a	28.4ab
Azera	3 pts	54.6a	69.6a	34.8ab	17.7a	14.7ab	8.1a	33.3ab
Azera+Pyganic	3 pts + 17 oz	44.8a	46.5a	28.5ab	12.6a	16.8ab	9.6a	26.5ab
Pyganic	17 oz	40.2a	51.9a	46.2ab	43.5a	30.0a	15.0a	37.8a
Veratran-D	10 lbs	37.8a	41.1a	8.7bc	14.1a	8.1ab	8.1a	19.7b
Untreated	-	63.2a	72.3a	72.6a	30.9a	37.8a	15.0a	48.6a
	F value	*15.45*	*17.75*	*14.21*	*18.66*	*4.04*	*13.19*	*62.23*
	P>F	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*0.002*	*<.0001*	*<.0001*

Means within a column followed by same letter are not statistically different (Turkey's HSD test, P>0.05).

IV. Conventional Insecticides Alternatives for Thrips Control in Fall Head Lettuce

Objective: The objective of this trial was to evaluate the efficacy of several conventional insecticides products against bean thrips and western flower thrips (WFT) in fall head lettuce.

Methods: Head lettuce 'PYB7101A' was direct seeded into double row beds on 42 inch centers on 29 Sep, 2016. 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. Product formulations and rates for each compound are provided in the tables.

Two foliar sprays were applied on 31 Oct and 15 Nov with a CO_2 pressurized boom sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 22.5 gpa. An adjuvant, Dyne-Amic (Helena Chemical Co.), was applied at 0.125% vol/vol with these spray treatments. A

Numbers of WFT from 5 plants per replicate were recorded at various sample dates following each application (DAT). Relative WFT numbers were measured by removing plants and beating them vigorously against a screened pan (12 inch x 7 inch x 2 inch) for a predetermined time (10 s). A 6 inch by 6 inch 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. Because of heterogeneity of mean variances, data for all insect were transformed using a log10 (x+1) function before analysis. All data were subjected to ANOVA; means were compared using Turkey's HSD test (P=0.05). Means from nontransformed data are presented in the tables.

Summary:

The bean thrips population was high and the WFT population was moderate for fall lettuce. The Radiant and Lannate treatments provided the most significant control of bean thrips, and the addition of M-Pede did not enhance the activity of Entrust. Both Torac and Exirel failed to provide comparable bean thrips control and were not significantly different from the untreated check. Initially, Lannate and the Radiant + M-peded treatments provided significant knockdown of WFT adults, but averaged across the trials, none of the treatments significantly reduced adult numbers relative to the untreated check. However, all the spray treatments significantly reduced WFT larvae compared with the untreated check. Among the treatments, the Radiant and Lannate treatments provided the best overall control of WFT larvae, and the addition of M-Pede to the Radiant significantly enhanved larval activity. The results of this trial affirm previous studies that Radiant and Lannate remain the indsurty standards for thrips control, and roational alternatives of comparable efficacy are still needed.

Table 1.

		Bean Thrips/ Plant							
Treatment	**Rate/ac**	***3 DAA-1***	***7 DAA-1***	***10 DAA-1***	***14 DAA-1***	***3 DAA-2***	***7 DAA-2***	***14 DAA-2***	***Avg.***
Radiant	7 oz	2.9cd	13.7abc	10.8ab	3.0bc	3.3ab	0.9bc	0.0b	4.9de
Radiant	5 oz	4.6bc	8.7bcd	13.8ab	3.0bc	2.4ab	4.2ab	0.9ab	5.4cde
Radiant + M-Pede	5 oz+2%	1.9cd	3.0d	9.0b	2.4c	1.8ab	1.2bc	0.0b	2.8e
Radiant + Torac	5+21 oz	8.0ab	8.1bcd	22.5ab	11.1abc	7.2ab	3.9ab	0.9ab	8.8bcd
Torac	21 oz	12.7a	24.6ab	36.3a	18.3ab	10.2a	3.3ab	4.2a	15.7ab
Lannate	0.75 lb+1.9	1.5d	4.2cd	10.5ab	7.8abc	0.6b	0.3c	0.3b	3.6e
Exirel	20 oz	12.2a	15.6abc	24.3ab	14.1abc	5.4ab	3.6ab	1.5ab	11.0abc
Untreated		17.0a	35.1a	44.7a	22.5a	15.6a	7.8a	2.7a	20.7a
	F	*21.74*	*8.77*	*4.42*	*4.87*	*3.81*	*9.29*	*3.41*	*21.26*
	P>F	*<.0001*	*<.0001*	*0.004*	*0.002*	*0.008*	*<.0001*	*0.01*	*<.0001*

Means within a column followed by same letter are not statistically different (Turkey's HSD test, P>0.05).

Table 2.

		Western Flower Thrips – Adult / Plant							
Treatment	**Rate/ac**	***3 DAA-1***	***7 DAA-1***	***10 DAA-1***	***14 DAA-1***	***3 DAA-2***	***7 DAA-2***	***14 DAA-2***	***Avg.***
Radiant	7 oz	3.9ab	8.1ab	10.5a	10.2a	7.5a	2.7a	3.6a	6.6a
Radiant	5 oz	2.5bc	7.8ab	13.8a	10.2a	5.7a	2.7a	2.1a	6.4a
Radiant + M-Pede	5 oz+2%	1.5bc	2.4c	11.7a	10.8a	5.4a	5.1a	2.4a	5.6a
Radiant + Torac	5+21 oz	2.9bc	9.0ab	12.0a	7.2a	4.5a	3.0a	2.1a	5.8a
Torac	21 oz	3.0bc	9.0ab	11.1a	13.5a	9.9a	5.4a	5.7a	8.2a
Lannate	0.75 lb+1.9	1.3c	4.5bc	13.5a	15.3a	6.0a	3.6a	1.8a	6.6a
Exirel	20 oz	4.1ab	9.0ab	18.3a	13.2a	9.3a	4.5a	4.8a	9.0a
Untreated		9.3a	11.7a	13.5a	9.0a	7.2a	6.6a	5.7a	9.0a
	F	*8.21*	*5.67*	*1.55*	*1.71*	*1.49*	*0.76*	*2.85*	*3.48*
	P>F	*<.0001*	*<.0001*	*0.21*	*0.22*	*0.22*	*0.62*	*0.03*	*0.01*

Means within a column followed by same letter are not statistically different (Turkey’s HSD test, P>0.05).

Table 3.

		Western Flower Thrips – Larvae / Plant							
Treatment	**Rate/ac**	***3 DAA-1***	***7 DAA-1***	***10 DAA-1***	***14 DAA-1***	***3 DAA-2***	***7 DAA-2***	***14 DAA-2***	***Avg.***
Radiant	7 oz	6.9bcd	6.3bc	4.2c	6.9bc	5.4abc	3.6cd	3.3c	5.3c
Radiant	5 oz	3.7cde	9.0bc	5.1bc	12.9ab	3.0bc	4.5bcd	3.0c	5.9c
Radiant + M-Pede	5 oz+2%	1.8e	3.3c	6.6bc	3.6c	1.2c	3.0d	4.2c	3.4d
Radiant + Torac	5+21 oz	9.7bc	10.8b	5.7bc	7.2bc	11.1abc	4.5bcd	4.5c	7.6c
Torac	21 oz	9.4b	17.4ab	11.1abc	21.6ab	18.6abc	12.9abc	12.6ab	14.8b
Lannate	0.75 lb+1.9	2.4de	5.7bc	7.5bc	6.6bc	5.7abc	3.9bcd	5.4abc	5.3c
Exirel	20 oz	9.5b	38.4a	22.2ab	32.7ab	20.1abc	20.7ab	7.2abc	21.6b
Untreated		28.1a	47.4a	43.2a	53.1a	44.1a	31.2a	16.5a	37.7a
	F	*9.22*	*15.71*	*4.64*	*8.31*	*4.96*	*7.06*	*5.91*	*36.54*
	P>F	*<.0001*	*<.0001*	*0.003*	*<.0001*	*0.002*	*0.0002*	*0.0007*	*<.0001*

Means within a column followed by same letter are not statistically different (Turkey's HSD test, P>0.05).

V. Organically-Allowed Insecticide Alternatives for Aphid and Thrips Control in Spring Head Lettuce

Objective: to evaluate several biopesticides for control of thrips and aphids used in organic spring lettuce production .

Methods: Head lettuce was direct seeded on 25 Jan, 2017 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 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 treatment compound are provided in the tables. Four foliar application was made on 5, 11, 17 and 24 Mar with a CO_2 operated sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 22.5 GPA. No adjuvants were applied with any of the sprays.

Evaluations of aphid populations were assessed by estimating the number of aphids / plant in whole plant, destructive samples 5 days following each spray application. On each sample 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 live aphids present. Numbers of western flower thrips (WFT) from 5 plants per replicate were recorded at 5 days following each spray application. Relative WFT numbers were measured by removing plants and beating them vigorously against a screened pan (12 inch x 7 inch x 2 inch) for a predetermined time (10 s). A 6 inch by 6 inch 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.

Because of heterogeneity of mean variances, data for all insect were transformed using a log10 (x+1) function before analysis. All data were subjected to ANOVA; means were compared using Turkey’s HSD test (P=0.05). Means from nontransformed data are presented in the tables.

Summary: WFT pressure was moderate for a spring trials. Unfortunately, when averaged across the four spray applications none of the organic products provide control of either WFT adults or larvae. In contrast, aphid pressure was heavy at the beginning of the trial and consisted mainly of green peach aphid. When averaged all samples and spray, all treatments, except Neemix significantly reduced aphid numbers relative to the untreated check. Unfortunately, the organic biopesticides only provided ~ 50% reduction in aphid numbers, and were still at unacceptably high levels (>9 aphids/plant) as harvest approached

Table 1.

Treatment	Rate/ac	Avg. Western Flower Thrips / Plant						Avg. Aphids / Plant					
		Adults		Larvae		Total		Green peach		Foxglove		Total	
Aza-Direct	3 pts	13.2	a	14.4	a	27.6	a	11.6	b	0.5	a	12.1	b
Azagaurd	16 oz	10.8	a	16.2	a	27.0	a	9.5	b	0.4	a	9.9	b
PFR 97	2 lbs	11.6	a	23.9	a	35.5	a	10.0	ab	0.2	a	10.2	b
Azera	2 pts	9.8	a	21.4	a	31.2	a	9.2	b	0.4	a	9.6	b
DeBug Turbo	32 oz	9.8	a	14.5	a	24.3	a	9.9	b	0.4	a	10.3	b
Neemix 4.5	10 oz	9.6	a	20.7	a	30.3	a	15.6	ab	0.4	a	16.0	ab
Trilogy	2%	10.5	a	27.2	a	37.7	a	9.3	b	0.4	a	9.7	b
M-Pede	2%	9.1	a	17.8	a	26.9	a	9.8	b	0.3	a	10.1	b
Untreated	-	10.8	a	26.7	a	37.5	a	19.6	a	0.5	a	20.1	a
	F	*1.15*		*2.41*		*2.24*		*4.07*		*4.07*		*4.24*	
	P>F	*0.36*		*0.05*		*<.06*		*0.004*		*0.004*		*0.003*	

Means within a column followed by same letter are not statistically different (Turkey's HSD test, P>0.05).

VI. Organically-Allowed Insecticide Alternatives for Aphid and Thrips Control in Spring Head Lettuce

Objective: to evaluate several biopesticides for control of thrips and aphids used in organic spring lettuce production.

Methods: Head lettuce was direct seeded on 25 Jan, 2017 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 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 treatment compound are provided in the tables. Three foliar applications were made on 6, 14 and 24 Mar with a CO_2 operated sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 18 GPA. No adjuvants were applied with any of the sprays.

Evaluations of aphid populations were assessed by estimating the number of aphids / plant in whole plant, destructive samples 5 days following each spray application. On each sample 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 live aphids present. Numbers of western flower thrips (WFT) from 5 plants per replicate were recorded at 5 days following each spray application. Relative WFT numbers were measured by removing plants and beating them vigorously against a screened pan (12-inch x 7-inch x 2 inch) for a predetermined time (10 s). A 6 inch by 6-inch 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.

Because of heterogeneity of mean variances, data for all insect were transformed using a log10 (x+1) function before analysis. All data were subjected to ANOVA; means were compared using Turkey's HSD test (P=0.05). Means from nontransformed data are presented in the tables.

Summary: WFT pressure was moderate for a spring trials. When averaged across the three spray applications only the Entrust +M-Pede provided control of either WFT adults or larvae. Like the previous trial, none of the other biopesticides provided comparable control to Entrust which is disappointing as a rotational alternative is sorely needed. Aphid pressure was very light and this trial and we were unable to determine whether any of the treatments could effectively control aphids.

Table 1.

Treatment	Rate	Avg WFT/ Plant			Avg. Aphids / Plant		
		Adult	*Larvae*	*Total*	*Green peach*	*Foxglove*	**Trial Avg.**
BioCeres	1.0 lb	10.9a	30.9ab	41.8a	0.1	0.1	0.2
BioCeres	3.0 lb	12.0a	30.5ab	43.4a	0.2	0.0	0.2
BioCeres + AzaGuard	1.0 + 16 oz	13.5a	25.5ab	39.0a	0.2	0.0	0.2
BioCeres + AzaGuard	3.0+ 16 oz	12.3a	20.3b	32.6a	0.2	0.0	0.2
DeBug Turbo	32 oz	13.7a	27.0ab	40.7a	0.1	0.0	0.1
AZA-Direct	3 pts	15.0a	21.2ab	36.3a	0.2	0.0	0.2
AzaGuard	16 oz	14.3a	23.1ab	37.4a	0.2	0.0	0.2
Entrust+M-Pede	7 oz+2%	7.9b	3.4c	11.3b	0.3	0.1	0.3
Untreated	-	12.1a	34.4a	46.5a	0.4	0.0	0.4
	F value	*10.73*	*41.12*	*32.51*	*0.47*	*1.01*	*0.61*
	P>F	*<.0001*	*<.0001*	*<.0001*	*0.86*	*0.46*	*0.77*

Means within a column followed by same letter are not statistically different (Turkey's HSD test, P>0.05).

VII. Evaluation of a New Conventional Insecticide (BAS 440) for Control of Aphids on Head Lettuce

Objective: The objective of the trial was to evaluate the efficacy of a new aphicide (BAS 440) against aphids under desert growing conditions.

Methods: Head lettuce 'Magosa SK' was direct seeded on 17 Nov, 2016 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 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 treatment compound are provided in the tables. Two foliar application was made on 24 Jan and 9 Feb with a CO_2 operated sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 22.5 GPA. Induce at 0.125 % was added to the BAS440 treatments on the first application; Dyne-amic (0.125%) v/v was applied to all other treatments. DyneAmic (0.25%) was applied to all treatments on the 2nd spray.

Evaluations of aphid populations were assessed by estimating the number of aphids / plant in whole plant, destructive samples. On each sample date, 6-8 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 aphids present. At harvest (2 Mar), 10 plants were randomly selected from each plot and sampled by visually examining all foliage within a harvested head and 4 wrapper leaves.

Summary: Aphid pressure was heavy at the beginning of the trial and consisted mainly of green peach aphid (GPA), while later in the trial at harvest, foxglove (FGA) was the predominate aphid. Table 1 show the seasonal average of aphids on head lettuce following the 2 sprays. For GPA, all the treatments significantly controlled the aphids, but Beleaf, Sequoia and Sivanto provided the most consistent control. As for FGA, the BAS 440 treatments and Movento did not significantly reduce FGA numbers relative to the Untreated check. At harvest, GPA contamination in heads was negligible (Table 2). Control of FGA at harvest was most significant in the Sequoia and Beleaf treatments, and significant control was not obtained with either of BAS440 treatments, Movento or Assail. It was not surprising the Assail performed poorly against FGA since we have seen for years that neonicotinoids are weak against this aphid. However, it was surprising that Movento did not perform better, and we're not certain why it did not. We also xpected the BAS440 to be much better as it has been in other areas. We will continue to evaluate this new compound for aphid activity in desert lettuce.

Table 1.

Treatment	Rate/ac	Seasonal Avg. Aphids / Plant		
		Green peach aphid	**Foxglove aphid**	**Total**
BAS 440	1.5 oz	1.7b	7.4ab	9.1abc
BAS 440	2 oz	1.7b	7.3abc	9.0ab
Movento	5 oz	1.0bc	2.6abc	3.6bcd
Beleaf	2.8 oz	0.9c	0.5de	1.4ef
Assail	4 oz	1.0bc	1.9bcd	2.9cde
Fulfill	2.8 oz	2.0b	1.2cd	3.2bcd
Sequioa	2 oz	0.8c	0.1e	0.9df
Sivanto	10 oz	0.7c	0.9cde	1.6def
Untreated	-	3.4a	9.4a	12.8a
	F Value	*16.91*	*13.66*	*18.61*
	P>F	*<.0001*	*<.0001*	*<.0001*

Means within a column followed by same letter are not statistically different (Turkey's HSD test, P>0.05).

Table 2.

Treatment	Rate/ac	**Harvest- Avg. Aphids / Head** Green peach aphid	Foxglove aphid	Total
BAS 440	1.5 oz	0.0a	41.6a	41.6a
BAS 440	2 oz	0.3a	35.7a	36.0a
Movento	5 oz	0.0a	8.1ab	8.1ab
Beleaf	2.8 oz	0.0a	0.8cd	0.8cd
Assail	4 oz	0.0a	9.9ab	9.9ab
Fulfill	2.8 oz	0.1a	3.8bc	3.9bc
Sequioa	2 oz	0.0a	0.5d	0.5d
Sivanto	10 oz	0.0a	4.4bc	4.4bc
Untreated	-	0.2a	35.7a	35.9a
	F Value	*0.78*	*18.53*	*18.952*
	P>F	*0.63*	*<.0001*	*<.0001*

Means within a column followed by same letter are not statistically different (Turkey's HSD test, P>0.05).

VIII. Evaluation of a New Conventional Insecticide (pyrifluquinazon) for Control of Aphids on Head Lettuce

Objective: The objective of the trial was to evaluate the efficacy of a new aphicide (pyrifluquinazon) against aphids under desert growing conditions.

Methods:

Lettuce 'Salute' was direct seeded was direct seeded on 7 Dec, 2016 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. Plots were arranged in a randomized complete block design with 4 replications. Formulations and rates for each compound are provided in the tables. Two applications were made on 10 Feb and 5 Mar. Foliar sprays were applied with a CO_2 operated boom sprayer at 40 psi and 22 gpa. A broadcast application was delivered through 4 TX-18 ConeJet nozzles per bed. Dyne-Ammic was applied to all treatments at 0.25% vol/vol. The Admire Pro treatment was applied by placing the insecticides 1.5 inches directly below each seed line with a modified fertilizer shank just prior to planting in a total water volume of 20.5 gpa

Green peach aphid (GPA) and Foxglove aphid (FGA) populations were assessed by estimating the number of aphids / plant in whole plant, destructive samples. On each sampling date, 5-10 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 (14 Mar), 10 heads +4 wrapper leaves were sampled for aphid contamination. Because of heterogeneity of mean variances, data were transformed using a $\log_{10}(x + 1)$ function before analysis and subjected to ANOVA; means were compared using Turkey's HSD test ($P \leq 0.05$). Means from non-transformed data are presented in the table.

Summary: Similar to the previous trials, GPA pressure was heavy at the beginning of the trial, while at harvest, (FGA) was the predominate aphid. The seasonal average of GPA on head lettuce following the 2 sprays was low, but differed among the treatments (Table 1). All of the treatments significantly reduced GPA relative to the untreated check. A similar trend was observed with FGA except that the Movento did not provide significant control. At harvest, GPA contamination in heads was negligible and did not differ among the treatments (Table 2). Control of FGA at harvest was most significant in the Sequoia and Beleaf treatments, and significant control was not obtained with either of pyrifluquinazon, Movento or Sivanto. Similar to the previous trial, it was surprising that Movento did not perform better, and we're not certain why it did not. Pyrifluquinazon did not appear to be as efficacious against aphids as the standards, Sequoia and Beleaf. We will continue to evaluate this new compound for aphid activity in desert lettuce.

Table 1.

		Seasonal Avg. Aphids / Plant		
Treatment	**Rate/ac**	**Green peach aphid**	**Foxglove aphid**	**Total**
Pyrfluquinazon	3.2 oz	0.20bc	0.75bc	0.95cd
Beleaf	2.8 oz	0.10c	0.16bc	0.26d
Movento	5 oz	0.30bc	1.59ab	1.89b
Sivanto	10 oz	0.30bc	0.75bc	1.05bcd
Sequoia	2 oz	0.10c	0.14c	0.24d
Admire Pro, AP	10.5 oz	0.40b	0.44bc	0.84bc
Untreated	-	1.60a	4.26a	5.86a
	F Value	*21.01*	*10.11*	*23.85*
	P>F	*<.0001*	*<.0001*	*<.0001*

Means within a column followed by same letter are not statistically different (Turkey's HSD test, P>0.05).

Table 2.

Treatment	Rate/ac	Harvest- Avg. Aphids / Head		
		Green peach aphid	**Foxglove aphid**	**Total**
Pyrfluquinazon	3.2 oz	0.08a	3.48ab	3.55ab
Beleaf	2.8 oz	0.05a	0.33b	0.38b
Movento	5 oz	0.03a	1.80ab	1.83ab
Sivanto	10 oz	0.00a	0.90ab	0.90b
Sequoia	2 oz	0.08a	0.45b	0.53b
Admire Pro, AP	10.5 oz	0.00a	0.93ab	0.93b
Untreated	-	2.50a	8.40a	10.90a
	F Value	*1.01*	*3.81*	*3.94*
	P>F	*0.45*	*0.01*	*0.01*

Means within a column followed by same letter are not statistically different (Turkey's HSD test, P>0.05).