Arizona Department of Agriculture
AILRC Grants Program – Final Report for 2014
December 2014

Project title: **Insect Management in Desert Head Lettuce**

Project Investigator: John C. Palumbo, University of Arizona, Yuma Agricultural Center

Location of Research: Yuma Valley Agricultural Center

Objective 1: *To continue to Compare The Knockdown And Residual Efficacy Of Several New Insecticides For* Thrips, Aphids, Whiteflies and Worms *Control Relative to the Industry Standards Currently Used in Desert Head Lettuce Production.*

The number of new insecticides being developed for insect control in head lettuce continues to increase each year. This is extremely important given the recent losses of a number of important insecticide uses (e.g., diazinon, dimethoate). Furthermore, this summer endosulfan will be permanently removed from the market. Many in the industry expect restrictions in the uses of pyrethroids and other older products to follow in the future. 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 growers 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.

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. Western flower thrips have become increasingly difficult and expensive to control in both spring and fall lettuce. Two of the primary products currently used for controlling thrips (Lannate and Orthene) are directly threatened by FQPA and their future registrations are uncertain. A complex of aphid species are well established in desert lettuce and their control can be expensive. Finally, whiteflies and worm pests such as beet armyworm and cabbage looper remain the most economically important pest in fall lettuce and typically require intensive management to prevent losses.

Newer insecticides currently available for control of key insect pests are shown in ***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. 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 **(Table 2).** 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.

Table 1. Industry standards currently used for insect management in head lettuce[1].

Product	Chemical Name	IRAC MOA group	Effective Insect Spectrum on Desert Lettuce				
			Worms	Leaf miners	Whiteflys	Thrips	Aphids
*Primarily considered **Worm** compounds*							
Radiant	Spinetoram	5	●	●		●	
Proclaim	Emamectin	6	●				
Intrepid	Methoxyfenozide	18A	●				
Voliam Xpress	Rynaxypyr+ Pyreth	28+3	●	●			
*Primarily considered **Aphid** compounds*							
Movento	Spirotetramat	23			●		●
Admire, Alias	Imidacloprid	4A			●		●
Assail	Acetamiprid	4A			●		●
Beleaf	Flonicamid	9C					●

Table 2. New insecticides currently in development for insect management

Active ingredient	Proposed Product Name	IRAC MOA group	Presumed Spectrum of Insect Activity				
			Worms	Leaf miners	Whiteflys	Thrips	Aphids
Cyazypyr -soil	Verimark SE	28	●	●	●		
Cyazypyr-foliar	Exirel SE	28	●	●	●		
Pyrifluquinazon	N/A	Unknown			●	●	●
Sulfoxaflor	Closer 2SC	4C			●		●
Flupyradifurone	Sivanto 240SL	Unknown			●		●
Tolfenpyrad	Turoc 15EC	21	●			●	●

I. Efficacy against Worms/Leafminer/Whitefly

Foliar Trial

CONTROL OF LEPIDOPTEROUS LARVAE WITH EXIREL IN HEAD LETTUCE

The objective of this trial was to compare the efficacy of a new insecticide, Exirel (cyantraniliprole), with insecticide standards currently used in head lettuce under fall growing conditions. Head lettuce '1221' was direct seeded into double row beds on 42 inch centers on 6 Sep, 2013. 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 sprays were applied on 24 Sep, and 7 and 26 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 22.5 GPA. An adjuvant, Dyne-Amic (Helena Chemical Co.), was applied at 0.125% vol/vol with these spray treatments. At various intervals after treatment (DAT), 10 plants were randomly selected from each replicate and destructively sampled for the presence of each insect species. BAW and 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, 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.

BAW and CL population pressure was moderate during this trial. All of the treatments provided significant reductions in larvae numbers on each post-treatment sample, except for Intrepid+Warrior and Proclaim. The Exirel treatment provided equivalent larval control to the other diamides insecticides (Coragen, Vetica, Volam Xpress), as well to the industry standard treatments, Radiant, and Proclaim+Pyrethroid. No phytotoxicity symptoms were observed following any of the insecticide treatments.

Table 1.

		Mean BAW larvae / 10 plants								
Treatment/formulation	**Rate/acre**	**3- DAT1 27-Sep**	**7- DAT1 1-Oct**	**10- DAT1 4-Oct**	**3- DAT2 10-Oct**	**7- DAT2 14-Oct**	**14 -DAT2 21-Oct**	**5- DAT3 31-Oct**	**10- DAT3 5-Nov**	**Avg.**
Radiant SC	5 oz	0.0 b	0.0 b	0.0 b	0.3 b	1.3 bc	0.0 c	0.5 c	0.5 a	0.3 c
Intrepid 2F+Warrior II	10 + 1.9 oz	0.3 b	0.0 b	0.9 b	1.3 b	2.9 ab	5.0 b	4.0 abc	1.5 a	2.0 b
Proclaim 5SG	3.5 oz	0.3 b	0.0 b	0.3 b	0.3 b	0.4 c	2.5 bc	5.0 ab	0.5 a	1.1 bc
Proclaim +Warrior II	3.8 + 1.9 oz	0.3 b	0.0 b	0.6 b	0.9 b	2.1 bc	4.0 bc	1.5 bc	0.5 a	1.2 bc
Proclaim+Brigade 2EC	3.8+5 oz	0.0 b	0.0 b	0.6 b	0.3 b	0.9 bc	2.0 bc	1.0 c	0.0 a	0.5 c
Exirel 10 SE	14 oz	0.0 b	0.0 b	0.0 b	0.0 b	0.0 c	0.5 c	1.5 bc	0.0 a	0.3 c
Coragen 1.6SC	5 oz	0.0 b	0.0 b	0.3 b	0.0 b	0.0 c	2.0 bc	0.5 c	0.0 a	0.4 c
Voliam Xpress	9 oz	0.0 b	0.0 b	0.0 b	0.3 b	0.4 c	1.0 bc	1.0 bc	0.5 a	0.4 c
Vetica	17 oz	0.0 b	0.0 b	0.3 b	0.3 b	1.3 bc	0.5 c	1.5 bc	0.5 a	0.5 c
UTC		5.3 a	7.2 a	2.2 a	6.3 a	5.8 a	14.0 a	8.0 a	5.0 a	6.7 a
	F value	*83.43*	*94.21*	*2.76*	*7.91*	*3.91*	*4.53*	*2.69*	*1.63*	*19.79*
	Pr > F	*<.0001*	*<.0001*	*0.02*	*<.0001*	*0.003*	*0.001*	*0.02*	*0.16*	*<.0001*

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

Table 2.

Treatment/formulation	Rate/acre	Mean CL larvae / 10 plants								
		3- DAT1	7- DAT1	10- DAT1	3- DAT2	7- DAT2	14 -DAT2	5- DAT3	10- DAT3	
		27-Sep	1-Oct	4-Oct	10-Oct	14-Oct	21-Oct	31-Oct	5-Nov	Avg.
Radiant SC	5 oz	0.0 b	0.0 b	0.0 a	0.0 b	0.0 b	3.5 b	2.5 bc	1.0 b	0.9 b
Intrepid 2F+Warrior II	10 + 1.9 oz	0.0 b	0.0 b	0.3 a	0.0 b	0.8 b	1.0 bc	0.0 c	0.5 b	0.3 b
Proclaim 5SG	3.5 oz	0.0 b	0.3 b	0.0 a	1.6 a	0.4 b	1.5 bc	4.5 ab	1.5 b	1.2 b
Proclaim +Warrior II	3.8 + 1.9 oz	0.0 b	0.0 b	0.0 a	0.0 b	0.0 b	1.0 bc	1.5 bc	0.0 b	0.4 b
Proclaim+Brigade 2EC	3.8+5 oz	0.0 b	0.0 b	0.0 a	0.0 b	0.0 b	0.0 c	1.0 c	0.0 b	0.1 b
Exirel 10 SE	14 oz	0.0 b	0.0 b	0.0 a	0.0 b	0.4 b	0.0 c	2.5 bc	0.5 b	0.4 b
Coragen 1.6SC	5 oz	0.0 b	0.0 b	0.0 a	0.3 b	1.3 b	1.5 bc	1.0 c	0.0 b	0.5 b
Voliam Xpress	9 oz	0.0 b	0.0 b	0.3 a	0.3 b	0.0 b	0.0 c	0.5 c	1.0 b	0.3 b
Vetica	17 oz	0.0 b	0.0 b	0.3 a	0.3 b	1.3 b	4.0 b	1.5 bc	0.5 b	0.9 b
UTC		1.0 a	1.9 a	0.9 a	1.9 a	7.9 a	9.5 a	8.0 a	11.0 a	5.3 a
	F value	*6.27*	*3.28*	*1.61*	*4.52*	*9.525*	*5.52*	*3.82*	*7.87*	*12.72*
	Pr > F	*<.0001*	*0.008*	*0.16*	*0.001*	*<.0001*	*0.0003*	*0.003*	*<.0001*	*<.0001*

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

Foliar Trial

INSECT CONTROL WITH DIAMIDE INSECTICIDES IN HEAD LETTUCE, 2013

The objective of this trial was to compare the efficacy of new foliar diamide insecticide for control against lepidopterous larvae under fall growing condition. Head lettuce "1221' was direct seeded into double row beds on 42 inch centers on 6 Sep, 2013. Plots were two beds wide by 35 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. Two foliar sprays were applied on 11 and 18 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 22.5 GPA. An adjuvant, Dyne-Amic (Helena Chemical Co.), was applied at 0.125% vol/vol with these spray treatments. At various intervals after treatment (DAT), 10 plants were randomly selected from each replicate and destructively sampled for the presence of lepidopterous larvae. BAW and 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, 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.

CL pressure was moderate and BAW pressure light during this trial. All of the Diamide foliar treatments provided equivalent control of both CL and BAW larvae following each application (Table 1 and 2), and averaged across all samples, the diamide compounds provided equitable control to the industry standard, Radiant. No phytotoxicity symptoms were observed following any of the insecticide treatments. This research was supported by a grant from the Arizona Iceberg Lettuce Research Council, 13-01.

Table 1.

		Mean large CL larvae / 10 plants					
		3 DAT1	**7 DAT1**	**3 DAT2**	**7 DAT2**	**14 DAT2**	**Trial**
Treatment	**Rate/ac**	*14-Oct*	*18-Oct*	*21-Oct*	*25-Oct*	*1-Nov*	**Avg.**
IKI-3106 50SL	11 oz	0.3 a	0.0 b	0.0 c	0.0 b	0.4 b	0.1 b
IKI-3106 50SL	16.4 oz	0.0 a	0.0 b	0.0 c	0.0 b	1.3 b	0.3 b
Radiant SC	5 oz	0.0 a	0.0 b	1.3 b	0.0 b	0.4 b	0.3 b
Exirel 10SE	13 oz	0.3 a	0.0 b	0.0 c	0.0 b	0.0 b	0.1 b
Belt 4SC	1.5 oz	0.0 a	0.0 b	0.4 bc	0.4 b	1.6 b	0.5 b
Untreated	-	0.3 a	2.8 a	2.5 a	5.0 a	7.5 a	3.6 a
	F value	*0.53*	*4.61*	*9.76*	*24.93*	*4.81*	*17.44*
	Pr > F	*0.75*	*0.009*	*0.0003*	*<.0001*	*0.008*	*<.0001*

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

Table 2.

		Mean large BAW larvae / 10 plants					
		3 DAT1	7 DAT1	3 DAT2	7 DAT2	14 DAT2	Trial
Treatment	**Rate/ac**	*14-Oct*	*18-Oct*	*21-Oct*	*25-Oct*	*1-Nov*	**Avg.**
IKI-3106 50SL	11 oz	0.0 a	0.6 a	0.0 a	0.0 b	0.0 b	0.1 b
IKI-3106 50SL	16.4 oz	0.0 a	0.0 a	0.0 a	0.0 b	0.0 b	0.0 b
Radiant SC	5 oz	0.0 a	0.0 a	0.0 a	0.0 b	0.0 b	0.0 b
Exirel 10SE	13 oz	0.0 a	0.3 a	0.0 a	0.0 b	0.0 b	0.1 b
Belt 4SC	1.5 oz	0.0 a	0.3 a	0.0 a	0.0 b	0.0 b	0.1 b
Untreated	-	0.3 a	0.6 a	0.0 a	2.1 a	2.5 a	1.1 a
	F value	*1.01*	*0.65*	*0*	*7.11*	*3.01*	*6.19*
	Pr > F	*0.46*	*0.66*	*0*	*0.001*	*0.05*	*0.003*

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

Soil Trial

CROSS-SPECTRUM INSECT CONTROL WITH SOIL APPLIED DIAMIDE INSECTICIDES

The objective of this trial was to compare the efficacy of a new diamides insecticide, Verimark (cyantraniliprole), with other diamides and neonicotinoid insecticides for cross-spectrum (sucking and chewing insect pests) control of major insects in head lettuce under fall growing conditions. Head lettuce '1221' was direct seeded into double row beds on 42 inch centers on 7 Sep, 2013. 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. Sub-surface, soil injection application of each 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. No other insecticides were applied to the soil treated plants during the trial. At various intervals after planting (DAP), 10 plants were randomly selected from each replicate and destructively sampled for the presence of each insect species. Evaluation of LM control was conducted by examining all leaves on each plant and counting the number of mines on each leaf. BAW and CL control was based on the examination of whole plants for presence of large (2^{nd} or older instars) larvae. Evaluations of SWF control was estimated by counting the number of total nymphs on two, 2-cm^2 disk sections taken from 2 consecutive basal leaves collected from each of 5 plants per replicate. SWF nymph densities on each leaf disk were estimated under magnification in the laboratory. Because of heterogeneity of mean variances, 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.

LM population pressure was light and differences among treatments and the untreated check were observed on all sample dates (Table 1). Overall, the addition of Admire Pro with Verimark did not improve LM control over Verimark applied alone, but both Verimark soil treatments provided significantly better control than Coragen+Admire and Durivo. A similar response was observed for SWF control (Table 2), where Coragen+Admire Pro and Durivo provided inconsistent residual control of large nymphs compared to the both the untreated check and the Verimark treatments. Again the addition of Admire Pro with Verimark did not significantly improve SWF control. BAW and CL population pressure was light until 22 and 26 DAP for BAW and CL respectively moderate, during this trial. Thereafter, larval population reached moderate levels for both species. Verimak applied alone provided BAW and CL control equivalent to the other soil treatments, except for CL at 42 DAP when treatment differences between the soil treatments and the untreated check were not significant. These results further validate previous studies that suggest Verimark can provide excellent levels of cross-spectrum activity in head lettuce that is commonly expected mixtures of soil and foliar insecticides. No phytotoxicity symptoms were observed following any of the insecticide treatments.

Table 1

		Mean *Liriomyza* leaf mines / Plant				
		20 DAP	**30 DAP**	**40 DAP**	**50 DAP**	
Treatment/formulation	**Rate/acre**	***26-Sep***	***6-Oct***	***16-Oct***	***26-Oct***	**Avg.**
Verimark 20SC	13.5 oz	0.0 b	0.0 b	1.5 b	1.0 cd	0.6 c
Verimark 20SC +Admire	13.5 + 10.4 oz	0.0 b	0.0 b	0.0 b	0.0 d	0.0 c
Coragen 1.6 SC+ Admire	5 oz + 10.4 oz	0.0 b	0.3 b	2.5 b	10.5 b	3.3 b
Durivo	13 oz	0.0 b	0.6 b	1.5 b	8.0 bc	2.5 b
Untreated check	-	1.0 a	8.4 a	17.0 a	27.0 a	13.3 a
	F value	*7.42*	*21.64*	*13.71*	*10.16*	*66.61*
	Pr > F	*0.003*	*<.0001*	*0.0002*	*0.0008*	*<.0001*

Table 2

		Mean *Liriomyza* leaf mines / Plant				
		20 DAP	**30 DAP**	**40 DAP**	**50 DAP**	
Treatment/formulation	**Rate/acre**	***26-Sep***	***6-Oct***	***16-Oct***	***26-Oct***	**Avg.**
Verimark 20SC	13.5 oz	0.4 b	0.4 c	0.5 c	0.3 a	0.4 c
Verimark 20SC +Admire	13.5 + 10.4 oz	0.2 b	0.3 c	0.5 c	0.3 a	0.3 c
Coragen 1.6 SC+ Admire	5 oz + 10.4 oz	0.1 b	1.7 b	0.7 bc	0.3 a	1.1 b
Durivo	13 oz	0.7 b	2.4 b	1.2 a	0.1 a	1.8 ab
Untreated check	-	1.1 a	3.8 a	0.9 ab	0.2 a	2.4 a
	F value	*3.57*	*27.41*	*6.78*	*2.11*	*31.91*
	Pr > F	*0.04*	*<.0001*	*0.004*	*0.14*	*<.0001*

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

Table 3.

		Mean BAW larvae / 10 plants						
		18 DAP	22 DAP	26 DAP	30 DAP	36 DAP	42 DAP	
Treatment/formulation	**Rate/acre**	***24-Sep***	***28-Sep***	***2-Oct***	***6-Oct***	***12-Oct***	***18-Oct***	**Avg.**
Verimark 20SC	13.5 oz	0.0 a	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b
Verimark 20SC +Admire	13.5 + 10.4 oz	0.0 a	0.0 b	0.0 b	0.3 b	0.0 b	1.0 b	0.2 b
Coragen 1.6 SC+ Admire	5 oz + 10.4 oz	0.0 a	0.0 b	0.0 b	0.3 b	0.4 b	2.0 b	0.5 b
Durivo	13 oz	0.0 a	0.0 b	0.0 b	0.3 b	0.4 b	5.0 b	1.0 b
Untreated check	-	1.0 a	5.3 a	5.6 a	7.5 a	5.4 a	11.5 a	6.1 a
	F value	*1.01*	*36.78*	*72.61*	*7.07*	*5.24*	*8.81*	*36.24*
	Pr > F	*0.45*	*<.0001*	*<.0001*	*0.004*	*0.01*	*0.002*	*<.0001*

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

Table 4.

		Mean CL larvae / 10 plants						
		18 DAP	22 DAP	26 DAP	30 DAP	36 DAP	42 DAP	
Treatment/formulation	**Rate/acre**	***24-Sep***	***28-Sep***	***2-Oct***	***6-Oct***	***12-Oct***	***18-Oct***	**Avg.**
Verimark 20SC	13.5 oz	0.0 a	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b
Verimark 20SC +Admire	13.5 + 10.4 oz	0.0 a	0.0 b	0.0 b	0.3 b	0.0 b	1.0 b	0.2 b
Coragen 1.6 SC+ Admire	5 oz + 10.4 oz	0.0 a	0.0 b	0.0 b	0.3 b	0.4 b	2.0 b	0.5 b
Durivo	13 oz	0.0 a	0.0 b	0.0 b	0.3 b	0.4 b	5.0 b	1.0 b
Untreated check	-	1.0 a	5.3 a	5.6 a	7.5 a	5.4 a	11.5 a	6.1 a
	F value	*1.01*	*36.78*	*72.61*	*7.07*	*5.24*	*8.81*	*36.24*
	Pr > F	*0.45*	*<.0001*	*<.0001*	*0.004*	*0.01*	*0.002*	*<.0001*

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

II. Efficacy against Aphids

GREEN PEACH APHID CONTROL IN HEAD LETTUCE

John C. Palumbo

The objective of this study was to evaluate the efficacy of the new active ingredients sulfoxaflor (Closer), and tolfenpyrad (Torac), and pyrifluquinazon as foliar alternatives for control of green peach aphids on spring head lettuce under desert growing conditions. Head lettuce 'Winter King' was direct seeded into double row beds on 42 inch centers on 29 Nov, 2012. 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 15 Feb and 5 Mar with a CO_2 operated boom sprayer at 40 psi and 20.5 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% vol/vol to all treatments. GPA 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 transformed (mean+1) and subjected to ANOVA; means were separated using a *F*-protected LSD ($P \leq 0.05$). Actual non-transformed means are presented in the tables.

GPA pressure was light during the trial. All of the treatments provided significant reductions in larvae numbers on each post-treatment sample, except for the Assail treatment which did not differ from the untreated check on three evaluations. Overall, the higher rates of Closer and pyrifluquinazon provided equivalent control to the industry standard, Movento. No phytotoxicity symptoms were observed following any of the insecticide treatments. This research was supported by a grant from the Arizona Iceberg Lettuce Research Council, 13-01.

		Mean GPA / plant			
		7 DAT-1	15 DAT-1	7 DAT-2	15 DAT-2
Treatment/formulation	Rate/acre	21-Feb	Feb-29	12-Mar	20-Mar
Closer 2SC	1.43 oz	1.4 b	2.0 bc	1.8 c	1.3 b
Closer 2SC	2.14 oz	2.1 b	1.1 cd	1.1 c	0.1 c
Closer 2SC	2.85 oz	1.0 b	0.9 cd	0.8 c	0.4 c
Torac 15EC	21 oz	2.2 b	1.3 cd	1.6 c	1.6 b
Pyrifluquinazon 20SC	3.2 oz	1.1 b	0.7 d	2.1 bc	0.9 bc
Assail 30SG	4 oz	1.8 b	5.7 ab	6.8 ab	4.4 a
Movento 2SC	5 oz	1.3 b	0.9 cd	1.1 c	0.4 c
Untreated check	-	8.6 a	10.9 a	11.5 a	6.4 a

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

III. Efficacy against Western Flower Thrips

EVALUATION OF SEQUOIA AND MOVENTO FOR CONTROL OF WESTERN FLOWER THRIPS

The objective of the trial was to evaluate the efficacy of the aphicides Sequoia and Movento against western flower thrips relative to the industry standards on romaine lettuce. Head lettuce 'Pennylea' was direct seeded on 5 Dec, 2013 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. Two foliar sprays were applied on 4 and 18 Feb. The applications were made with a CO_2 pressurized boom sprayer that delivered a broadcast application at 40 psi and 22.5 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 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 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.

WFT population levels were moderate during this trial. Sequoia and Movento applied alone did not significantly reduce WFT adult numbers relative to the non-treated control (Table 1). However, in most case, combination of either compound with either Lannate or Radiant provided significant improvements in adult control. Movento, however did demonstrate significant efficacy against WFT larvae relative to the non-treated control on several post-spray evaluations (Table 2). In contrast, Sequoia did not reduce WFT larvae numbers compared to the non-treated control. Tank mixtures of Movento or Sequoia with Radiant and Lannate resulted in enhanced control of WFT larvae. The study was clearly showed that Movento and Sequoia did not provide adequate control of WFT. No phytotoxicity symptoms were observed following any of the insecticide treatments. This research was supported by a grant from the Arizona Iceberg Lettuce Research Council, 14-05

Table 1.

Treatment/ formulation	Rate amt product/acre	WFT Adults / Plant						
		3 DAT-1	***7 DAT-1***	***14 DAT-1***	***3 DAT-2***	***7 DAT-2***	***14 DAT-2***	**Avg**
Sequoia 2F	2 fl oz	3.8ab	5.7ab	6.9a	5.5ab	3.8bc	9.9a	6.3abc
Sequoia+Radiant 1SC	2+7 fl oz	1.1c	2.4c	9.4a	4.3abc	3.2bc	11.9a	5.5cde
Sequoia+Lannate 90SP	2 fl oz+0.75 lb	1.4bc	2.8bc	8.3a	2.3bc	2.1c	11.2a	4.9de
Sequoia+Torac 15EC	2 fl oz+21 fl oz	2.4abc	3.3bc	8.7a	4.1abc	4.9ab	13.5a	6.1bcd
Movento 2F	5 fl oz	4.3a	7.0a	9.1a	6.1a	8.2a	9.6a	7.6a
Movento+Radiant	5+7 fl oz	1.1c	2.0c	6.8a	2.1bc	2.3bc	10.7a	4.3e
Movento+Lannate	5 fl oz+0.75 lb	1.3c	2.0c	8.7a	1.9c	2.5bc	14.1a	5.3de
Movento+Torac	5 fl oz+21 fl oz	2.5abc	2.1c	8.0a	3.8abc	3.4bc	13.8a	5.6bcde
Non-treated check	-	4.0ab	5.5ab	6.3a	7.5a	4.0abc	11.5a	6.8ab
	F value	*6.79*	*10.29*	*1.48*	*5.97*	*6.58*	*0.52*	*13.39*
	P > F	*0.0001*	*<.0001*	*0.22*	*0.0003*	*0.0001*	*0.83*	*<.0001*

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

Table 2.

Treatment/ formulation	Rate amt product/acre	WFT Larvae / Plant						
		3 DAT-1	***7 DAT-1***	***14 DAT-1***	***3 DAT-2***	***7 DAT-2***	***14 DAT-2***	**Avg**
Sequoia 2F	2 fl oz	4.2a	9.6ab	19.6a	12.4a	10.5a	3.0a	11.2a
Sequoia+Radiant 1SC	2+7 fl oz	1.7ab	1.5d	2.5cd	1.1cde	1.5bcd	0.5b	1.9d
Sequoia+Lannate 90SP	2 fl oz+0.75 lb	0.7b	2.5cd	4.5bc	1.3cde	0.8cd	1.2ab	2.8cd
Sequoia+Torac 15EC	2 fl oz+21 fl oz	3.3ab	5.9abc	8.0b	3.7b	3.5b	2.3a	5.5b
Movento 2F	5 fl oz	4.5a	9.3ab	9.2b	2.5bc	2.3bc	0.9ab	6.5b
Movento+Radiant	5+7 fl oz	1.2ab	0.8d	1.6d	0.8de	0.6d	0.2b	1.0e
Movento+Lannate	5 fl oz+0.75 lb	0.6b	1.3d	3.5bcd	0.4e	0.7d	0.4b	2.2de
Movento+Torac	5 fl oz+21 fl oz	2.4ab	4.6bc	5.1bc	1.8bcd	0.7d	0.6b	3.4c
Non-treated check	-	3.5a	16.3a	23.4a	16.8a	14.0a	2.8a	13.9a
	F value	*5.55*	*19.66*	*24.13*	*40.92*	*35.81*	*9.83*	*136.72*
	P > F	*0.0005*	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*

EVALUATION OF INSECTICIDES FOR CONTROL OF WESTERN FLOWER THRIPS

The objective of the trial was to evaluate the efficacy of foliar insecticides against western flower thrips relative to the industry standards on romaine lettuce. Romaine 'Sunbelt' was direct seeded on 24 Jan, 2014 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. Two foliar sprays were applied on 6 and 17 Feb. The applications were made with a CO_2 pressurized boom sprayer that delivered a broadcast application at 40 psi and 22.5 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 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 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.

WFT population levels were moderate during this trial. Movento did not significantly reduce WFT adult numbers relative to the industry standards (Warrior II+Lannate and Radiant) or the non-treated check on any of the sample dates (Table 1). Torac significantly reduced adult numbers compared to the non-treated check across the trial. The addition of Torac with Movento significantly reduced adult numbers on all sample dates except 3 DAT-2. Overall, the two industry standards, Warrior II+Lannate and Radiant, provided the most consistent adult WFT control. Movento did significantly reduce WFT larvae compared to the non-treated check at 11 DAT1 and on all samples following the second application (Table 2). The Torac + Movento mixture did not consistently improve the performance of either product applied alone. Overall, Radiant provided the most significant reduction in WFT larvae compared to all other spray treatments and the non-treated check. No phytotoxicity symptoms were observed following any of the insecticide treatments.

Table 1

Treatment/ formulation	Rate amt product/acre	WFT Adults / Plant						
		3 DAT-1	7 DAT-1	11 DAT-1	3 DAT-2	7 DAT-2	11 DAT-2	Avg
Torac 15EC	21 fl oz	3.1 cd	3.4 c	4.5 b	3.0 bc	3.2 bc	3.6 cd	3.5 bc
Radiant 2SC	7 fl oz	1.8 d	2.7 cd	4.4 b	1.8 c	2.1 cd	2.7 d	2.5 d
Movento 2F	5 fl oz	5.5 ab	5.7 ab	8.6 a	5.8 a	7.3 a	9.0 a	6.9 a
Warrior II+ Lannate 90SP	1.9 fl oz+ 0.75 lb.	1.7 d	1.9 d	5.1 b	1.6 c	1.9 d	3.4 cd	2.6 d
Torac + Lannate	21 fl oz + 0.75 lb.	2.0 d	3.2 cd	5.1 b	1.6 c	3.1 bc	3.4 cd	3.1 cd
Torac + Movento	21 fl oz + 5 oz	3.3 bcd	3.7 bc	5.1 b	3.9 ab	3.6 b	4.0 bc	3.9 b
Non-treated check	-	7.6 a	6.9 a	8.6 a	5.2 ab	6.8 a	6.1 ab	6.8 a

Table 2

Treatment/ formulation	Rate amt product/acre	WFT Larvae / Plant						
		3 DAT-1	7 DAT-1	11 DAT-1	3 DAT-2	7 DAT-2	11 DAT-2	Avg
Torac 15EC	21 fl oz	3.6 ab	5.4 ab	11.1 c	5.4 bc	5.1 b	4.0 b	5.8 cd
Radiant 2SC	7 fl oz	0.7 c	1.4 c	2.0 e	0.7 e	0.7 d	1.1 d	1.1 f
Movento 2F	5 fl oz	7.6 ab	9.9 a	21.2 b	7.7 b	2.5 bc	2.1 bc	8.5 c
Warrior II+ Lannate 90SP	1.9 fl oz+ 0.75 lb.	0.2 d	1.9 bc	9.7 cd	2.9 d	1.0 cd	2.6 bc	3.1 e
Torac + Lannate	21 fl oz + 0.75 lb.	0.8 c	1.2 c	6.1 d	2.3 d	1.2 cd	1.8 cd	2.2 e
Torac + Movento	21 fl oz + 5 oz	3.1 b	5.1 ab	12.0 c	3.4 cd	1.9 c	2.4 bc	4.6 d
Non-treated check	-	7.0 a	14.1 a	39.4 a	33.4 a	30.3 a	29.2 a	25.6 a

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

Objective 2. To establish an Area-wide Insect Trapping Network in the Yuma Valley, Gila Valley, Dome Valley and Wellton/Roll areas that will provide real time information for PCAs on adult insect activity of important insect pests.

Information was gathered from a network of traps that were placed and monitored weekly from mid-August through April. A total of ten trap locations were situated in the Yuma Valley (3), Gila Valley (2) and Dome Valley (2), Wellton (2) and Tacna/Roll (1) areas. Traps were located near or adjacent to the AZMET station when possible. The approximate location of traps in each valley was determined by a survey of Yuma growers and PCAs prior to August. At each site, pheromone traps were used to monitor for adult activity of corn earworm and tobacco budworm, as well as beet armyworm and cabbage looper. In addition, yellow sticky traps were used to monitor aphids, thrips and leafminer adults. Traps were checked weekly and data was processed at the Yuma Ag Center. A The data was organized and presented by species and trap location. Relative weekly trends were also presented across the season.

Real-time information on trap captures at each location was provided bi-weekly to all PCAs and growers who receive our Veg IPM Updates via email. PCAs and growers can request weekly updates via individual emails. However, all trapping data during the course of the 2013-2014 lettuce growing season was also assessable at any time through will UA Crop Information website http://ag.arizona.edu/crops/crops.html

The project was designed to measure the activity and movement of adult populations of a number of key pests. The project provided an indication of when pest activity (e.g., corn earworm moth flights) is increasing based on pheromone / sticky trap captures. The data is not intended to indicate field infestations, as trap data is largely a reflection of adult movement. If nothing else, the data may make PCAs aware of increased pest activity in some areas and encourage intensified scouting in susceptible produce fields. The pests monitored included: corn earworm, tobacco budworm, beet armyworm, cabbage looper using pheromone traps; aphids, thrips and whiteflies using yellow sticky traps. A total of 8 trapping locations were established in the following areas (approximate location):

Trap Locations

1.	**Roll**	**- 38E and Co. 5th St.**
2.	**Wellton**	**- 28E and Co. 10th St.**
3.	**Dome**	**- 18E and Co. 6th St.**
4.	**S. Gila**	**- Hwy 95 and Ave 10 E**
5.	**N. Gila**	**- Laguna Dam Rd and Co. 3rd St.**
6.	**YAC**	**- Somerton Ave and Co. 8th St.**
7.	**YV mid**	**- Ave C1/2 and Co. 15th St.**
8.	**YV south**	**- Ave H and Co. 19th St.**

Roll

Wellton

Dome Valley

S. Gila Valley

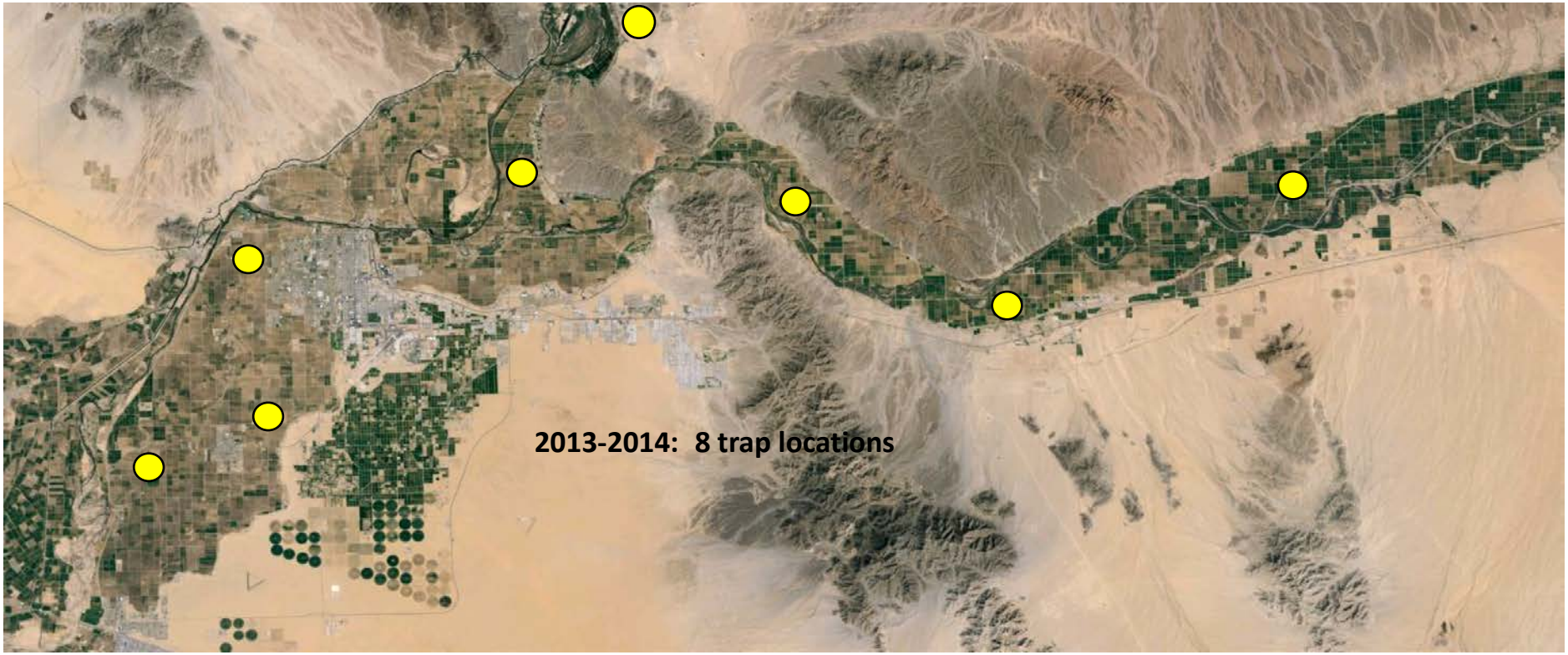
N. Gila Valley

N. Yuma Valley

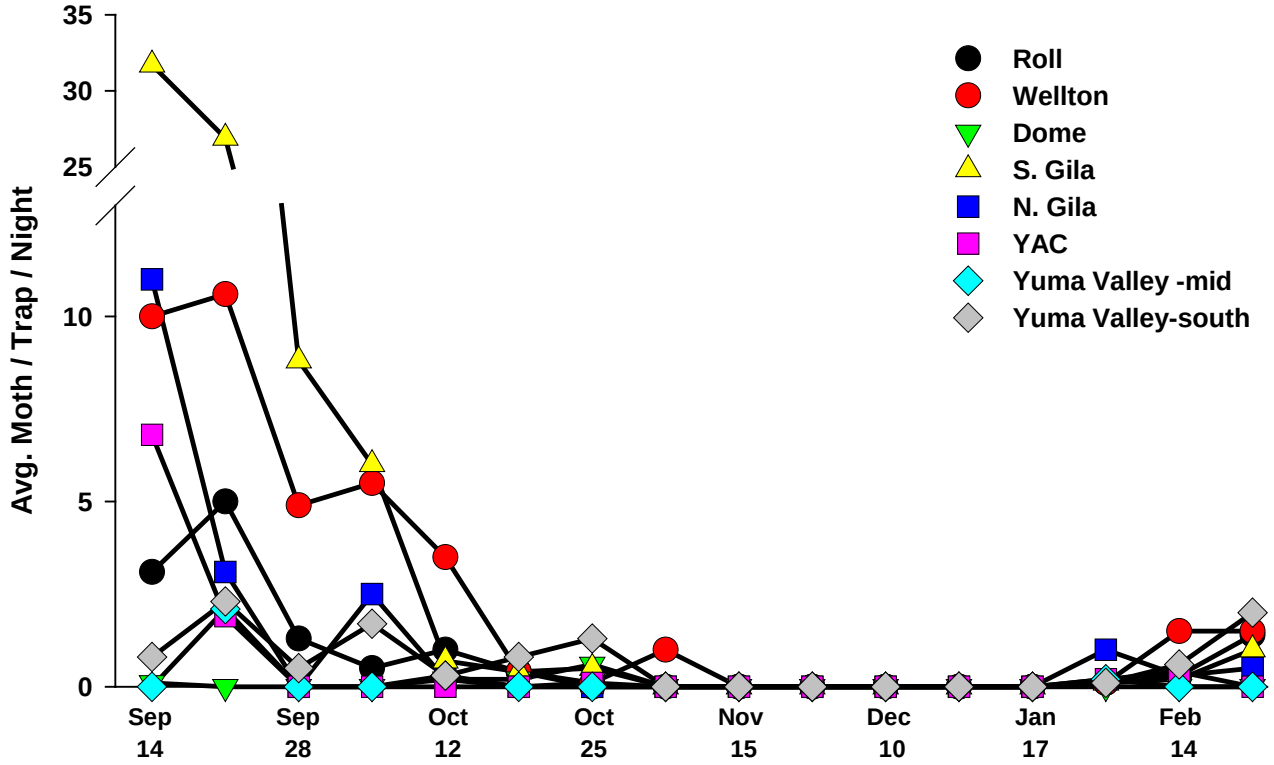
Mid-Yuma Valley

S. Yuma Valley

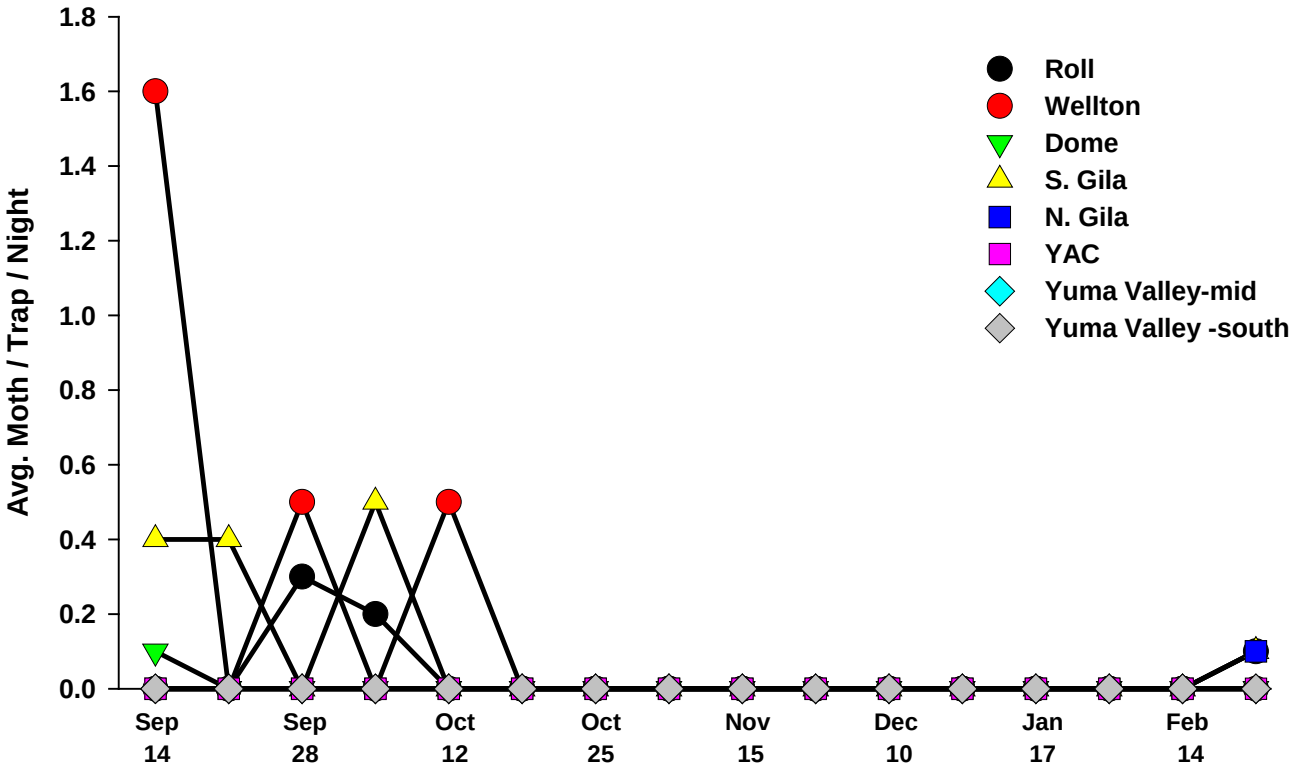
Area-wide Insect Trapping Network



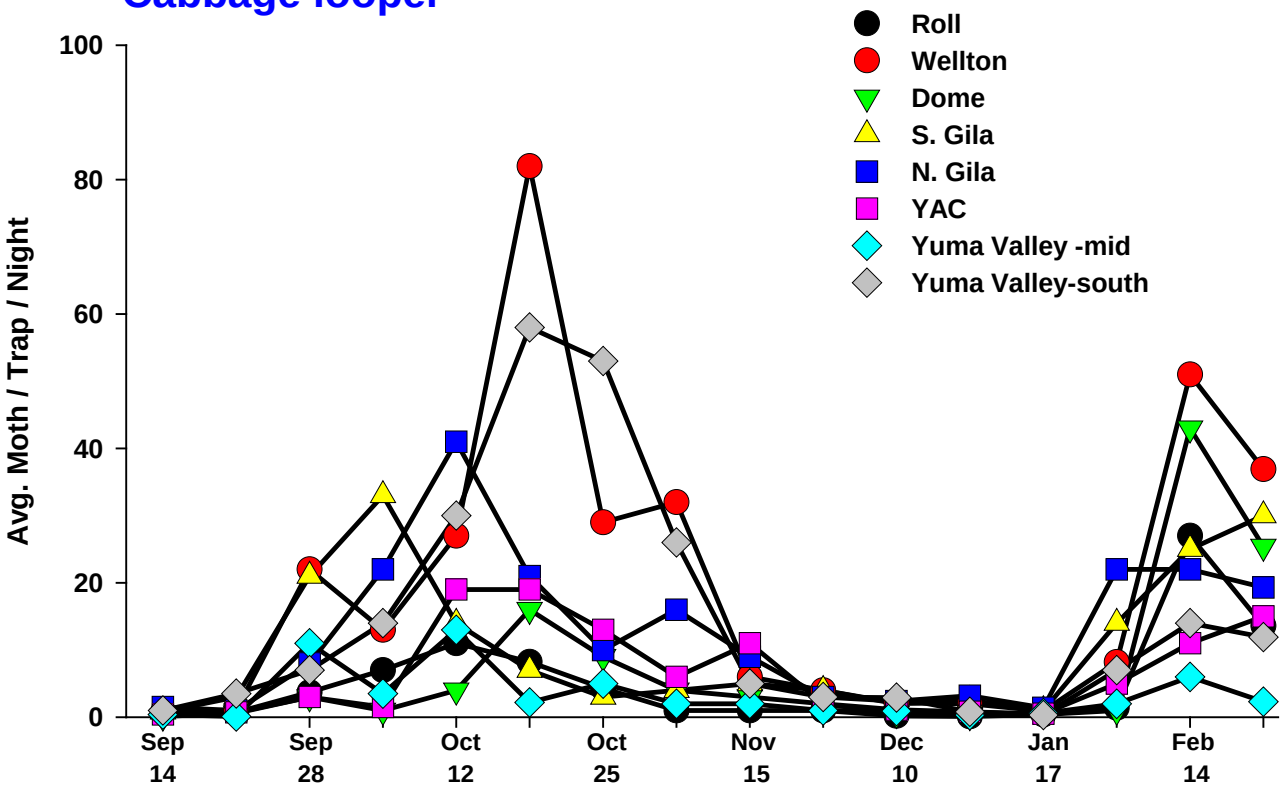
Corn earworm



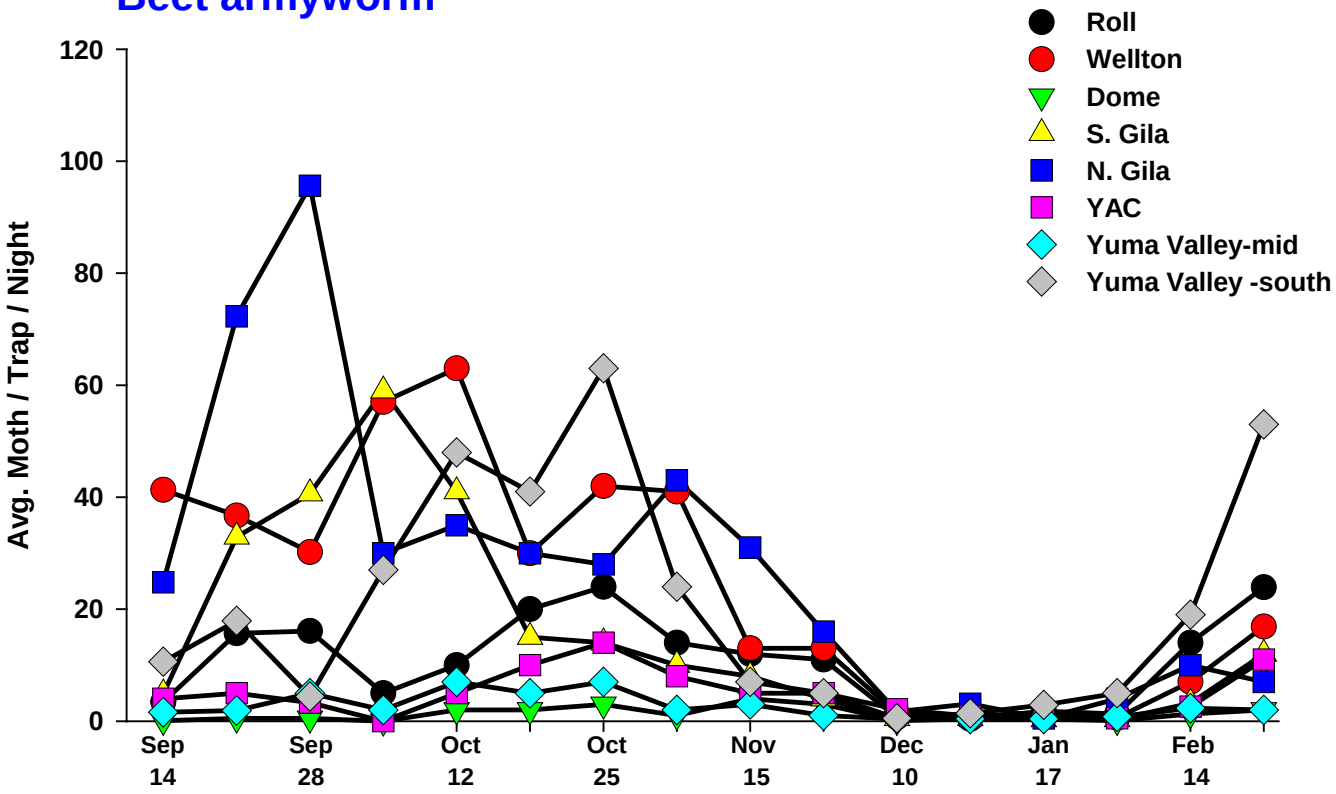
Tobacco budworm



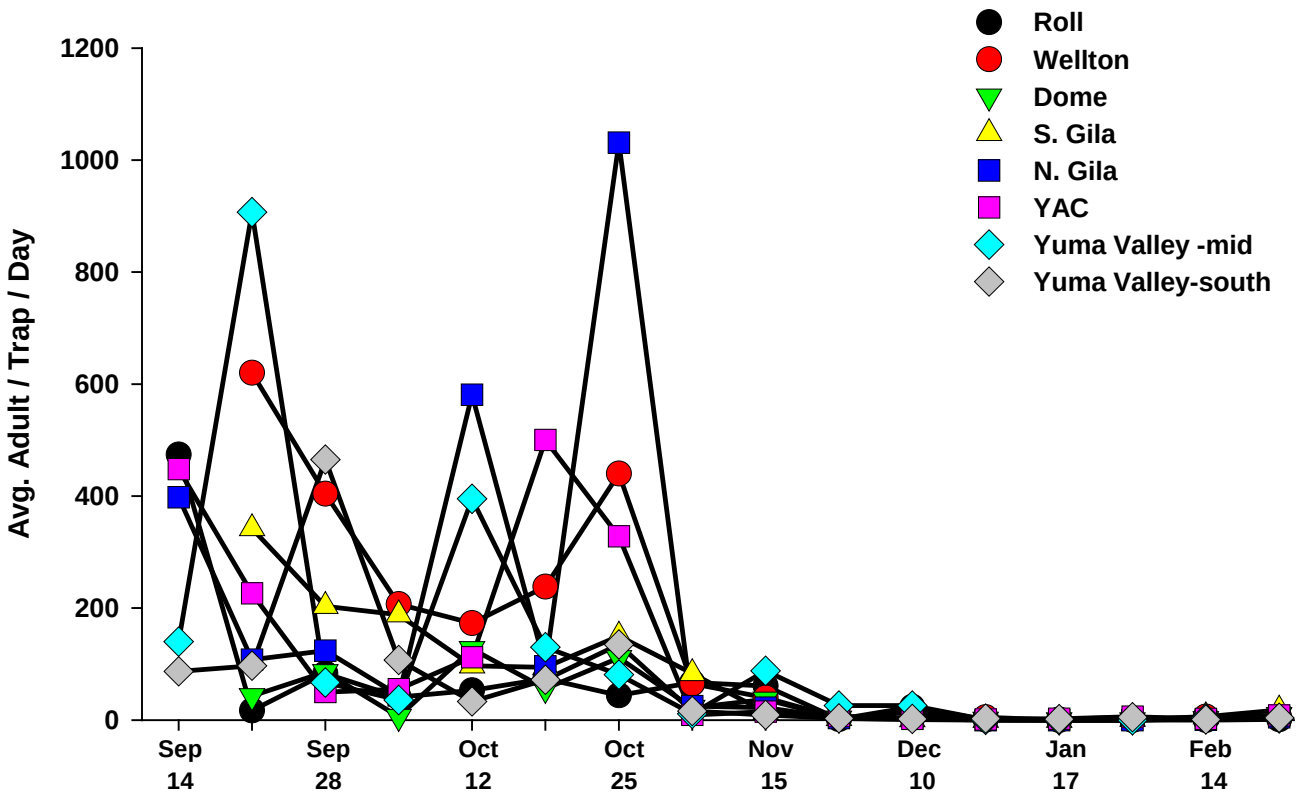
Cabbage looper



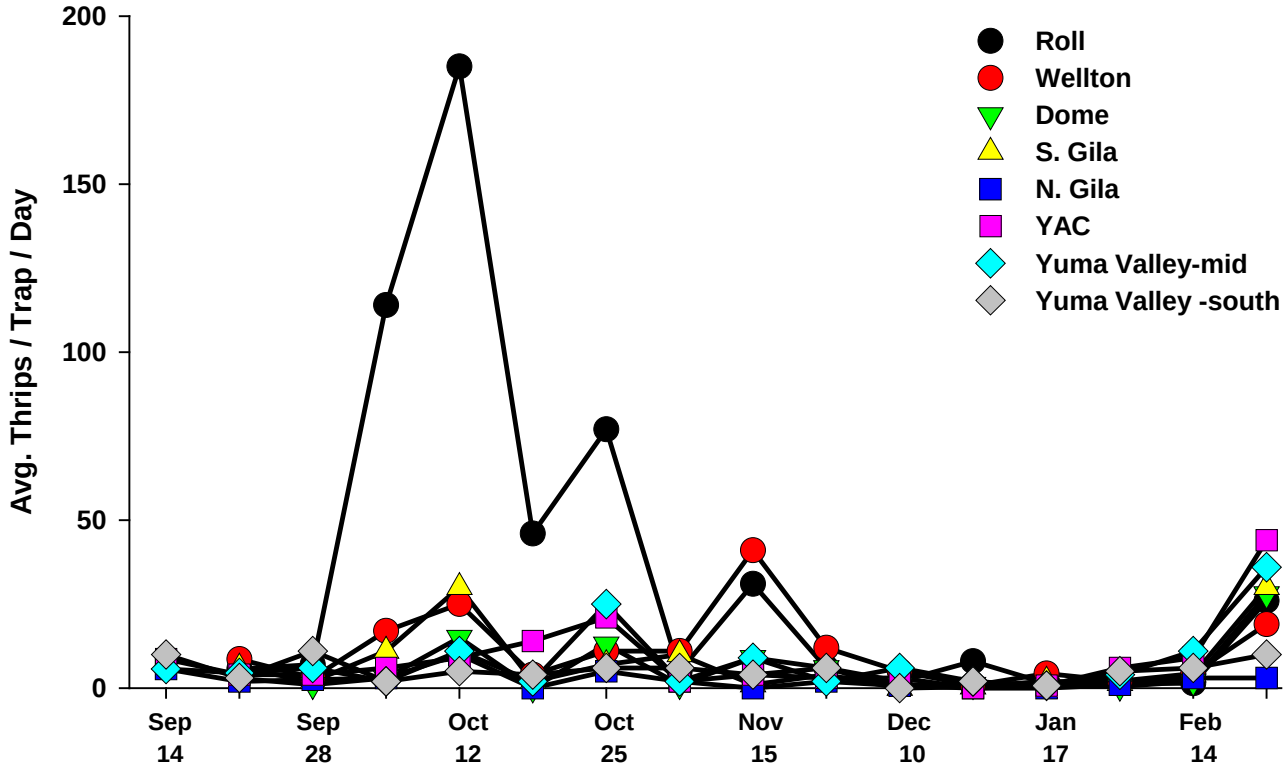
Beet armyworm



Whiteflies



Western Flower Thrips



Winged (Alate) Aphids