

Foxglove Aphids in Lettuce: Control with Reduced-Risk and Conventional Insecticides

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Abstract

Several small-plot studies were conducted in the spring of 2003 to compare the residual efficacy of several new reduced risk insecticides with a number of conventional aphicide compounds on head lettuce and romaine. Our efforts were primarily directed at determining efficacy against the foxglove aphid, a newly discovered pest in Yuma. In general, several new neonicotinoid foliar compounds provided good residual control of all aphid species including foxglove aphid. Other new compounds were less consistent. *Admire*, the standard soil systemic used in lettuce, was inconsistent against Foxglove aphid providing 85-90% control relative to >95% control against other aphid species present in the plots. Conventional aphid compound such as *Capture*, *dimethoate*, *endosulfan*, *Orthene* and *MSR* consistently provided good, economic control of Foxglove aphids in both head and romaine lettuce. Based on the results of these and previous studies, a sampling procedure and action threshold are recommended for foxglove aphid control in desert lettuce.

Introduction

As a key pest of desert lettuce, aphids represent one of the most important insect problems currently facing the industry. A new aphid species, the foxglove aphid, *Aulacorthum solani*, was found infesting commercial lettuce fields in the Yuma area for the first time this past growing season. It has been present in California since at least 1940, and has caused problems for lettuce growers in Salinas for the past 5 years. The foxglove aphid was first discovered infesting head lettuce at low levels the Yuma Agricultural Center in the spring of 2001. Then in the spring of 2002 foxglove aphids reached high population levels at YAC on spring plantings, but were not reported in commercial fields (Table 1). This past spring foxglove aphid populations were wide-spread throughout the Yuma Valley, particularly in fields near the Colorado river and adjacent to citrus orchards and residential areas.

Unlike the lettuce aphid which was first found in Yuma five years ago, the foxglove aphid is known to colonize a much broader range of plant hosts, including a wide variety of weeds (i.e., Shepards purse, ground cherry, pigweed), ornamentals (i.e., geraniums, gladiolas, verbena) and crops (i.e., cucurbits, beans, canola, spinach, citrus, safflower, tomatoes). This large availability of hosts and apparent adaptation to our winter and spring growing conditions suggests that foxglove aphids might present growers with some new challenges.

Although we are uncertain how this new species will behave under desert growing conditions in the long-term, infestations this spring reached high levels in experimental plots and in some commercial fields. Another aphid species, *Acyrtosiphon lactucae* (no common name) which is commonly misidentified as potato aphid, was also present this year in extremely high levels. Because of the importance of these aphids as contaminants of lettuce and other leafy vegetables, we designed several insecticide trials this past season to determine how effective conventional, reduced-risk and other new insecticides were against these aphids under local growing conditions

Materials and Methods

Small-plot, field studies were conducted in head lettuce and romaine at the University of Arizona, Yuma Agricultural Center in the spring 2003 growing seasons to evaluate the efficacy of several new reduced risk and conventional insecticides for control of aphids and thrips. In each trial, lettuce was direct seeded into double row beds on 42 inch centers and sprinkled beginning the following day. Plots for each trial consisted of 2-4 beds, 50' long with a two bed buffer between the plots. Plots were arranged in a randomized complete block design with 4 replications. Treatments and rates for each crop are presented in the data tables. Specific information for each trial is listed below:

	Head Lettuce-I	Head Lettuce- II	Romaine -I	Romaine - II
Variety	Bubba	Desert Spring	PIC	PIC
Planting date	Nov 14	December 4	December 12	January 10
Harvest date	Mar 6	March 12	March 17	April 9
Spray dates	1/21, 2/4, 2/16	1/26, 2/8, 2/18	1/22, 2/8, 2/18, 3/17	3/13, 3/21, 3/30
Pre-spray aphid densities	0.7 aphids/plant 20% infested plants	1.4 aphids/plant; 16 % infested plants	0.3 aphids / plant 6% infested plants	33.5 aphids/plants; 100% infested plants

In the head lettuce-I trial, the at-planting soil applications of Admire, Platinum and dinotefuron were applied as a preplant injection at a depth of 1.5" below the seed line at bed shaping in 15 GPA final dilution. The side dress treatment of Platinum was applied at 2nd side dress (Jan 15) similar to fertilizer side dressing and the materials were placed on the bed shoulder at @ 3" below the soil in 30 GPA final dilution. In all trials, foliar spray applications were hand applied with a CO₂ operated boom sprayer operated at 60 psi and 27 GPA. A directed spray (~75% band, with rate adjusted for band; nozzles directed inward toward the plants) was delivered through 3 nozzles (TX-10) per bed. An adjuvant was applied to all foliar treatments; DyneAmic, Exit, Hook or Induce at 0.065%v/v. The first spray in each trial was initiated when aphids were first found colonizing plants (see above; pre-spray aphid densities).

Aphid populations were assessed by estimating the number of aphids /plant in whole plant, destructive samples. Five aphid species were present on plants during the trials and have been classified into two groups for analysis in the following (1) Foxglove aphid, and (2) Green aphid complex consisting of *Acyrtosiphon lactucae* (no common name), potato aphid and green peach aphid. In addition, Lettuce aphids were present in significant numbers during the Romaine-II trial. On each sampling date, 8-10 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 alate (winged) and apterous (non-winged) aphids present. In the head lettuce, infestation levels of apterous aphids at harvest were estimated by randomly selecting 10 plants within each replicate, visually counting the number of aphids on frame/wrap per leaves and heads separately. In romaine, all leaves were sampled when plants were harvested and particular attention was given to hearts and terminal growing points.

Results and Discussion

Head Lettuce I: Foxglove aphids were the dominant aphid species during this trial, but *A. lactucae* was also very abundant (**Table 2**). Several new insecticides, both soil and foliar applied, were evaluated for economic aphid control. The soil applied neonicotinoid treatments provided marginal control of foxglove aphids at harvest, and head contamination was lowest in the Admire (16 oz) plots (Table 2). None of the soil treatments were comparable to the foliar sprays in controlling foxglove aphids, but all of the soil treatments except dinotefuron suppressed populations of the green aphid complex to very low levels. In most cases, all of the foliar treatments reduced aphid numbers to acceptable levels at harvest. Dinotefuron did not provide significant control relative to the other foliar compounds, and Assail applied alone, provided marginal control of Foxglove aphid. When combined with Capture, Assail provided significantly better control. Fonicamid, Actara and Fulfill provided excellent control of all aphids, and addition of Capture did not significantly improve efficacy.

Head Lettuce II: Foxglove aphid abundance was lower in this trial, whereas *A. lactucae* abundance was extremely high (**Table 3**). Interestingly, green peach and potato aphid populations were low, comprising less than 10% of the green aphid complex. This trial was originally designed to evaluate thrips (thus the inclusion of the Success treatments) but we focused on the aphids due to their overwhelming presence in the plots. All treatments were applied as foliar spray and the 3rd application was made 22 days before harvest. The Success treatments did not control aphids and in fact actually resulted in greater numbers of foxglove aphids than the untreated control. The Lannate + Mustang treatments did significantly suppress Foxglove aphid numbers, but did not significantly lower numbers of green aphids compared with the untreated check. All of the older compounds evaluated provided significant control of all aphid species at harvest (>95% control). In particular, MSR+Capture, Othene+Mustang and dimethoate provided very good residual efficacy. Endosulfan applied alone was a little less consistent on Foxglove aphid.

Romaine I: This trial was designed similar to the above trial in head lettuce, but only older treatments registered on Romaine were evaluated. Aphid numbers in general were lower in this trial, not exceeding 100 aphids/plant (**Table 4**). Foxglove aphids were the dominant aphid species in the untreated plots, but GAC were actually higher in the Success (6 oz) treatment than in the check. Similar to the above trials, Success and Lannate did not significantly reduce aphid numbers. Foxglove aphids were best controlled in plots treated with dimethoate, Provado, endosulfan, and Fonicamid. Overall, the dimethoate and endosulfan combination was particularly effective against aphids during the trial. Fulfill did reduce numbers at significantly lower levels than the check, but not as efficaciously as the older compounds.

Romaine II: This test was a late season trial on romaine where aphid numbers were allowed to establish on plants prior to spray initiation. Numbers of aphids exceeded 33 aphids / plant before the 1st application where lettuce aphids were 15.5 aphids/ plant, green aphids were about 12 aphids/plant and foxglove were 5.1 aphids. We also focused on tank mixtures with older contact materials and newer systemic compounds to evaluate both knockdown and residual control. For the 1st spray all treatments were combined with Mustang. Fonicamid provided the most significant efficacy of Foxglove at 7-DAT, but was not as effective against lettuce aphids (**Table 5**). The dimethoate and Actara treatments provided the most significant knockdown efficacy against Green and Lettuce aphids. Following the 2nd spray combined with Capture, again fonicamid provided the best foxglove aphid control. Dimethoate provided good green and lettuce aphid knockdown, but appeared to be less effective on foxglove aphid. Relative to the untreated check, Actara provided good efficacy of both green and lettuce aphids. Residual efficacy of foxglove aphid following the 3rd spray was again most significant with the Fonicamid combination. Similar to the previous application, Actara and dimethoate provided good sustained knockdown of the green aphid complex. Although, both of these treatments provided >90% control of lettuce aphids at 10 DAT #3, romaine hearts harvested in these plots were not marketable due to excessive aphid infestation (>70 aphids/heart).

Conclusions and Recommendations

- **Conventional Insecticides:** Dimethoate, MSR and Orthene consistently provided economic efficacy of foxglove and green aphids in head lettuce and romaine. These products should be used at high rates and users should be aware of the restrictive PHI and REI for each compound.
- **Reduced-risk Insecticides:** Fonicamid and Actara consistently provided good systemic residual control of foxglove aphids and the green aphid complex. Fulfill was less consistent, but provided good residual control on head lettuce when applied to low aphid densities. Assail provided inconsistent efficacy and performed best when combined with a contact insecticide. Presently, Actara, Fonicamid and Assail are not registered for use on lettuce in Arizona, but labels may be available in 1-2 years. Based on field performance to date, these products should be used at higher rates.
- **Soil-applied Insecticides:** Admire appeared to provide less control of Foxglove aphids (@ 85-90% control) than green aphids (>95%) in head lettuce. However, other studies this past spring showed that Admire provided good control of foxglove aphids (90+ % control), particularly when populations were lighter. At best, Platinum appears to be comparable to Admire, and dinotefuron has shown inconsistent performance as both a soil and foliar treatment.
- **Sampling:** Whole plant samples should be taken season long, with particular attention paid to the lower frame leaves for the green aphid complex and foxglove aphids, and the terminal growth for lettuce aphids. When alatae (winged forms) are found on plants, they should be keyed out to species. Many non-pest alates aphids can be found on lettuce but will not significantly colonize (i.e. cowpea aphid, cabbage aphid, english grain aphid). However, presence of alatae foxglove and green complex aphids is usually followed by colonization by apterous forms (colonizing non-winged). Sampling should then be intensified to detect colonization.
- **Action Threshold:** The compounds used in these trials should be applied when aphids first begin to colonize. This is consistent with a threshold level of 5-10% infested plants (the percentage of plants infested with 1 or more non-winged aphids). Sprays should be initiated at when this level is exceeded and preventing colonization at harvest has been most consistent using spray intervals of 14-18 days. None of the products tested have the capability to rapidly knockdown heavy aphid infestations on heading plants.

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Table 1. Aphid infestations on untreated head lettuce plants at harvest, YAC 1999-2003.

Season	Planting date	Harvest date	Variety	Mean Apterous Aphids / Plant at Harvest					
				Green aphid complex ^a		Lettuce aphid		Foxglove aphid	
				Head	Frame	Head	Frame	Head	Frame
1999-2000	11-Oct	24-Jan	<i>Grizzley</i>	0	0	0	0	-	-
	1-Nov	20-Feb	<i>Wolverine</i>	0	0	0	0	-	-
	15-Nov	1-Mar	<i>Del Rio</i>	1.3	0.6	12.3	0	-	-
	1-Dec	23-Mar	<i>Jackel</i>	0.3	0.3	8.2	0.5	-	-
	15-Dec	23-Mar	<i>Diamond</i>	0.2	0.1	42.9	0.6	-	-
2000-2001	11-Oct	25-Jan	<i>Grizzley</i>	2	14.4	0	0	-	-
	1-Nov	2-Mar	<i>Wolverine</i>	15.2	38.5	5.1	0	-	-
	15-Nov	3-Mar	<i>Del Rio</i>	8.5	42.6	6.5	0.9	-	-
	1-Dec	26-Mar	<i>Jackel</i>	2.6	12.9	9.6	0.4	-	-
	15-Dec	26-Mar	<i>Diamond</i>	0.3	3.0	8.2	0.6	-	-
2001-2002	10-Oct	14-Jan	<i>Wolverine</i>	0	0	0	0	0	0
	28-Oct	4-Feb	<i>Grizzley</i>	0	2.3	0	0	0.3	0
	15-Nov	5-Mar	<i>Wolverine</i>	0.5	7.1	0	0	0	0.1
	3-Dec	22-Mar	<i>Diamond</i>	3.6	7.9	1.1	0.1	1.4	6.3
	13-Dec	6-Apr	<i>Diamond</i>	1.0	1.5	6.3	0.4	11.7	2.9
2002-2003	10-Oct	14-Jan	<i>Winterhaven</i>	0.4	3.5	0	0	0.5	3.4
	29-Oct	12-Feb	<i>Winterhaven</i>	1.1	6.9	0	0	2.4	48.1
	14-Nov	9-Mar	<i>Bubba</i>	96.6	244.6	44.7	16.4	33.9	150.9
	3-Dec	18-Mar	<i>Diamond</i>	105.5	345.6	145.7	21.4	125.9	201.3
	12-Dec	18-Mar	<i>Diamond</i>	126.2	170.9	182.2	18.9	81.8	101.0

Data taken from samples of whole plants taken at harvest in small, untreated ¼ acre plots of head lettuce at the Yuma Ag Center.

^a Green aphid complex consisting of *Acyrtosiphon lactucae*, potato aphid and green peach aphid

Table 2. Head Lettuce –I. Aphid densities on heads, wrapper and frame leaves of lettuce plants at harvest, Mar 6th (18 DAT 3), YAC 2003

		Apterous Aphids (mean / plant)					
Aphid		Foxglove Aphid			Green Aphid Complex ^a		
Treatment	Rate/acre	Wrappers	Heads	Total	Wrappers	Heads	Total
Admire at plant	At plant - 16 oz	43.6 bc	8.0 cd	51.7 bc	0.3 bc	0.6 c	0.9 bcd
Platinum	At plant - 8 oz	39.4 bc	22.6 bc	62.0 bc	1.0 bc	0 c	1.0 bcd
Platinum	Side dress - 8 oz	64.4 b	16.9 bc	81.2 bc	7.1 b	1.2 bc	8.3 b
dinotefuron	At plant - 500 g a.i.	82.3 b	28.5 ab	110.8 b	117.7 a	22.0 a	139.7 a
dinotefuron	Foliar- 120 g a.i.	52.8 b	28.4 ab	81.2 bc	44.1 a	8.6 b	52.7 a
Assail	Foliar- 1.7 oz	18.0 cd	14.8 bc	32.9 c	3.2 bc	1.3 c	4.6 bcd
Assial+Capture	Foliar- 1.7 oz+5 oz	3.7 de	3.4 de	7.1 d	1.0 bc	0 c	1.0 bcd
Actara	Foliar- 4 oz	2.2 e	0.9 e	3.1 d	0 c	0 c	0 d
Actara+Capture	Foliar- 4 oz + 5 oz	1.1 e	1.2 e	2.3 d	0.4 bc	0.5 c	1.0 bcd
Fulfill	Foliar- 2.75 oz	1.5 e	1.4 e	2.9 d	1.6 bc	2.8 bc	4.4 bcd
Fulfill+Capture	Foliar- 2.75 oz + 5 oz	2.2 e	1.6 e	3.8 d	0.2 bc	0 c	0.2 cd
Flonicamid	Foliar- 0.13 lb a.i.	2.7e	2.0 e	4.7 d	0 c	0.2 c	0.2 cd
Untreated	--	233.0 a	70.4 a	303.4 a	194.8 a	39.1 a	233.9 a

^a GAC, green aphid complex consisting of *Acyrtosiphon lactucae*, potato aphid and green peach aphid.; population at this time consisted primarily of *Acyrtosiphon lactucae*.

Table 3. Head Lettuce –II. Aphid densities on heads, wrapper and frame leaves of lettuce plants at harvest, Mar 12th (22 DAT#3), YAC 2003

Treatment	Rate	Apterous aphids (mean / plant)					
		Foxglove aphid			Green aphid complex ^a		
		Frame	Heads	Total	Frame	Heads	Total
Success	6.0 oz	209.6 ab	37.5 ab	247.1 ab	368.1 ab	49.2 bc	417.3 ab
Success	10. oz	243.9 ab	22.0 abc	265.9 ab	776.7 a	63.9 ab	840.5 a
Success +Mustang	5 oz+ 4 oz	448.9 a	46.4 a	494.9 a	633.7 a	67.9 ab	701.7 a
Lannate+Mustang	0.75 lb+4.0 oz	121.4 ab	4.9 cd	126.3 bc	305.7 b	9.7 cd	315.4 b
MSR + Capture	2 pts + 5 oz	7.7 d	0.4 e	8.1 e	6.7 d	2.5 d	9.3 d
Provado + Endosulfan	3.75 oz+32 oz	9.0 d	3.5 cde	12.5 e	20.6 cd	5.8 cd	26.4 cd
Orthene+Mustang	1 lb + 4.0 oz	10.4 d	2.2 de	12.6 e	23.8 cd	0.9 d	24.7 cd
Dimethoate	0.75 pt	13.0 cd	2.6 de	15.6 e	15.9 cd	2.3 d	18.2 cd
Endosulfan	1.0 qt	22.2 cd	4.2 cde	26.4 de	35.3 c	4.5 cd	39.8 c
Untreated		98.5 bc	8.3 bcd	106.7 cd	1034.5 a	138.9 a	1173.3 a

Means followed by the same letter are not significantly different (LSD $p < 0.05$)

^a GAC, green aphid complex consisting of *Acyrtosiphon lactucae*, potato aphid and green peach aphid.; population at this time consisted primarily of *Acyrtosiphon lactucae*.

Table 4. Romaine - I. Aphid densities on all leaves of romaine plants at pre-harvest and at harvest, YAC 2003

Treatment	Rate	Apterous aphids (mean / plant)					
		Pre- Harvest Feb 25 th (7 DAT 2)			Harvest – Mar 17 th (7 DAT 4)		
		FG	GAC ^a	Total	FG	GAC ^a	Total
Success	6 oz	-	-	-	57.3 a	40.1 a	97.4 a
Success	9.5 oz	21.5 a	3.4a	24.9 a	38.1 a	7.7 ab	45.8 ab
Success+Mustang	5 oz+ 4 oz	-	-	-	32.5 a	3.1 abc	35.6 b
Lannate+Mustang	0.75 lb +4 oz	8.8 ab	2.1 a	10.9 b	34.3 ab	1.2 bc	35.5 b
Provado+Endosulfan	3.7 oz+ 1 qt	0.6 de	0.6 a	1.2 c	1.5 d	0 c	1.5 d
Fulfill	2.75 oz	3.3 bc	1.9 a	5.2 bc	8.5 bc	2.9 bc	11.4 c
Dimethoate+Endosulfan	12 oz+1 qt	2.3 c	1.1 a	3.4 c	0.9 d	0 c	0.9 d
Flonicamid	0.133 lb	0.2 e	1.4 a	1.6 c	5.1 cd	0.7 c	5.8 cd
Dimethoate/Malathion	12 oz+2 pts	1.2 cd	1.5 a	2.7 c	1.7 d	0.1 c	1.8 d
Untreated	-	13.7 a	8.3a	24.0 a	42.4 a	3.7 bc	46.1 ab

Means followed by the same letter are not significantly different (LSD $p < 0.05$)

^a GAC, green aphid complex consisting of *Acyrtosiphon lactucae*, potato aphid and green peach aphid.; population at this time consisted primarily of *Acyrtosiphon lactucae*.

Table 5. Romaine - II. Aphid densities on all leaves of romaine plants at pre-harvest and at harvest, YAC 2003

Pre-Harvest March 20		7-DAT 1			
Treatment	Rate/ac	Mean Aphids / Plant			
		FG	Green complex	LA	Total^a
Dimethoate+Mustang Max	0.75 pt+4.0 oz	15.9 b	8.3 c	19.7 bcd	49.8 d
Mustang Max	4.0 oz	47.8 a	94.7 a	37.9 abc	184.0 ab
Provado + Mustang Max	3.75 oz+4.0 oz	36.2 ab	125.3 a	18.4 cd	180.9 abc
Fonicamid+Mustang Max	0.133 lb ai	7.0 c	34.1 bc	45.9 ab	88.3 cd
Actara+Mustang Max	4 oz+ 4.0 oz	25.5 ab	12.1 c	9.9 d	47.9 d
Assail+Mustang Max	1.7 oz + 4.0 oz	16.6 b	22.7 bc	44.9 bcd	86.6 cd
Fulfill+Mustang Max	2.75 oz+4.0 oz	19.1 ab	26.5 bc	47.5 abc	99.6 bcd
Untreated		34.9 ab	80.6 ab	107.9 a	234.5 a

Mean followed by the same letter are not significantly different (LSD $p<0.05$).

^a Green aphid complex consisting of *Acyrtosiphon lactucae*, potato aphid and green peach aphid;

^b LA=lettuce aphid, *Nosanovia reibi-nigri*.

Pre-Harvest March 28		7-DAT 2			
Treatment	Rate/ac	Mean Aphids / Plant			
		FG	Green complex	LA	Total^a
Dimethoate+Capture	0.75 pt+6 oz	34.1 abc	1.4 d	16.2 d	52.5 cde
Capture	6.0 oz	59.3 ab	44.3 b	63.8 b	168.7 b
Provado + Capture	3.75 oz+6.0 oz	21.6 bc	56.5 b	76.9 b	155.7 b
Fonicamid+ Capture	0.133 lb ai+6 oz	2.8 d	2.4 cd	36.1 bc	41.3 de
Actara+ Capture	4 oz+ 6.0 oz	15.9 c	2.3 cd	19.3 cd	37.7 e
Assail+ Capture	1.7 oz + 6.0 oz	16.7 c	42.7 b	46.9 b	106.4 bc
Fulfill+ Capture	2.75 oz+6.0 oz	24.5 abc	11.2 bc	48.3 b	84.3 bcd
Untreated		65.8 a	266.9 a	364.5 a	700.6 a

Mean followed by the same letter are not significantly different (LSD $p<0.05$).

^a Green aphid complex consisting of *Acyrtosiphon lactucae*, potato aphid and green peach aphid;

^b LA=lettuce aphid, *Nosanovia reibi-nigri*.

Table 5. Romaine - II. continued .

Harvest Apr 9		10- DAT 3			
Treatment	Rate/ac	Mean Aphids / Plant			
		FG	Green complex ^a	LA ^b	Total
Dimethoate+Endosulfan	0.75 pt+32 oz	11.4 b	0.4 e	89.1 b	101.4 b
Endosulfan	32 oz	81.3 a	30.0 bc	178.0 ab	290.3 b
Provado + Endosulfan	3.75 oz+32 oz	68.6 a	5.9 bc	162.7 b	237.1 b
Flonicamid+ Endosulfan	0.133 lb ai+32z	2.9 c	2.3 cde	150.4 b	155.9 b
Actara+ Endosulfan	4 oz+ 32 oz	13.2 b	1.2 de	70.0 b	84.4 b
Assail+ Endosulfan	1.7 oz + 32 oz	11.0 b	16.1 b	165.0 ab	192.1 b
Fulfifll+ Endosulfan	2.75 oz+32 oz	19.8 b	5.0 bcd	204.7 ab	229.9 b
Untreated		67.6 a	465.7 a	831.8 a	1365.0 a

Mean followed by the same letter are not significantly different (LSD $p < 0.05$).

^a Green aphid complex consisting of *Acyrtosiphon lactucae*, potato aphid and green peach aphid;

^b LA=lettuce aphid, *Nosanovia reibi-nigri*.