Insecticide Alternatives for Aphid Management in Head Lettuce

The University of Arizona $ College of Agriculture $ Tucson, Arizona 85721

By John C. Palumbo, Research Scientist (Entomology), Yuma Ag. Center

An aphid complex consisting of the green peach aphid, *Myzus persicae*, the potato aphid, *Macrosiphum euphorbiae*, and the lettuce seed-stem aphid, *Acyrthosiphon lactucae* has seemingly always caused problems for Arizona lettuce growers. Green peach aphid has generally been considered the most important aphid species of the complex because of its relative tolerance to some older insecticides (Kerns et al. 1998), and its ability to reach high population levels in lettuce. This has recently changed as two new species have emerged that now pose serious concerns to the lettuce industry

A new exotic aphid species, the lettuce aphid, *Nosanovia ribis-nigri* was found infesting lettuce in the Salinas valley of California in 1998. This aphid quickly spread throughout the coastal growing areas and is now considered their primary aphid pest (Anonymous 2003). Commonly found on lettuce in Europe and Canada, this pest had never previously been reported in the western U.S. By 2000, the lettuce aphid was found in the desert growing of Arizona, presumably arriving from the coast via lettuce transplants and harvest equipment. Although this aphid reportedly has a narrow host range for composite species, it has quickly become established in the desert growing areas and is now considered a key pest of spring lettuce in Arizona (Palumbo 2003a, Table 1). To add further complexity to the aphid situation, another new aphid species, the foxglove aphid, *Aulacorthum solani*, was found infesting commercial lettuce fields in the Yuma area for the first time in 2002 (Palumbo 2003b). This species is principally considered a serious pest of potatoes throughout the U.S, and is only considered an occasional pest of lettuce and leafy vegetables grown in Canada. Although it has been reported on a wide range of hosts in California, it was not previously thought to occur in Arizona. Based on our recent observations over the past 3 years in Yuma, it appears that foxglove aphid has become established in the desert (Palumbo 2003a, Table 1). Many growers and PCAs now consider foxglove aphid a serious aphid pest in desert lettuce production.

It is not uncommon to find all five aphid species simultaneously infesting lettuce fields in desert cropping systems, and if not controlled populations can quickly build up to very high densities throughout the plant depending on weather conditions (Table 1). Green peach aphids and potato aphids can be difficult to control with contact insecticides because they feed primarily on the lower surface of older lettuce leaves, gradually moving into the heads as population densities increase. In contrast, lettuce and foxglove aphids present a different challenge in controlling aphids in lettuce. These aphid species prefer to feed and colonize in the terminal growth of lettuce plants, and particularly deep within developing lettuce heads. Control of lettuce and foxglove aphids with contact insecticides can be more difficult because of the aphids' preference for the protected terminal growth. Once aphids are detected, it is not uncommon for growers to apply insecticides on a regular basis.

Arizona growers have relied on two different management approaches to control aphids in lettuce. Both of them are preventative approaches that utilize insecticides to prevent aphids from colonizing and contaminating plants. One aphid management approach involves the soil application of the systemic, neonicotinoid insecticide imidacloprid (Admire 2F). The compound has low environmental risk and is considered an OP replacement. Long residual control of green peach and potato aphids in lettuce can be achieved by a single, at-planting soil application. Through root uptake, the compound provides significant reduction of aphid colonization on winter lettuce crops for up to 75 days. Furthermore, because Admire is applied as a liquid in the bed preparation or planting operations, there is no additional application costs associated with its use. This prophylactic approach has been the industry standard since 1993 and has been applied on as much as 80% or the head and leaf lettuce acreage planted annually in the AZ and CA deserts (Agnew 2000).

The second approach to aphid management in the desert growing areas of Arizona and California is a preventative foliar approach. Fields not planted with Admire are routinely treated with foliar insecticides upon detection of aphid colonization. With the exception of the foliar formulation of imidacloprid (Provado), foliar aphid control has been achieved almost entirely through the use of high-risk, organophosphate insecticides from germination to harvest. The organophosphates endosulfan, dimethoate, acephate**,** oxydemeton-methyl and diazinon, and the carbamate methomyl **are** the most frequently used insecticides for foliar aphid control in lettuce (Anonymous 2003, Agnew 2000, Kurtz 1999; Table 2). After years of extensive use, many of these compounds only provide marginal efficacy against green peach aphid, and it is now a common practice for pest control advisors and growers to tank-mix the OPs with a pyrethroid, or other OPs to achieve adequate control (Kerns et al. 1998, Palumbo 2003c).

Many of the organophosphate uses have been severely restricted due to FQPA (Table 2). For example, the manufacturers of dimethoate have agreed to voluntarily remove its use from head lettuce and other crops effective January 2005. In addition, endosulfan**,** an endocrine disruptor, is rarely used in California due to water issues, and new proposed use restrictions will undoubtedly limit its use in Arizona in the future. The uses of acephate and oxydemeton-methyl are currently limited due to their long pre-harvest intervals which prevent their uses during the middle of the season and near harvest. The regulatory impact of FQPA on diazinon suggests that any continued uses in lettuce are questionable. Finally, methomyl and malathion use do not appear to be affected by FQPA, but provide only marginal efficacy against the aphid complex in Arizona (Palumbo 2003c).

Given the complexities of the desert lettuce cropping systems, it is apparent that new reduced- and low-risk insecticides offer the most immediate hope as alternatives for conventional sprays and prophylactic Admire applications (Palumbo and Ellsworth 2001a). Many of the new insecticides being developed today are selective compounds with more environmentally friendly, safer attributes. These compounds possess very safe toxicological profiles through the development of new mechanisms of toxicity and routes of activity (Larson 1997, Table 2). We have identified three new compounds that are either currently registered for use in lettuce, or will be in the near future.

The reduced-risk/OP replacement insecticide pymetrozine (Fulfill) has the greatest potential for short-term implementation in lettuce pest management programs. Pymetrozine belongs to a new, novel chemistry know as the pyridine azomethines (Table 2). A highly selective, anti-feeding compound, it has a unique mode of action that acts specifically on the salivary pump of sucking insects causing rapid cessation of feeding. It is slow acting, but has both contact and systemic activity on aphids and, to a lesser extent on whiteflies. Due to its selective mode of action, pymetrozine is safe against most non-target organisms. The compound is currently labeled for use in lettuce and cole crops in Arizona and California.

Acetamiprid (Assail) is another reduced-risk/OP replacement insecticide that is a second-generation neonicotinoid with contact and systemic activity via foliar applications (Table 2). It has excellent activity against sucking pests such as aphids and whitefly, but unlike other compounds in this chemistry it is less efficacious when applied to the soil. As a foliar spray, it is the most efficacious neonicotinoid against whiteflies, and is considered very safe to pollinators. Although it is neonicotinoid, judicious use of this compound, in replacement of prophylactic uses of imidacloprid soil treatments, is suggested to be more a more sustainable use of the class of chemistry (Palumbo et al. 2003). The compound is currently labeled for use in lettuce and cole crops in California, with a registration in Arizona expected in 12-18 months.

The third candidate for implementation in lettuce pest management programs is the flonicamid (Table 2). According to a manufacture technical bulletin, flonicamid is a systemic insecticide that is a quick acting compound that immediately suppresses the feeding of aphids and other sucking insects (ttp://www.fmc.com/Corporate/V2/NewsDetail/0,1597,1531,00.html). It is proposed to be non-toxic to beneficials, and has an excellent toxicology profile. Flonicamid has been described as a new chemistry (cyanomethany trifluoromethyl nicotinamide) with a novel mode of action different from other commercially available products (IRAC 2003). It does not work on acetylcholine esterase (OPs and carbamates), or nicotinic acetylcholine receptors (neonicotinoids) and thus appears to be unique and should help with pest resistance management. It is not presently registered for use on any vegetable crop, but review of flonicamid is on EPA's work plan.

We have a considerable amount of experience evaluating these new insecticides against aphids in lettuce. They have shown varying levels of efficacy and control in lettuce depending on the aphid species targeted and timing of application. Against green peach aphid and potato aphid, acetamiprid and pymetrozine have consistently shown excellent residual activity when applied at low aphid densities and then reapplied at 14-d intervals (Palumbo et al. 1998, 1999, 2001). They have also prevented head contamination in lettuce when applied in rotation with each other. Data on flonicamid is more limited, but several trials last year suggest that it may be more efficacious than either of the other new compounds (Palumbo 2003a, Palumbo 2003c) We are currently evaluating flonicamid in small lettuce plots at the Yuma Agricultural Center and data shows that it provides excellent residual activity when applied to moderate densities of green peach aphid (*Fig 1*). We have considerably less experience evaluating these insecticides against foxglove and lettuce aphids. However, studies have shown that all the compounds can provide good efficacy against these pests if applied at low aphid densities before head formation begins (Palumbo et al. 2001, Palumbo 2003b). Future studies have been designed to address specific questions on spray timing and post-treatment assessment to assist PCAs and growers in correctly using these new compounds for economic aphid control on desert lettuce.

Table 1. Aphid population densities on head lettuce at harvest

Growing Season	Planting date	Harvest date	Lettuce Variety	Temperature (ºF)			Rain (in.)	Mean Apterous Aphids / Plant at Harvest					
								Green Aphid [a] Complex		Lettuce Aphid		Foxglove Aphid	
				Max	Min	Avg		Head	Frame	Head	Frame	Head	Frame
1999-2000	11-Oct	24-Jan	*Grizzley*	*81*	48	64	0	0	0	0	0	0	0
	1-Nov	20-Feb	*Wolverine*	*75*	45	58	0.1	0	0	0	0	0	0
	15-Nov	1-Mar	*Del Rio*	*75*	45	59	0.1	11.3	20.6	12.3	0	0	0
	1-Dec	23-Mar	*Jackel*	*73*	44	60	0.3	0.3	0.3	8.2	0.5	0	0
	15-Dec	23-Mar	*Diamond*	*74*	45	60	0.3	0.2	0.1	42.9	0.6	0	0
2000-2001	11-Oct	25-Jan	*Grizzley*	*74*	50	61	1.2	2	14.4	0	0	0	0
	1-Nov	2-Mar	*Wolverine*	*70*	45	57	1.16	15.2	38.5	5.1	0	0	0
	15-Nov	3-Mar	*Del Rio*	*70*	44	56	1.12	18.5	42.6	6.5	0.9	0	0
	1-Dec	26-Mar	*Jackel*	*72*	46	58	2.9	2.6	12.9	9.6	0.4	0	0
	15-Dec	26-Mar	*Diamond*	*73*	47	59	2.9	0.3	3.0	8.2	0.6	0	0
2001-2002	10-Oct	14-Jan	*Wolverine*	*78*	49	63	0.1	0	0	0	0	0	0
	28-Oct	4-Feb	*Grizzley*	*72*	44	58	0	0	2.3	0	0	0.3	0
	15-Nov	5-Mar	*Wolverine*	*74*	44	58	0	0.5	7.1	0	0	0	0.1
	3-Dec	22-Mar	*Diamond*	*72*	41	57	0	10.6	7.9	1.1	0.1	11.7	2.9
	13-Dec	6-Apr	*Diamond*	*73*	42	57	0	1.0	1.5	6.3	0.4	1.4	6.3
2002-2003	10-Oct	14-Jan	*Wolverine*	*77*	47	59	0.03	0.4	3.5	0	0	0.5	3.4
	29-Oct	12-Feb	*Grizzley*	*74*	45	59	1.27	1.1	6.9	0	0	2.4	48.1
	14-Nov	9-Mar	*Bubba*	*73*	45	59	1.27	96.6	244.6	44.7	16.4	33.9	120.9
	3-Dec	18-Mar	*Diamond*	*73*	44	58	1.23	105.5	345.6	145.7	21.4	125.9	201.3
	12-Dec	18-Mar	*Diamond*	*74*	45	59	1.23	126.2	170.9	182.2	18.9	81.8	101.0

Source: Palumbo (2003a)

Data taken from samples of whole plants taken at harvest in small, untreated ¼ acre plots of head lettuce at the Yuma Ag Center (Palumbo 2003a)..

[a] Green aphid complex consisting of *Acyrthosiphon lactucae* , potato aphid and green peach aphid.

Table 2. Insecticide Alternatives for Aphid management in Lettuce.

Chemical	Trade name	Chemistry	Activity	Environmental Risks [a]			Availability / FQPA Restrictions
				Human	Natural enemies	Aquatic/ Avian	
meviphos	Phozdrin	OP	vapor	***	***	***	EPA cancellation , April 1994
dimethoate	Dimethoate 267	OP	contact	**	***	**	Voluntary cancellation effective Jan 2005 [e]
endosulfan	Thionex, Thiodan,Phaser	Organochlorine	contact	***	**	***	REI extended to 4 d; Use reduced to 2 lb ai total /season, Environmental concerns.
acephate	Orthene	OP	systemic	**	***	*	21 d PHI; Head lettuce only
oxydemeton-methyl	Metasystox-R	OP	systemic	**	**	***	28 d PHI; Head lettuce only
diazinon	Diazinon	OP	contact	**	***	***	Continued registration questionable under FQPA/FIFRA., 1 application/crop
malathion	Malathion	OP	contact	**	***	*	REI extended to 24 hr ; 14 d PHI;
methomyl	Lannate	carbamate	contact	***	***	***	Buffer zones required near water; 72 hr REI
bifentrhin	Capture	pyrethroid	contact	**	**	***	7 d PHI
imidacloprid	Admire/Provado	neonicotinoid	systemic	**	*	**	***OP replacement***; 7 d PHI for foliar use
thiamthoxam	Platinum	neonicotinoid	systemic	**	*	**	***OP replacement***; AZ label pending
acetamiprid [b]	Assail	neonicotinoid	systemic/ ingestion	*	*	*	***Reduced risk / OP replacement***; labeled in CA; pending in AZ; 7 d PHI
pymetrozine [c]	Fulfifll	pyradine azomethines	systemic/ ingestion	*	*	*	***Reduced risk / OP replacement***; labeled in AZ and CA; 7 d PHI
flonicamid [d]	Turbine	cyanomethany trifluoromethyl nicotinamide	systemic/ ingestion	na	*	na	***OP replacement*;** currently under EPA review

AZ Crop Profile for Lettuce (Agnew 2000); Pest Management Strategic Plan for California and Arizona Lettuce Production, 2003 (Anonymous 2003)

[a] Source: ETOXNET, http://extoxnet.orst.edu/pips/dimethoa.htm ; ***, Highly toxic; **, moderately toxic; *, minimal toxicity or risk; Human risks includes occupational and dietary risks; Natural enemies include toxicity to aphid natural enemies and transient pollinators.

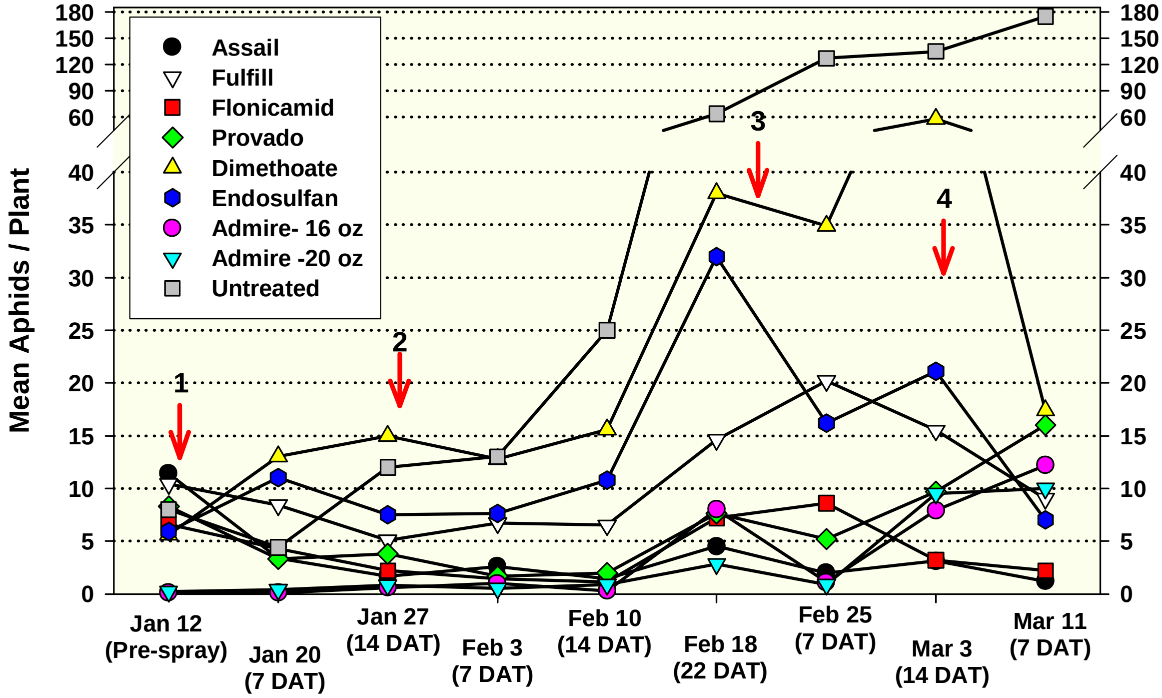
[b] Source: USEPA / OPP; http://www.epa.gov/opprd001/factsheets/acetamiprid.pdf

[c] Source; Cornel Univ., PMEP; http://pmep.cce.cornell.edu/

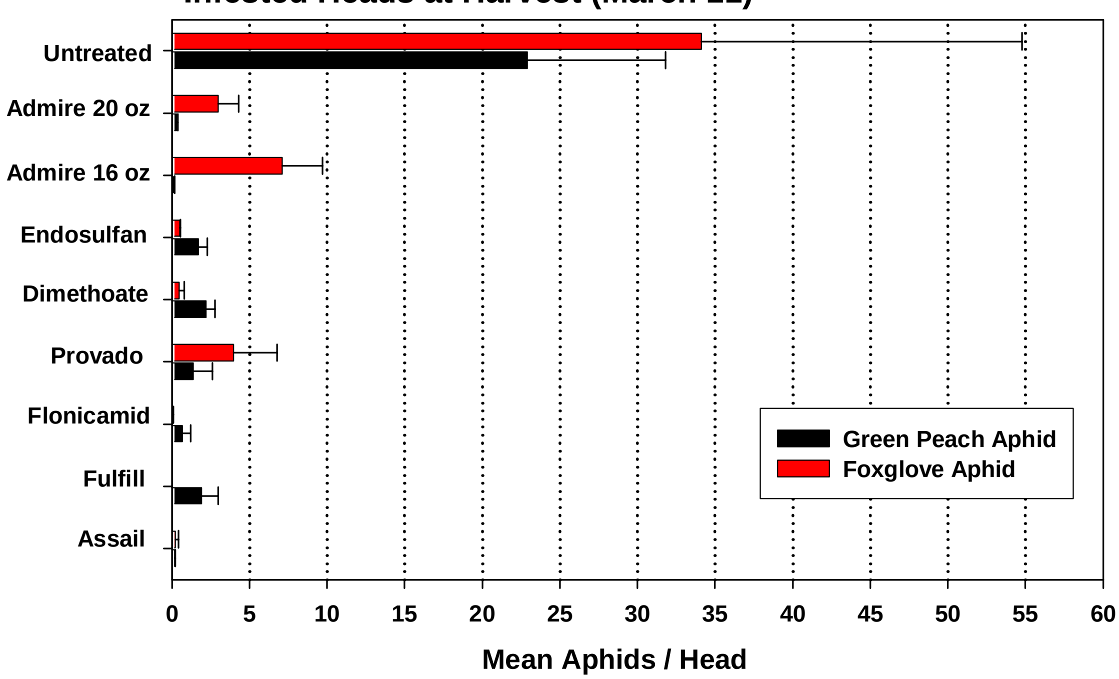
[d] Source: IR-4 Project; http://ir4.rutgers.edu/newchemistry.pdf (mode of action is different from other commercially available products)

[e] Source: USEPA / Federal Register: ; http://www.epa.gov/fedrgstr/EPA-PEST/2004/January/Day-28/p1824.htm

Fig. 1 **Residual Efficacy of Inseticides Against Aphids in Head Lettuce**



Infested Heads at Harvest (March 11)



References

Anonymous. 2003. Pest management strategic plan for California and Arizona lettuce production 2003**,** http://pestdata.ncsu.edu/pmsp/pdf/CAAZLettuce.pdf

Agnew, K. 2000. Crop profile for Lettuce in Arizona. OPMP / PIAP, http://pestdata.ncsu.edu /cropprofiles/docs /azlettuce.html.

IRAC. 2003. IRAC Mode of Action Classification v 3.3, October 2003, http://www.irac-online.org/ documents/ moa/moa.pdf

Kerns, J.C. Palumbo, and D.N. Byrne. 1998. Relative susceptibility of Red and Green Forms of Green Peach Aphid to insecticides. http://cals.arizona.edu/pubs/crops/az1101/az1101_25.html

Kurtz, E. 1999. Crop Profile for Lettuce (Leaf) in California. OPMP / PIAP http://pestdata.ncsu.edu/cropprofiles /docs/calettuce-iceberg.html

Larson, L.L. 1997. Novel Organic and Natural Product Insect Management Tools. 8 pp. http://www.ent. agri. umn. edu/ academics/classes/ipm/impchap.htm

Palumbo, J., C. Mullis Jr., F. Reyes, and A. Amaya. 1998. New Insecticide Alternatives for Aphid Management in Head Lettuce. *In* N. F. Oebker [ed.], Vegetable Report Series P-115. Publ. No. AZ1101. University of Arizona, College of Agriculture and Life Sciences, Cooperative Extension, Tucson, Arizona. pp. 1-10. URL: *http://cals.arizona.edu/pubs/crops/az1101/az1101_1.html*

Palumbo, J., C. Mullis Jr., F. Reyes, A. Amaya, and L. Ledesma. 1999. Application and Timing of Insecticides for Aphid Management in Head Lettuce. *In* D. N. Byrne and Baciewicz, Patti [ed.], Vegetable Report Series P-117. Publ. No. AZ1143. University of Arizona, College of Agriculture and Life Sciences, Cooperative Extension, Tucson, Arizona. pp. 94-107. URL: *http://cals.arizona.edu/pubs/crops/az1143/az1143_23.pdf*

Palumbo, J.C. and P.C. Ellsworth. 2001a. Key crop / pest complexes in the diverse cropping systems of the Southwest and their FQPA-threatened insecticides ("high-risk"), conventional and reduced risk alternatives. University of Arizona, College of Agriculture and Life Sciences, Cooperative Extension, Tucson, Arizona. URL:*http://cals.arizona.edu/crops/pesticides/table alternativestble.html*

Palumbo, J.C. 2001. Influence of Admire and Platinum on the Population Growth of the Lettuce Aphid Under Field Conditions. *In* D. N. Byrne and Baciewicz, Patti [ed.], Vegetable Report Series P-127. Publ. No. AZ1252. University of Arizona, College of Agriculture and Life Sciences, Cooperative Extension, Tucson, Arizona. pp. 14-19. URL: *http://cals.arizona.edu/pubs/crops/az1252/az1252-2c.pdf*

Palumbo, J.C., F.J. Reyes, C.H. Mullis Jr., A. Amaya, L. Ledesma, and L. Carey. 2001. Neonicotinoids and Azadirachtin in Lettuce: Comparison of Application Methods for Control of Lettuce Aphids. *In* D. N. Byrne and Baciewicz, Patti [ed.], Vegetable Report Series P-127. Publ. No. AZ1252. University of Arizona, College of Agriculture and Life Sciences, Cooperative Extension, Tucson, Arizona. pp. 35-42. URL: *http://cals.arizona.edu/pubs/crops/az1252/az1252-2e.pdf*

Palumbo, J.C., P.C. Ellsworth, T.J. Dennehy, and R.L. Nichols. 2003. Cross-Commodity Guidelines for Neoneonicotinoid Insecticides in Arizona. IPM Series 17. Publ. No. AZ1319. University of Arizona, College of Agriculture and Life Sciences, Cooperative Extension, Tucson, Arizona. 4 pp. URL: *http://cals.arizona.edu/pubs/insects/az1319.pdf*

Palumbo, J.C. 2003a. Insect Management For Desert Lettuce Production. AILRC Grants Program – Final Report for 2002-2003, September 2003 http://agriculture.state.az.us/CD&P/AILRC%20Report%200203 %20Palumbo.pdf

Palumbo, J.C. 2003b. The Emergence of the Foxglove Aphid, Aulacorthum solani, as an Economic Pest of Lettuce in the Desert Southwest. In D. N. Byrne and Baciewicz, Patti [ed.], Vegetable Report Series P-136. Publ. No. AZ1323. University of Arizona, College of Agriculture and Life Sciences, Cooperative Extension, Tucson, Arizona. pp. 76-92.

URL: http://cals.arizona.edu/pubs/crop s/az132 3/az1323_ 1g.pdf

Palumbo, J.C. 2003c. Foxglove Aphids in Lettuce: Control with Reduced-Risk and Conventional Insecticides. In D. N. Byrne and Baciewicz, Patti [ed.], Vegetable Report Series P-136. Publ. No. AZ1323. University of Arizona, College of Agriculture and Life Sciences, Cooperative Extension, Tucson, Arizona. pp. 55-63. URL: *http://cals.arizona.edu/pubs/crops/az1323/az1323_1e.pdf*

Written April 2004. This document and more on vegetable pests can be found at *http://cals.arizona.edu/crops/vegetables/insects/aphid/insecticidealts.html*