MANAGEMENT OPTIONS FOR BLUE ALFALFA APHIDS IN CALIFORNIA ALFALFA

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ABSTRACT

The blue alfalfa aphid continues to challenge alfalfa production systems and IPM programs in California. This pest was effectively managed with a combination of host plant resistance, biological control, cultural control, and insecticides for ~40 years starting in the mid-late 1970's. But since 2013, outbreak populations of this pest have occurred in California resulting in increased costs of production and crop losses. Exact reasons for this shift in the severity of this aphid pest are unknown. Until the IPM program for blue alfalfa aphid is again "stabilized", insecticides are a key tactic used to manage this pest. Efficacy of registered insecticides against blue alfalfa aphid has been erratic. There is a need for new active ingredients for use in alfalfa with improved aphid activity, less impact on natural enemies, as well as strategies to extend the utility of registered products. Studies were conducted with these goals.

Key Words: blue alfalfa aphid, insecticides, natural enemies, IPM

INTRODUCTION

Aphids are consistent pest management challenges to alfalfa production worldwide. The aphid species that infest alfalfa in the U.S. were likely introduced from Europe and feed on alfalfa and other legumes. The pea aphid, *Acyrthosiphum pisum*, is the most widespread aphid pest of alfalfa in the U.S. In California, this species can probably be found at some level in every field. It was first reported as a pest of alfalfa over 100 years ago. The spotted alfalfa aphid, *Therioaphis maculalta*, was first found in the U.S. damaging alfalfa in 1954 (New Mexico) and quickly spread over the lower Great Plains, southwest and western U.S. Within 6 years of its introduction, this aphid was found to be overwintering as eggs allowing it to spread into and survive colder climatic areas to the north. The blue alfalfa aphid, *Acyrthosiphon kondoi*, was introduced to California in 1974 and first found near Bakersfield (Kono 1975, Summers 1975). It quickly spread to other parts of the Central Valley and to Imperial Valley in 1975 (Sharma et al. 1976). The fourth commonly-occurring aphid pest of alfalfa in California is the cowpea aphid, *Aphis craccivora*. This species was first found damaging alfalfa in 1999 (Natwick 1999a, Natwick 1999b, Natwick 1999c, Summers 2000a, Summers 2000b) although it was present in the state prior to that date feeding on other leguminous plants.

The emergence of these four aphid species as alfalfa pests all have some similarities but also some important differences. Upon discovering these aphids damaging alfalfa in a limited area, the infestations quickly spread to other states and the aphid pests adapted to a range of conditions. Given the wide range of conditions under which alfalfa is grown from the desert

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areas to the temperate areas with hard winters in northern California this allowed the pests to widely infest alfalfa fields. For instance, the infestations of cowpea aphids in alfalfa were reported in Imperial Valley in the winter of 1999 and in Iowa alfalfa in summer 2002. Secondly, upon the initial introduction, yield losses were extremely high from these "new" aphid pests before being mitigated due to some combination of natural enemies adapting to the new invaders, an awareness of and improved monitoring for these pests, the development of short-term management tactics, and ultimately the development of a management program for the pest including sustainable management tactics. The key management tactic that was developed was host plant resistance to the aphid pests was developed in commercial alfalfa cultivars.

Aphids are ideally suited as invasive pests and the knowledge of the exact timing of the new aphid introduction and origin of the aphid are often unknown. This latter information can be useful for discovering useful management tactics. Aphids have several characteristics that facilitate their establishment including 1.) the ability of females to reproduce without having males in the system or conversely the same aphid can transition to a phase where both males and females are present in order to produce eggs and to survive unfavorable conditions and 2.) aphids commonly develop biotypes which are genetic variants of the aphid species, which appear identical to the original aphid, that may have different biological traits.

In recent years, the blue alfalfa aphid (BAA) has increased greatly in severity. This pest emerged in high population densities in 2013. In March 2013, developing populations were seen in Kern Co. and other areas of the Central Valley (Fresno, Merced, San Joaquin Co.) experienced high populations later – April and May. The Lancaster area and desert production areas also saw elevated levels of blue alfalfa aphid. It is not unusual to see some early season build-up of blue alfalfa aphid and occasionally an insecticide application is needed in the late winter/early spring. But usually the host plant resistance that controls this species, along with natural enemies (a fungus that infects and kills the aphids and also insect parasitoids and predators), combine to manage this pest. High populations continued in 2014 in the desert and in the central valley. Some build-up was also seen in the intermountain area in June. In 2015, BAA populations were seen at high levels in the desert areas starting in January and throughout the intermountain area starting in April. Populations in the Central Valley were very spotty. For more details on the infestation patterns and observations over the last 3 years see the Alfalfa and Forage News blog http://ucanr.edu/blogs/Alfalfa/ . Reasons for these changes in BAA populations and management are unknown at this time. But given the recent outbreaks of BAA and the increasingly wide distribution of the problems, more information is needed on insecticide efficacy to provide some short-term management options. In addition, there was a need for new active ingredients to help to combat this problem. Several aphid management products were evaluated by Natwick and collaborators in Imperial Co. and Godfrey and Long in Yolo Co. in 2014 and 2015 and by Orloff in Siskiyou Co. in 2015. Results from these studies will be summarized.

MATERIALS AND METHODS

Treatments were applied with ground broadcast applications with a CO_2 backpack sprayer to small plots with four replications. A NIS (surfactant) was added to all treatments at 0.25%. At predetermined intervals following application, aphid populations were assessed using a standard

15" sweep net with 180° sweeps; samples consisted of either 10 or 20 sweeps per plot. Populations of aphids (pea, blue alfalfa, and cowpea) and natural enemies were quantified. In addition, crop response was evaluated at one location (IREC, 2015). Plant height, damage rating and yield data were collected. Pertinent details of the studies are summarized in Table 1. Treatments evaluated were based on availability, need/desire to answer key questions, and potential to benefit the alfalfa industry. There was no attempt to include all registered products in each study. Experimental, i.e., unregistered products, were included as available from crop protection companies and will be clearly indicated as "Not Registered on Alfalfa".

Table 1. Details for insecticide tests for blue alfalfa aphid in California, 2014-15.

Location	Appl. Date	Plot Size	GPA
DREC, Holtville	2/7/14	13.33 x 50 ft.	20
DREC, Holtville	2/3/15	13.33 x 50 ft.	20
Davis	4/11/14	20 x 25 ft.	25
Davis	3/25/15	20 x 25 ft.	25
IREC, Tulelake	4/17/15	20 x 20 ft.	20

RESULTS

Imperial Valley – Holtville Studies:
Studies from 2014 and 2015 will be highlighted.

Table 2. Blue Alfalfa Aphids per Sweep, Holtville, CA, Treated 7 Feb. 2014.

Treatment	Rate per A	3-DAT[x]	7-DAT	14-DAT[z]	21-DAT	PTA[y]
Check	--------	159.4 a	98.9 a	71.4 a	51.8 ab	97.3 a
Warrior II 2.09 CS	1.92 fl oz	34.0 c	30.7 b	13.9 c	52.4 ab	47.5 bc
Endigo ZCX 2.71 ZC #	3.9 fl oz	21.6 c	26.3 b	23.3 bc	37.0 ab	39.9 bc
Besiege 1.25 ZC	9.0 fl oz	39.5 bc	34.7 b	32.5 abc	54.2 ab	52.4 bc
Cobalt Advanced	24.0 fl oz	27.3 c	28.3 b	28.0 abc	41.6 ab	50.0 bc
Fulfill #	5.5 fl oz	78.2 bc	61.1 ab	54.4 ab	39.7 ab	58.9 abc
Grandevo	3 lb	98.9 ab	69.1 ab	61.7 ab	88.1 a	81.1 ab
Beleaf 50 SG	2.8 oz	51.8 bc	32.6 b	29.0 abc	17.8 b	37.0 c
Mustang 1.5 EW	4.3 fl oz	42.3 bc	44.3 ab	38.5 ab	42.0 ab	53.2 bc
Stallion 3.025 EC	11.75 fl oz	28.6 c	24.7 b	23.8 bc	51.7 ab	49.1 bc
Stallion 3.025 EC+ Dimethoate 2.67E	11.75 + 16.0 fl oz	23.3 c	27.2 b	25.1 bc	35.7 ab	41.3 bc

Means within columns followed by the same letter are not significantly different, Tukey's HSD

Test; *P*= 0.05.
Pre-treatment populations averaged 43.6 per sweep
^{x} Days after treatment.
^{y} Post treatment average.
^{z} Log_{10} (X+1) transformed data used for analysis, back-transformed means reported.
not registered for use in alfalfa.

Table 3. Blue Alfalfa Aphids per Sweep, Holtville, CA. Treated 3 Feb. 2015, CA.

Treatment	**Rate per A**	**3-DAT^x**	**7-DAT**	**10-DAT**	**14-DAT**	**PTA^z**
Check	--------	126.3 a	163.5 a	161.3 a	224.3 a	168.9 a
Beleaf 50SG [1]	2.8 oz	65.6 bc	77.6 cde	49.9 f	75.7 cd	67.2 d
Beleaf 50SG [2]	2.8 oz	53.7 bc	48.6 e	48.0 f	101.4 cd	62.9 d
Transform WG #	1.0 oz	41.2 cd	50.3 e	82.9 de	68.9 d	60.8 d
Sivanto 200SL	10.0 fl oz	26.6 d	46.8 e	47.7 f	89.7 cd	52.7 d
BAS 31065 I #	2.28 fl oz	65.5 bc	133.3 ab	141.5 ab	168.5 b	127.2 b
BAS 31065 I #	2.85 fl oz	70.8 b	107.9 bc	109.3 cd	172.8 b	115.2 bc
Pyrifluquinazon 20SC#	1.6 fl oz	55.8 bc	59.2 de	53.2 ef	76.8 cd	61.3 d
Pyrifluquinazon 20SC#	3.2 fl oz	61.5 bc	65.0 de	57.2 ef	71.3 d	63.8 d
Cobalt Advanced	28.0 fl oz	45.8 bcd	92.6 cd	120.0 bc	113.9 c	93.1 c

Means within columns followed by the same letter are not significantly different, LSD; *P*= 0.05.
Pre-treatment populations averaged 94.5 per sweep
^{x} DAT is days after treatment.
^{z} PTA is post treatment average.
[1] NIS @ 0.25% added to the spray mixture. [2] COC @ 32 fl oz/acre added to the spray mixture.
not registered for use in alfalfa.

Central Valley – Davis Studies:
Studies from 2014 and 2015 will be highlighted.

Table 4. Blue Alfalfa Aphids per Sweep, Davis, CA, 2014.

Treatment	**Rate per A**	**3-DAT^x**		**6-DAT**		**9-DAT**		**12-DAT**		**15-DAT**		**Avg.**
Untreated	---	44.7	a	53.3	abc	56.1	a	61.2	ab	24.5	a	48.0
Stallion SC*	11.75 fl oz	8.0	bc	24.2	cd	32.5	bcd	59.9	ab	21.3	a	29.2
Mustang EW*	4.3 fl oz	3.8	c	44.0	bcd	30.2	bcd	55.5	ab	21.4	a	31.0
Stallion SC + Dimethoate*	11.75 + 16 fl oz	1.6	c	16.0	d	8.9	d	33.3	bc	15.9	a	15.1
Warrior II**	1.92 fl oz	5.3	c	21.7	d	32.5	bcd	40.2	bc	28.8	a	25.7
Lorsban	32 fl oz	10.4	bc	28.4	bcd	37.6	bcd	20.5	c	18.7	a	23.1

Advanced**												
Grandevo**	2 lbs	37.8	ab	75.2	a	70.1	ab	76.8	a	17.8	a	55.5
Cobalt Advanced**	38 fl oz	10.9	bc	18.3	d	24.3	cd	40.2	bc	20.0	a	22.7
Centric 40WG** #	3.5 fl oz	38.6	ab	58.7	bc	33.8	bcd	32.5	bc	23.2	a	37.4
Belay** #	5 fl oz	10.0	bc	19.2	d	17.2	cd	42.8	bc	9.2	a	19.7

Means within columns followed by the same letter are not significantly different, LSD; P= 0.05.
Pre-treatment populations averaged 36.0 per sweep
* Agri-Dex 16 fl oz/A added
** 0.25% NIS added
x DAT is days after treatment.
not registered for use in alfalfa.

Table 5. Blue Alfalfa Aphids per Sweep, Davis, CA, 2015.

Treatment	Rate per A	2-DAT[x]		5-DAT		8-DAT		11-DAT		Avg.
Untreated	---	15.0	bcd	8.6	bc	1.3	bcd	0.8	bc	6.4
Stallion SC + Dimethoate*	11.75 + 16 fl oz	3.3	f	3.6	cd	1.2	bcd	0.9	bc	2.3
Warrior II**	1.92 fl oz	10.9	cdef	3.8	cd	1.3	bcd	1.1	bc	4.3
Lorsban Advanced**	16 fl oz	21.6	ab	11.2	b	2.0	b	1.3	bc	9.0
Cyclaniliprole 50SL** #	22 fl oz	25.4	a	20.1	a	4.1	a	2.7	a	13.1
Cobalt Advanced**	26 fl oz	3.7	ef	4.0	cd	0.7	d	0.7	bc	2.3
Sivanto**	10.5 fl oz	4.3	ef	3.0	cd	0.5	d	0.6	c	2.1
Sivanto**	14 fl oz	7.9	def	4.4	cd	0.5	d	0.4	c	3.3
Sivanto + Baythroid XL**	10.5 + 2.8 fl oz	8.0	def	2.1	d	1.1	bcd	0.6	bc	2.9
Beleaf 50SG**	2.8 oz	7.1	def	5.8	bcd	1.1	bcd	1.6	b	3.9
Endigo ZCX** #	4.5 fl oz	18.3	abc	3.4	cd	0.8	cd	0.7	bc	5.8
Pyganic EC 1.4**	64 fl oz	13.3	bcde	4.4	cd	0.7	d	1.2	bc	4.9
Transform** #	0.75 oz	5.2	ef	8.1	bcd	1.0	bcd	0.9	bc	3.8
Transform** #	1.0 oz	5.5	def	2.7	cd	1.9	bc	0.7	bc	2.7
Transform # + Lorsban Advanced**	0.75 oz + 16 fl oz	11.1	cdef	3.0	cd	0.7	d	0.9	bc	3.9

Means within columns followed by the same letter are not significantly different, LSD; P= 0.05.
Pre-treatment populations averaged 10.5 per sweep
* Agri-Dex 16 fl oz/A added
** 0.25% NIS added
x DAT is days after treatment.
not registered for use in alfalfa.

Intermountain area – IREC study:
A study from 2015 will be highlighted.

Table 6. Blue Alfalfa Aphids per Sweep, Tulelake, CA, 2015.

Treatment	Rate per A	Blue Alfalfa Aphids per Sweep			
		3-DAT[x]	7-DAT	14-DAT	Avg.
Untreated	---	503	245	293	347.0
Stallion SC + Dimethoate	11.75 + 16 fl oz	191	82	821	364.7
Warrior II + Dimethoate	1.92 + 16 fl oz	167	67	643	292.3
Lorsban Advanced	16 fl oz	377	263	511	383.7
Cobalt Advanced	26 fl oz	269	108	508	295.0
Sivanto	5 fl oz	179	45	21	81.7
Sivanto	7 fl oz	192	25	22	79.7
Sivanto	10 fl oz	193	39	17	83.0
Sivanto + Lorsban Advanced	7 + 16 fl oz	192	49	20	87.0
Lannate	32 fl oz	219	190	1142	517.0
Beleaf 50SG	2.8 oz	326	90	31	149.0
Endigo ZCX #	4.5 fl oz	86	29	30	48.3
Transform #	0.75 oz	201	42	20	87.7
Transform #	1.0 oz	192	15	21	76.0
Transform # + Lorsban Advanced	0.75 oz + 16 fl oz	185	49	24	86.0
Grandevo	3 lbs	388	202	248	279.3
LSD 0.05		95	72	166	

x DAT is days after treatment.
not registered for use in alfalfa.

Table 7. Effect of insecticide treatment and rate on alfalfa height, injury rating and the yield of 1st and 2nd cuttings.

Treatment	Rate per A	Height (cm) 5/26/15	Aphid Feeding Injury[1] 5/26/15	1st Cut Yield (tons/A) 6/5/15	2nd Cut Yield (tons/A) 7/6/15
Untreated	---	30	3.1	1.81	2.11
Stallion SC + Dimethoate	11.75 + 16 fl oz	17	7.8	1.19	2.04
Warrior II + Dimethoate	1.92 + 16 fl oz	23	6.8	1.50	2.10
Lorsban Advanced	16 fl oz	27	5.0	1.58	2.04
Cobalt Advanced	26 fl oz	27	5.3	1.58	2.05

Sivanto	5 fl oz	37	1.8	2.09	2.31
Sivanto	7 fl oz	35	1.9	1.97	2.15
Sivanto	10 fl oz	36	1.5	2.02	2.29
Sivanto + Lorsban Advanced	7 + 16 fl oz	39	1.1	2.10	2.11
Lannate	32 fl oz	14	8.4	1.05	2.05
Beleaf 50SG	2.8 oz	37	1.0	2.00	2.18
Endigo ZCX #	4.5 fl oz	40	0.0	2.02	2.08
Transform #	0.75 oz	36	1.5	2.02	2.12
Transform #	1.0 oz	35	1.8	1.91	2.24
Transform # + Lorsban Advanced	0.75 oz + 16 fl oz	37	0.4	2.06	2.22
Grandevo	3 lbs	30	3.1	1.75	2.11
LSD 0.05		4	1.5	0.24	ns

[1] Aphid Feeding Injury rating. 0 = no injury 10 = severe stunting and damage
not registered for use in alfalfa.

Table 8. Beneficials per Sweep, Tulelake, CA, 2015.

Treatment	**Rate per A**	**Beneficials per Sweep[1]**			
		3-DAT[x]	**7-DAT**	**14-DAT**	**Avg.**
Untreated	---	4.3	2.5	8.1	5.0
Stallion SC + Dimethoate	11.75 + 16 fl oz	1.2	1.4	7.4	3.3
Warrior II + Dimethoate	1.92 + 16 fl oz	1.4	1.4	6.0	2.9
Lorsban Advanced	16 fl oz	1.9	2.4	7.6	4.0
Cobalt Advanced	26 fl oz	1.4	1.2	6.5	3.0
Sivanto	5 fl oz	2.1	2.2	3.5	2.6
Sivanto	7 fl oz	2.0	1.8	4.7	2.8
Sivanto	10 fl oz	2.4	2.0	3.6	2.7
Sivanto + Lorsban Advanced	7 + 16 fl oz	1.0	1.5	2.9	1.8
Lannate	32 fl oz	1.2	2.8	8.6	4.2
Beleaf 50SG	2.8 oz	1.8	1.8	5.0	2.9
Endigo ZCX #	4.5 fl oz	1.1	1.0	4.0	2.0
Transform #	0.75 oz	2.5	1.9	4.0	2.8
Transform #	1.0 oz	2.3	1.4	4.1	2.6
Transform # + Lorsban Advanced	0.75 oz + 16 fl oz	0.7	1.4	4.9	2.3
Grandevo	3 lbs	2.8	2.0	7.2	4.0
LSD 0.05		1.2	1.0	2.1	

x DAT is days after treatment. # not registered for use in alfalfa.
[1] Beneficial insects included ladybird beetle larvae and adults, parasitic wasps, minute pirate bugs, and bigeyed bugs.

SUMMARY

- BAA control with Pyrethroid and Organophosphate insecticides was erratic ranging from zero to moderate efficacy.
- Mixtures of Pyrethroid and Organophosphate insecticides, either premixes or tank-mixes, tended to be somewhat more efficacious than single active ingredients.
- The most efficacious insecticides against BAA were Sivanto, Transform, Beleaf and Pyrifluquinazon but they were only providing between 60% to 70% control compared the untreated and all had BAA levels similar to the pretreatment levels at 14-DAT.
- Sivanto was registered for use on alfalfa in 2015.
- Beleaf has a 24c Special Local Needs registration on forage alfalfa with the limitation of 62 days between application and harvest.
- Transform and Pyrifluquinazon are not registered for use on alfalfa in California.
- Neonicotinoid insecticides (Belay® [clothianidin], Centric®, [thiamethoxam alone] and Endigo [thiamethoxam as a component of mixtures], also showed this 60 to 70% level of efficacy. No neonicotinoid insecticides are registered for use on forage alfalfa.
- The impacts of the insecticides on natural enemies ranged from severe to nonsignificant. Besides the direct effects, the availability of alternative prey items (assuming the aphids are controlled) for the predators is an important factor influencing survival of natural enemies of aphid pests.
- In some cases where populations of beneficials were decimated, BAA numbers spiked greatly.
- High BAA levels, untreated or plots with low to moderate control with insecticides, resulted in reduced alfalfa height and increased damage ratings.
- In one study in the intermountain area, alfalfa yields were compromised by high BAA numbers (compared with yields in untreated plots) with up to a 45% reduction. Yields in plots with excellent BAA control (80% reduction) were increased 10-15% compared with that in untreated plots.
- Watch fields closely for aphids as outbreaks can quickly occur with significant impacts due to the toxins that these aphids inject while feeding.

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