EMERGING AND IMPORTANT INSECT PESTS OF ALFALFA IN THE WESTERN UNITED STATES

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Four insects species have emerged as important pests of alfalfa in the Western United States during the past decade. Cowpea aphid has long been a resident insect of the Western United States, but became a significant alfalfa pest during the past two years. The silverleaf whitefly has been a serious pest of alfalfa since 1991. Silverleaf whitefly reduces hay yield and contaminates alfalfa hay with a sugary excrement, "honeydew", causing problem with harvest and marketing. Spider mites have long been a pest of alfalfa grown for seed and have become a serious pest of alfalfa grown for hay production since the late 1980's. Spotted alfalfa aphid has been a pest of alfalfa in the United States for nearly a half-century, but has been kept in check by highly resistant alfalfa varieties. During the mid-1990's, spotted alfalfa started showing signs of overcoming the host plant resistance in alfalfa.

COWPEA APHID

There has been concern among western states alfalfa growers the past 2 year about a new black aphids on alfalfa. The aphid has been identified as the cowpea aphid (also known as black legume aphid or groundnut aphid), *Aphis craccivora* Koch (Blackman and Eastop 1984). Originally named, *Aphis medicaginis,* cowpea aphid has been in California since the 1900's (Essig 1911). Historically, cowpea aphid has been an occasional invader of new stands of alfalfa during the winter and occasionally infesting older alfalfa stands, but not causing economic injury (Natwick 1999a). In December, 1998, cowpea aphid built to economically damaging levels on alfalfa in Imperial County, California (Natwick 1999b). During the spring of 1999, cowpea aphids spread to alfalfa in high and low desert regions of California and is now reported as an alfalfa pest in Arizona, Iowa, Kansas, Nevada and Texas (Summers 2000b).

The new pest taxonomically keys to *Aphis craccivora*, but behaves differently from previously known populations of cowpea aphid. Cowpea is a small insect (1.4 to 2 mm long), dark to black aphid. Adults are shiny black and immature aphids may be lightly dusted with wax. Colonies start on the growing points of the host plant, but unabated can quickly infest the entire plant. Cowpea aphid has a broad host range with a marked preference for Leguminosae, but is found on plants in several plant families including weed and crop species. Nearly 30 virus diseases are transmitted by cowpea aphid (Blackman and Eastop 1984) including alfalfa enation, a serious virus disease of alfalfa in Europe, North Africa and Saudi Arabia (Hampton 1990).

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Historically, cowpea aphid has been a warm weather pest found on several crops and weeds including cotton (Anonymous 1996). In addition to the western United States, cowpea aphid (possibly a new biotype) has emerged as a pest of alfalfa in South America and in Saudi Arabia (Summers 2000b). When an alfalfa field is threatened by a rapidly growing population of cowpea aphid, treatment with an insecticide may be warranted, just as we would treat fields to prevent heavy infestations of blue alfalfa aphid, pea aphid or spotted alfalfa aphid. Treatment thresholds have not been established for cowpea aphid on alfalfa, but in some areas of California growers have had to treat alfalfa 3 times before the second cutting (Summers 2000a). When alfalfa stands are becoming heavily infested with aphids, an insecticide treatment can prevent yield loss, due to stunting and leaf drop, and quality loss, due to contamination with honeydew and sooty molds (Natwick 1999b). Cowpea aphid has been observed attacking both forage and seed alfalfa and can be found in low desert alfalfa during both winter and summer months. Aphid parasites, *Lysiphibus* sp. and *Diaraetiella* sp., have been reared from cowpea aphid mummies collected from both the high and low desert and numerous aphid predators have been observed feeding on cowpea aphid including bigeyed bugs, damsel bugs, lacewings, lady beetles, and syrphid fly larvae (Summers 2000b).

PROCEDURES

A field study was conducted during the winter of 2000 at the University of California Desert Research and Extension Center, Holtville, CA. A first year stand of alfalfa, VAR. CUF 101, was used for the experiment. Plots were arranged in a randomized complete block design with four replications. Insecticide treatments and application rates are listed in Table 1. Plots measured 25 feet by 50 feet and insecticide treatments were broadcast using a tractor mounted spray boom with 19 nozzles (TJ-60 11003VS) at 40 psi delivering 24.75 GPA applied on 24 January, 2000.

Aphids samples from each plot consisting of number of aphids per ten stems were taken on 21 January, 3 days prior to insecticide applications and aphid samples were continued in the same manner after 1 day after treatment (DAT), 3 DAT, 7 DAT, 10 DAT, 14 DAT, 22 DAT and 25 DAT. Six 0.25 m^2 quadrants were randomly sampled by hand clipping and separately bagging the alfalfa hay in each plot on 13 March. Each paper bag of hay was dried in a dehydrator. Alfalfa sampled were weighed in grams. Leaves were then stripped from the stems and weighed. Stem weights were calculated from the difference in hay weight and leaf weight. Percent leaf values were then calculated. Percent crude protein (%CP) values (AOAC 1980), acid detergent fiber (ADF) values (Goering and Van Soest 1970), and in vitro true digestibility (IVTD) values (Brothers et al. 1994) were determined using standard analytical practices. Treatment differences for data set variables were estimated with analysis of variance (ANOVA) and mean separation with a protected Least Significant Differences Test ($LSD_{0.05}$). Coefficients of Correlation were estimated for feed quality parameters and alfalfa hay yield (MSTAT-C 1988).

RESULTS

Cowpea aphid populations were found to be homogenous among the treatments following the pre-treatment samples (Table 1). Aphid levels for all insecticide treatments except the Actara® and Fulfill® were significantly lower than for the non-treated control from 1 DAT through 25 DAT and for the cutting cycle cowpea aphid means (Table 1 and 2).

All of the insecticide treatments with the exception of Actara® and Fulfill® produced significantly more fresh weight hay than the control (Table 2) and had higher leaf weight high stem weights than the control (Table 3). Percent leaf content above 53 is acceptable, 53 to 50 is marginal and below 50 is poor for alfalfa hay production in the Desert Southwest of the United States. All treatments in the experiment had percent leaf content above the minimal acceptable level. Only the insecticide treatments Dimethoate, Baythroid Plus Dimethoate, and Warrior produced hay with lower leaf percentages than the control (Table 3).

The percent crude protein (CP) values for all treatments including the non-treated control were within an acceptable range for California premium quality hay, and there were no differences among the CP values for the treatments (Table 4). CP values below 20 are considered to be low for alfalfa hay produced in the Desert Southwest. A percent acid detergent fiber (ADF) range of 26 to 28 represents alfalfa hay of excellent to good quality for the Desert Southwest of the United States. ADF values greater than 28 are considered marginal for this production region. All of the insecticide treatments and the non-treated control were within the excellent range for ADF and there were no differences among the treatments for ADF values (Table 4). All of the insecticide treatments and the control were within acceptable range for in vitro true digestibility (IVTD) for this region, a value of 72 or less being considered low, and there were no differences among the treatments for ADF values (Table 4). Alfalfa hay quality and crop production value should not be based on any one of the feed quality parameters alone.

Correlation analysis did not reveal a relationship of aphid population densities with feed quality parameters % ADF, % CP, or IVTD. Correlation analysis did reveal a positive relationship ® = 0.448; p = 0.004) of aphid population densities with other than percent leaf content (Table 5). The percentages of leaf content are thought to have risen with increased density of cowpea aphid due to shortened internode lengths, stunting. The coefficients of correlation for aphid densities to plant height, fresh weight of hay, and dry weight of hay (-0.416, -0.573, and -0.503, respectively) were all negatively correlated. Therefore, cowpea aphids reduce the quantity of alfalfa hay produced as well as reducing quality through contamination of the hay with honeydew and sooty molds.

SILVERLEAF WHITEFLY

The sweetpotato whitefly, Bemisia tabaci (Gennadius) strain B, later described as a new whitefly species, B. argentifolii Bellows & Perring, (Bellows et al. 1994) first became an economically important pest of alfalfa in California and Arizona during the summer of 1991 (Natwick et al. 1993). Silverleaf whitefly can cause economic damage to alfalfa in the low desert regions of Southern California and Arizona from July through September (Yee et al. 1997).

Infestations of silverleaf whitefly reduce alfalfa hay quality via honeydew contamination. Honeydew is a whitefly excrement composed of sugar, water and amino acids. Sooty molds, fungi that produce black spores, often grow on honeydew. Sooty molds are not known to harm cattle or horses, but resemble mold from water damaged hay that produce toxins. Hay buyers are not likely to buy moldy looking hay or will discount the price of the hay. If insecticides were registered whitefly control in alfalfa, they would not be cost effective. Varieties were screened for resistance to silverleaf whitefly in 1992 and differences in levels of susceptibility were noted (Natwick and Robinson 1993). An

alfalfa resistant to silverleaf whitefly has been developed at the University of California Desert Research and Extension Center (Teuber et al. 1999). Seed increases are currently being completed in Imperial Valley, California and a new alfalfa variety resistant to silverleaf whitefly will likely be released next year.

SPIDER MITES

Historically, spider mites have not caused wide spread damage to alfalfa grown for hay. Spider mites may be harbored on the lower leaves of alfalfa plant throughout the year. Serious damage to hay fields has generally associated with water stress. When infested fields are watered, the problem often clears up in a matter of days (Anonymous 1985). The clover mite (*Bryobia praetiosa* Koch) and the brown wheat mite (*Petrobia latens* Müller) may be found in alfalfa from January through May, limited by high temperatures (90 to 100 degrees F). Several species of spider mites are found in low desert production areas of Western Arizona and Southern California from March through October: twospotted spider mite (*Tetranychus urticae* Koch), Carmine spider mite (*T. cinnabarinus* Boisdival), Strawberry mite (*T. turkestani* Ugarov & Nikolski), and desert spider mite *(T. desortorum* Banks). Spider mites feed by inserting long needlelike mouthparts to remove plant sap from leaves which become stippled with chlorotic spots. Severe feeding damage may turn brown leaves from necrosis and desiccation causing defoliation. Damage usually starts in the lower plant canopy and moves upward as the mites move to new leaves. Severe feeding damage reduces yield and may retard regrowth. In recent years, spider mites have been more common in alfalfa hay fields during the spring summer months. The cause of this phenomenon is not fully understood. Pyrethroid insecticides have been implicated as causal agents for secondary outbreaks of mites in other crops. There has not been a clear cause and effect relationship established between pyrethroid use on alfalfa grown for hay and mite outbreaks. When alternative classes of insecticides are available to control alfalfa hay pests, it is wise to avoid using the pyrethroid insecticides, especially in fields with a history of mite problems.

SPOTTED ALFALFA APHID

Spotted alfalfa aphid (*Therioaphis maculata*) was introduced into Arizona and California in the 1950's, causing sever damage (Stern and Reynolds 1958). A combination of introduced parasites and resistant varieties brought the pest under control (Lehman 1978, Nielson et al 1970). Spotted alfalfa aphid still occasionally causes problems in susceptible varieties are grown (Natwick 1987). Spotted alfalfa aphid is capable of stunting susceptible varieties. High aphid densities deposit honeydew, a sticky excrement of sugars and amino acids. Honeydew can foul harvesting equipment and supports the growth of sooty molds reducing marketability of hay. Since 1996, a few growers have had spotted alfalfa aphid appear in highly resistant alfalfa varieties. Spotted alfalfa aphid are appearing on highly resistant alfalfa varieties in Saudi Arabia an fields are being treated with insecticides. The reasons for the appearance of spotted alfalfa aphid in highly resistant varieties is being investigated. There have been few reports of crop loss or need for insecticide application in alfalfa cultivars highly resistant to spotted alfalfa aphid. It is reasonable to believe that cultivars highly resistant spotted alfalfa aphid will continue to keep the pest in check along with the indigenous and introduced natural enemies. To determine when insecticide treatments are needed for spotted alfalfa aphid follow the recommendations in Table 6 (Anonymous 1985).

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Table 1. Cowpea Aphids per Stem In Alfalfa, Holtville, CA, 2000.

Treatment	lb ai/ac	3DPT	1DAT[a]	3DAT[b]	7DAT	10DAT	14DAT[b]	22DAT[a]	25DAT
Untreated	--------	41.9 a	25.0 a	22.6 a	30.2 a	47.5 a	72.5 a	41.9 ab	25.3 ab
Actara 25 WG	0.047	38.6 a	16.7 b	16.4 ab	15.2 b	33.2 b	58.7 a	49.3 a	29.0 a
Actara 25 WG	0.086	40.7 a	13.5 bc	11.1 bc	10.2 bc	29.7 b	42.8 a	40.7 ab	17.8 bc
Fulfill 50 WG	0.089	45.1 a	18.9 ab	26.4 a	16.2 b	46.8 a	45.3 a	30.2 bc	27.7 a
Baythroid 2	0.0375	41.3 a	8.7 cd	5.8 de	5.7 c	6.4 c	8.1 bc	15.6 d	11.0 cd
Baythroid 2 + Dimethoate 267	0.0375 + 0.375	36.7 a	7.8 cde	2.8 g	4.5 c	2.6 c	4.9 cd	5.3 e	6.9 d
Warrior T	0.025	50.7 a	8.3 cde	3.4 fg	2.8 c	2.0 c	3.0 d	4.3 e	10.3 cd
Mustang 1.5 EW	0.04	38.9 a	6.2 de	7.1 cd	5.4 c	6.2 c	11.3 b	17.4 cd	6.9 d
Dimethoate E267	0.375	41.2 a	3.7 e	3.5 efg	3.6 c	2.7 c	4.5 d	8.5 de	6.7 d
Aphistar 1.4 EW	0.125	39.9 a	9.2 cd	5.2 def	4.9 c	3.6 c	2.9 d	3.1 e	2.7 d

DPT = days pre-treatment; DAT= days after treatment. Mean separation within columns by $LSD_{0.05}$.
[a] Square root transformed data used in analysis, reverse transformed means reported.
[b] Log transformed data used in analysis, reverse transformed means reported.

TABLE 2. Fresh and Dry Weight of Alfalfa in Grams per 0.25 m^2, Percentages of Dry Weight, Plant Height in cm, and Aphid Means for After Insecticide Treatments, Holtville, California, 2000.

Treatment	pt /acre	Fresh	Dry	% Dry	Plant ht	Aphids[a]
Dimethoate 267	0.375	372.7 a	72.9 a	19.6 a	19.83 ab	4.84 d
Baythroid 2 + Dimethoate E267	0.0375+ 0.375	328.6 ab	64.6 ab	19.9 a	22.35 a	5.17 d
Warrior T	0.025	325.1 b	63.8 ab	19.4 a	19.30 bc	4.96 d
Aphistar 1.4 EW	0.125	324.3 b	65.2 ab	20.1 a	20.53 ab	4.52 d
Baythroid 2	0.0375	321.9 bc	66.8 ab	20.6 a	20.23 ab	8.95 c
Mustang 1.5 EW	0.04	298.2 bc	60.6 b	20.4 a	19.98 ab	8.58 c
Actara 25 WG	0.047	275.9 cd	56.6 bc	20.8 a	19.85 ab	31.33 ab
Actara 25 WG	0.086	237.7 de	46.4 d	19.5 a	19.72 ab	23.70 b
Fulfill 50 WG	0.089	230.3 de	49.0 cd	21.0 a	19.13 bc	30.36 ab
Untreated	--------	215.6 e	47.2 cd	21.9 a	16.78 c	37.80 a

[a] Log transformed data were used for analysis; reverse transformed means are reported.
Mean separations within columns by $LSD_{0.05}$.

TABLE 3. Weight of Alfalfa Leaf, Stem, and Total Weight as Grams per 0.25 m^2, Percent Leaf, and Aphid Means for After Insecticide Treatments, Holtville, California, 2000.

Treatment	pt /acre	gm stem	gm leaf	gm hay	% leaf	Aphids[a]
Dimethoate 267	0.375	24.88 a	48.05 a	72.93 ab	65.7 bc	4.84 d
Baythroid 2	0.0375	21.85 ab	44.98 ab	66.83 ab	67.1 abc	8.95 c
Baythroid 2 + Dimethoate E267	0.0375+ 0.375	21.85 ab	42.78 ab	64.63 ab	65.8 bc	5.17 d
Aphistar 1.4 EW	0.125	20.50 bc	44.70 ab	65.20 ab	68.3 abc	4.52 d
Warrior T	0.025	22.13 ab	41.65 abc	63.78 ab	65.3 c	4.96 d
Mustang 1.5 EW	0.04	19.00 bc	41.58 abc	60.58 b	68.9 ab	8.58 c
Actara 25 WG	0.047	17.35 cd	39.25 bcd	56.6 bc	69.6 a	31.33 ab
Actara 25 WG	0.086	13.83 d	32.53 d	46.35 d	70.1 a	23.70 b
Fulfill 50 WG	0.089	14.55 d	34.40 cd	48.95 cd	70.1 a	30.36 ab
Untreated	--------	14.53 d	32.65 d	47.18 cd	69.2 a	37.80 a

[a] Log transformed data were used for analysis; reverse transformed means are reported.
Mean separations within columns by $LSD_{0.05}$.

TABLE 4. Feed Quality and Aphid Means Following Insecticide Treatments, Holtville, CA, 2000.

Treatment	pt/acre	Aphids[d]	% CP[a]	% ADF[b]	IVTD[c]
Untreated	--------	37.80 a	25.35 a	20.47 a	72.96 a
Fulfill 50 WG	0.089	30.36 ab	24.78 a	21.15 a	72.43 a
Actara 25 WG	0.047	31.33 ab	24.31 a	20.70 a	72.77 a
Actara 25 WG	0.086	23.70 b	24.97 a	19.44 a	73.75 a
Mustang 1.5 EW	0.04	8.58 c	25.68 a	20.16 a	73.20 a
Baythroid 2	0.0375	8.95 c	25.71 a	20.49 a	72.94 a
Baythroid 2 +Dimethoate 267	0.0375 + 0.375	5.17 d	24.77 a	20.32 a	73.07 a
Warrior T	0.025	4.96 d	25.45 a	19.38 a	73.81 a
Dimethoate E267	0.375	4.84 d	25.67 a	20.20 a	73.16 a
Aphistar 1.4 EW	0.125	4.52 d	25.34 a	21.00 a	72.54 a

[a] Percent crude protein. [b] Percent acid detergent fiber. [c] In vitro true digestibility.
[d] Log transformed data were used for analysis; reverse transformed means are reported.
Mean separations within columns by $LSD_{0.05}$.

TABLE 5. Coefficients of Correlation for Feed Quality Parameters, Plant Height, Fresh and Dry Weight of Alfalfa, Leaf Weight in Grams, and Percent Leaf from Hay, Holtville, California, 2000.

	%CP[a]	%ADF[b]	IVTD[c]	Plant Ht cm	Fresh Wt gm	Dry Wt gm	gm Leaf	% Leaf
CPA[d]	-0.140	0.122	-0.122	-0.416**	-0.573**	-0.503**	-0.448	0.442**

[a] Percent crude protein.
[b] Percent acid detergent fiber.
[c] In vitro true digestibility.
[d] Log of cutting cycle cowpea aphid means
**$P_{0.01}$

Table 6. Control Action Thresholds for Spotted Alfalfa Aphid[a].

Spring months	40 aphids per stem
Summer months	20 aphids per stem
Overwintering populations: last fall cutting	50-70 aphids per stem
Reseeded alfalfa in low desert	20 aphids per stem

[a] Modified from Integrated Pest Management for Alfalfa Hay. University of California Statewide Integrated Pest Management Project, DANR, Publication 3312 (Anonymous 1985).