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The Comparison of Aerial and Sprinkler Applied Delayed Applications of Kerb to Lettuce

Barry Tickes, University of Arizona Cooperative Extension

Introduction

It has become a common practice to delay applications of Kerb when using sprinklers to establish lettuce in the low desert where high volumes of water are applied prior to weed germination. Prior to the 2003-04 season, the only option for making applications to wet fields was by air. A third party special local need registration (24C) label was granted to the Western Growers Association in the summer of 2003 which allows for the application of Kerb through sprinklers in Arizona. According to the Association records, approximately 21,000 acres of lettuce were treated with sprinkler applied Kerb during the 2003-04 season. Tests conducted in 2002-03 season indicated that sprinkler applications were effective and sometimes superior to aerial applications. Additional tests were conducted this season.

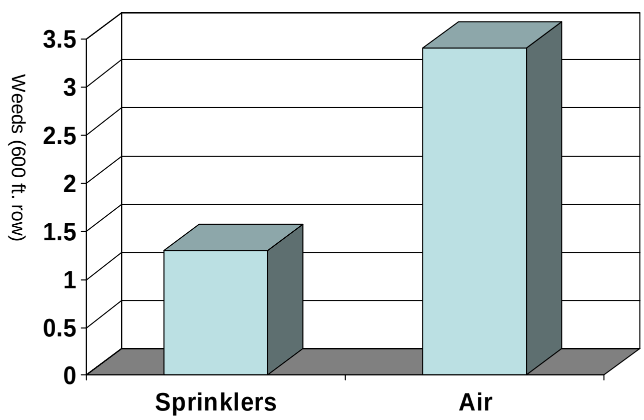
Procedure

This project was intended to compare application techniques on a commercial scale and could not be conducted with small plots under controlled conditions. Three tests were conducted this season by dividing 20 to 40 acre blocks in half and applying an equal rate of Kerb through sprinklers on one half and by air on the other half. Sprinklers were run from 4 to 6 hours after application on both halves except in Test Number 5 which was included here not as an equal comparison of aerial and sprinkler applied Kerb but to demonstrate the importance of proper water management when using this technique. In test Number 5 the sprinkler applied half of the field received an additional 2 inches of water following the Kerb application and resulted in significantly inferior weed control compared to the other half applied by air. Weed counts were made just prior to thinning on 10 randomly selected beds and are reported as an average of the 10 with a description of each test.

Test 1

Location: Dome Valley (20E and Co 8th Street)
Grower/PCA: Pasquinelli/Jeff Havins
Plot Size: 18 acres
Date applied: 12-11-03

Days after Sprinklers Started: 4
Rate: 1.3 lb/ac
Evaluated: 1-15-04
Weeds: Nettleleaf Goosefoot

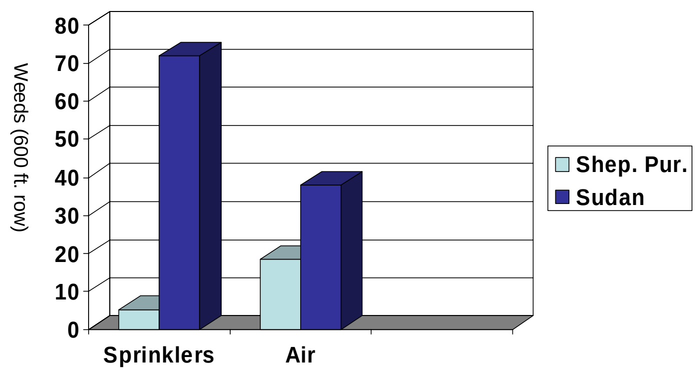


In this test: There were few weeds in this 36 acre block and it appeared as if both the aerial and sprinkler applied Kerb was effective. Weed counts indicated that the aerial applied 18 acres had slightly more needleleaf goosefoot that escaped treatment than the sprinkler applied 18 acres. Crop injury in the form of marginal chlorosis and leaf burn was present in both halves of this field and was thought to be the result of cold temperatures rather than the herbicide.

Test 2

Location: Tacna (41E and County 5th Street)
Grower/PCA: Amigo Farms/Jeff Nigh
Plot size: 11 acres
Date applied: 12-31-03

Days after sprinklers started: 5
Rate: 1.3 lb./ac
Evaluated: 1-30-04
Weeds: Shepardspurse and Sudangrass

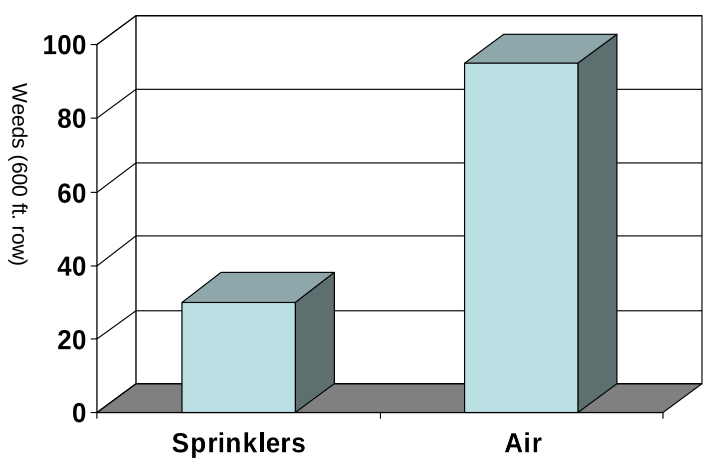


In this test: Shepardspurse control was significantly better in the sprinkler applied section of this block than it was on the aerial applied section. Sudangrass control, however, was poor in both the sprinkler and aerial applied sections. There was more Sudangrass in the sprinkler applied section than in the aerial applied section. There may have been a greater infestation in this section than in the aerial applied section but control of this weed was poor in both.

Test 3

Location; Yuma Valley (13th St & Avenue B)
Grower/PCA: Curry Farms/Bill Fox
Plot Size: 17 acres
Date Applied: 10-20-02

Days after sprinklers started: 3
Rate: 1.3 lb./ac
Evaluated: 11-19-02
Weeds: Shepardspurse

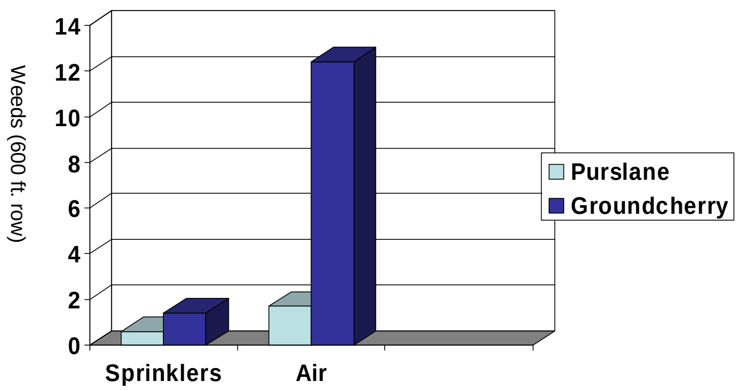


In this test: There was a high infestation of shepardspurse in this block. Control was significantly better in the sprinkler applied half than in the aerial applied half.

Test 4

Location: Yuma Valley (Ave H and Co 15th St)
Grower/PCA: Amigo Farms/Jeff Nigh
Plot Size: 13 acres
Date applied: 6-5-02

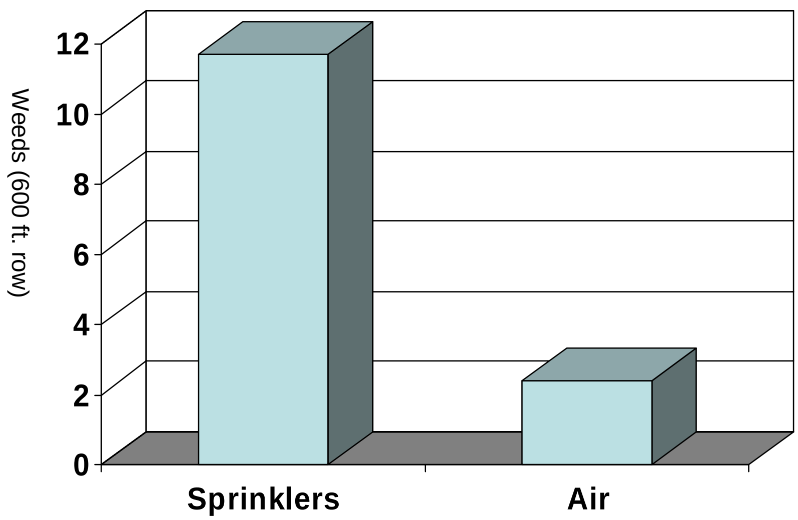
Days after sprinklers started: 1
Rate: 1.5 lb./ac
Evaluated: 6-25-02
Weeds: Common Purslane, Wright Groundcherry



In this test: This test was conducted in mid-summer to compare aerial and sprinkler applied Kerb applications. This test was conducted 3 months before lettuce was planted and was not intended to represent a typical Kerb application. Weed counts indicated that the sprinkler application was significantly more effective in controlling both Groundcherry and Purslane than the aerial application.

Test 5

Location: Yuma Valley (Ave C and Co. 12th Street)
Grower/PCA: E. Harrison/Bill Fox
Plot Size: 17 acres
Date applied: 12-4-03
Days after sprinklers started: 3
Rate: 1.7 lb./ac
Evaluated: 1-6-04
Weeds: Shepardspurse



In this test: This test was not an equal comparison between aerial and sprinkler applications of Kerb but is included here because it demonstrates the importance of proper water management when making delayed applications of Kerb to minimize leaching of the herbicide. Our intention was to treat half of this 34 acre block with 1.7 lb./ac Kerb applied by air and half with 1.7 lb./ac Kerb applied through the sprinklers. The entire 34 acre block was mistakenly treated by air with 1.7 lb./ac. causing in the sprinkler applied half to receive two applications totaling 3.4 lb./ac. To minimize crop injury, the sprinklers were run an additional 24 hours on this half of the block. No crop injury occurred due to the leaching of the herbicide but weed control was also reduced significantly compared to the half of the field that did not receive the additional water.

Discussion

Broadleaf weed control was better in all tests from the sprinkler applied Kerb than from the aerial applications. Test 5 was not an equal comparison of the two application techniques because of the extra water applied to the sprinkler applied section of this field. Sudangrass control was poor in Test 2 and worse in the sprinkler applied section. The reason for this is unclear. Crop injury occurred only in Test 1 and this was thought to be from cold temperatures rather than from the herbicide. It was equally present in both the aerial and sprinkler applied sections of the field. It can be concluded from these tests that applying Kerb through sprinklers to lettuce is effective and often superior to aerial applications. Proper timing and water management are necessary for the success of both aerial and sprinkler applications.

Common Groundsel – An emerging Weed Problem in Low Desert Alfalfa

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Introduction

Common Groundsel (Senecio Vulgaris) is a difficult to control and potentially poisonous weed that has become established in LaPaz County and is becoming increasingly widespread. This weed has been present in alfalfa grown at higher elevations in locations surrounding the low desert for many years but did not become established here until recently.

Common Groundsel belongs to the composite or sunflower family. This family includes about 900 species including many weeds that have been here for a long time including sowthistle, prickly lettuce, marstail, sunflower, camphorweed, cocklebur, povertyweed, dandelion, the thistles and others. This family also includes several major crops including lettuce, artichokes and flowers such as chrysanthemum, marigold and daisy. Common groundsel contains pyrrolizidine alkaloids (PA) which can be toxic to cattle and horses. PA does not seem to affect sheep and poisoning of horses and cattle is not widespread even in areas where this weed has existed for many years. Other weeds in the senecio genus, such as tansy ragwort (senecio jacoboca), are more toxic.

Although small and isolated infestations of this weed have been reported over the years, the first large scale and heavy infestation was confirmed about 6 years ago by Dan Hensley in the Butler Valley. The weed can now be found in alfalfa fields throughout the Parker Valley. No confirmed findings have been reported in Yuma County.

The seed from this weed is easily dispersed by wind, water, machinery and animals. It is flowering at the same time that sheep grazing of alfalfa fields is occurring. The proliferation of groundsel can also be correlated to the widespread use of the imadazlionone herbicides, Raptor and Pursuit, which are weak on this family of weeds.

Control

A thick healthy stand of alfalfa has always been good weed control. Most weeds cannot compete with the frequent cutting and rapid crop regrowth. There are times, however, when herbicides are required. A test was conducted this season to evaluate both currently registered herbicides and potential new herbicides for the control of common grounsel. This test was conducted in a heavily infested second year alfalfa field along Mohave Road, North of Agnes Wilson Road. The test contained six preemergence and five postemergence herbicides. The preemergence treatments were applied on 10-29-03 when the alfalfa was 1-3" in height and the postemergence treatments were applied on 11-25-03 when the alfalfa was 4-12" in height and the grounsel was 1 leaf to 3 inch rosette. These treatments were applied with a backpack sprayer calibrated at 20 gallons per acre. The plot size was 42' by 100' with 3 replications. Visual evaluations of percent control were made on 1-28-04. The treatments and results were:

Herbicide	Rate	Time	Control (%)
Eptam 7E	4 pts.	Pre	37
Zorial 80	2.5 lbs.	Pre	92
Velpar 2L	2 pts.	Pre	97
Sencor 75 DF	0.6 lbs.	Pre	57
Visor 2EC	2 pts.	Pre	90
Chateau WG	4 oz.	Pre	95
Sencor 75 DF	0.6 lbs.	Post	90
Velpar 2L	2 pts.	Post	98
Gramoxone Max 3 EC	2.7 pts.	Post	87
Pursuit 2 EC	6 oz.	Post	68
Raptor 1 EC	6 oz.	Post	68

Phytoxicity in the form of leaf burning and/or stunting was noted following several of these treatments although the crop had fully recovered in all cases at the time of evaluation. The postemergence application of Sencor, Velpar and Gramoxone and the preemergence application of Velpar caused the most severe injury. Chateau, Pursuit and Raptor caused stunting but not leaf burn and no injury was evident from Eptam, Zorial or Visor. Velpar and Sencor have caused serious crop injury in many other tests but injury was moderate and temporary at this location this year.

Control with the preemergence treatments ranged from 37% with Eptam to 97% with Velpar. Eptam was sprayed on the surface and incorporated with the irrigation water within 2 days. Better deposition and control may have been achieved if it had been applied as a water run application. Velpar produced excellent control but is not likely to be registered in the low desert because of crop injury observed to non-dormant alfalfa. Velpar has been used for 20 years on dormant and semi-dormant varieties with excellent results. Chateau also produced excellent control in this test. This is a new herbicide produced by Valent that is currently used as soybeans and peanuts. Registration is being actively pursued in Arizona and California on alfalfa. Visor also produced very good to excellent control. Visor is produced by Dow AgroSciences and is currently registered on oranges and grapefruit. Dow is not currently actively pursuing a registration in alfalfa. Sencor is registered for use in alfalfa following sheeping or cutting when little crop foliage is present. Poor control was achieved with preemergence applications and excellent control resulted form postemergence applications. Crop injury is common when alfalfa foliage is present. The only currently registered herbicide that produced excellent preemergence control in this test was Zorial. No crop injury was apparent from this treatment. Zorial is registered on established alfalfa in Arizona and California. Sensitive crops cannot be planted into treated fields for 16 months following the last Zorial application.

Excellent early postemergence control was achieved with Velpar and Sencor although both will often cause unacceptable crop injury when applied at this time. Gramoxone produced good control when applied to very small weeds with good coverage. Larger weeds or those receiving partial coverage would not ordinarily be controlled. All crop foliage present at the time of application is lost from this contact herbicide. New growth is not affected. Buctril is another contact herbicide that was not included in this test but is registered and has produced very good control to small weeds under commercial conditions. Crop injury is much less severe than with Gramoxone. Both Pursuit and Raptor were weak on this weed and should not be used exclusively when much Groundsel is present in field to be treated.

Management of Aphids in *Brassica* Seed Crops with Selective Insecticides

John C. Palumbo and Barry Tickes

Introduction

A number of insects can cause serious problems in broccoli and cauliflower grown for seed. Sucking insects such as aphids and false chinch bugs can be serious pests later in the season during reproductive growth periods when plants are actively being pollinated and producing seed. These pests injure the crops primarily by feeding on the developing seed. Aphids feeding in blooms and seed pods are particularly easy to kill with most conventional OP and carbamate insecticides because they are directly exposed to foliar sprays. However, aphid control becomes a problem during pollination when the crop is in bloom and bees are actively foraging in the field. Insecticides presently registered for use in seed crops are considered highly toxic to bees. Thus, to avoid killing bees, pollination often must be interrupted. The colonies are either temporarily removed from the field, or applications must be made at night. In either case, several days can pass before the bees resume normal foraging activity. Repeated applications to control aphid populations may cause a significant disruption in pollination and reduced seed yield and quality.

A number of selective aphicides are being developed that provide selective aphid control, with little or no toxicity or repellency to honey bees. Fulfill® (pymetrozine, Novartis) is presently labeled on leafy vegetables and has an SLN registration for *Brassica* seed crops in Arizona (AZ-000004). Our experiences in lettuce suggests that the product can provide 10-14 residual control of aphids when applications are initiated when aphids first begin to colonize on foliage. Other promising candidates (not labeled) Aphistar® (triazimate, Rohm&Haas) and Pirimor® (pirimicarb, Zeneca) have excellent contact and systemic aphid activity on a number of crops. Similarly, studies in lettuce have shown that these two compounds provided about 14-21 d residual aphid control. Unfortunately, both products are carbamates, and their future status is not known. Another promising product under consideration is Assail® (acetamiprid, Ceragri), which is also safe to pollinators. The compound is a neonicitinoid, similar in activity to Admire® and the product was recently granted a registration for use in broccoli and cauliflower in California. In previous field trials, it has shown good control of green peach aphid on lettuce and broccoli. Selectivity can also be achieved by applying the pesticides to the plant without exposing pollinators to the toxicant. Platinum® (thiamethoxam, Syngenta), also a neonicotinoid, has recently been labeled on melons for whitefly control with labels pending on leafy vegetables and *Brassica* crops for aphids. It is applied in-furrow at planting and has similar activity as Admire. The primary difference between the two products is that Platinum is very mobile in the soil and moves readily with furrow irrigation. Trials in head lettuce and melons have shown that residual aphid control is actually better when the product is applied at side dress rather than at planting. This approach extends residual control closer to harvest. It may be possible to use this approach in *Brassica* seed crops by side-dressing the product at layby, thus providing residual control at the time aphids begin to colonize in the spring. Given that the products will soon be labeled on cole crops, evaluating this approach may result in an effective management tool. We completed a replicated study in 2003. *<u>Note:</u> Admire is not labeled for use on seed crops.*

Because the value of these compounds for aphid control in *Brassica* seed crops grown in Arizona needs to be determined, we conducted studies to measure aphid control with these new experimental compounds under non-blooming (early aphid development) and blooming (heavy aphid pressure) conditions. We also studied aphid population dynamics by identifying and quantifying the aphid species complex on a broccoli seed crop and determined their distribution on plants during the pre-bloom growth period. Ultimately, our goal is to gather data to assist Arizona seed growers and PCA's in making management decisions and to support registrations for new insecticides.

Materials and Methods

2001 Study: The study was conducted in a 5 acre commercial cauliflower seed field in Yuma, Arizona. Male transplants were established in the field on single row, 42 inch beds on 20 September, 2000 and female transplants were established on 30 September. Plants were furrowed irrigated throughout the trial. Large plots were established in the field by equally dividing the field into plots 10 beds wide by 600 ft long. For the insecticide study, untreated plots were established within randomly selected plots and were 10 beds wide by 75 ft long. Equal numbers of male and female plants were distributed equally on alternating beds within each plot. Each treatment was replicated three times in a randomized complete block design.

Foliar applications were made with a commercial Melroe sprayer (Dune Co., Yuma, AZ) that delivered a directed spray at 25 gpa and 40 psi through 2 nozzles per bed. The first application was made on March 8th when female plants were in full bloom. Pirimor 50 DF @ 0.5 lb ai/acre, Fulfill 50 WG @ 0.17 lb ai/acre, and Aphistar 50 W @ 0.124 lb ai/acre were applied at about 1800 hr. A 2nd application was made in a similar manner on March 17th. However, Fulfill was not reapplied, and those plots were over-sprayed with Pirimor (see table below). Plants were still blooming and bees were actively working. A crop oil concentrate was added to each treatment at 3 oz/ac.

Spray TMT #1	Spray TMT #2	Rate /ac
1. Pirimor 50DF	Pirimor 50 DF	8 oz
2. Aphistar 50W	Aphistar 50W	4 oz
3. Fulfill 50WG	Pirimor 50 DF	4.5 oz
4. Untreated check	–	–

Aphid populations were assessed by visually examining plant leaves and terminals and recording the number of wingless, colonizing aphids. Two sampling units were used in this study; a single frame leaf from individual plants, and infested seed pod extensions. Prior to the first application (pre-treatment samples), 40 female and 40 male plants were randomly selected across the field and examined. On each sampling date 5 young (a fully expanded leaf about 4-5th nodes from the terminal) and 5 old (3-4th leaf position from the base of the plant) leaves per plot were examined and the number of aphids per leaf were counted. Once bloom began and plants began to set seed, aphid colonies were visually examined on seed pod extensions. The number of seed pods (extensions) infested with aphids was recorded. The number of aphids on each pod was estimated using two methods. When only a few infested pods were found (ie., treated plots), the number of aphids on each pod was counted in the field When a large number of pods was found infested with high aphid densities (ie., untreated plots), 5-8 representative pods from each plot were collected, taken into the laboratory, and the number of aphid per pod was estimated by direct counts. Treatment means were analyzed using a 1-way ANOVA and means separated by a protected LSD $_{(P<0.05)}$.

2003 Study: The study was conducted in a 2-acre broccoli ‘Marathon’ seed field at the Yuma, Arizona. Male and female transplants were established in the field on single row, 42 inch beds on 4 and 25 October, respectively. Plants were furrowed irrigated throughout the trial. Plots were established in the field by equally dividing the field into plots 8 beds wide by 80 ft long. Equal numbers of male and female plants were distributed equally on alternating beds within each plot. Each treatment was replicated three times in a randomized complete block design. For insecticide trial the following 8 treatment combination were evaluated.

	Spray #1 (Feb 18)	**Rate/ac**		**Spray #2 (Mar 22)**	**Rate/ac**		**Spray #3 (Apr 4)**	**Rate/ac**
1	Pirimor 50DF	3 oz / acre		Pirimor	3 oz		Pirimor	3 oz
2	Fulfill 50WG	2.75 oz		Fulfill	2.75 oz		Fulfill	2.75 oz
3	Assail 70W	1.7 oz		Assail	1.7 oz		Assail	1.7 oz
4	MSR + Capture	2 pts + 6 oz		Capture	6 oz		Capture	3 oz
5	Platinum-sidedress	8 oz		Capture	6 oz			
6	Admire--sidedress	24 oz		Capture	6 oz			
7	Admire--sidedress	24 oz						
8	Untreated	-		Untreated	-		Untreated	-

Several insecticide treatments were applied in this trial. A single Platinum (8 oz/ac) and two Admire (24 oz/ac) treatments were side-dressed on the shoulder of beds, 2-3 inches below the soil in 30 gpa final dilution on Nov 30. Foliar applications were made with a Melroe sprayer (UA YAC) that delivered a directed spray at 25 gpa and 40 psi through 3 nozzles per bed. The first application was made on Feb 18th at 1800 hr. (pre-bloom). A second application was made on March 22nd . Plants were blooming and bees were actively working the field. A third application was made post-bloom on Apr 4 after the bees were removed.

Aphid populations were assessed similar to the 2001 study by visually examining young and old leaves from both male and female plants prior to the first spray application, and seed pod extensions during seed production. Beginning in mid-November, sampling was initiated to determine the abundance and location of aphid species during the pre-blooming growth period. We randomly sampled 80 male plants and 80 female plants about every 14 days from the 2-acre block. From each plant we selected an older leaf from the frame and a younger leaf from the terminal area of the plant. All aphids on each leaf were identified to species and counted. Following the spray applications, the number of seed pods (extensions) infested with aphids was recorded. The number of aphids on each pod was estimated on March 30 by randomly selecting 3 light-moderate and 3 heavy infested pods from each plot and counting the total number of aphids. Treatment means were analyzed using a 1-way ANOVA and means separated by a protected LSD $_{(P<0.05)}$.

Results and Discussion

2001 Study: During the pre-bloom growth period (January-March), our plant counts revealed that two distinct aphid populations were distributed within the cauliflower plants. The frame leaves were largely infested with green peach aphids (GPA >90%) with a small proportion of cabbage aphid and turnip aphid present. Conversely, as plants began to extend and flower production began, the plant terminals and seed pods were predominately infested with cabbage aphids (CA; > 90%) and a small percentage of GPA (Table 1).

The female plants were in full bloom when the 1st application was made. Tables 1 and 2 show the subsequent changes in aphid populations at 3 and 7 DAT, respectively. Both the Pirimor and Aphistar provide excellent knockdown of established CA on plant terminals and seed pods and resulted in significantly fewer infested seed pods compared with the untreated control. The Fullfill spray provided good control of the GPA found on the frame leaves, but provided marginal knockdown of CA on plant terminals and seed pods. Although aphid numbers were not statistically different among the insecticide treatments, it was clear that the Fulfill treatment allowed a much higher number of aphids to remain in seed pods. Furthermore, the aphid numbers increased significantly in the Fulfill treatment from 3 to 7 days after treatment. Consequently, we applied a second application of Pirimor to the Fulfill plots.

Following the second application (Tables 3 and 4), the Aphistar and Pirimor applications significantly reduced aphid numbers and infested pods for 28 days following the application. No damage to the seed pods in treated plots was noted. Aphid numbers in the untreated plots declined steadily during the 28 day period but this was due to the large number of lady beetles that migrated into the plots. Unfortunately most of the seed pods in the untreated plots were seriously damaged due to excessive aphid feeding.

The results of this study suggested that several selective insecticides, in particular Pirimor, have good activity on aphids and also offer bee safety,. None of the products that we applied appeared to affect the foraging honey bees. Furthermore, we did not observe dead bee in the plots. However, Pirimor is an carbamate insecticide and may not be registered for seed crop uses for years if even at all. Similarly, Aphistar has good bee safety and aphid activity, but registration has not been pursued by the manufacturer, and will not likely be registered in the future, as it is also an carbamate. Fulfill does provide bee safety, but did not provide what we would consider acceptable control in the 2001 study. Unfortunately we were looking forward to retesting these effects in 2002, but we unable to because our plots were oversprayed from an adjacent field The compound that we were most interested in looking at in 2002 was Assail. This compound is a neonicotinoid (same chemistry as Admire), and has been shown to provide good bee safety. It has excellent activity against green peach aphid in head lettuce and cole crops, and was thought to provide excellent control of cabbage aphid on exposed seed pods.

2003 Study**:** Similar to 2001, results from our pre-bloom sampling surveys showed that the primary aphid species found were cabbage aphids, turnip aphids, and green peach aphids. Geeen peach aphids tended to colonize plants slightly earlier and were found to primarily on the older frame leaves low on the plant (Table 6).. In most cases, male and female plants were colonized to the same extent. Their numbers peaked in late January, and were found on seed pods at very low densities. Cabbage and turnip aphids behaved similarly, and were combined for this summary. There appeared to be no clear preference between their colonization on older and younger leaves. Similarly, they appeared to colonize males and females equally. During the bloom period (March-April), the population was almost exclusively cabbage aphid feeding on seed pods and extensions. Their numbers were higher than green peach aphid, and rapidly colonized seed pods and extensions once pollination was completed and bloom had dropped. Cabbage aphid was the primary species (>90%) found feeding on developing seed pods in this test. Based on both years results, sampling for aphids on seed crops should begin a week or so prior to bloom. Scouting should focus on younger leaves from the terminal area. Once blooming begins, sampling should focus almost exclusively on newly developing seed pod extensions.

The first spray application made to the foliage of pre-blooming plants did not apper to significantly reduce population densities (Table 7). This may in part due to lower densities at this time, but also the tendency for the aphids to move into the developing seed pod extenstions (Fig 1). Cabbage aphids were the primary species present on seed pods, and were easily knocked down by contact materials Capture and MSR. Estimates of actual densities per seed pod extension showed that contact activity varied by compound. Perhaps most impressive was the estimated population levels of cabbage aphids on untreated plants (Table 8 and 9). These high levels were sustained in the check plots for the duration of the plot and resulted in significant mortality once seed set was complete (Fig 2), and ultimately resulted in 100% mortality of seed pod extensions in the untreated check due to aphid feeding.

Of the bee safe products, Pirimor provided the most consistent residual aphid control similar to 2001. This was achieved with 3 applications at a 3 oz rate. Both Assail or Fulfill worked well on foliage, but did not provide comparable control on seed pods. Given Fulfill’s weakness as a contact material on seed crops, it should not be recommended for cabbage aphid control on broccoli seed crops. Although Assail performed better, it needs to be further evaluated before recommendations can be made. Both the side-dress applications of Platinum and Admire provided good aphid suppression prior to seed pod extension. A single Capture application following bloom rapidly controlled colonizing aphids in these plots. The Capture spray will likely provide some control of false chinch bugs on maturing plants (False chinch bugs were not present in the test). The Admire only treatment did not provide adequate protection from aphids during seed production.

In general, the pre-bloom application did not appear to prevent aphids from quickly colonizing seed following extension and bloom (Table 7, Fig 1). In years where aphids number are lighter (such as 2001), a pre-bloom application may significantly suppress colonization.. As noted above, aphid densities were extremely high in the untreated check, and to a lesser extent in the Fulfill plots. The aphids had a direct impact on plant mortality. We had intended to measure seed quality in the plots, but seed yields were not taken due to heavy late season losses to S*clerotinia* and bird damage in all plots.

Acknowledgments

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Table 1. Within plant distribution of aphid species in pre-blooming cauliflower, Yuma Mesa, Spring 2001.

		Mean aphids / leaf						
		Cabbage/Turnip Aphid				Green Peach Aphid		
Sample date	**Leaf** [a]	**Female**	**Male**		**Leaf** [a]	**Female**	**Male**	
2-Jan	**Young**	0	0	NS	**Young**	0	0	NS
	Old	0.8	0.6	NS	**Old**	0.2	0	NS
		NS	NS			NS	NS	
20-Jan	**Young**	0	0	NS	**Young**	0	0	NS
	Old	0	0.1	NS	**Old**	0.2	0.1	NS
		NS	NS			NS	NS	
20-Feb	**Young**	0.2	0.2	NS	**Young**	0	0	NS
	Old	2.2	1.5	NS	**Old**	0.5	0.9	NS
		*	*			NS	NS	
8-Mar	**Young**	22.6	13.6	NS	**Young**	0.2	0.2	NS
	Old	2.9	2.8	NS	**Old**	6.9	4.8	NS
		*	*			*	*	

NS, treatments were not significantly differ rent, (t-test, p>0.05), * treatments were significantly different (p<0.05)
[a] Young refers to terminal leaves; Old refers to lower frame leaves on plants.

Table 2. Aphid numbers at 3 days following the 1st application on a female cauliflower plants in full bloom, Yuma Mesa, Spring 2001.

	March 11 (*3 Days Following Application #1*)			
Treatment	No. aphids[a] / frame leaf	No. aphids[b] / plant terminal	No. infested seed pods/ plant	No. aphids[b] / seed pod
Pirimor / Pirimor	47.1 b	1.4 b	0.13 b	12.0 d
Fulfill / Pirimor	17.0 c	90.1 b	0.54 b	161.2 b
Aphistar / Aphistar	37.1 bc	10.9 b	0.16 b	76.1 c
Untreated check	98.0 a	591.8 a	2.00 a	304.0 a

Means followed the same letter are not significantly different ; ANOVA, protected LSD $(p < 0.05)$.
Pre-treatment means: 91.5 aphids / frame leaf; 515.8 aphids /terminal ; 2.1 infested pods/plant.
[a] population consisted primarily of Green peach aphids (>90%).
[b] population consisted primarily of cabbage aphids (>90%).

Table 3. Aphid numbers at 7 days following the 1st application on a female cauliflower plants in full bloom, Yuma Mesa, Spring 2001.

	March 15 (7 Days Following Application #1)			
Treatment	No. aphids [a] / frame leaf	No. aphids [b] / plant terminal	No. infested seed pods/ plant	No. aphids [b] / seed pod
Pirimor	67.6 b	1.7 b	0.22 b	7.7 c
Fulfill	45.0 b	202.8 b	2.50 ab	86.3 b
Aphistar	107.5 ab	9.0 b	0.25 b	38.2 bc
Untreated check	223.7 a	1901.3 a	5.35 a	361.0 a

Means followed the same letter are not significantly different ; ANOVA, protected LSD $(p < 0.05)$.
Pre-treatment means: 91.5 aphids / frame leaf; 515.8 aphids /terminal ; 2.1 infested pods/plant.
[a] population consisted primarily of green peach aphids (>90%).
[b] population consisted primarily of cabbage aphids (>90%).

Table 4. Mean Aphid numbers on frame leaves and terminals at 7,14, 21, and 28 d following the 2nd application on female cauliflower plants in full bloom, Yuma Mesa, Spring 2001.

	No. aphids/ frame leaf [a]				No. aphids / terminal b			
	March 24	**March 31**	**April 7**	**April 14**	**March 24**	**March 31**	**April 7**	**April 14**
Treatment	*7 DAT*	*14 DAT*	*21 DAT*	*28 DAT*	*7 DAT*	*14 DAT*	*21 DAT*	*28 DAT*
Pirimor / Pirimor	9.1 b	2.7 b	3.7 b	2.0 b	0.6 b	0 b	0 b	0 b
Fulfill / Pirimor	7.6 b	6.2 b	34.3 b	1.5 b	0.4 b	0 b	0 b	0 b
Aphistar / Aphistar	11.8 b	3.4 b	3.3 b	0.4 b	0 b	0 b	2.5 b	0 b
Untreated check	177.7 a	95.7 a	52.9 a	20.5 a	889.9 a	712.0 a	307.0 a	205.5 a

Means followed the same letter are not significantly different ; ANOVA, protected LSD $(p < 0.05)$. [a] population consisted primarily of Green peach aphids (>90%).

[b] population consisted primarily of cabbage aphids (>90%).

Table 5. Mean Aphid numbers on frame leaves and terminals at 7,14, 21, and 28 d following the 2nd application on female cauliflower plants in full bloom, Yuma Mesa, Spring 2001.

	No. infested seed pods/terminal				No. aphids / seed pod [a]			
	March 24	**March 31**	**April 7**	**April 14**	**March 24**	**March 31**	**April 7**	**April 14**
Treatment	*7 DAT*	*14 DAT*	*21 DAT*	*28 DAT*	*7 DAT*	*14 DAT*	*21 DAT*	*28 DAT*
Pirimor / Pirimor	0.12 b	0 b	0 b	0 b	5.7 b	0 b	0 b	0 b
Fulfill / Pirimor	0.24 b	0 b	0 b	0 b	1.5 b	0 b	0 b	0 b
Aphistar / Aphistar	0.03 b	0.1 b	0.1 b	0 b	0.3 b	1.7 b	2.0 b	0 b
Untreated check	2.0 a	1.8 a	1.1 a	0.6 a	448.5 a	290.8 a	234.5 a	162.5 a

Means followed the same letter are not significantly different ; ANOVA, protected LSD $(p < 0.05)$.

[a] population consisted primarily of cabbage aphids (>90%).

Table 6. Aphid abundance on frame leaves prior to and 11 d following the 1st application broccoli plants, pre-bloom, Yuma Ag Center, 2003

		Mean aphids / leaf /plant							
		Feb 18 (pre-spray)				March 1 (11-DAT#1)			
Treatment	**Rate**	**GPA**	**CA**	**TA**	**Total**	**GPA**	**CA**	**TA**	**Total**
Pirimor 50DF	3 oz / acre	2.1	24.0	4.0	30.1	1.0	1.5	0	2.5
Fulfill 50WG	2.75 oz	1.2	4.2	1.2	6.6	2.0	1.0	0	3.0
Assail 70W	1.7 oz	2.0	4.0	3.3	9.3	5.0	1.2	0.5	6.7
MSR + Capture	2 pts + 6 oz	3.0	4.3	0	7.3	0	0	0	0
Platinum/Capture	8 oz + 6 oz	1.5	4.1	0	5.6	0	0	0	0
Admire/ Capture	24 oz + 6 oz	0	2.5	0	2.5	0	3.6	0	3.6
Admire	24 oz	0	2.0	0	2.0	0	0	0	0
Untreated	-	4.5	8.2	0	12.7	4.5	13.5	0	18.0

* No significant differences among treatments *(AOV, LSD, P<0.05).*

Table 7. Within plant distribution of aphid species in pre-blooming broccoli, Yuma Ac Center, 2003

	Mean aphids / leaf							
	Cabbage/Turnip Aphid				Green Peach Aphid			
Sample date	**Leaf** [a]	**Female**	**Male**		**Leaf** [a]	**Female**	**Male**	
28-Nov	**Young**	0	0	NS	**Young**	0	0	NS
	Old	0	0	NS	**Old**	0	0	NS
		NS	NS			NS	NS	
11-Dec	**Young**	0	0	NS	**Young**	0	0	NS
	Old	0.1	0	NS	**Old**	0.3	0.4	NS
		NS	NS			NS	NS	
30-Dec	**Young**	0	0	NS	**Young**	0	0	NS
	Old	0.5	0.1	NS	**Old**	0.2	0.3	NS
		*	NS			NS	NS	
14-Jan	**Young**	0	0.1	NS	**Young**	0.2	0	NS
	Old	0.8	0.6	NS	**Old**	0.8	0.3	NS
		*	*			*	NS	
28-Jan	**Young**	0	5.3	*	**Young**	0	0	NS
	Old	1.3	1.8	NS	**Old**	1.9	0.5	NS
		NS	*			*	NS	
18-Feb	**Young**	3.0	3.1	NS	**Young**	0	1.0	NS
	Old	17.3	14.0	NS	**Old**	1.0	6.0	*
		*	*			*	*	
1-Mar	**Young**	20.0	6.0	*	**Young**	0	0	NS
	Old	1.0	1.5	NS	**Old**	3.2	3.3	NS
		*	*			*	*	

NS, treatments were not significantly differ rent, (t-test, p>0.05), * treatments were significantly different (p<0.05)
[a] Young refers to terminal leaves; Old refers to lower frame leaves on plants.

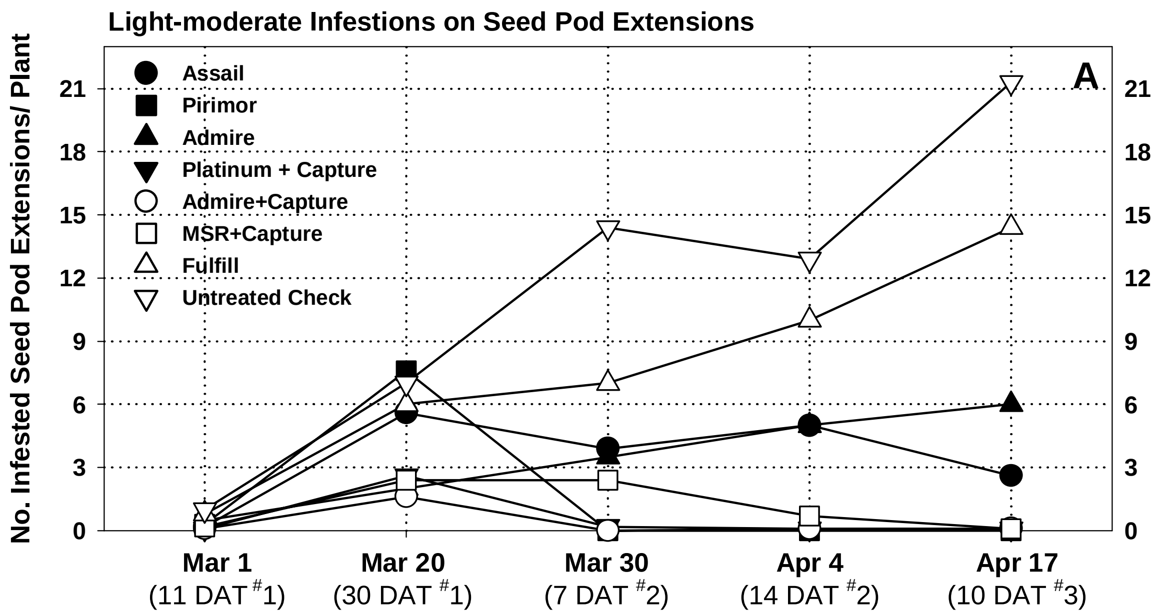
Table 8. Mean aphid densities on seed pod extensions on Mar 30 (7 d following 2nd application), YAC 2003.

Treatment	Rate	Avg. aphids / seed pod extension		
		Light-Mod.	Heavy	Total
Pirimor 50DF	3 oz / acre	75.8	0	75.8
Fulfill 50WG	2.75 oz	376.0	1793.5	2169.5
Assail 70W	1.7 oz	265.0	1513.0	1778.0
MSR + Capture	2 pts + 6 oz	653.0	2710.5	3363.5
Platinum / Capture	8 oz + 6 oz	49.5	0	49.5
Admire / Capture	24 oz + 6 oz	0	0	0
Admire	24 oz	61.2	980.0	1041.2
Untreated	-	975.2	2323.6	3290.8

Table 8. Estimated aphid densities on reproductive part of broccoli plants on Mar 30 (7 d following 2nd application), YAC 2003.

Treatment	Rate	Avg. aphids / plant		
		Light-Mod.	Heavy	Total
Pirimor 50DF	3 oz / acre	60.6	0	60.6
Fulfill 50WG	2.75 oz	2481.6	15616.5	18098.1
Assail 70W	1.7 oz	1033.5	605.2	1638.7
MSR + Capture	2 pts + 6 oz	1567.2	542.0	2109.7
Platinum / Capture	8 oz + 6 oz	9.9	0	9.9
Admire / Capture	24 oz + 6 oz	6.0	0	6.0
Admire	24 oz	195.8	882.1	1077.9
Untreated	-	13750.3	30439.2	444189.5

Figure 1. Measurements of aphid infestations on seed pod extensions on treated and untreated broccoli seed crop, YAC 2003



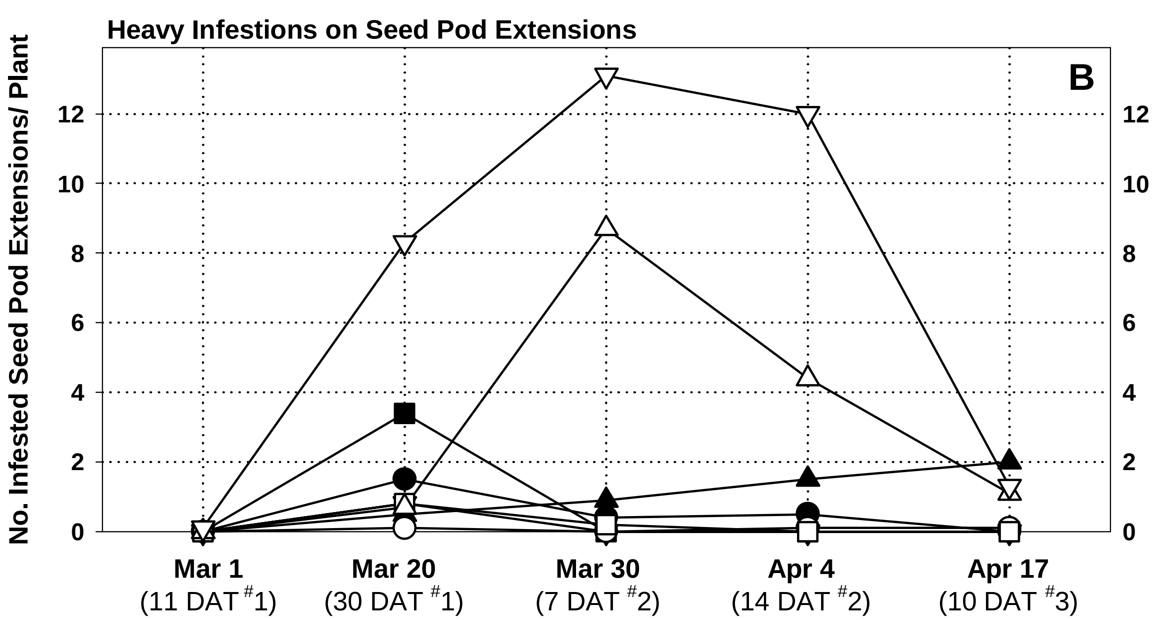
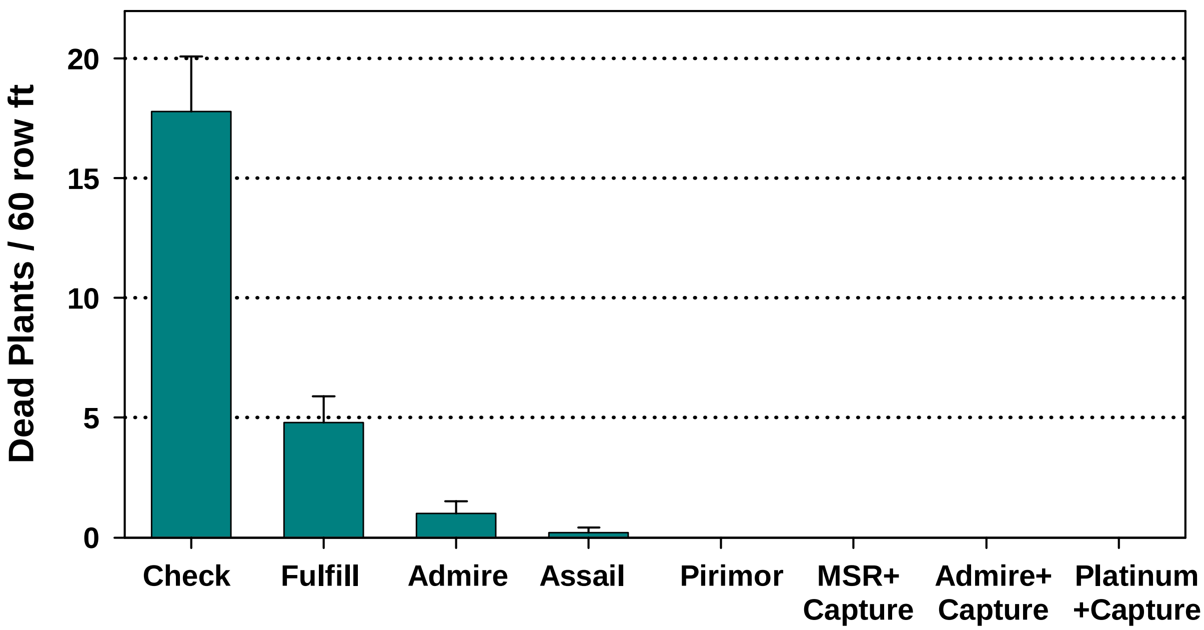


Figure 2. Estimates on plant mortality attributed to direct feeding damage by aphids on seedpod extensions, broccoli seed crop, YAC 2003



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

John C. Palumbo

Note: *Foxglove aphids have been observed colonizing head and leaf lettuce in experimental plots at the Yuma Agricultural Center since mid-January. The intensity of observed infestation levels are similar to what was observed this time last year. PCA's should be aware of the presence of this aphid species, particularly when temperatures begin to warm up. For assistance in identification of foxglove aphids visit: http://ag.arizona.edu/crops/vegetables/insects/advisories/2003/JCPaphidkey1203.pdf or contact us at the Agricultural Center.*

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. 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, *Acyrthosiphon 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 CO_2 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 *Acyrthosiphon 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 1). 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 1). 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 foliars reduced aphid numbers to acceptable levels at harvest. Dinotefuron did not provided 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. Flonicamid, 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 2).*** 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, Othehene+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 3).*** 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 Flonicamid.

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. Flonicamid 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 flonicamid 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 Flonicamid 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: Flonicamid 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, Flonicamid 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.

Acknowledgments

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Table 1. 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 *Acyrthosiphon lactucae* , potato aphid and green peach aphid.; population at this time consisted primarily of *Acyrthosiphon lactucae.*

Table 2. Head Lettuce –II. Aphid densities on heads, wrapper and frame leaves of lettuce plants at harvest, Mar 12th (22 DAT#3), YAC 2003

		Apterous aphids (mean / plant)					
		Foxglove aphid			Green aphid complex [a]		
Treatment	**Rate**	**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 *Acyrthosiphon lactucae* , potato aphid and green peach aphid.; population at this time consisted primarily of *Acyrthosiphon lactucae.*

Table 3. Romaine - I. Aphid densities on all leaves of romaine plants at pre-harvest and at harvest, YAC 2003

		Apterous aphids (mean / plant)					
		Pre- Harvest *Feb 25th (7 DAT 2)*			**Harvest –** *Mar 17th (7 DAT 4)*		
Treatment	**Rate**	**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 *Acyrthosiphon lactucae* , potato aphid and green peach aphid.; population at this time consisted primarily of *Acyrthosiphon lactucae.*

Table 4. 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
Flonicamid+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
Fulfifll+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 *Acyrthosiphon 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
Flonicamid+ 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
Fulfifll+ 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 *Acyrthosiphon lactucae*, potato aphid and green peach aphid;
[b] LA=lettuce aphid, *Nosanovia reibi-nigri.*

Table 4. Romaine - II. continued .

Harvest Apr 9		**10- DAT 3**			
		Mean Aphids / Plant			
Treatment	**Rate/ac**	**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 *Acyrthosiphon lactucae*, potato aphid and green peach aphid;

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