FINAL REPORT

ANT MANAGEMENT IN ALMONDS
Project No. 04-RC-01

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Problem and its Significance:
Southern fire ants, *Solenopsis xyloni* McCook, remain a major pest of almonds throughout the San Joaquin Valley and, to some extent the Sacramento Valley. Previous work by the PI and cooperating CE personnel has shown the effectiveness and provided data on the proper usage of two bait insecticide products for ant control, which have been subsequently registered (1-4). Two important issues remain, however. 1. Other products for ant control are in various stages of development and may become available for use. The products most advanced in the process need to be evaluated in comparison with the currently registered material. These new compounds are desirable to include in the growers arsenal for resistance management purposes. In addition, both registered baits are synthetic compounds not acceptable for use by organic growers. Materials acceptable for organic production need to be evaluated for performance against ants in terms of population reduction and longevity of efficacy. 2. The interaction of bait products with resident vegetation still has not been thoroughly elucidated. Some observations have suggested that certain weed species, particularly prostrate (spotted) spurge, *Chamaesyce maculata* [L.] may out-compete the bait products for attractiveness to the ants, thus reducing the baits efficacy. However, these weed species may also out-compete almond kernels for attractiveness and thus reduce nut damage. The effects of weeds on bait uptake and on almond kernel damage need evaluation.

Objectives:
Objective 1. Evaluate new ant bait products in advanced stages of development for efficacy in comparison to currently registered products. Included in this experiment will be a spinosad product- Conserve® (essentially the same as previously tested Justice®) and a boric acid product- Bushwhacker®, both of which are OMRI approved and should be organically acceptable materials. Much discussion, both pro and con, about the efficacy of Bushwhacker has taken place in the industry, but to the PI's knowledge, no repeatable, replicated study has evaluated it for use in almond ant control.

Objective 2. Compare the degree of bait uptake in areas with weed/cover crop vegetation compared to areas without a vegetation cover. Compare the damage to almond kernels where vegetation cover is present versus bare orchard floor.

Plans and Procedures:
Objective 1. Replicated randomized plots were established in a Kern county almond orchard near McFarland. The design was similar to the experimental design used in previous studies (1-4). Plot size was six rows by 10 trees. New bait products included in the trail were Conserve Ant Bait with the active ingredient spinosad, and Bushwhacker having the active ingredient boric acid. These were compared to both Clinch Ant Bait and Esteem Ant Bait (active ingredients- abamectin and pyriproxifen respectively). Treatments are shown in Table 1. Products were evaluated by the use of hot-dog vials (previously described (1)) for ant activity and kernel

damage in almond bait tubes (previously described (1-4)). Commercial harvest almond samples were collected by project staff after the 4-August harvest and examined by grower personnel for ant damage. Data are analyzed using appropriate ANOVA statistical analyses.

Objective 2. A location was selected having an abundant cover crop of native annuals, including prostrate spurge, in which to establish the experiment. A split-plot experiment was set up where mowing of the cover crop (the grower standard) vs. herbicide application was to be the main treatment, continued mowing vs. un-mowed cover was the secondary treatment laid across the herbicide/standard treatments and ant bait vs. no ant bait was the tertiary treatment. The herbicides (Roundup + Goal @ 1 qt + 8oz / Acre respectively) were applied 1-June. The mowed pots were mowed on 13-June and 23-June. The bait treatment (Clinch) was applied 8-July. SFA were sampled on 1-July, 22-July and 31-July by hot-dog vial bait tubes. Almond kernel bait tubes were placed out in plots on 2-August and retrieved on 4 August to measure potential harvest damage. Commercial harvest samples were also taken after harvest on 10-August.

Results:

Objective 1. The results of treatments for Objective 1 are shown in Tables 2-3. There were significant effects observed from the treatments in both post-treatment hot-dog samples (Table 1). Clinch, Conserve and Esteem significantly reduced ant numbers below the untreated control in both the 3-week and 6-week hotdog bait vial samples. Bushwhacker had significantly fewer ants than the control at the 6-week sample but not at 3 weeks. It did not reduce ants as well as Clinch, Conserve or Esteem at 6 weeks. Imidan® was applied as a hull-split spray on 29-June which accounts for the large drop in ant numbers at the 9-July ant sample. Overall damage to almond kernels in the PVC bait tubes was low throughout the study (Table 3). Average damage was only slightly more than one kernel out of ten per tube in any of the treatments. Despite the low numbers there were significant differences among the treatments. Both Clinch and Esteem had significantly fewer numbers of damaged kernels than Bushwhacker or Conserve and the control. Bushwhacker was significantly better than Conserve but not the control. Each kernel was rated for the amount of ant damage, i.e. less than 10% of the kernel removed or greater than 10% removed. Clinch and Esteem were again better than Bushwhacker, Conserve or the control, especially for amounts of tissue damage greater than 10%. Commercial harvest damage by ants was very low, only exceeding 1% in the Conserve plots. There were no significant differences among any of the treatments. We speculate that because the nuts tended to be small there were very few open shells to allow ants entry to the kernel and thus minimal damage. Once again, Clinch and Esteem have demonstrated the effectiveness seen in previous trials. Esteem's slightly higher damage, though not significantly higher, is likely due to the relatively short duration between its application and harvest. Previous studies indicate that the minimum pre-harvest timing for Esteem is 6 weeks and it is preferably applied 7-8 weeks pre-harvest. We cannot explain why Conserve failed to reduce ant damage despite the fact that it reduced ant numbers significantly. In previous trials Conserve (Justice) performed similarly to Lorsban treatments, i.e. there was a rapid knockdown of ants within a few days followed by some recovery in numbers about 4 weeks post-treatment. Perhaps this material needs to be applied much closer to harvest, possibly within a week, to perform best. Bushwhacker did not perform as well as Clinch and Esteem during the time period allotted to this trial. Boric acid is a slow acting toxicant and this product may need a longer time to reduce ant numbers and damage. We were unable to follow up with post-harvest sampling to observe if and when Bushwhacker may have further reduced ant numbers.

Objective 2.: Sampling and data collection and statistical analyses have been completed for this objective. Data are shown in Tables 4–6. And Figures 1–3. Factors considered in the analyses

were a. bait application versus no bait, b. mowing versus no mowing in the secondary treatment, c. the grower's standard management regime versus continued application of herbicides.

There were significant reductions of ant numbers and ant damage by applying Clinch bait. Reductions were evident in the ant activity samples primarily at the 4+ week post-treatment sample. An Imidan navel orangeworm treatment had been applied just prior to the 3-week sample and this depressed the amount of activity to the point where differences due to bait application could not be discerned. Clinch bait significantly reduced damage to nuts in almond bait stations that were sampled just prior to harvest. Ant damage in the commercial harvest samples was also significantly reduced to below 1%.

The use of additional mowing treatments along with bait or in addition to the grower standard or herbicide treatments had no effect on ant activity and harvest damage.

There was a highly significant difference in ant activity and damage in all measurements between the grower standard regime and the use of additional herbicide treatments, which kept the ground virtually bare during the experiment. In all cases the herbicide/bare ground treatments had more ants and more ant damage than the grower standard treatment. These results are diametrically opposite of previous experiments and observations in which the plots with little to no vegetation had less ant activity and damage. We cannot explain why this difference occurred in this experiment. Where bait was applied to both vegetation regimes, ants and damage were reduced in both systems significantly compared to no bait. So it does not appear that vegetation competes with the bait thus reducing its efficacy. There was a significant difference between vegetation regimes as measured by ant activity although not as marked as for the other measurements. There was a very strong reduction in damage in the grower standard for both the almond bait tube and commercial harvest samples. This suggests that the vegetation remaining in the grower standard treatment may have attracted the ants away from the almonds in both sample methods.

We did not attempt to characterize the species makeup or relative and absolute abundance of the vegetation in these plots, which was an significant omission in the conduct of this experiment. The ability for resident vegetation to attract ants away from harvested nuts, or to not have any effect, must depend largely on the composition of the vegetation itself. There is little doubt that certain types of plants have more attraction to ants than other types, perhaps due to possession of extra-floral nectarines, or to the type and abundance of seed they produce. These differences in attractiveness and the reasons therefore have not been examined for vegetation commonly occurring in almond orchards. In this experiment the vegetation at this site did not have a significant effect on bait efficacy. However, this may not be the case at other locations where more attractive plants, or a higher density of plants may prevent adequate bait uptake resulting in some crop damage. We would encourage growers to pay close attention to ant activity when baits are applied, after the appropriate interval for reduction to take place, to determine whether the treatment is effective.

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Table 1. Ant bait materials included in bait screening trial.

Treatment	A.I.	Lb. product/Acre	Lb. a.i./Acre
Bushwhacker	boric acid	3.0 lb	0.54
Clinch	abamectin	1.0 lb	0.00011
Conserve	spinosad	4.5 lb	0.000675
Esteem/Distance	pyriproxifen	2.0 lb	0.01
Untreated Control	—	—	—

Table 2. Mean number of ants per hotdog vial at each sample date.

Treatment	17-Jun[1]	9-Jul[2]	31-Jul
Bushwhacker	81.8	25.0 b	47.0 b
Clinch	133.7	1.8a	5.0a
Conserve	134.7	2.0a	23.8a
Esteem/Distance	83.6	9.8a	22.0a
Untreated Control	76.6	20.2 b	79.9 c

[1] 17-Jun is immediate pre-treatment, 9-July and 31-July are 3 weeks and 6 weeks post-treatment respectively.

[2] Numbers followed by the same letter(s) are not significantly different (LSD @ 5%).

Table 3. Mean number of ant damaged almond kernels per PVC bait station.

	Total[1,2]	<10%	≥10%	Percent Harvest Damage
Bushwhacker	0.861c	0.222bc	0.639b	0.67
Clinch	0.250a	0.139a	0.111a	0.17
Conserve	1.222d	0.306d	0.917b	1.33
Esteem/Distance	0.500b	0.194ab	0.278a	0.50
Untreated Control	1.194cd	0.278cd	0.917b	0.67 NS

[1] Total= all damaged kernels per bait tube, <10%= no. of kernels with less than 10% damage, ≥10%= no. of kernels with equal or greater than 10% damage.

[2] Numbers followed by the same letter(s) are not significantly different (LSD @ 5%).

Table 4. Total number of ants sampled by hotdog vials per sample date.

	Pre-Treatment		
FACTOR	7/1/04	7/22/04	7/31/04
Herbicide	20180a	4630a	16229a
Grower Standard	11261 b	2096 b	858 b
Mowed	18415a	3021a	9333a
Not Mowed	13026a	3705a	7754a
Bait	17413a	1944a	2964a
No Bait	14028a	4782 b	14123 b

Table 5. Number of damaged nuts in PVC almond kernel bait tubes (N=10 nuts/tube).

FACTOR	SUM of Damaged Nuts	Mean No/Tube
Herbicide	54a	0.5625a
Grower Standard	6 b	0.0625 b
Mowed	31a	0.322916667a
Not Mowed	29a	0.302083333a
Bait	18a	0.1875a
No Bait	42 b	0.4375 b

Table 6. Number of damaged nuts in 200 nuts per plot sampled at harvest.

	Sum of Damaged Nuts @ Harvest	
Factor	AVG/200	Percent Damage
Herbicide	5.00a	2.50% a
Grower Standard	1.06 b	0.53% b
Mowed	2.375a	1.19% a
Not Mowed	3.6875a	1.84% a
Bait	1.688a	0.84% a
No Bait	4.375 b	2.19% b

Figure 1. Average number of ants in hot-dog bait vials at pre-treatment, 3 weeks and 4.5 weeks post-treatment. (6 vials per plot)

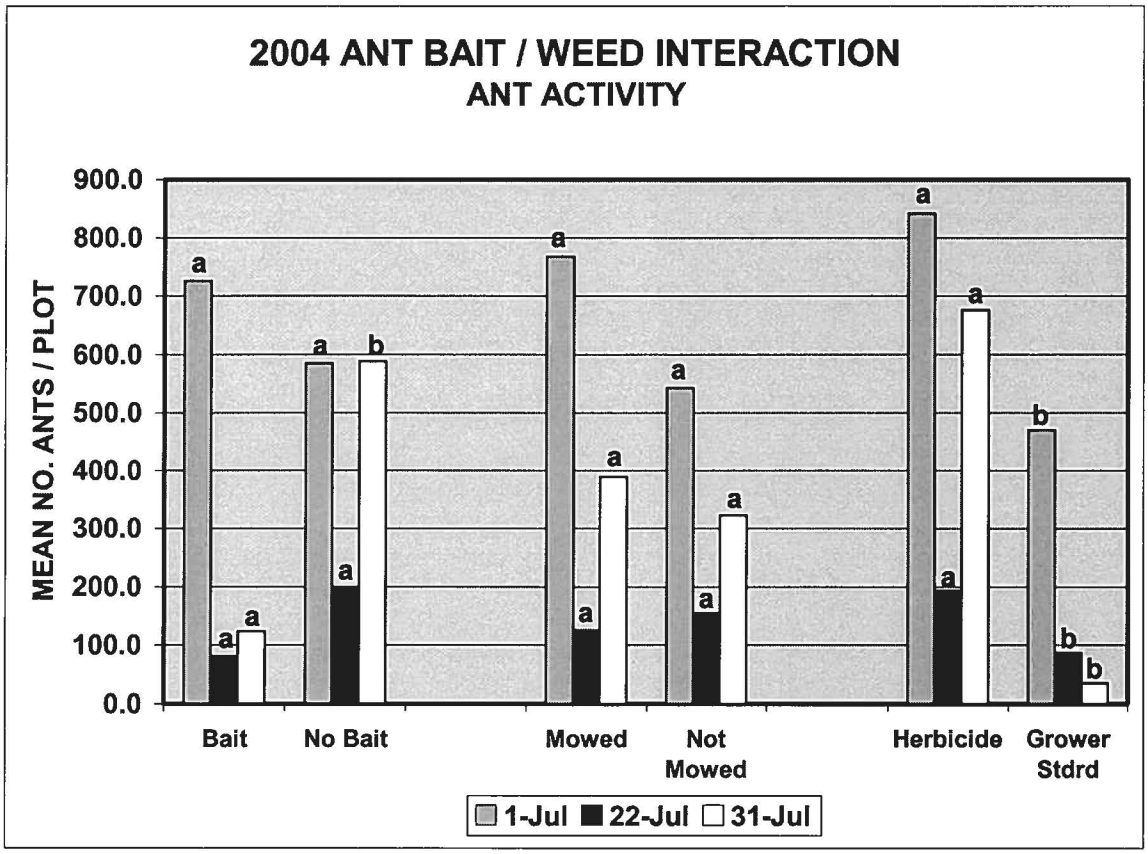

Figure 2. Number of damaged almond kernels in almond bait stations at harvest. (6 bait tubes per plot)

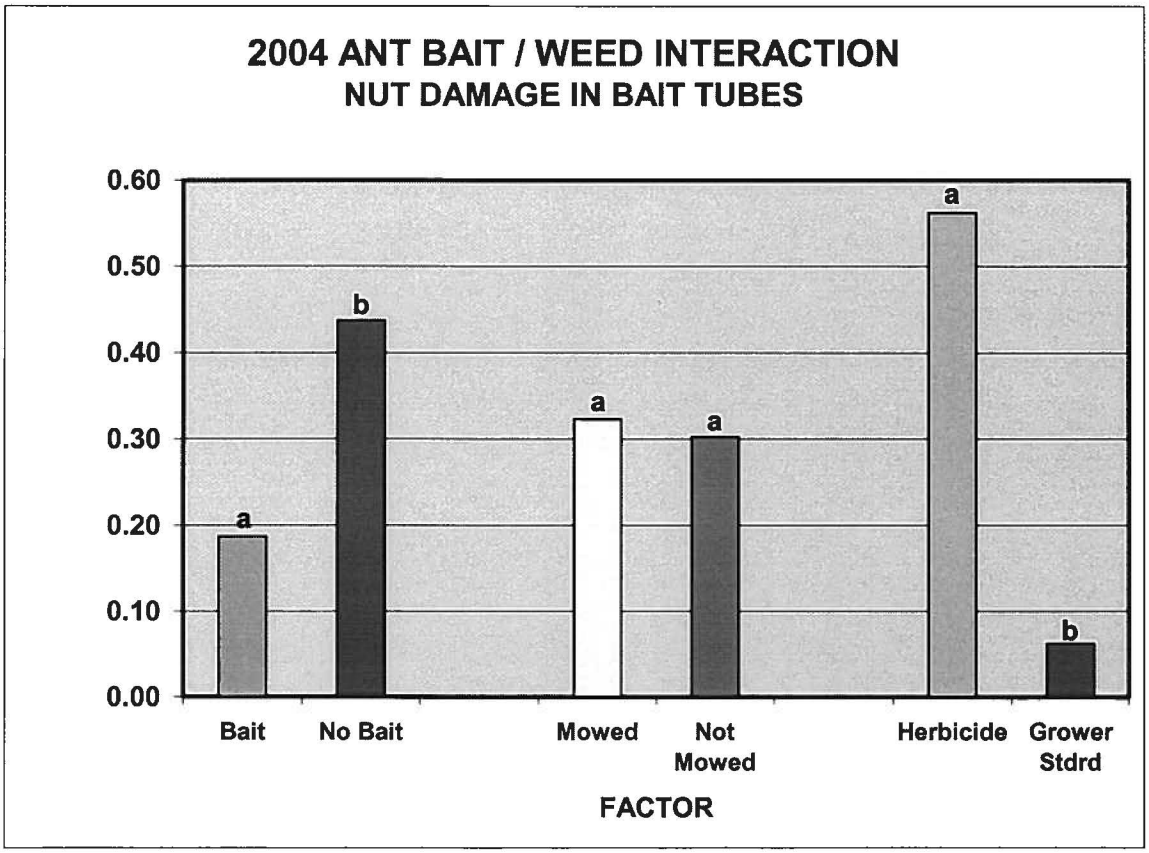

Figure 3. Average percentage of ant-damaged nuts from commercial harvest, 1600 nuts sampled per treatment.