California Pepper Commission

Research Report 2020-2021

I. IDENTIFICATION

A. California Pepper Commission.
B. Insect Pest Management on Peppers
C. Proposal for period beginning March 2020, ending February 2021.
D. Principal Investigator:

Dr. Thomas Perring
Department of Entomology
University of California, Riverside

E. Cooperating Personnel:

Greg Kund
Department of Entomology
Univ. of California, Riverside

F. Locations of Work:
U.C. Riverside Agricultural Operations
Riverside, CA
Riverside County, CA

G. Plants:
BELL PEPPER: *Capsicum anuum* L. 'Cal Wonder'

H. Insects:
Tomato/Potato Psyllid: *Bactericera cockerell*i (Sulc)
Beet armyworm (BAW): *Spodoptera exigua* (Hübner)
Tomato Fruitworm(TFW): *Helicoverpa zea* (Boddie)
Leafminer: *Liriomyza sativae* (Blanchard)
Leafminer: *Liriomyza trifoilii* (Burgess)
Lygus bugs: *Miridoa* spp.
Stink bugs (SB): *Pentatomidae* spp.
Bagrada bug (BB): *Bagrada hilaris*
Pepper weevil (PW): *Anthonomus eugenii* (Cano)
Green peach aphid (GPA): *Myzus persicae* (Sulzer)
Twospotted spider mite (SM): *Tetranychus urticae* (Koch)

II. Field Screening Trials for Identification of Effective Pesticides

Seedlings were transplanted in a sandy loam type soil on 2 June, 2020 at the University of California Riverside's Agricultural Operations field #10E. Experimental plots were 3 rows wide (5-ft centers) by 40 ft long and separated by a 3-ft buffer. The pepper transplants were drip irrigated (water pH 7.2 - 7.5). The beds were covered with a black plastic mulch to improve irrigation efficiency and to reduce the amount of weed control. Treatments were replicated 4 times in a RCB block design (Figure 1). Application dates and a treatment list are shown in Table 1. All applications were made during working hours when wind conditions were mild. A tractor-mounted boom sprayer with 6 nozzles per row incorporated D-3 orifice disks, #25 cores, and 50 mesh screens. Operating pressure was 100 psi delivering 100 gpa. All treatments included an adjuvant as specified except treatment number three, which consisted of Pyganic, Trilogy, and Entrust.

Table 1: Pepper Chemical Trial List of Treatments 2020

Treatment #	Compound	Rate-Product	Application Dates	Company
1	Untreated	-	-	-
2	Intrepid + Sequoia 2 SC Radiant SC Dyne-amic	10.0 oz 4.5 oz 7.0 oz 0.25%	7/31, 8/19 7/24, 8/12	Corteva
3	Organic IPM Pyganic 1.4EC Trilogy EC Entrust SC	 32.0 oz 64.0 oz 8.0 oz	 7/14, 7/24, 8/19 7/24, 8/19 7/31, 8/12	 Valent Certis Corteva
4	Chem Standard: Asana XL Dyne-amic	 9 oz 0.25 %	 7/14, 7/24, 7/31, 8/12, 8/19	 Dupont

Figure 1. The field trial was composed of eight treatments with 4 replicates each for a total of 32 plots. Beds were covered with black plastic mulch. The field was located at UCR Agricultural Operations.

Early and late season field counts of insect populations were taken by counting a single branch from four plants per plot (plots were replicated four times per treatment) to determine what impact the treatments had on insect populations. On 22 August, 100 mature-green to ripe fruit were harvested from the center row of each replicate (400 per treatment) and examined for calyx damage, internal worm damage (TFW), external worm damage (BAW), potato psyllid (PP), spider mite (SM), aphids (GPA), and hemipterous pests (SB). Hemipterous pests include stink bugs and a more recent pest, bagrada bug (BB). Fifty fruit also were opened and inspected for damage from pepper weevil larvae (PW) (Figure 2). Results are shown in Table 2.

Figure 2. Fifty harvested pepper fruit were picked for each tray and were subsequently evaluated for pepper weevil damage by cracking open each fruit. Damage was recorded when either larval feeding or adults were present inside the fruit.

Results

Field Sampling
Combined early and late season field counts of psyllids revealed significant differences between the treatments for the number of eggs, nymphs and the total number of psyllids. Treatment four had the highest number of total psyllids, which was the Asana XL treatment (Figure 3). The Asana XL treatment also showed high numbers of aphids in the late season field counts as well as in the harvest assessment. Early season insect populations such as whiteflies, leafminers, and mites were seen in the field but there were no significant numbers to report.

Harvest Evaluation
Evaluation of the pepper fruit for internal damage by TFW and PW feeding did not show any differences between any of the treatments. The pest pressure by these insects was very low even though some were seen in the field. Harvest assessment of aphid infestation levels showed a difference for treatment 4 which was the Asana product (Figure 4). Weekly applications of this pyrethroid dramatically increased aphid populations. Lepidopteran pressure was low to moderate in the category of 'external damage by BAW' but we did see some differences between the treatments and the untreated check (Figure 5). All of the treatments performed well to control BAW. Calyx damage assessment showed that there were differences between the treatments (Figure 6) and that all treatments performed better than the untreated check. Potato

psyllids were present in the field, but they did not have a significant impact on the quality of the fruit this year. Mite population and bagrada bug numbers were low this year. Bagrada bug typically feeds on cole crops and mustard plants, but they are capable of doing damage to pepper plants when given the opportunity. Classic symptoms of bagrada bug damage are star shaped lesions on the pepper fruit (Figure 7).

Plastic Mulch Bed Covering

This year we decided to test the benefits of using black plastic mulch to cover the beds of the pepper field. The purpose of covering the beds was to improve irrigation efficiency of the drip irrigation system as well as reduce the resources needed to eradicate weeds. The mulch was very effective at reducing weed problems. Overall irrigation efficiency seemed to improve but we did have some problem areas within the field that were difficult to repair as the drip tape was buried under the mulch. Labor costs to install and remove the mulch would have to be compared to the overall benefits of improved irrigation efficiency, reduction of weeds, and overall plant health and fruit yield.

Table 2.

Treatment/ Formulation		Rate Amt/acre	Mean Number of Fruit Damaged/Replicate [a]					
			Internal	External	All Leps	Pepper Weevil Internal	Calyx Damage	Aphids
1	Untreated	-	0.00	4.50 a	4.50 a	0.00	10.25 a	0.00 b
2	Intrepid +	10.0 oz	0.00	0.75 b	0.75 b	0.00	2.25 b	0.00 b
	Sequoia 2 SC	4.5 oz						
	Radiant SC	7.0 oz						
	Dyne-amic	0.25%						
3	Organic IPM		0.00	1.00 b	1.00 b	0.00	3.25 b	0.00 b
	Pyganic 1.4EC	32.0 oz						
	Trilogy EC	64.0 oz						
	Entrust SC	8.0 oz						
4	Chem Standard:		0.00	1.25 b	1.25 b	0.00	3.00 b	7.25 a
	Asana XL	9 oz						
	Dyne-amic	0.25 %						
ANOVA F value (by column)			--	3.870	3.870	--	27.58	5.695
ANOVA P value (by column)			--	0.038	0.038	--	0.001	0.012

[a] Means in columns followed by the same letter are not significantly different (P<0.05 level, Fisher's LSD Test). Internal damage due primarily to (TFW); external damage due primarily to (BAW). Calyx damage can be attributed to (TFW), (BAW), and (PW) feeding.

Figure 3. Pepper field early and late season combined Potato Psyllid counts.

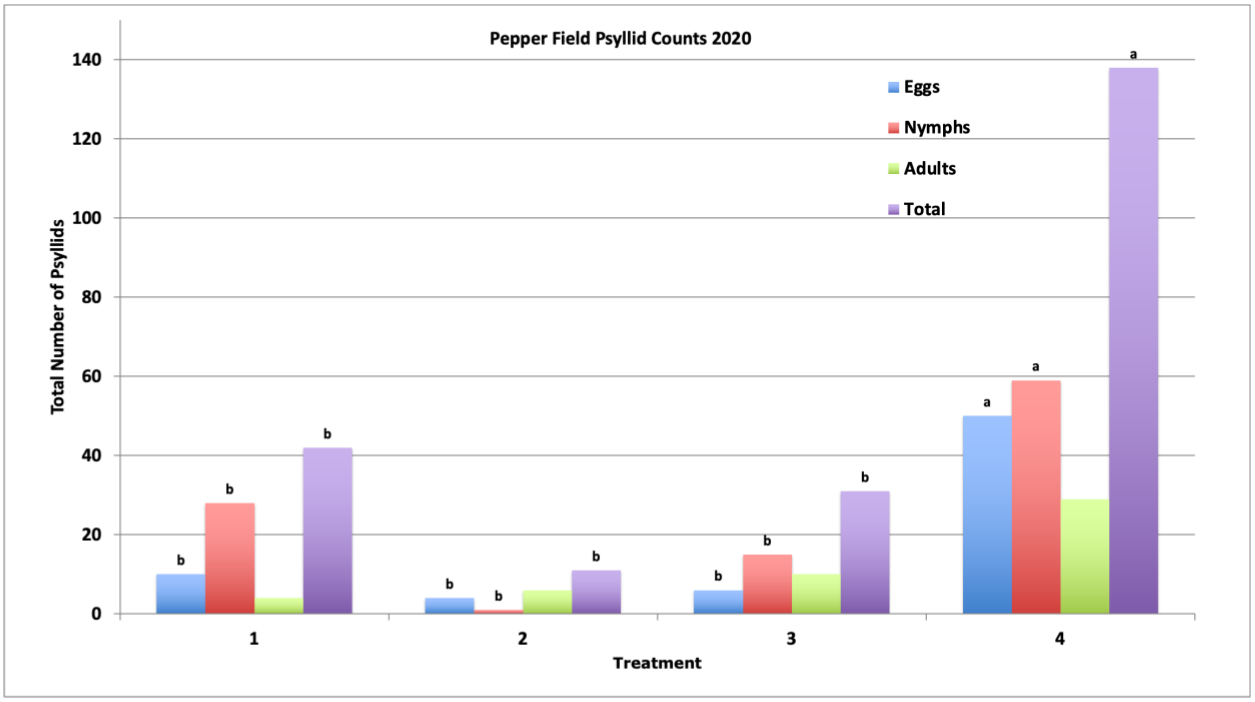


Figure 4. Pepper harvest assessment aphid infestation levels.

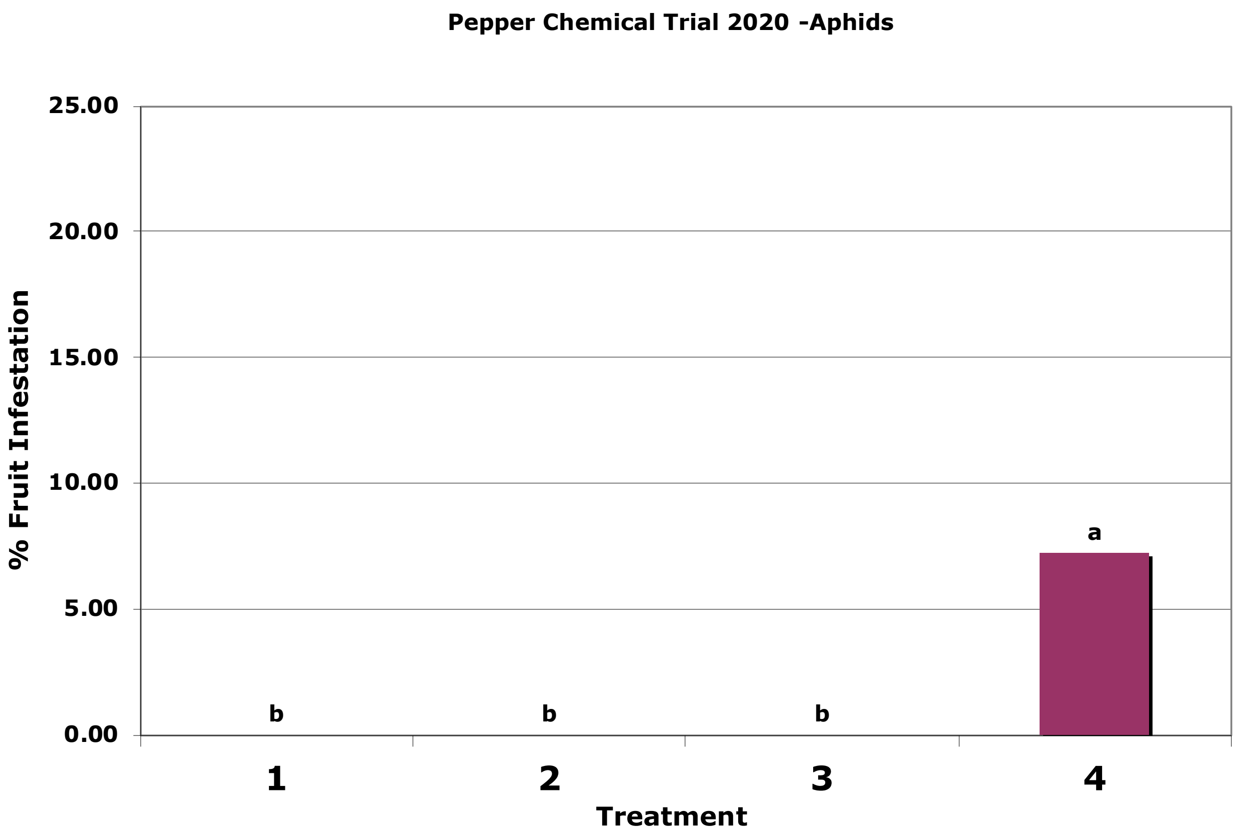


Figure 5. Pepper harvest assessment of Lepidopteran damage.

Pepper Chemical Trial 2020

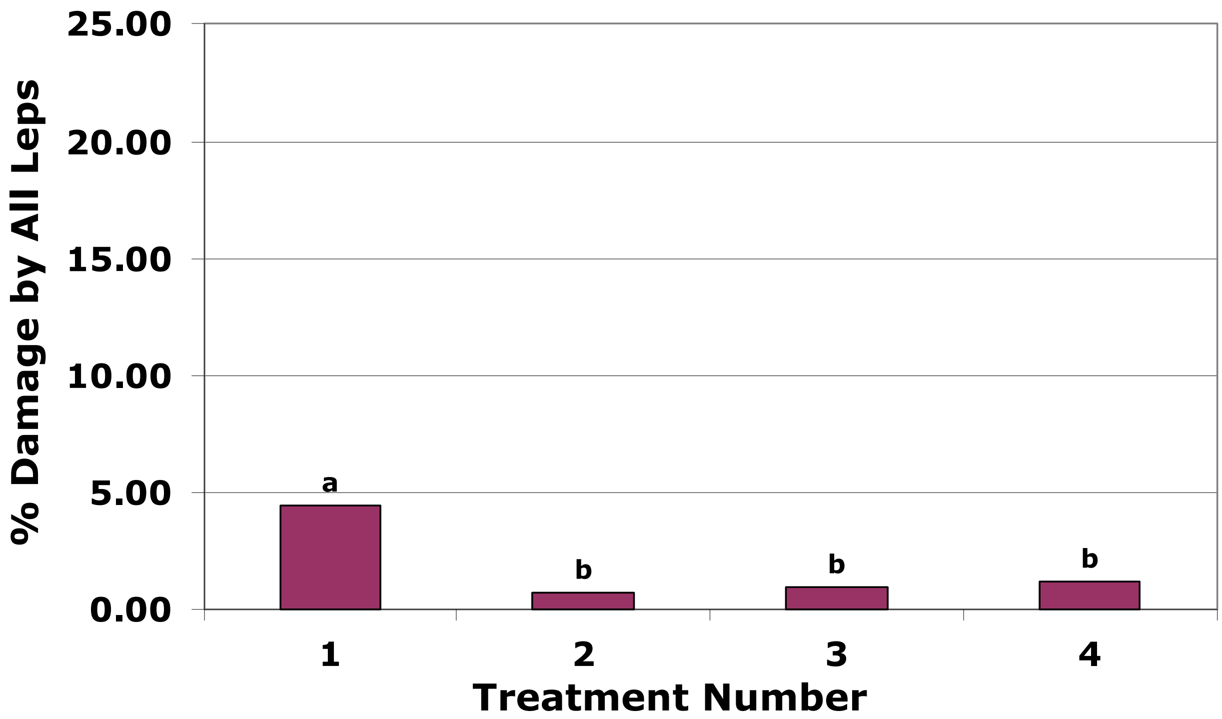


Figure 6. Pepper harvest assessment of calyx feeding damage.

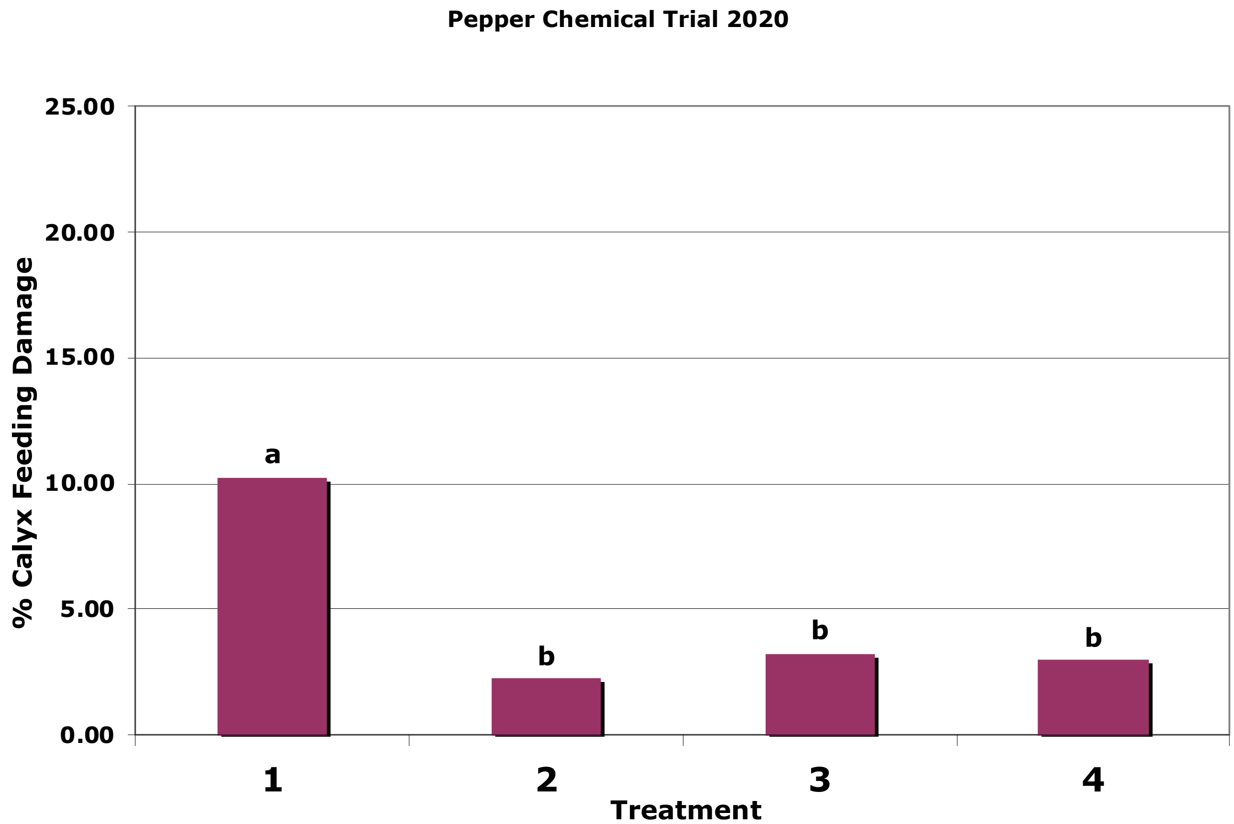


Figure 7. Bagrada bugs cause damage by feeding with their needle-like mouthparts. Multiple insertions of their mouthparts at each feeding site causes cell wall damage to the pepper fruit resulting in the visible star shaped patterns.

III. Laboratory Research on potato psyllids
Objectives:

For the third year, we tested the susceptibility of the potato psyllid *Bactericera cockerelli* to Exirel™ using a field collected population of pepper psyllids found on *Capsicum annuum* CV. "California Wonder" peppers, which were collected from Temecula, CA.

Key Conclusion:

- Exirel™ provided good control of psyllids at rates that are well below recommended field application amounts.

Methods

A colony of *B. cockerelli* psyllids was initiated on April 17, 2019 from insects collected at a regional nursery located in Temecula, CA. The susceptibility of the population to Exirel™ was tested by placing 10 2nd-3rd instar psyllid nymphs on a leaf with a camel-hair brush (Figure 8). The host plants used were *Capsicum annuum* CV. "California Wonder" peppers. The nymphs were allowed to acclimate to the new leaf for an hour prior to being sprayed with a hand-held sprayer. The entire plant was sprayed until runoff and both sides of the leaves were sprayed for maximum coverage. Each treatment was replicated 5 times (Figure 9). All treatments included "Dyne-amic" as an adjuvant at 0.25%. The range of rates tested were determined from several preliminary assays. We started with the highest field rate and did multiple dilutions until we were able to find rates in the LC_{95}, LC_{90}, LC_{50}, and LC_{25} range. The following rates of Exirel™ were tested:

1) Non-treated
2) 1.6 ppm (0.2 oz/Ac)
3) 0.8 ppm (0.1 oz/Ac)
4) 0.6 ppm (0.075 oz/Ac)
5) 0.4 ppm (0.05 oz/Ac)
6) 0.2 ppm (0.025 oz/Ac)

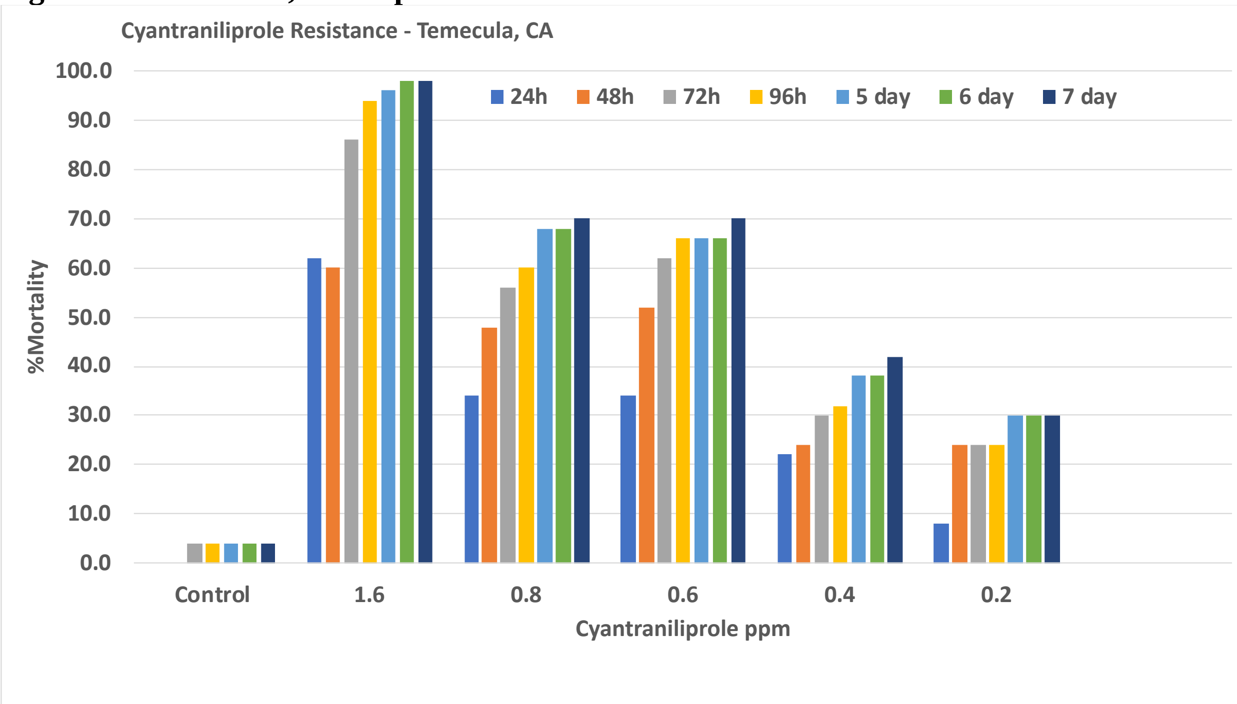
The nymphs were counted for mortality every 24 hours for a total of 7 days and the data for each day were analyzed independently. The JMP Pro 13.1 statistical program was used to conduct probit analyses.

Figure 8. Treated psyllid nymphs

Figure 9. Psyllid nymph bioassay setup

Results
The results indicate that this population of psyllids was very susceptible to Exirel™ (Figure 10), indicating that resistance to Exirel is very low. The highest rate of Exirel™ tested (1.6 ppm) is well below recommended commercial label rates and yet a high level of control (86%) was achieved in 72 hours with higher mortality reached at 4, 5, and 6 days post treatment.

Figure 10. Temecula, CA Population



IV. Additional Research
We are continuing to test strategies and chemicals for psyllid control that disrupt insect behavior and cause mortality. Successful repellents and insecticides will be incorporated into an IPM program. We have been testing several novel compounds that have shown promising results for insect control and we are hopeful that some of these products will eventually be available to pepper growers. We are continuing to study pepper weevil control and are testing some alternative products that would comply with the Food Quality Protection Act.

V. Additional Funding Support
Funding from the Pepper Commission has been leveraged by acquiring additional financial support for our pepper research. We have received monetary awards to study and develop pepper IPM program strategies, as well as chemical industry support.