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California Pepper Commission
Research Report 2010-2011

I. IDENTIFICATION

A. California Pepper Commission.
B. Insect Pest Management on Peppers
C. Proposal for period beginning March 2010, ending February 2011.
D. Principal Investigator:
Dr. John T. Trumble
Department of Entomology
University of California, Riverside
E. Cooperating Personnel:
William Carson, Greg Kund and Casey Butler
Department of Entomology
Univ. of California, Riverside
F. Locations of Work:
U.C. Riverside,
U.C. South Coast Res. & Ext. Center
Ventura and Orange Counties, CA
G. 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.
Pepper weevil (PW): *Anthonomus eugenii* Cano

II. Field Screening Trials for Effective Pesticides

Seedlings were transplanted in a sandy loam type soil on 10-11 May at the University of California's South Coast Research and Extension Center. Experimental plots were 3 rows wide (5-ft centers) by 40 ft long and separated by a 5-ft buffer. The pepper transplants were drip irrigated (water pH 7.2 - 7.5). Treatments were replicated 4 times in a RCB block design. Application dates and a treatment list are shown in Table 1. All applications were made at twilight. A tractor-mounted boom sprayer with 6 nozzles per row incorporated D-3 orifice disks, #25 cores, and 50 mesh screens. Operating pressure was 125 psi delivering 100 gpa. All treatments included Dyne-amic as an adjuvant at 0.25% v/v except Movento which included Destiny at 0.25% v/v.

Table 1: Pepper Chemical Trial List of Treatments 2010

Treatment #	Compound	Rate-Product	Application Dates	Company
1	Control	-	-	-
2	2A) Admire Pro 2B) Oberon 240 SC 2C) Oberon 240 SC + Baythroid 2EC 2D) Movento 240 SC + Baythroid 2 EC	14.0 oz/Ac 8.5 oz/Ac 8.5 oz/Ac 2.8 oz/Ac 5.0 oz/Ac 2.8 oz/Ac	5/27 6/10 6/24, 7/8 7/22, 8/5	Bayer
3	3A) Oberon 240 SC 3B) Oberon 240 + Synapse 240 WG 3C) Movento 240 SC + Synapse 240 WG 3D) Movento 240 SC	8.5 oz/Ac 8.5 oz/Ac 3.0 oz/Ac 5.0 oz/Ac 3.0 oz/Ac 5.0 oz/Ac	6/10 6/24, 7/8 7/22 8/5	Bayer
4	Radiant	6.0 oz/Ac	7/1, 7/15, 7/29, 8/12	Dow
5	IPM #1 Actara 25 WG + Coragen SC [a] Dipel + Movento 240 SC	 4.0 oz/Ac 5.0 oz/Ac 1 lb/Ac 5.0 oz/Ac	 7/8, 7/15, 8/5 8/12	 Syngenta Dupont Valent Bayer
6	IPM #2 Voliam Flexi 40 WG Baythroid 2EC Leverage 2.7 SE	 7.0 oz/Ac 2.8 oz/Ac 5.1 oz/Ac	 7/8, 7/15 7/29 8/5	 Syngenta Bayer Bayer
7	Lannate 2.4 LV Pounce 3.2 EC + X77	48 oz/Ac 8 oz/Ac 0.125% v/v	7/1, 7/8, 7/22, 8/5	Dupont FMC

[a] Coragen was tank mixed and applied once with Actara on 7/8.

Leafminer populations and effects on leafminer parasites were evaluated by weekly counts of leafminer pre-pupae and pupae and dead adult parasites in four 9x11 inch trays/replicate from 13 July through 9 September, inclusive. On (23 August), 200 mature-green to ripe fruit were harvested from the center row of each replicate (800 per treatment) and examined for Lepidopterous internal damage (TFW), external damage (BAW), and hemipterous pests (SB).

One hundred fruit were also inspected for damage from pepper weevils (PW).

Lepidopteran pressure was low to moderate in the categories of External damage by the bet armyworm (BAW) (Table 2). There were no significant differences between any treatments for Lepidopterous insect damage. Internal damage by pepper weevil was very low this year. We did see some differences with treatment 7 which actually increased potato psyllid numbers (Figure 1). Leafminer populations were low, and no statistical separation was possible on any sample dates. The results of dead adult parasites were not included this year due to low numbers recorded from the tray counts. No phytotoxicity was observed in any of the treatments.

All data were analyzed with ANOVA and a Fisher's Protected LSD test (P<0.05).

Figure 1. Potato Psyllid Infestation.

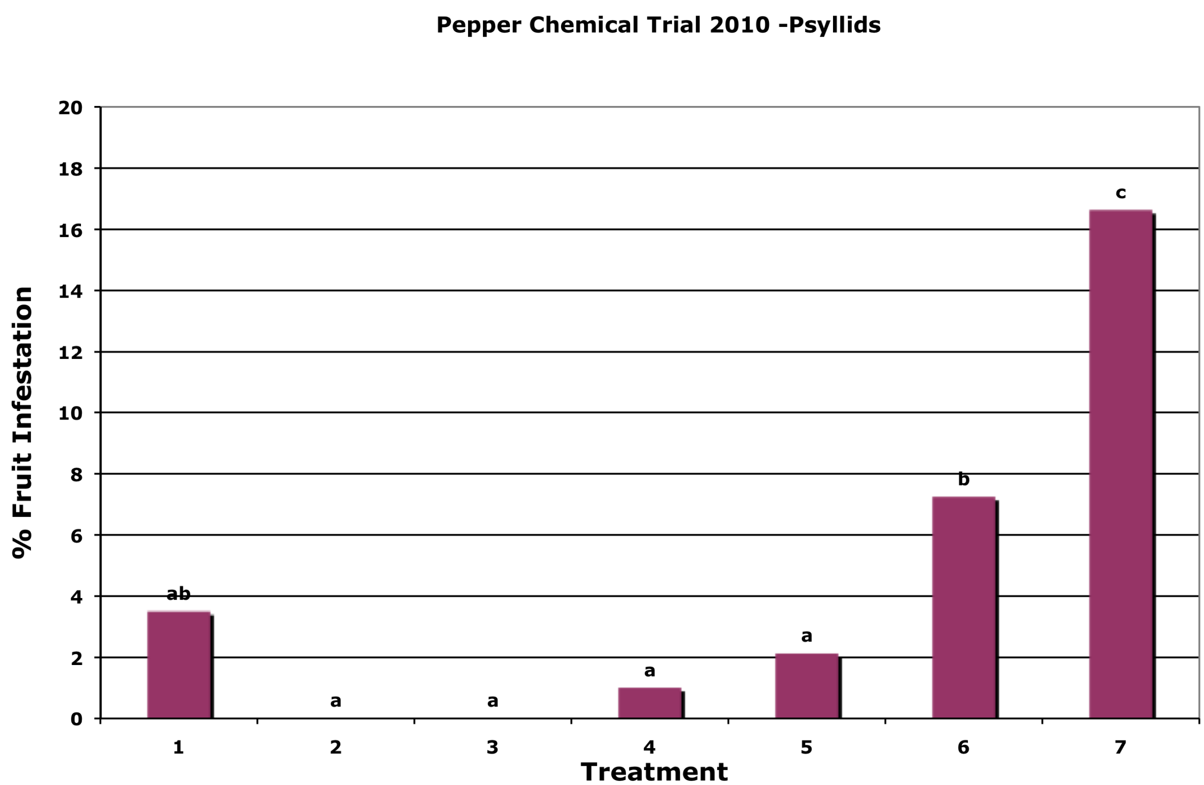


Figure 2. Calyx feeding damage by treatment. Pepper weevil pressure was low this season. The untreated control is treatment #1.

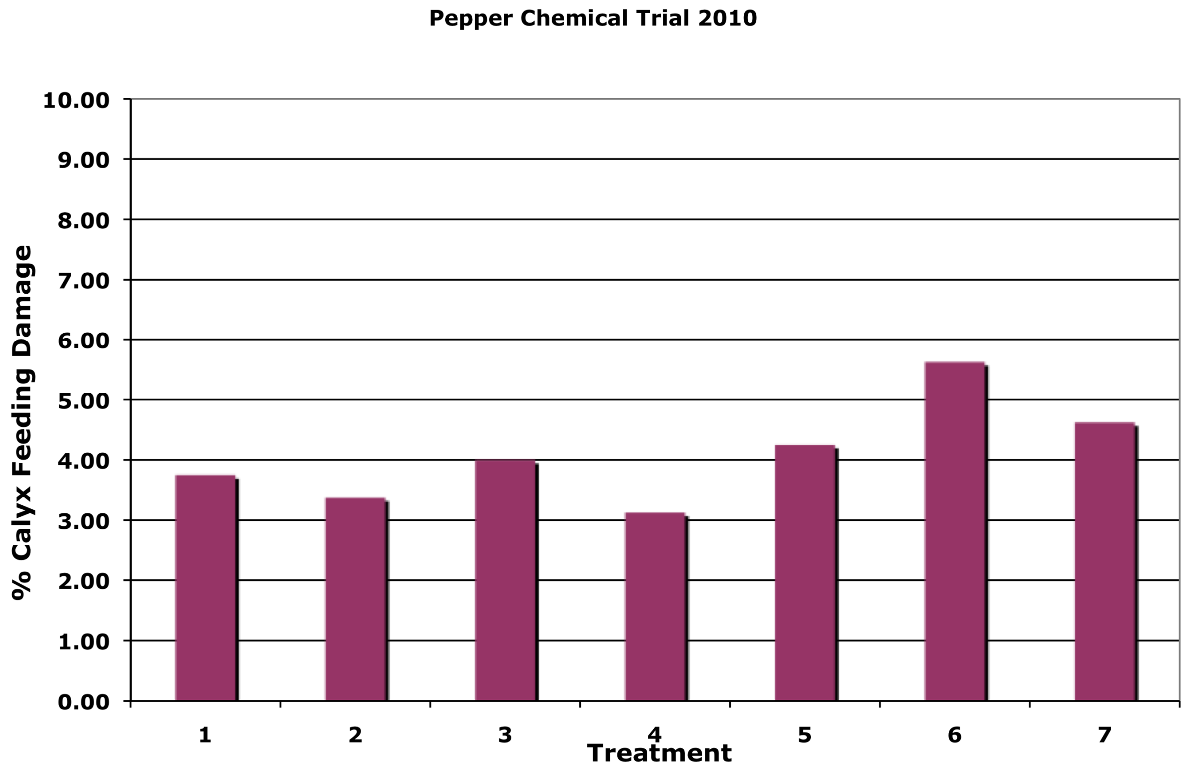


Figure 3. Damage by beet armyworm, tomato fruitworm, and cutworms.

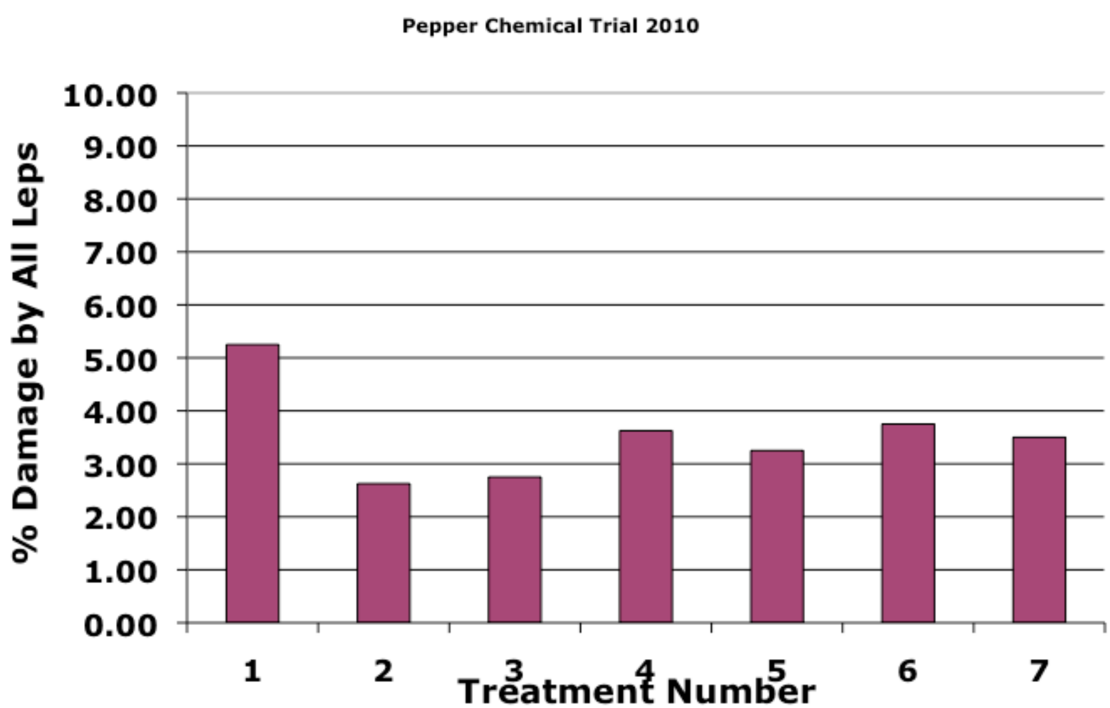


Figure 4. Internal fruit damage by pepper weevil. Pepper weevil pressure was low.

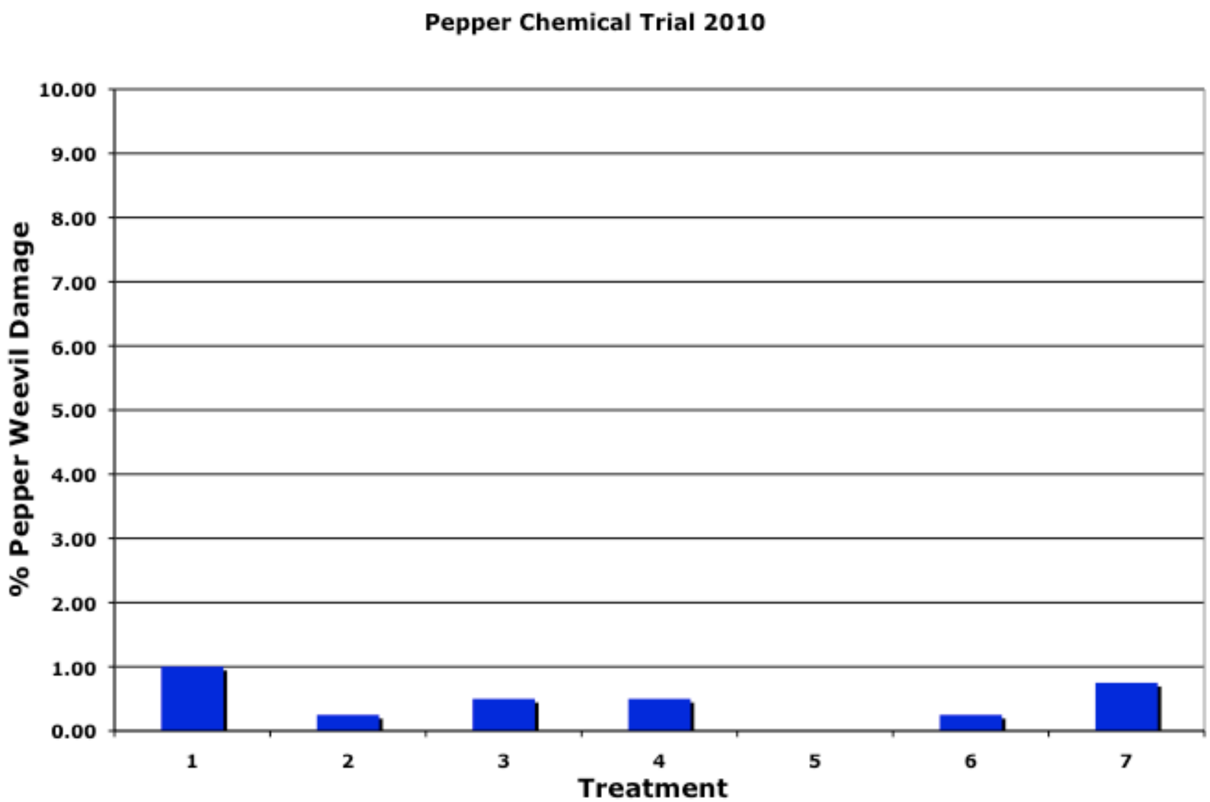


Table 2. Chemical trial mean number of Damaged Fruit

Table 2.		Mean Number of Fruit Damaged/Replicate [b]					
Treatment/ Formulation	Rate Amt/acre	Internal	External	All Leps	Pepper Weevil Internal	Calyx Damage	Bugs
1 Control	-	0.00	10.50	10.50	1.00	7.50	0.25
2 2A) Admire Pro	14.0 fl oz	0.50	4.75	5.25	0.25	6.75	1.25
2B) Oberon 240 SC	8.5 fl oz						
2C) Oberon 240 SC	8.5 fl oz						
+Baythroid 2EC	2.8 fl oz						
2D) Movento 240 SC	5.0 fl oz						
+Baythroid 2 EC	2.8 fl oz						
3 3A) Oberon 240 SC	8.5 fl oz	0.00	5.50	5.50	0.50	8.00	1.00
3B) Oberon 240 +	8.5 fl oz						
Synapse 240 WG	3.0 fl oz						
3C) Movento 240SC +	5.0 fl oz						
Synapse 240 WG	3.0 fl oz						
3D) Movento 240 SC	5.0 fl oz						
4 Radiant	6.0 fl oz	0.00	7.25	7.25	0.50	6.25	1.50
5 IPM #1		0.00	6.50	6.50	0.00	8.50	5.00
Actara 25 WG +	4.0 fl oz						
Coragen SC [a]	5.0 fl oz						
Dipel +	1 lb fl oz						
Movento 240 SC	5.0 fl oz						
6 IPM #2		0.00	7.50	7.50	0.25	11.25	4.00
Voliam Flexi 40 WG	7.0 fl oz						
Baythroid 2EC	2.8 fl oz						
Leverage 2.7 SE	5.1 fl oz						
7 Lannate 2.4 LV	48 fl oz	0.00	7.00	7.00	0.75	9.25	0.25
Pounce 3.2 EC +	8 fl oz						
X77	0.125% v/v						
ANOVA F value (by column)		1.000	1.427	1.257	0.776	0.699	2.067
ANOVA P value (by column)		0.451	0.251	0.319	0.598	0.653	0.101

[a] Coragen was tank mixed and applied once with Actara on 7/8.

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

III. <u>IPM strategies in Peppers</u>

Seedlings were transplanted in a sandy loam type soil on 3-4 June at the University of California's South Coast Research and Extension Center. Experimental plots were 3 rows wide (5-ft centers) by 40 ft long and separated by a 5-ft buffer. The pepper transplants were drip irrigated (water pH 7.2 - 7.5). Treatments were replicated 4 times in a RCB block design. This year the IPM program was incorporated into the chemical screening trial. Treatment 1 was the control and treatments 5 and 6 were IPM rotations. Treatment 7 was a chemical standard. Applications were made as specified in (Table 1). All applications were made at twilight. A tractor-mounted boom sprayer with 6 nozzles per row incorporated D-3 orifice disks, #25 cores, and 50 mesh screens. Operating pressure was 125 psi delivering 100 gpa. All treatments included Dyne-amic as an adjuvant at 0.25% v/v except Movento which included Destiny at 0.25% v/v. Leafminer populations and effects on leafminer parasites were evaluated by weekly counts of leafminer pre-pupae and pupae and dead adult parasites in four 9x11 inch trays/replicate from 13 July through 9 September, inclusive. On (23 August), all of the mature-green to ripe fruit were harvested from the center row of each replicate. The number and weight of the fruit were recorded for harvest yield data. From each replicate 100 fruit were sub-sampled (400 per treatment) and examined for Lepidopterous internal damage (tomato fruitworm) and external damage (beet armyworm)(Figure 3). Fruit were also inspected for damage to the calyx, and from pepper weevils (Figure 4), hemipterous pests and presence of psyllids (Figure 1). The results for insect damage are summarized in (Table 2).

Lepidopteran pressure was low in the categories of External damage by beet armyworm and no differences were seen. Internal damage from tomato fruitworm was not significant this year. Internal damage by pepper weevil was low this year. There were low levels of damage to the calyx and no differences were found between any of the treatments. Leafminer populations were low, and no statistical separation was possible on any sample dates. The results of dead adult parasites were not included this year due to low numbers recorded from the tray counts. No phytotoxicity was observed in any of the treatments. We did see a difference between the chemical standard and IPM rotations for the infestation levels of psyllids. There was a significant increase in psyllid numbers in the IPM#2 and chemical standard treatments. These treatments used carbamates and pyrethrins which can kill beneficial insects and actually cause an increase in the numbers of psyllids.

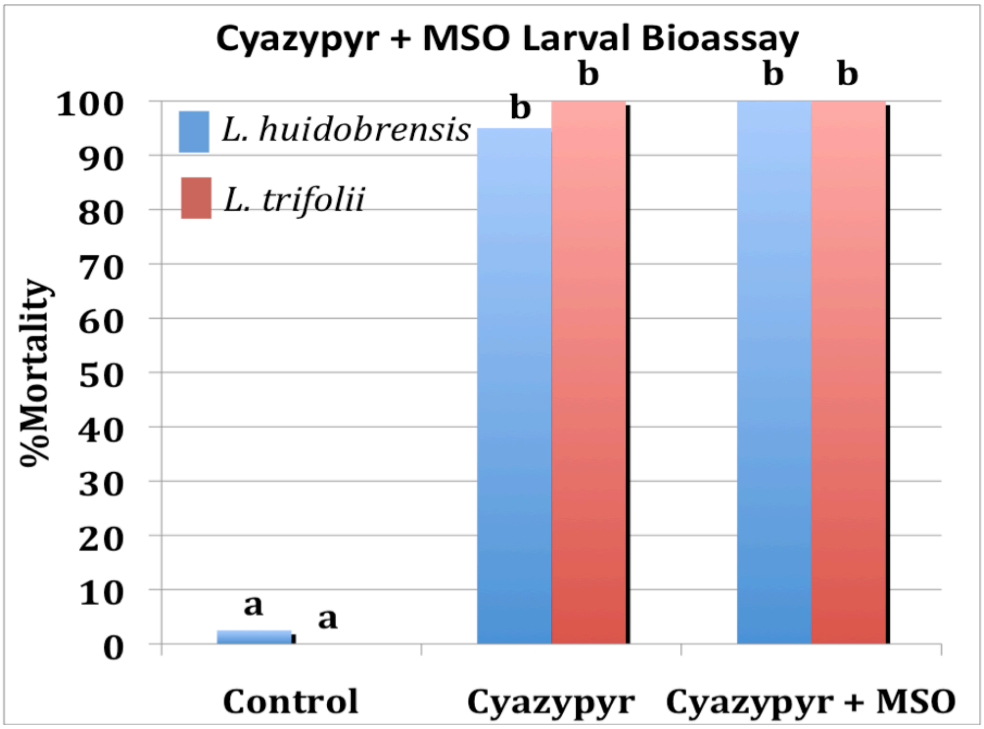
IV. Leafminer trials

Objective 1. Larval tests with *L. trifolii* and *L. huidobrensis*
<u>Experimental Design:</u>

<u>Larvae</u>
One day old newly emerged adult *L. trifolii* were allowed to oviposit on lima bean plants. Ten first instar larvae were identified on each plant and any remaining larvae were killed to simplify tracking and recording of survivorship. The leaves of each plant were sprayed until runoff to achieve maximum coverage of the leaves. Larval mortality was recorded daily until 100% kill or pupation was achieved. *Lyriomyza huidobrensis* were tested in the same manner using peas as the host plant.

Results:
Larval tests using cyazypyr have shown a nearly 100% reduction in survival when compared to the control (Figure 5) without the use of a penetrant. Methylated seed oil (MSO) used as a penetrant along with cyazypyr provided 100% mortality of the *L. trifolii* larvae. Similar results were seen with cyazypyr + MSO against *L. huidobrensis* larvae.

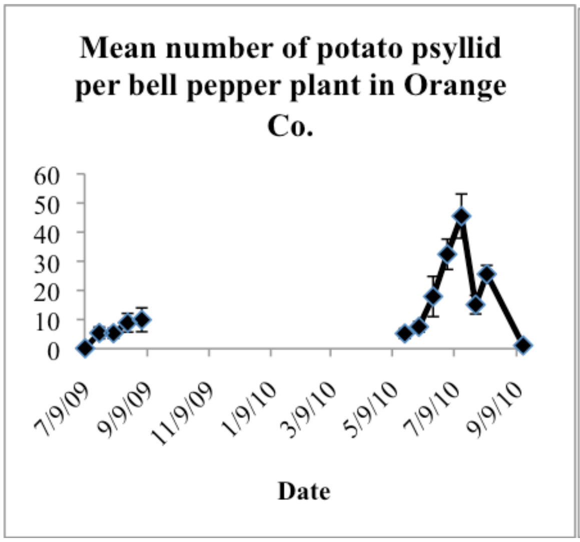
Figure 5. Cyazypyr larval test with MSO

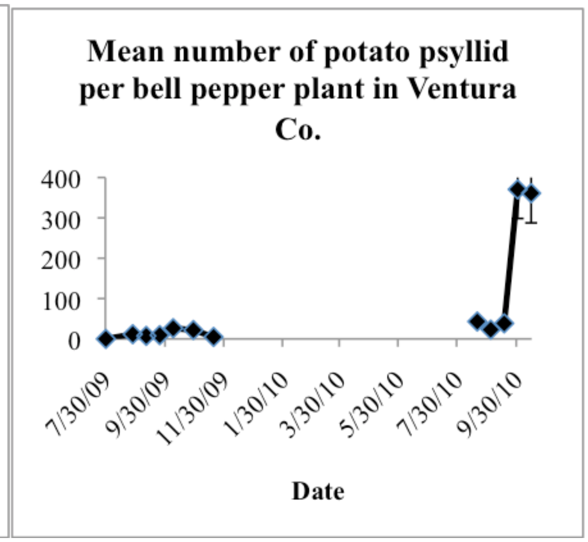


V. Distribution and phenology of psyllids

In the development of an integrated pest management program against the potato psyllid, *Bactericera cockerelli* (Sulc) (Hemiptera: Triozidae), it is critical that sampling plans be developed that efficiently and easily determine occurrence and population density of this insect. Such information will be important in determining action thresholds for management decisions. Our objectives for this study were to 1) document the phenology and distribution of the potato psyllid in southern California and 2) determine the distribution of potato psyllids both within commercial potato fields and within potato plants. Our methods relied on a systematic sampling design to count all of the psyllids on crop plants. Results of our study indicated that psyllids arrive within agricultural fields in different counties at different times and experience different population trajectories depending on the crop. This movement between crops clearly suggests the need for an area wide management program against this insect. To most efficiently sample potato psyllids in southern California, we recommend starting on the edges of fields and sampling the underside of leaves in the middle of the plant.

Figure 1. Mean numbers of psyllids found in bell peppers in Orange and Ventura counties in California during 2009 and 2010.





VI. Additional Research

Future studies to determine if thiamethoxam has the same activity against the adult psyllid as imidacloprid will be performed. We are also testing alternative strategies and chemicals for psyllid control such as repellents to disrupt insect behaviors. If successful we will incorporate these techniques into an IPM program.

Studies on sampling of psyllids in peppers are still being analyzed. Some of this information will be presented in the oral report.

VII. 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 from the SCRI and PMAP funding agencies to study and develop pepper IPM program strategies.