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California Pepper Commission
Research Report 2014-2015

I. IDENTIFICATION

A. California Pepper Commission.
B. Insect Pest Management on Peppers
C. Proposal for period beginning March 2014, ending February 2015.
D. Principal Investigator:
Dr. John T. Trumble
Department of Entomology
University of California, Riverside
E. Cooperating Personnel:
William Carson, Greg Kund, and Sean Prager
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 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 3-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% vol/vol.

Table 1: Pepper Chemical Trial List of Treatments 2014

Treatment #	Compound	Rate-Product	Application Dates	Company
1	Control	-	-	-
2	Radiant 1.0 SC	7.0 oz/Ac	7/17, 7/24, 7/31, 8/7, 8/14, 8/21, 8/28	Dow
3	Intrepid 2F+ Warrior	10.0 oz/Ac 3.0 oz/Ac	7/17, 7/24, 7/31, 8/7, 8/14, 8/21, 8/28	Dow Syngenta
4	a) Verimark 200 SC[a] b)Actara 25 WG+ BeetleGone![b] c)Closer SC+ BeetleGone!	13.5 oz/Ac 5.0 oz/Ac 6 lbs/Ac 5.0 oz/Ac 6 lbs/Ac	6/26, 7/17, 7/24, 7/31, 8/7, 8/14, 8/21	Dupont Syngenta Phyllom Dow
5	Lannate 2.4 LV+ Pounce 3.2 EC	48 oz/Ac 8 oz/Ac	7/17, 7/24, 7/31, 8/7, 8/14, 8/21	Dupont FMC

[a] Verimark was applied once on 6/26 as a soil drench

[b] BeetleGone was tank mixed and applied six consecutive weeks.

Pepper Weevil

Fruitworm

A late season field count of psyllids was taken by counting eggs, nymphs and, adults on a single branch of five plants per replicated plot to determine what impact the treatments had on potato psyllid populations. On 11 Sep, 100 mature-green to ripe fruit were harvested from the center row of each replicate (400 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, and potato psyllid PP. Results are shown in Table 2.

Lepidopteran pressure was estimated to be moderate to high in the categories of External damage by BAW (Figure 4). Internal damage by PW was moderate this year with the control sustaining 15% damage (Figure 2). We did see some differences between treatments for potato psyllid PP numbers (Figure 1). Treatments 3 and 5 had higher psyllid numbers on the fruit. Damage to the calyx showed no statistical differences between treatments and can be attributed to TFW, BAW, and PW feeding (Figure 3). Harvest assessment of aphid damage showed treatments 3 and 5 had high levels of aphid damage with peppers covered in sticky sooty mold (Figure 5). The field counts of psyllids revealed significant differences between the treatments, and treatment five had the highest number of total psyllids (Figure 6).

Table 2.

Treatment/ Formulation		Rate Amt/acre	Mean Number of Fruit Damaged/Replicate [b] Internal	External	All Leps	Pepper Weevil Internal	Calyx Damage	Psyllids
1	Control	-	2.5 abc	10.75	13.25 b	15.00	46.25 b	9.00 b
2	Radiant 1.0 SC	7.0 oz/Ac	1.25 ab	6.00	7.25 ab	7.00	49.25 b	2.50 a
3	Intrepid 2F+ Warrior	10.0 oz/Ac 3.0 oz/Ac	0.75 a	2.25	3.00 a	2.50	43.75 b	21.75 d
4	a) Verimark 200 SC b)Actara 25 WG+ BeetleGone! c)Closer SC+ BeetleGone!	13.5 oz/Ac 5.0 oz/Ac 6 lbs/Ac 5.0 oz/Ac 6 lbs/Ac	3.00 bc	6.25	9.25 b	11.25	40.25 ab	6.00 ab
5	Lannate 2.4 LV+ Pounce 3.2 EC	48 oz/Ac 8 oz/Ac	3.25 c	6.75	10.00 b	2.00	32.00 a	14.50 c
ANOVA F value (by column)			3.113	2.367	3.400	2.666	3.906	18.572
ANOVA P value (by column)			0.047	0.099	0.036	0.073	0.023	0.001

[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 be attributed to (TFW), (BAW), and (PW) feeding

Figure 1. Potato Psyllid infestation

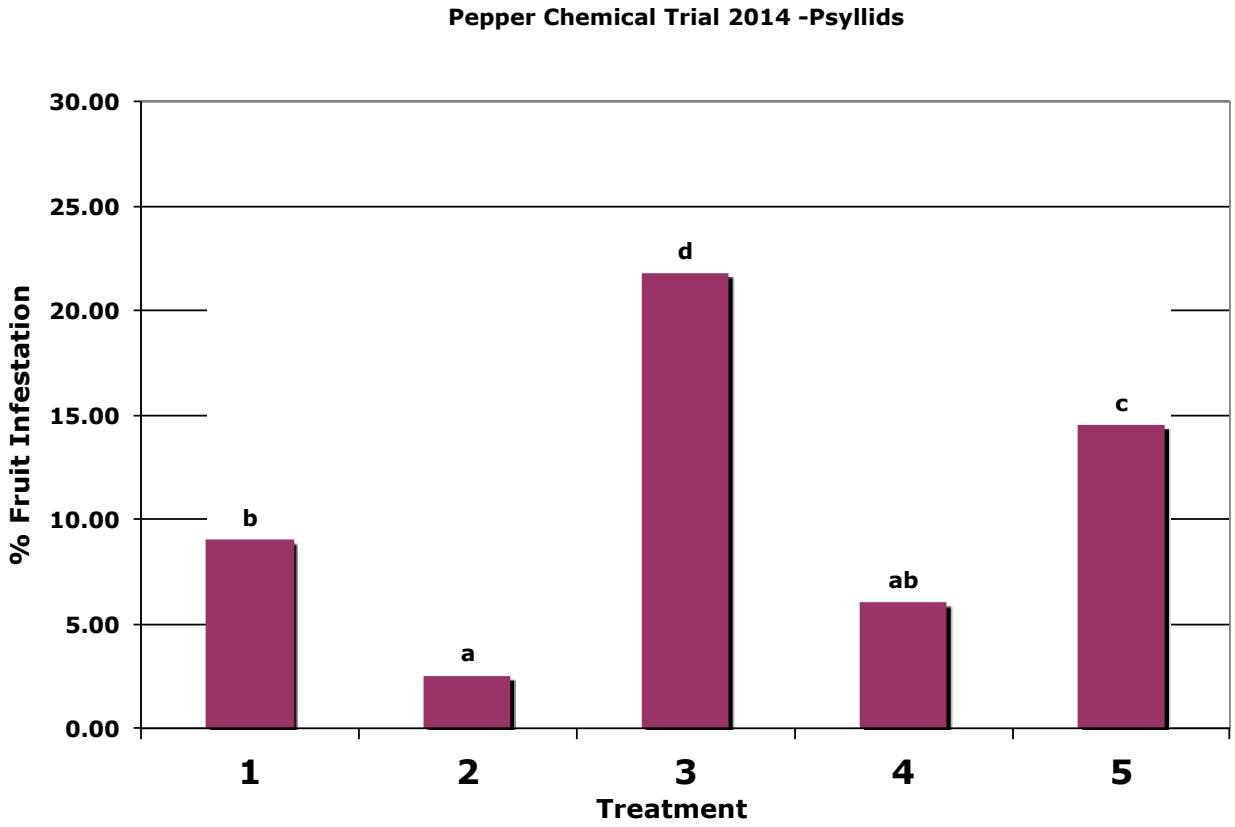


Figure 2. Pepper weevil damage

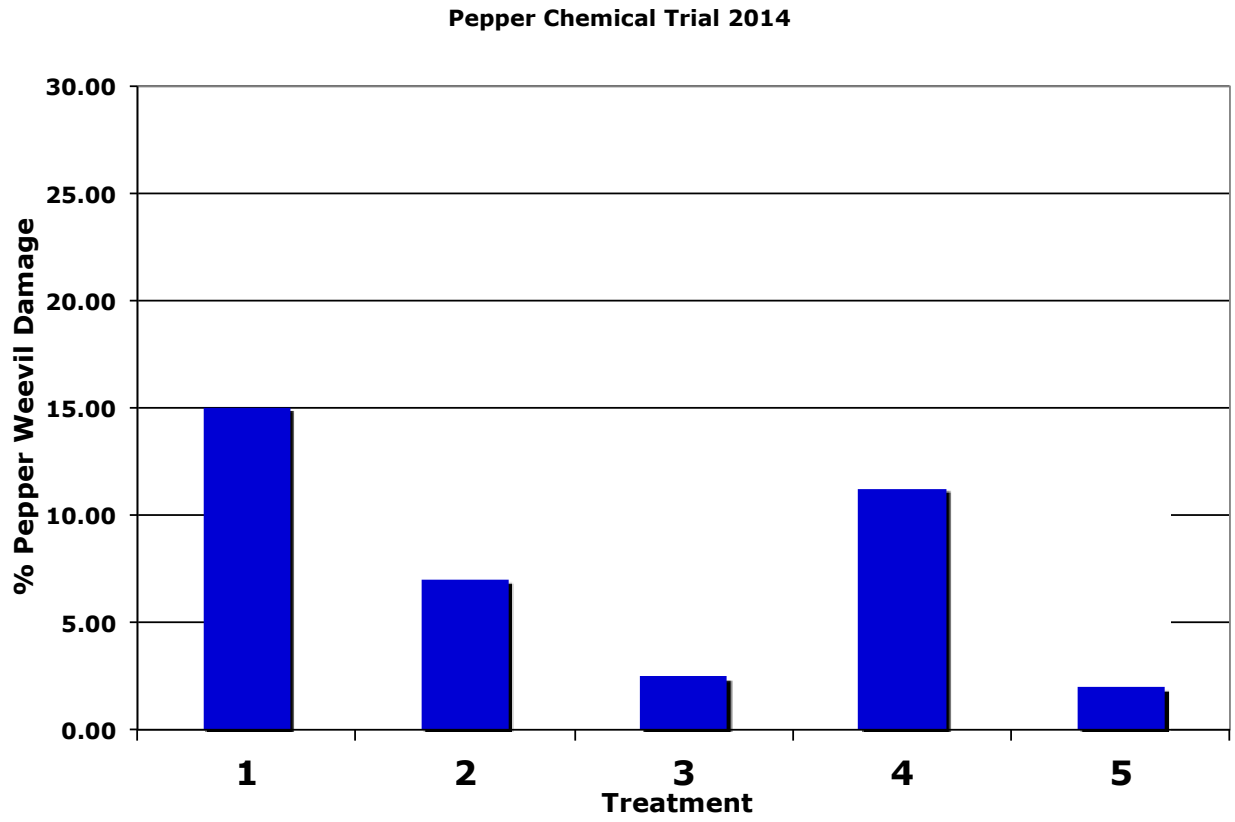


Figure 3. Calyx feeding damage

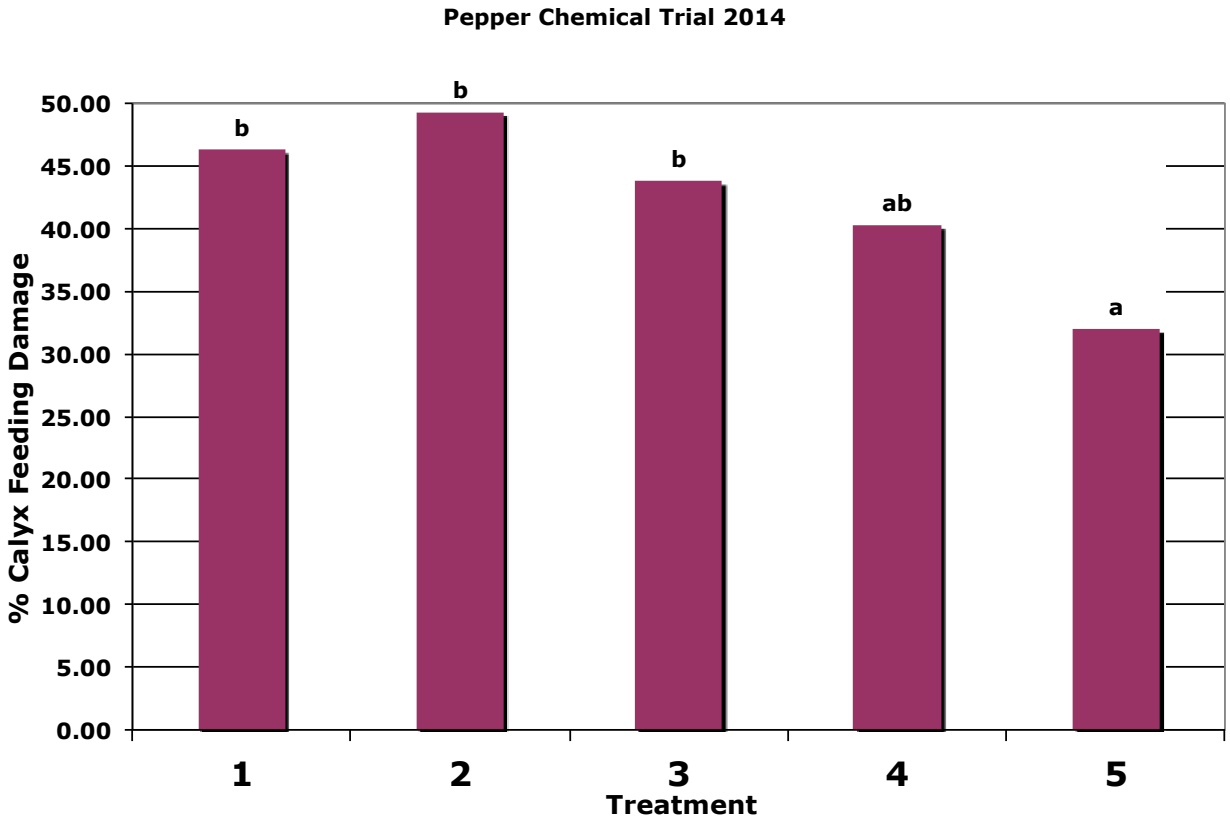


Figure 4. Lepidopteran damage

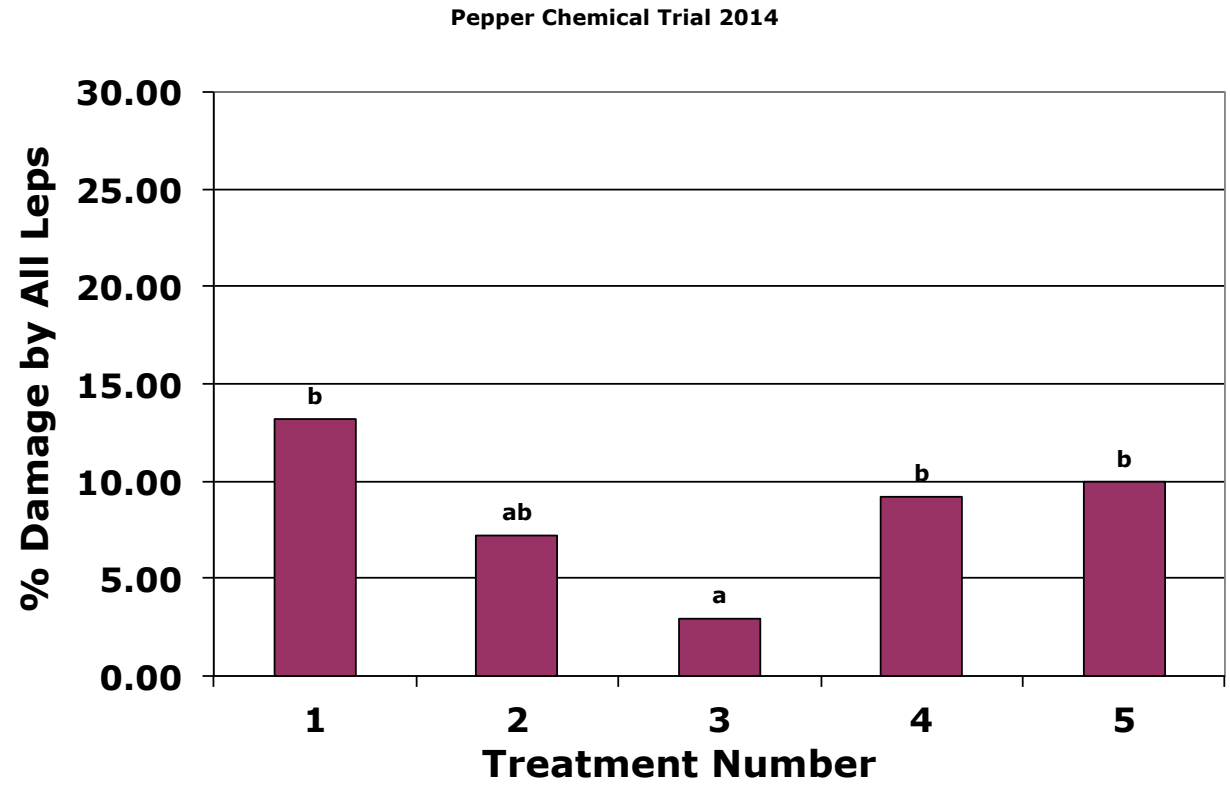


Figure 5. Aphid damage

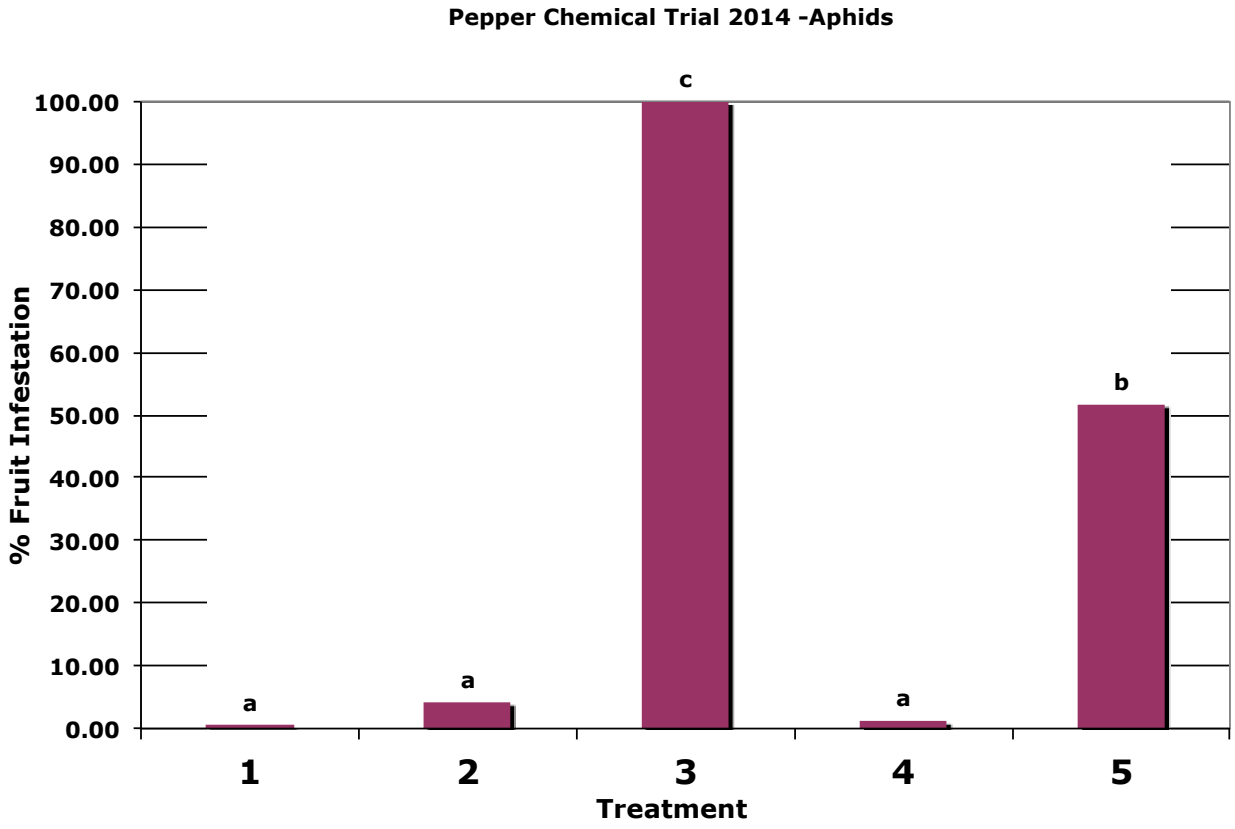
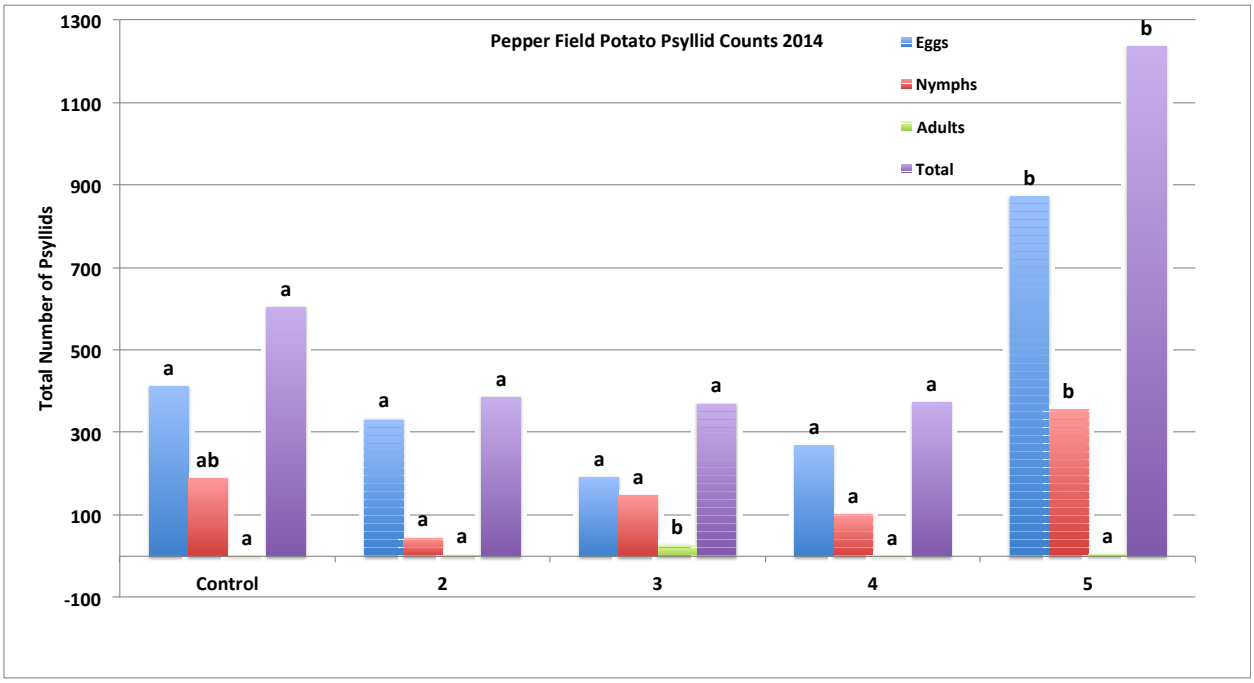


Figure 6. Pepper field Potato Psyllid counts



III. IPM Strategies in Peppers

Seedlings were transplanted in a sandy loam type soil on 10 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 3-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 treatment 4 was an IPM rotation. Treatment 5 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. On (11 September), all of the mature-green to ripe fruit were harvested from the center row of each replicate. From each replicate 100 fruit were sampled (400 per treatment) and examined for Lepidopterous internal damage (tomato fruitworm) and external damage (beet armyworm)(Figure 4). Fruit were also inspected for damage to the calyx, and from pepper weevils (Figure 3), hemipterous pests and presence of psyllids (Figure 1). The results for insect damage are summarized in (Table 2).

Lepidopteran pressure was moderate to high in the categories of external damage by beet armyworm. Internal damage from tomato fruitworm was moderate this year and differences were seen among the treatments. Internal damage by pepper weevil was moderate to high this year but no differences were shown. Calyx damage was high and there were differences between the treatments. No phytotoxicity was observed in any of the treatments. We did see a significant difference between the chemical standard and IPM rotations for the infestation levels of psyllids. There was a significant increase in psyllid numbers with treatment 5, which is a chemical standard treatment. This treatment used carbamates and pyrethrins, which can kill beneficial insects and actually cause an increase in the numbers of psyllids. We have seen this occur in our previous chemical standard trials.

IV. Virus Interaction Studies

We investigated the ecological and epidemiological relationships among solanaceous plants, plant pathogenic viruses, vectoring, and non-vectoring insects. It is typically assumed that within fields, there is one pathogen, one host plant, and one insect vector. However, many settings such as crop fields are mosaics of plants, diseases, and insects, and viral infection leads to plant immune defense that can alter insect behaviors. Of particular concern is the pathogen Tomato Spotted Wilt Virus (TSWV). In our preliminary studies, a model system using solanaceous plants are infected with Tobacco Mosaic Virus (TMV) by a mechanical transmission technique. This model system allows us to obtain results much quicker than working with other viruses, which are difficult to maintain in culture. Our early findings have been interesting.

We have determined that plants infected with viruses will alter the responses of potato psyllids. In particular, potato psyllids seem to avoid plants that are infected with pathogenic viruses. This leads to less landing on plants and also to less oviposition. We investigated how infection with viruses such as TSWV influences transmission of CLso. Additionally, we are collaborated with researchers at the USDA to determine biochemical responses correlated with these behaviors and infection rates. We have submitted a manuscript for publication.

V. Additional Research

We are testing alternative strategies and chemicals for psyllid control such as repellents to disrupt insect behaviors. Successful repellents will be incorporated into an IPM program. We are continuing to study pepper weevil control and have attempted to acquire grant funding to support this research.

VI. 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 USDA and the Specialty Crop Research Initiative (SCRI) to study and develop pepper IPM program strategies, as well as chemical industry support. We submitted a phase II grant proposal to DPR focusing on development of IPM programs in commercial pepper growing operations.