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California Pepper Commission
Research Report 2017-2018

I. IDENTIFICATION

- A. California Pepper Commission.**
- B. Insect Pest Management on Peppers**
- C. Proposal for period beginning March 2017, ending February 2018.**
- D. Principal Investigator:**
 - Dr. John T. Trumble
 - Department of Entomology
 - University of California, Riverside
- E. Cooperating Personnel:**
 - Greg Kund
 - Department of Entomology
 - Univ. of California, Riverside
 - Michael Jones
 - Department of Entomology
 - Univ. of California, Riverside
- F. Locations of Work:**
 - U.C. Riverside Agricultural Operations
 - Riverside, CA
 - Riverside County, CA
- G. Insects**
 - Tomato/Potato Psyllid: *Bactericera cockerelli* (Sulc)
 - Beet armyworm (BAW): *Spodoptera exigua* (Hübner)
 - Tomato Fruitworm(TFW): *Helicoverpa zea* (Boddie)
 - Leafminer: *Liriomyza sativae* (Blanchard)
 - Leafminer: *Liriomyza trifolii* (Burgess)
 - Lygus bugs: *Miridoa* spp.
 - Stink bugs (SB): *Pentatomidae* spp.
 - Pepper weevil (PW): *Anthonomus eugenii* Cano
 - Green peach aphid (GPA): *Myzus persicae* (Sulzer)

II. Field Screening Trials for Effective Pesticides

Seedlings were transplanted in a sandy loam type soil on 4 May at the University of California Riverside's Agricultural Operations field #5I. Experimental plots were 3 rows wide (5-ft centers) by 20 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 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 Dyne-amic as an adjuvant at 0.25% vol/vol except treatment 9, which used Pyganic, Trilogy, Mycotrol O, and Entrust, and treatment number eleven, which consisted of Venerate and Bond Max.

Table 1: Pepper Chemical Trial List of Treatments 2017

Treatment #	Compound	Rate-Product	Application Dates	Company Sponsor
1	Control	-	-	-
2	a) Minecto Pro #970639 (small) Dyne-amic b) Warrior II W/Zeon 2.08 CS c) Actara 25 WG Dyne-amic	10.0 floz 0.25 %v/v 1.5 floz 4.0 oz wt 0.25 %v/v	6/22, 7/20 6/28, 7/14, 7/26, 8/10 7/7, 8/3	Syngenta
3	a) Exirel 0.83 SE Dyne-amic b) Warrior II W/Zeon 2.08 CS c) Actara 25 WG Dyne-amic	13.5 floz 0.25 %v/v 1.5 floz 4.0 oz wt 0.25 %v/v	6/22, 7/20 6/28, 7/14, 7/26, 8/10 7/7, 8/3	Syngenta
4	a) Minecto PRO #970639 (small) Dyne-amic b) Vydate C-LV 3.77 SL Dyne-amic c) Endigo 2.06 ZC	10.0 floz 0.25 %v/v 1.06 pt 0.25 %v/v 4.5 floz	6/22, 7/20 6/28, 7/14, 7/26, 8/10 7/7, 8/3	Syngenta
5	a) Exirel 0.83 SE Dyne-amic b) Vydate C-LV 3.77 SL Dyne-amic c) Endigo 2.06 ZC	13.5 floz 0.25 %v/v 1.06 pt 0.25 %v/v 4.5 floz	6/22, 7/20 6/28, 7/14, 7/26, 8/10 7/7, 8/3	Syngenta
6	a) Vydate C-LV 3.77 SL Dyne-amic b) Actara 25 WG Dyne-amic c) Brigade 2 EC	1.06 pt 0.25 %v/v 4.0 ozwt 0.25 %v/v 6.4 floz	6/22, 7/7, 7/20, 8/3 6/28, 7/26 7/14, 8/10	Syngenta
7	Radiant SC + Sequoia 2 SC	7.0 Fl oz 4.5 Fl oz	6/22, 6/28, 7/7, 7/14, 7/20, 7/26, 8/3, 8/10	Dow
8	IPM a-Verimark ^a b-Radiant SC c-Sequoia 2 SC	13.5 oz 7.0 oz 4.5 oz	6/22, 6/28, 7/20, 7/26 7/7, 8/3	
9	Organic IPM a-Pyganic 1.4EC b-Trilogy EC c-Mycotrol O	32.0 oz 64.0 oz 32.0 oz	6/22, 7/20, 8/10 6/28, 7/26, 8/3 7/7, 7/14	

	d-Entrust SC	8.0 oz	7/7, 7/14	
10	Chem Standard: Asana XL Dyne-amic	9 oz 0.25 %	6/22, 6/28, 7/7, 7/14, 7/20, 7/26, 8/3, 8/10	
11	Venerate XC Bond Max	3 qt 18 Fl oz	6/22, 6/28, 7/7, 7/14, 7/20, 7/26, 8/3, 8/10	Marrone Bio

^a Verimark was applied once on 6/22 as a soil drench



Pepper Weevil



Fruitworm

An early and mid-season field count of insect populations were taken by counting a single branch of four plants per replicated plot. On 23 Aug, 50 mature-green to ripe fruit were harvested from the center row of each replicate (200 per treatment) and examined for Lepidopterous internal damage (TFW), external damage (BAW), and hemipterous pests (SB). Fifty fruit were also inspected for damage from pepper weevils (PW), potato psyllid (PP), and aphids (GPA). Results are shown in Table 2.

Lepidopteran pressure was moderate to high in the category of 'external damage by BAW' (Figure 2). Internal damage by the pepper weevil was very low this year and could be a result of hot weather conditions. Some pepper weevils were seen in the field, but comparisons between treatments were not significant. Potato psyllids were present in the field but we did not see significant numbers in our harvest assessment. Damage to the calyx by TFW, BAW, and PW feeding showed no differences between treatments (Figure 1). Harvest assessment of aphid infestation did show a difference for treatment 10, which was the Asana product (Figure 3). Field counts of psyllids revealed significant differences between the treatments. Treatment ten had the highest number of total psyllids (Figure 4).



Mean Number of Fruit Damaged/Replicate ^b

Table 2.

Treatment/ Formulation	Rate Amt/acre	Internal	External	All Leps	Pepper Weevil Internal	Calyx Damage	Psyllids
1 Control	-	0.50	6.50 a	7.00 a	0.00	2.00	0.25
2 a) Minecto Pro #970639 (small) Dyne-amic	10.0 floz 0.25 %v/v	0.00	6.00 ab	6.00 ab	0.00	0.50	0.25
b) Warrior II W/Zeon 2.08 CS	1.5 floz						
c) Actara 25 WG Dyne-amic	4.0 ozwt 0.25 %v/v						
3 a) Exirel 0.83 SE Dyne-amic	13.5 floz 0.25 %v/v	0.00	3.00 bc	3.00 bcd	0.00	1.50	0.00
b) Warrior II W/Zeon 2.08 CS	1.5 floz						
c) Actara 25 WG Dyne-amic	4.0 ozwt 0.25 %v/v						
4 a) Minecto PRO #970639 (small) Dyne-amic	10.0 floz 0.25 %v/v	0.25	1.00 c	1.25 d	0.00	0.50	0.00
b) Vydate C-LV 3.77 SL Dyne-amic	1.06 pt 3.77 SL 0.25 %v/v						
c) Endigo 2.06 ZC	4.5 floz						
5 a) Exirel 0.83 SE Dyne-amic	13.5 floz 0.25 %v/v	0.00	3.25 abc	3.25 bcd	0.00	0.75	0.00
b) Vydate C-LV 3.77 SL Dyne-amic	1.06 pt 3.77 SL 0.25 %v/v						
c) Endigo 2.06 ZC	4.5 floz						
6 a) Vydate C-LV 3.77 SL Dyne-amic	1.06 pt 3.77 SL 0.25 %v/v	0.75	4.00 abc	4.75 abc	0.00	2.75	0.00
b) Actara 25 WG Dyne-amic	4.0 ozwt 0.25 %v/v						
c) Brigade 2 EC	6.4 floz						
7 Radiant SC + Sequoia 2 SC	7.0 Fl oz 4.5 Fl oz	0.50	2.25 c	2.75 bcd	0.00	1.00	0.00

8	IPM		0.25	2.75 bc	3.00 bcd	0.00	0.50	0.00
	a-Verimark	13.5 oz						
	b-Radiant SC	7.0 oz						
	c-Sequoia 2 SC	4.5 oz						
9	Organic IPM		0.00	1.50 c	1.50 cd	0.00	0.75	0.00
	a-Pyganic 1.4EC	32.0 oz						
	b-Trilogy EC	64.0 oz						
	c-Mycotrol O	32.0 oz						
	d-Entrust SC	8.0 oz						
10	Chem Standard:		0.50	4.25 abc	4.75 abc	0.00	1.25	1.00
	Asana XL	9 oz						
	Dyne-amic	0.25 %						
11	Venerate XC	3 qt	0.25	4.25 abc	4.50 abcd	0.00	1.25	0.00
	Bond Max	18 Fl oz						
ANOVA F value (by column)			0.750	2.279	2.448	--	0.833	1.620
ANOVA P value (by column)			0.674	0.037	0.026	--	0.601	0.144

^a Verimark was applied once on 6/22 as a soil drench

^b 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 1. Calyx feeding damage

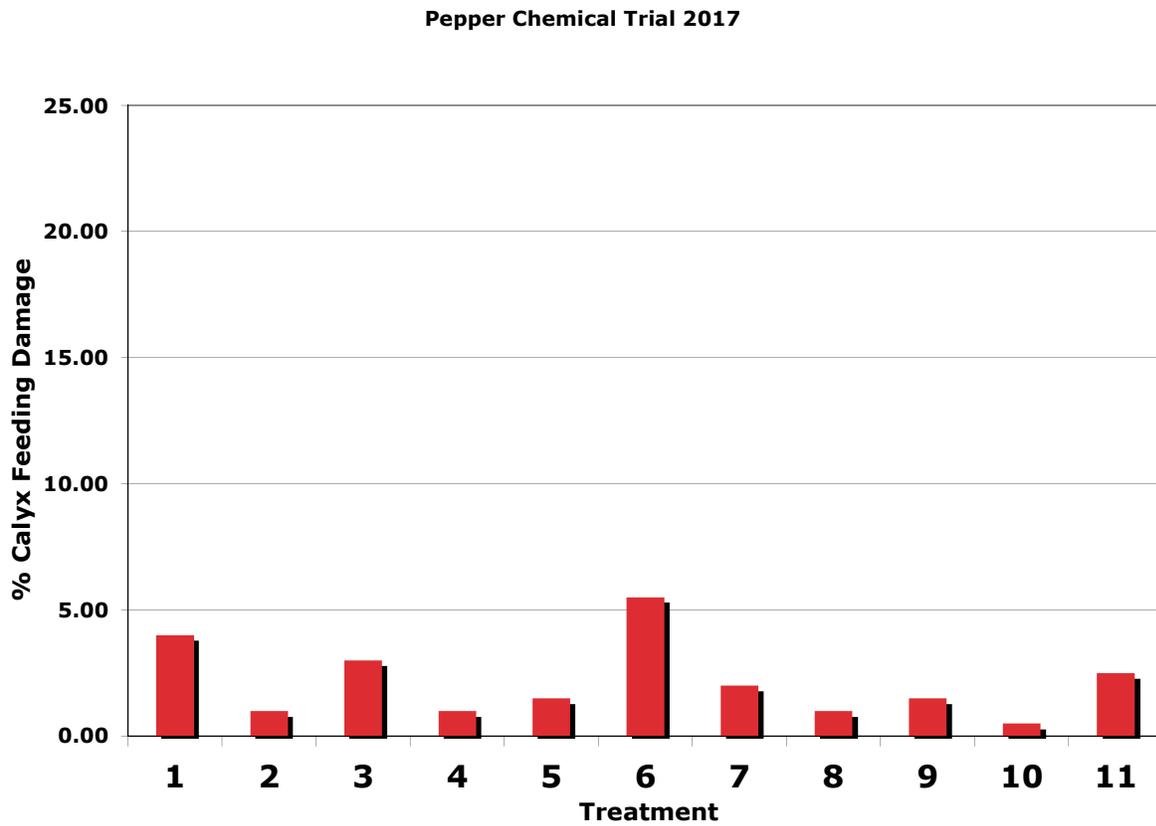


Figure 2. Lepidopteran damage

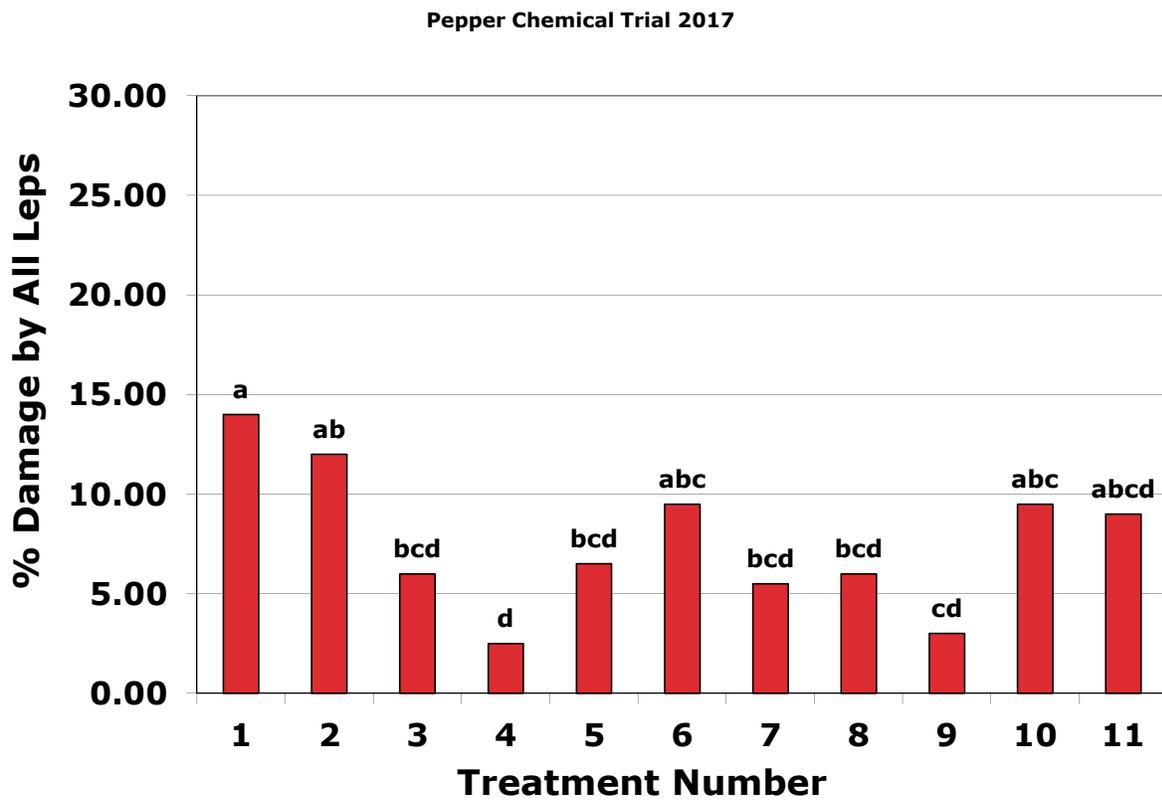
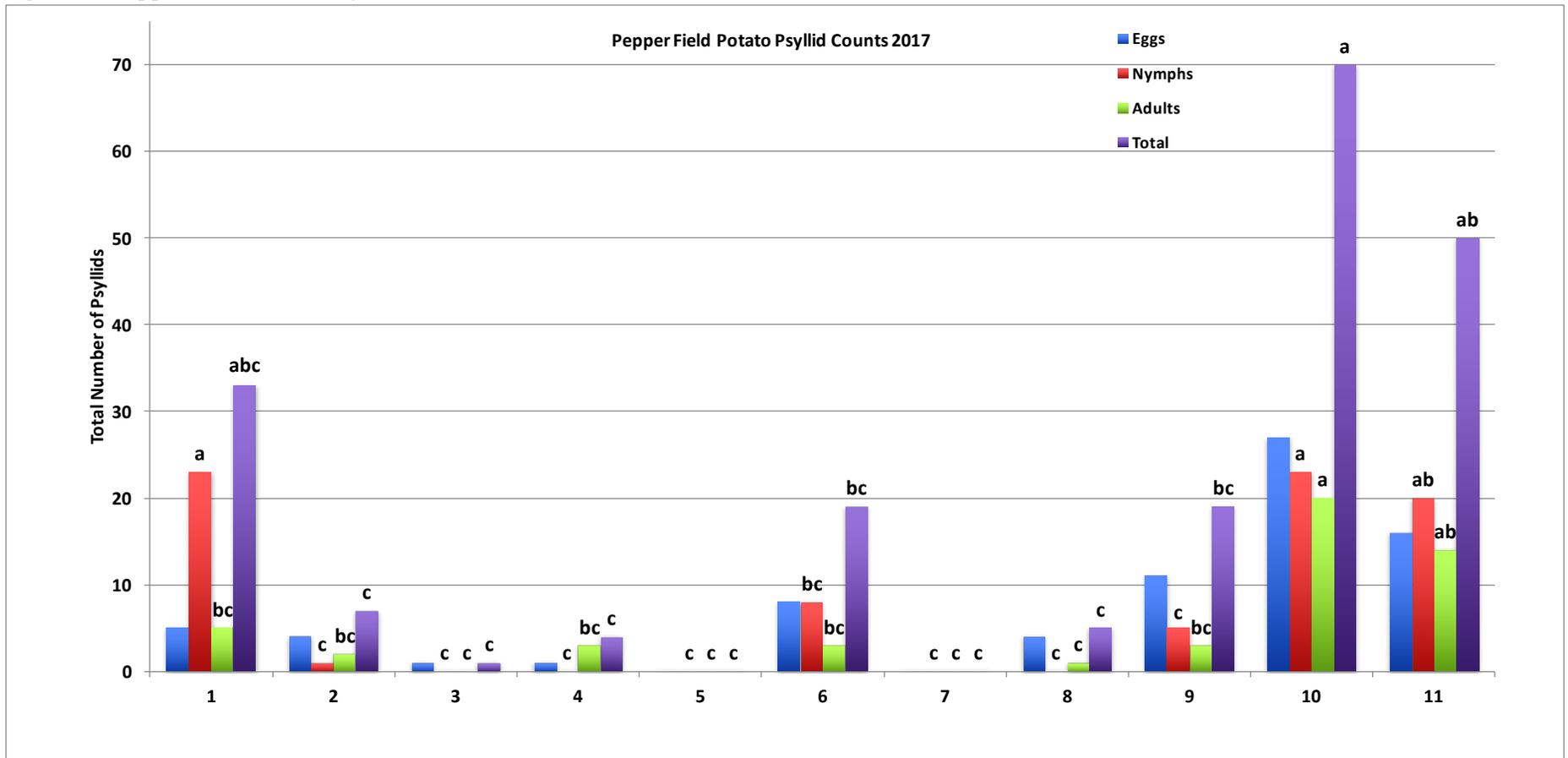


Figure 3. Pepper field Potato Psyllid counts.



III. Laboratory Research

Objectives:

- I. Test the efficacy of VST06340 on *Myzus persicae* using different surfactants
- II. Test the efficacy of Marrone Bio® products on *Bactericera cockerelli* nymphs

Key Conclusions:

- VST06340 in the liquid form applied at the rate of 0.1 lb/Ac in combination with the surfactant Capsil at 0.125% had a significant effect on the mortality of green peach aphids.
- The Venerate product provided the highest rate of mortality, but there were still some survivors in all treatments, which completed development to the adult stage.

Objective 1. Efficacy test of VST06340 on *Myzus persicae* nymphs

The goal of this test was to determine if the VST treatments alone and in combination with different surfactants had an effect on the mortality of green peach aphids.

Methods:

Bell pepper plants 8 inches in height were used as the host for the green peach aphids. Each treatment was replicated four times with fifty aphids transferred to each leaf as the replicate. The nymphs were transferred with a camel hair brush from pepper leaves that came from our laboratory green peach aphid colony. Hand held spray bottles were used to apply each treatment. The untreated control was sprayed with water. Each plant was sprayed just prior to runoff of the material to maximize the amount of active ingredient remaining on the plants.

Mixtures of the following treatments were prepared:

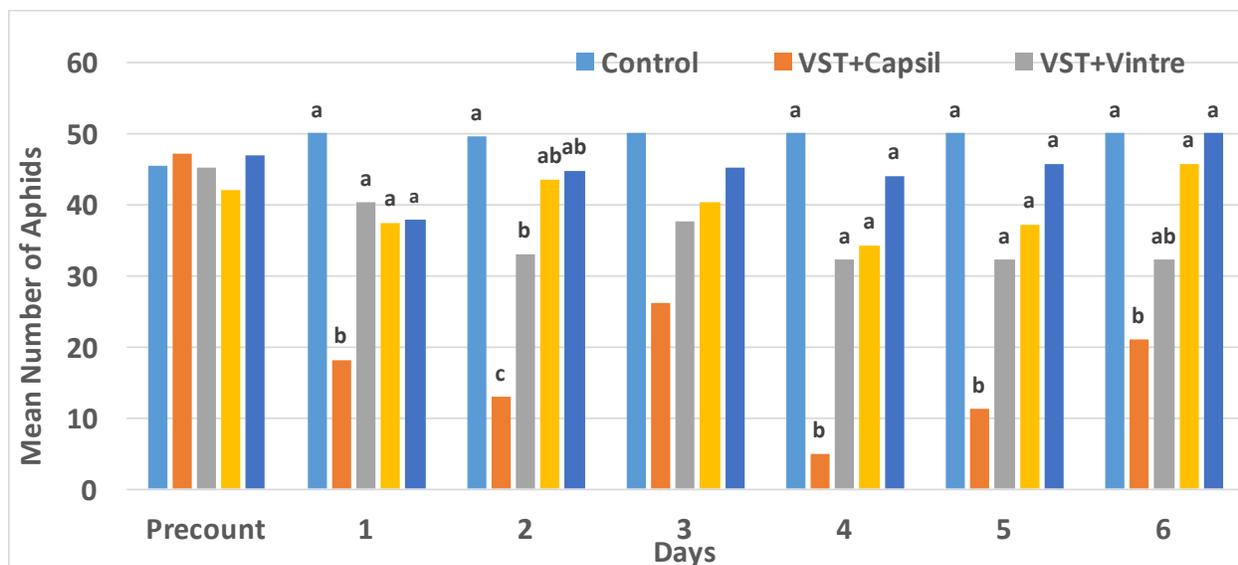
1. Water
2. VST06340 5 ppt + Capsil 0.125%
3. VST06340 5 ppt + Vintre 0.125%
4. VST06340 5 ppt + MSO 0.125%
5. VST06340 5 ppt + LI-700 0.125%

Daily mortality counts were recorded for a period of 6 days. Data were analyzed with the JMP statistical program using ANOVA and Fisher's Protected LSD test ($p < 0.05$).

Results:

There were significant differences between the treatments on all days except day 3. The VST06340 treatment with Capsil provided the best control of the aphids (Figure 4).

Figure 4. Mean number of *Myzus persicae* aphids



Objective 2. Test the efficacy of Marrone Bio® products on *Bactericera cockerelli* nymphs

The goal of this test was to determine if the Marrone Bio® products “Grandevo WDG”, “Venerate XC”, and “MBI-203D-SDP WDG” treatments had an effect on the mortality of potato psyllid nymphs in the second and third instar life stages.

Methods:

Plants 8 inches in height were used as the host for the potato psyllid nymphs. Each treatment was replicated five times with 30 2nd to 3rd instar nymphs. The nymphs were transferred with a camel hair brush from tomato leaves that came from our Texas strain susceptible potato psyllid colony. Hand held spray bottles were used to apply each treatment. The untreated control was sprayed with water. Each plant was sprayed just prior to runoff of the material to maximize the amount of active ingredient remaining on the plants.

Mixtures of the following treatments were prepared:

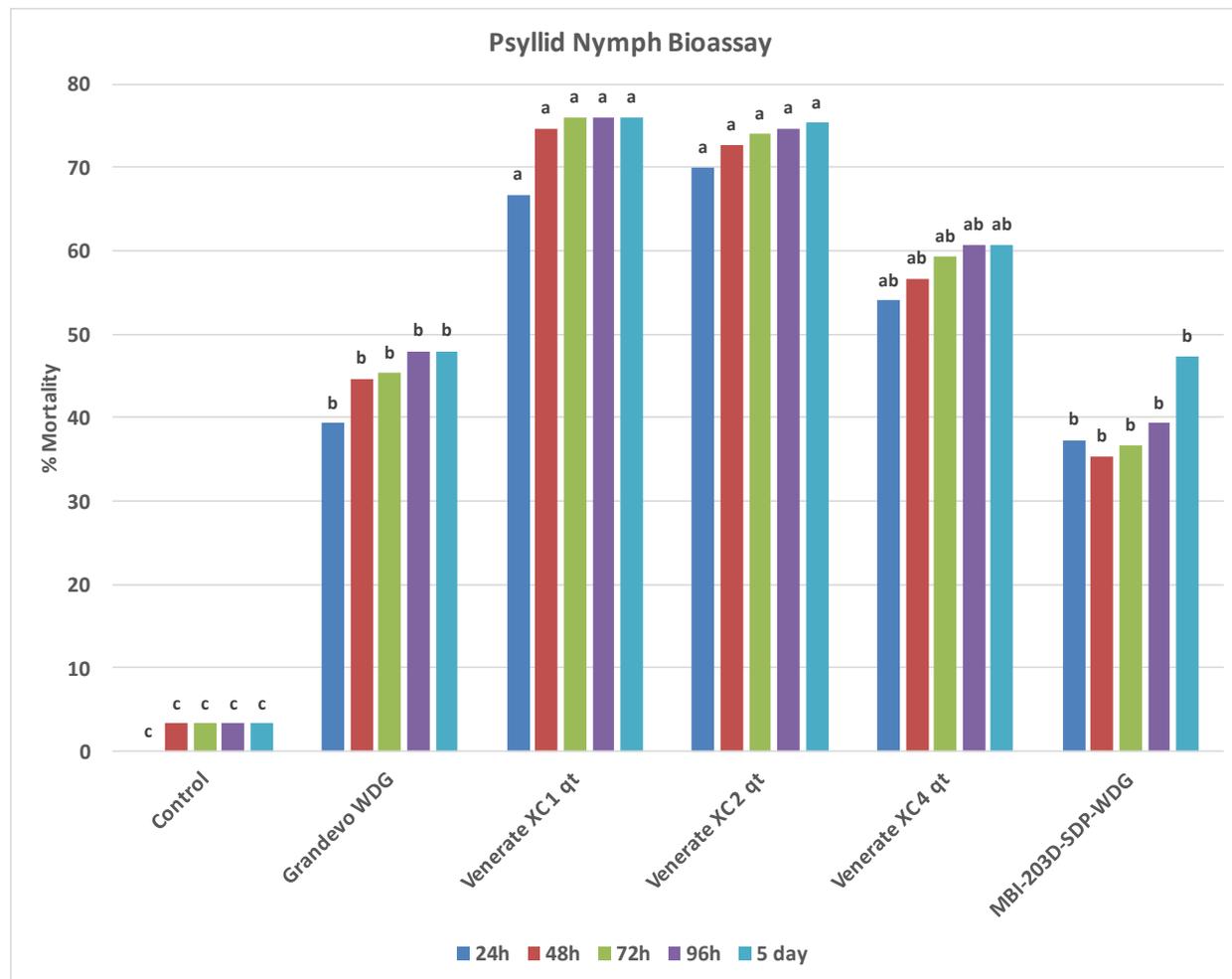
1. Water
2. Grandevo WDG + Dyne-amic 0.25%
3. Venerate XC 1 qt/Ac + Dyne-amic 0.25%
4. Venerate XC 2 qt/Ac + Dyne-amic 0.25%
5. Venerate XC 4 qt/Ac + Dyne-amic 0.25%
6. MBI-203D-SDP WDG + Dyne-amic 0.25%

Daily mortality counts were recorded for a period of 5 days. Data were analyzed with the JMP statistical program using ANOVA and Fisher’s Protected LSD test ($p < 0.05$).

Results:

There were significant differences between the treatments as shown in (Figure 5). The Venerate product provided the highest rate of mortality, but there were still some survivors in all treatments that were able to complete development to the adult stage.

Figure 5. *Bactericera cockerelli* 2nd to 3rd instar nymph mortality



IV. Additional Research

We are testing alternative strategies and chemicals for psyllid control such as repellents to disrupt insect behaviors. Successful repellents and insecticides will be incorporated into an IPM program. 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.