CALIFORNIA MELON RESEARCH BOARD
2015 Final Report

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PROJECT TITLE:

New Insecticide Alternatives for Insect Management in Melons

PRINCIPLE INVESTIGATOR:

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Objective: To continue to evaluate the efficacy of insecticide alternatives and develop alternatives to endosulfan for whitefly adults and CYSDV in spring and fall melons.

SUMMARY OF RESEARCH RESULTS:

- CYSDV continues to be serious problem in fall cantaloupes. Whitefly infestations and virus incidence were moderately heavy in spring crops this year, but surprisingly were lighter than normal in the fall melons. However, the need for foliar and soil insecticide alternatives for whitefly control are still great, particularly considering the industries heavy reliance on neonicotinoids and regulatory issues surrounding pollinator protection.

- Experimental trials in 2015 continued to evaluate foliar and soil insecticides that can provide rapid control of whitefly adults on cantaloupes. Results of our studies this year have allowed us to update our recommendations for use of foliar and soil insecticides that will assist melon growers to cost-effectively control whiteflies and CYSDV until new alternatives become available.

- Results of our research show that a core of foliar insecticides will provide suppressive activity against whiteflies and CYSDV. These include the neonicotinoids Venom, Scorpion and Assail, and to a lesser extent Sequoia. Exirel (cyazypyr) was recently registered and has shown good whitefly activity comparable to the standards, but this year was less consistent in suppressing CYSDV. Sivanto applied as a foliar spray showed excellent activity, but does not currently have a foliar label on melons. The most promising near-term foliar compound is pyrifluquinazone which is likely 12-18 months from a registration. Long-term, a new experimental compound EXP_2415 showed activity against whiteflies and CYSDV comparable to the standards, but is still under development and is likely several years from commercial availability.

- Soil insecticides were again extensively evaluated this year in both drip chemigation and soil shank trials. Sivanto (*flupyradifurone)* is currently available for soil use in melons, and when applied as an at-planting treatment delayed CYSDV incidence comparable to the Venom standard. Verimark for a second year did not perform similarly to either Venom or Sivanto. Fortunately, EXP_2415 also has soil activity and provided whitefly control and CYSDV suppression as good as Sivanto and Venom when applied as a soil systemic treatment.

I. SOIL INSECTICIDE ALTERNATIVES

A. Drip Chemigation *- Spring and Fall 2015*

Research procedures: Cantaloupe plots planted with 'Navigator' were established on 17 Apr, 2015 and plots planted with 'Alaniz Gold' were established on 14 Aug, 2015 at the Yuma Agricultural Center. Both trials were managed similarly to local growing practices. Plots consisted of one 84-inch bed, 50 ft long with a 7 buffer between each plot. The studies were designed as a randomized complete block design with 4 replicates / treatment. The treatments and rates are shown in the tables below. All treatments, except the untreated control, were treated with a single soil insecticide application through the drip tape 10 days after planting (1 leaf stage). The tape was placed 6" below the seed line and the system was set up to deliver 0.67 gpm/100ft of tape at 8 psi. Distance between emitters was 8 inches. The duration of chemigation was as follows: The irrigation system was run for ½ hr; then the treatments were delivered through the system for ~20 minutes; followed by another 3 hrs of irrigation to flush the lines and irrigate the plots. Adult populations were estimated using a modified vacuum method was used that employed a DeWALT DC500 2- gallon portable vacuum which was fitted with 5 oz cloth-screened containers to capture and retain vacuumed adults. On each sample date, 5 separate plants from each replicate were sampled by vacuuming and containers with adults were taken into the laboratory, where the number of adults/ plant was recorded. Immature densities were estimated periodically by sampling 10 plants / plot, where 3 leaves per plant were collected from various node locations on the primary terminal. Leaves were taken into the laboratory where densities of eggs, and nymphs were counted on two, 2-cm^2 leaf discs of each leaf using a dissecting microscope. CYSDV incidence was recorded by recording the number of leaves that expressed symptoms of the virus and yellow interveinal chlorosis consistent with CYSDV infection in 50 ft within each plot. Because of heterogeneity of mean variances, data were transformed using a $\log_{10}(x + 1)$ function before analysis and subjected to ANOVA; means were compared using Turkey's HSD test ($P \leq 0.05$). Means from non-transformed data are presented in the tables.

Research Results**:** The objective of this trial was to compare for a 2nd year the efficacy of Sivanto, Verimark and a new experimental compound (EXP-2415) against Venom for control of whiteflies and CYSDV when applied to melons through drip irrigation. The data from both the spring and fall trials clearly shows that Sivanto, particularly at the 28 oz rate, significantly reduced whitefly adults and nymphs on melons comparable to the Venom standard (Tables 1-2, and 4-5). These results corroborate our results from last year that showed Sivanto had excellent activity on adults. Similarly, Sivanto significantly reduced the early onset of CYSDV symptoms comparable to Venom in the absence of any additional soil applications or foliar sprays (Tables 3 and 6). Presumably, this reduction in virus incidence is likely a result of the rapid feeding cessation (feeding stops in less than 1 hr) associated with Sivanto intoxication. Furthermore, the new experimental compound (EXP_1524) also provided whitefly control and CYSDV suppression comparable to both Sivanto and Venom. Not much is known about this compound yet because it is still in early stages of development. Both of these compounds are viable alternatives to Venom for early season whitefly control in melons. In contrast, again for a 2nd year, Verimark and Admire Pro did not provide significant control of whiteflies or CYSDV in either the fall or spring trials. A higher rate of Verimark was applied in this trial (13.5, oz) but still did not see any improvement relative to the lower rate (10.5 oz) used last year. Unfortunately, Verimark does not appear to be a viable soil insecticide alternative for either whitefly or CYSDV management under our desert melon growing conditions.

Spring Trial

Table 1. Whitefly adult abundance following drip chemigation on spring melons, 2015

		Whitefly Adults / Sample					
Soil		*7 DAA*	*14 DAA*	*21 DAA*	*28 DAA*	*35 DAA*	*42 DAA*
Treatment	**Rate**	**28-May**	**4-Jun**	**11-Jun**	**18-Jun**	**25-Jun**	**2-Jul**
EXP_2415	-	5.1cd	2.5c	3.3d	33.5b	32.0a	15.2c
Admire Pro	10.7 oz/ac	11.1b	8.8ab	6.7bcd	66.3ab	88.0a	36.0b
Verimark	13.5 oz/ac	25.1a	16.5a	9.4ab	67.9ab	53.2a	34.4b
Venom	6 oz/ac	3.4d	4.9bc	3.7cd	30.9b	58.3a	20.2c
Sivanto	21 oz/ac	9.8bc	9.9a	12.1ab	47.7b	65.2a	28.9b
Sivanto	28 oz/ac	6.3bcd	9.7a	8.5bc	33.3b	123.3a	36.2b
UTC	-	24.0a	15.5a	26.1a	96.3a	98.6a	52.1a

Table 2. Whitefly nymph densities following drip chemigation on spring melons, 2015

		Whitefly Nymphs /cm^2					
Soil		*7 DAA*	*14 DAA*	*21 DAA*	*28 DAA*	*35 DAA*	*42 DAA*
Treatment	**Rate/ac**	**28-May**	**4-Jun**	**11-Jun**	**18-Jun**	**25-Jun**	**2-Jul**
EXP_2415	-	0.8a	0.7b	0.6b	0.6c	2.7c	6.0b
Admire Pro	10.7 oz/ac	1.2a	4.3b	5.1b	3.2bc	7.1bc	20.9b
Verimark	13.5 oz/ac	1.7a	6.4b	8.1b	4.5b	8.2bc	16.6b
Venom	6 oz/ac	1.3a	2.9b	1.4b	1.2bc	6.6bc	16.4b
Sivanto	21 oz/ac	0.9a	3.3b	5.7b	4.0bc	9.0b	15.1b
Sivanto	28 oz/ac	1.5a	1.9b	2.7b	2.6bc	6.4bc	14.8b
UTC	-	1.8a	23.9a	27.3b	12.1a	20.5a	49.5a

Means followed by the same letter are not significantly different (P>0.05).

Table 3. Incidence of CYSDV at various interval in fall melons treated with soil insecticides via drip chemigation, Spring 2015

		CYSDV Incidence (YIVC symptomatic leaves / 50 ft.)		
Soil Treatment	**Rate/ac**	**19-Jun**	**26-Jun**	**3 Jul**
EXP_2415	-	21.0bc	37.3bc	75.0bc
Admire Pro	10.7 oz/ac	64.0a	124.0a	253.1a
Verimark	13.5 oz/ac	67.5a	103.3a	253.5a
Venom	6 oz/ac	15.5c	33.2bc	63.3c
Sivanto	21 oz/ac	30.3b	44.8b	106.3b
Sivanto	28 oz/ac	14.5c	24.3c	59.5c
UTC	-	62.5a	105.3a	278.5a

Means followed by the same letter are not significantly different (P>0.05).

Fall Trial

Table 4. Whitefly adult abundance following drip chemigation on fall melons, 2015

		Whitefly Adults / Sample					
Soil		*7 DAA*	*14 DAA*	*21 DAA*	*28 DAA*	*35 DAA*	*42 DAA*
Treatment	**Rate**	**3 Sep**	**10 Sep**	**17 Sep**	**24 Sep**	**1 Oct**	**8 Oct**
EXP_2415	-	11.7a	3.1b	3.4d	7.1ab	3.6a	5.7c
Admire Pro	10.7 oz/ac	13.4a	3.8b	4.3cd	7.0ab	7.0a	7.1c
Verimark	13.5 oz/ac	12.8a	13.3a	9.2b	16.4a	12.4a	12.8a
Venom	6 oz/ac	8.9a	2.2b	6.6bc	4.1b	6.3a	5.6c
Sivanto	21 oz/ac	12.5a	2.7b	7.6b	16.8a	6.8a	9.4b
Sivanto	28 oz/ac	9.9a	4.5b	6.8bc	7.5ab	5.2a	6.6c
UTC	-	27.3a	13.3a	16.5a	15.5a	12.4a	16.7a

Means followed by the same letter are not significantly different (P>0.05).

Table 5. Whitefly nymph densities following drip chemigation on fall melons, 2015

		Whitefly Nymphs /cm^2					
Soil		*7 DAA*	*14 DAA*	*21 DAA*	*28 DAA*	*35 DAA*	*42 DAA*
Treatment	**Rate/ac**	**3 Sep**	**10 Sep**	**17 Sep**	**24 Sep**	**1 Oct**	**8 Oct**
EXP_2415	-	0.5c	0.5d	0.5d	1.0b	4.1c	3.7a
Admire Pro	10.7 oz/ac	1.7bc	1.1cd	0.9cd	1.1b	3.3c	5.2a
Verimark	13.5 oz/ac	2.5b	2.2bc	2.8b	4.4ab	10.8a	16.9a
Venom	6 oz/ac	2.4b	1.1cd	0.4d	1.9b	5.6bc	6.2a
Sivanto	21 oz/ac	2.6b	2.4b	1.7bc	3.0b	10.3ab	12.6a
Sivanto	28 oz/ac	2.4b	0.9d	0.4d	1.5b	4.7c	4.4a
UTC	-	5.0a	5.6a	5.2a	7.5a	13.4a	19.3a

Means followed by the same letter are not significantly different (P>0.05).

Table 6. Incidence of CYSDV at various interval in fall melons treated with soil insecticides via drip chemigation, Fall 2015

		CYSDV Incidence (Total symptomatic leaves / 50 ft.)		
Soil Treatment	**Rate/ac**	**18 Sep**	**26 Sep**	**5 Oct**
EXP_2415	-	14.8c	59.0bc	187.8c
Admire Pro	10.7 oz/ac	48.0a	173.0a	352.8a
Verimark	13.5 oz/ac	40.3ab	154.0a	312.6a
Venom	6 oz/ac	8.8c	45.8cd	178.0c
Sivanto	21 oz/ac	15.8bc	69.5b	237.5b
Sivanto	28 oz/ac	6.8c	41.8d	165.3c
UTC	-	34.8ab	151.5a	333.5a

Means followed by the same letter are not significantly different (P>0.05).

I. SOIL INSECTICIDE ALTERNATIVES

B. Shank, At-plant Injection *- Spring and Fall*

Research procedures: Cantaloupe plots planted with 'Navigator' were established on 17 Apr, 2015 and plots planted with 'Alaniz Gold' were established on 14 Aug, 2015 at the Yuma Agricultural Center. Plots consisted of one 84-inch bed, 50 ft long with a 7 buffer between each plot. The study was designed as a randomized complete block design with 4 replicates / treatment. The treatments and rates are shown in the tables below. All treatments, except the untreated control, were treated with a single soil shank injection at planting time applied 3" directly below the seed line in 10.5 GPA total volume. No foliar sprays were applied during the study. Whitefly adults, nymphs and CYSDV incidence were evaluated at various intervals using the sampling methods described in the above drip chemigation trials.

Research Results**:** These studies were conducted adjacent to the drip study using similar experimental plot designs. The objective of these trials were similar to the drip trials; to evaluate Sivanto, Verimark and EXP_2415 applied to melons as a standard shank application for whitefly/CYSDV control compared to the standard Venom treatment. Although, insect and CYSDV numbers varied between the drip and shank trials, the results were quite similar in both systems. In essence, only Sivanto (28 oz) and the EXP_2415 provided whitefly control and CYSDV suppression comparable to Venom. Plots in the untreated check, Admire Pro, Verimark and Sinato-low rate (21 oz) treatments were more infested with whiteflies and collapsed to vine decline before yield estimates could be made. Finally, based on the three replications of both the drip and shank studies, it is concluded that Verimark simply does not provide adequate whitefly activity in melons and can't be considered as a viable soil systemic application alternative.

Spring Trial

Table 7. Whitefly adult abundance following shank at-plant application on spring melons, 2015

		Whitefly Adults / Sample					
Soil		*14 DAA*	*21 DAA*	*28 DAA*	*35 DAA*	*42 DAA*	*50 DAA*
Treatment	**Rate**	**8 May**	**15 May**	**22 May**	**29 May**	**6 Jun**	**14 Jun**
EXP2415	100 g ai/ha	0.1a	0.2c	-	3.3c	1.1c	4.3c
Admire Pro	10.7 oz/ac	0.2a	0.6b	-	7.3ab	6.3ab	14.0a
Verimark	13.5 oz/ac	0.1a	1.2a	-	10.7a	4.1ab	11.8ab
Venom	6 oz/ac	0.0a	0.0c	-	4.3c	2.5b	5.8bc
Sivanto	21 oz/ac	0.2a	0.1c	-	7.0ab	6.9a	7.6ab
Sivanto	28 oz/ac	0.0a	0.2c	-	6.3bc	5.4ab	7.0ab
UTC	-	0.1a	1.7a	-	11.0a	2.8b	18.1a

Table 8. Whitefly nymph densities following shank at-plant application on spring melons, 2015

		Whitefly Nymphs /cm^2					
Soil		*14 DAA*	*21 DAA*	*28 DAA*	*35 DAA*	*42 DAA*	*50 DAA*
Treatment	**Rate/ac**	**8 May**	**15 May**	**22 May**	**29 May**	**6 Jun**	**14 Jun**
EXP2415	100 g ai/ha	0.0	0.2a	0.0c	1.7c	2.8d	1.7c
Admire Pro	10.7 oz/ac	0.0	0.3a	0.1c	2.8bc	17.3c	9.0b
Verimark	13.5 oz/ac	0.0	0.0a	0.6b	4.4ab	31.4b	12.6a
Venom	6 oz/ac	0.0	0.0a	0.1c	1.5c	5.1d	2.0c
Sivanto	21 oz/ac	0.0	0.0a	0.1c	2.2c	8.1d	4.4c
Sivanto	28 oz/ac	0.0	0.3a	0.1c	1.9c	5.9d	2.7c
UTC	-	0.0	0.0a	1.2a	5.9a	37.9a	15.7a

Means followed by the same letter are not significantly different (P>0.05).

Table 9. Incidence of CYSDV at various interval in fall melons treated with soil insecticides via shank at-plant application, spring 2015

		CYSDV Incidence (Total symptomatic leaves/50 ft.)	
Soil Treatment	**Rate/ac**	**19 Jun**	**2 Jul**
EXP2415	100 g ai/ha	16.3bc	44.5cd
Admire Pro	10.7 oz/ac	41.3a	93.0a
Verimark	13.5 oz/ac	22.5ab	77.8ab
Venom	6 oz/ac	16.5abc	38.0cd
Sivanto	21 oz/ac	20.8ab	53.8bc
Sivanto	28 oz/ac	8.0c	31.3d
UTC	-	21.5ab	83.8ab

Means followed by the same letter are not significantly different (P>0.05).

Fall Trial

Table 10. Whitefly adult abundance following shank, at-plant applications on fall melons, 2015

		Whitefly Adults / Sample					
Soil		*14 DAA*	*21 DAA*	*28 DAA*	*35 DAA*	*42 DAA*	*50 DAA*
Treatment	**Rate**	**27 Aug**	**4 Sep**	**11 Sep**	**18 Sep**	**25 Sep**	**3 Oct**
EXP2415	100 g ai/ha	5.5c	15.2a	1.9cd	18.7a	4.1c	7.2a
Admire Pro	10.7 oz/ac	5.9c	12.8a	2.8bcd	17.7a	5.4bc	4.4a
Verimark	13.5 oz/ac	18.4a	11.0a	8.4a	36.0a	12.6ab	8.9a
Venom	6 oz/ac	4.4c	7.4a	1.4d	19.1a	5.3c	4.5a
Sivanto	21 oz/ac	6.7bc	11.5a	5.1ab	17.4a	9.6bc	7.2a
Sivanto	28 oz/ac	9.3bc	13.2a	4.1abc	18.0a	6.6bc	5.9a
UTC	-	13.0ab	15.8a	8.2ab	19.4a	24.5a	6.6a

Means followed by the same letter are not significantly different (P>0.05).

Table 11. Whitefly nymph densities following shank, at-plant applications on fall melons, 2015

		Whitefly Nymphs /cm^2					
Soil		*14 DAA*	*21 DAA*	*28 DAA*	*35 DAA*	*42 DAA*	*50 DAA*
Treatment	**Rate/ac**	**27 Aug**	**4 Sep**	**11 Sep**	**18 Sep**	**25 Sep**	**3 Oct**
EXP2415	100 g ai/ha	0.0	0.9b	0.9d	1.0cd	1.7c	4.8cd
Admire Pro	10.7 oz/ac	0.0	1.7b	2.1cd	1.7c	1.7c	3.3cd
Verimark	13.5 oz/ac	0.0	5.9a	4.5ab	3.1b	3.9b	12.6a
Venom	6 oz/ac	0.0	0.6b	1.4cd	0.4d	2.1c	3.0d
Sivanto	21 oz/ac	0.0	2.1b	2.9bc	1.6c	3.8b	8.2abc
Sivanto	28 oz/ac	0.0	1.6b	1.9cd	1.2cd	2.3c	7.1bcd
UTC	-	0.0	6.7a	5.8a	6.2a	5.9a	11.7ab

Means followed by the same letter are not significantly different (P>0.05).

Table 12. Incidence of CYSDV at various interval in fall melons treated with soil insecticides via shank at-plant application, spring 2015

		CYSDV Incidence (Total symptomatic leaves/50 ft.)	
Soil Treatment	**Rate/ac**	**18 Sep**	**2 Oct**
EXP2415	100 g ai/ha	3.5d	45.0b
Admire Pro	10.7 oz/ac	55.5a	146.5a
Verimark	13.5 oz/ac	41.5ab	115.3a
Venom	6 oz/ac	10.8c	46.8b
Sivanto	21 oz/ac	9.8cd	65.5b
Sivanto	28 oz/ac	17.3bc	49.0b
UTC	-	24.0abc	132.0a

Means followed by the same letter are not significantly different (P>0.05).

II. FOLIAR INSECTICIDE ALTERNATIVES

A. Conventional Foliar Insecticides - Spring

Research procedures: Cantaloupe plots planted with 'Navigator' were established at the Yuma Agricultural Center on 24 Apr 2015 and managed similarly to local growing practices. Plots consisted of one 84-inch bed, 45 ft long with a 7 buffer between each plot. The study was designed as a randomized complete block design with 4 replicates / treatment. The treatments are shown in the tables below. Three foliar spray applications treatments were made on 26 May, 8 Jun and 16 Jun. The foliar spray treatments were applied with a CO_2 sprayer that delivered 26.0 GPA at 50 psi, using 2 – TX18 ConeJet nozzles per bed. All foliar treatments included an adjuvant Dyne-Amic at 0.25% v/v. Assessments of whiteflies and CYSDV were conducted similar to soil insecticide trials above.

Research Summary: The objective of this trial was to compare standard insecticides as foliar sprays for control of whitefly adults and relative suppression of CYSDV symptoms. Whitefly abundance and CYSDV incidence was very high in the spring. Most of the products provided excellent knockdown of adults and residual control up to 7 days. Among the alternatives, Venom, Venom+Brigade, Exirel (both rates) and pyrifluquinazone provided the most consistent control of adults as well as immatures (Tables 13 and 14). Exirel was a little slow in knocking down adults (1 DAA) compared to the others products, but quickly provided good control at 3 and 7 DAA. As previous trials have shown, Sequoia provided some knockdown activity it did not appear to provide as consistent control. Assail was also inconsistent in this trial at the 5.3 oz rate. In terms of CYSDV incidence, we observed a significant reduction in the number of symptomatic leaves, where all treatments suppressed CYSDV relative to the non-treated check (Table 15). However, the Venom treatments and pyrifluquinazone provided the most significant suppression of CYSDV. The fact that the Venom (3 zo) + Brigade treatment provided statistically comparable activity to the Venom (4 oz) treatment is important because growers are only 6 oz total are allowed during the crop season. Thus, two 3 oz application can be applied as opposed to a single 4 oz spray. The results of this trial are consistent with previous trials that support the recommendation of all of these foliar alternatives for controlling whitefly adults in an effort to reduce CYSDV incidence.

Table 13. Knockdown and residual activity of conventional insecticides against whitefly adults, Spring 2015

Spray # 1 ***(26 May)***

Treatment	Rate/ac	Avg. Whitefly Adults / Sample 1 DAA1 **27 May**	3 DAA1 **29 May**	7 DAA1 **2 Jun**	10 DAA1 **5 Jun**
Assail 30WG	5.3 oz	6.8bc	4.8ab	3.9ab	6.2abc
Exirel	20 oz	12.3ab	3.2bc	2.9abc	4.3cd
Exirel	16 oz	10.0ab	2.3bc	2.1bc	3.8d
Pyrifluquinazone	3.2 oz	2.3d	0.9de	1.2d	4.1d
Venom	4 oz	0.7e	0.6e	1.4cd	4.1d
Venom+Brigade	3 + 6 oz	1.4de	1.5cd	2.1bc	5.3bcd
Sequoia	4.5 oz	4.5c	2.9bc	3.4ab	6.4ab
Untreated	-	21.3a	10.7a	4.9a	7.4a

Spray # 2 ***(8 Jun)***

Treatment	Rate/ac	Avg. Whitefly Adults / Sample 1 DAA2 **9 Jun**	3 DAA2 **11 Jun**	7 DAA2 **15 Jun**
Assail 30WG	5.3 oz	1.7b	3.0bc	54.9ab
Exirel	20 oz	1.6b	1.7cde	7.0de
Exirel	16 oz	1.8b	1.1de	5.5e
Pyrifluquinazone	3.2 oz	0.3c	1.1de	9.5d
Venom	4 oz	0.5c	0.9e	24.0c
Venom+Brigade	3 + 6 oz	0.7c	2.3cd	46.1b
Sequoia	4.5 oz	2.2b	5.8b	35.7bc
Untreated	-	7.1a	28.6a	84.6a

Spray # 3 ***(16 Jun)***

Treatment	Rate/ac	Avg. Whitefly Adults / Sample 1 DAA3 **17 Jun**	3 DAA3 **19 Jun**	7 DAA3 **23-Jun**	14 DAA3 **30 Jun**
Assail 30WG	5.3 oz	26.3b	15.5bc	31.1bc	31.3bc
Exirel	20 oz	6.0e	7.5d	16.8cd	21.9c
Exirel	16 oz	6.4de	6.4d	24.7bcd	27.7bc
Pyrifluquinazone	3.2 oz	8.9de	6.1d	8.2e	8.5d
Venom	4 oz	9.8cd	8.9cd	13.0de	23.3c
Venom+Brigade	3 + 6 oz	14.3c	8.8cd	14.9cd	46.3ab
Sequoia	4.5 oz	38.2b	18.6b	44.1b	35.0bc
Untreated	-	178.7a	122.0a	161.2a	77.9a

Means followed by the same letter are not significantly different (P>0.05).

Table 14. Whitefly immature densities at 14 DAA-3, spring 2015

		Whitefly Immatures / cm²				
Treatment	Rate/ac	Egg	Small nymph	Large nymph	Total nymphs	Eclosed pupae
Assail 30WG	5.3 oz	15.5	10.3b	2.6bc	12.9c	0.2b
Exirel	20 oz	11.1ab	3.1c	0.4e	3.5e	0.0c
Exirel	16 oz	10.7b	4.0c	0.3e	4.3e	0.0c
Pyrifluquinazone	3.2 oz	5.2b	1.9c	0.4e	2.3e	0.0c
Venom	4 oz	16.2a	4.0c	0.9de	4.9d	0.0c
Venom+Brigade	3 + 6 oz	10.9ab	4.7c	2.1cd	6.8d	0.1bb
Sequoia	4.5 oz	22.9a	15.2b	4.7b	19.9b	0.4b
Untreated	-	17.1a	30.5a	16.6a	47.1a	3.4a

Means followed by the same letter are not significantly different (P>0.05).

Table 15. Incidence of CYSDV following insecticide treatments on spring melons, 2015

			CYSDV Incidence (symptomatic leaves / 35 ft)	
Treatment	Rate/ac	Avg. Adults	23 Jun	1 July
Assail 30WG	5.3 oz	15.0b	35.5ab	40.3bcd
Exirel	20 oz	7.1c	46.5a	49.8bc
Exirel	16 oz	7.5c	39.8a	51.5b
Pyrifluquinazone	3.2 oz	4.3e	21.5bc	27.3ef
Venom	4 oz	6.8d	13.3c	27.0f
Venom+Brigade	3 + 6 oz	11.6c	22.8abc	31.5def
Sequoia	4.5 oz	15.9b	26.8abc	37.0cde
Untreated	-	55.1a	47.3a	78.8a

Means followed by the same letter are not significantly different (P>0.05).

B. Conventional Foliar Insecticides - Fall

Research procedures: Cantaloupe plots planted with 'Alaniz Gold were established at the Yuma Agricultural Center on 14 Aug, 2015 and managed similarly to local growing practices. Plots consisted of one 84-inch bed, 45 ft long with a 7 buffer between each plot. The study was designed as a randomized complete block design with 4 replicates / treatment. The treatments are shown in the tables below. Three foliar spray applications treatments were made on 30 Aug, 11 Sep and 23 Sep. The foliar spray treatments were applied with a CO_2 sprayer that delivered 23.6 GPA at 50 psi, using 2 – TX18 ConeJet nozzles per bed. All foliar treatments included an adjuvant Dyne-Amic at 0.25% v/v except one of the Exirel treatments where a new adjuvant (NanoTech) was compared. Assessments of whiteflies and CYSDV were conducted similar to soil insecticide trials above.

Research Results: The objective of this trial was to further evaluate the efficacy of foliar compounds against the industry standard (Scorpion) under fall conditions. Scorpion, Sivanto and pyrfluquinazon provided the best overall control of adults, immatures and suppression of CYSDV symptoms following foliar sprays (Table 16, 17 and 18). Exirel (Cyazypyr) provided control of whiteflies comparable to the Venom treatment, but did not provide significant suppression of CYSDV, which was unusual compared to previous years. There were no significant differences in the Exirel +adjuvant treatments. We had assumed that the NaonTech would provide better leaf penetration of

Exirel sprays, and thus better knockdown, but this was not the case. Again, the Sequoia and Assail treatments were not as consistently effective against the adults and CYSDV suppression compared to the standard. The results of this trial are encouraging, but may not have immediate impact for growers. First, Sivanto is not labeled for foliar uses on cantaloupes or honeydews (soil only) due to concerns with crop injury. Second, pyrifluquinazone is not currently labels on melons in the US, but is anticipated in 12-18 months. Thus, the use of either of these products on melons as foliar sprays is still a few years away.

Table 16. Whitefly nymph densities at intervals following each application, Fall 2015

Spray # 1 ***(30 Aug)***

		Avg. Whitefly Adults / Sample		
		1 DAA1	3 DAA1	7 DAA1
Treatment	**Rate/ac**	**31 Aug**	**2 Sep**	**6 Sep**
Assail 30WG	5.3 oz	1.7b	1.3c	4.3bc
Pyrifluquinazone	3.2 oz	0.9b	3.3b	5.2bc
Sequoia	4.5 oz	2.6b	3.9ab	3.3c
Exirel+ DyneAmic	20 oz	2.8b	4.9ab	5.8b
Exirel+ NanoTech	20 oz	1.3b	3.6ab	4.6bc
Scorpion	7 oz	1.1b	4.1ab	3.4c
Sivanto	10.5 oz	1.1b	2.7b	3.9bc
Untreated	-	14.1a	6.4a	21.4a

Spray # 2 ***(11 Sep)***

		Avg. Whitefly Adults / Sample		
		1 DAA2	3 DAA2	7 DAA2
Treatment	**Rate/ac**	**12 Sep**	**14 Sep**	**18 Sep**
Assail 30WG	5.3 oz	8.0b	4.4b	25.4ab
Pyrifluquinazone	3.2 oz	2.5c	1.6b	10.1b
Sequoia	4.5 oz	4.9c	6.7b	19.0b
Exirel+ DyneAmic	20 oz	8.8b	2.6b	14.5b
Exirel+ NanoTech	20 oz	4.8c	1.5b	11.0b
Scorpion	7 oz	2.9c	2.3b	7.8b
Sivanto	10.5 oz	2.2c	1.9b	9.0b
Untreated	-	12.9a	15.9a	36.7a

Spray # 3 ***(23 Sep)***

		Avg. Whitefly Adults / Sample		
		1 DAA3	3 DAA3	7 DAA3
Treatment	**Rate/ac**	**Sep 24**	**Sep 26**	**Sep 30**
Assail 30WG	5.3 oz	4.0b	5.8b	5.8b
Pyrifluquinazone	3.2 oz	1.2c	1.3c	1.4c
Sequoia	4.5 oz	2.4bc	5.2b	4.0bc
Exirel+ DyneAmic	20 oz	3.6b	2.4bc	1.7c
Exirel+ NanoTech	20 oz	3.5b	3.0bbc	2.6bc
Scorpion	7 oz	1.9bc	1.2c	2.7bc
Sivanto	10.5 oz	2.4bc	2.8bc	2.5c
Untreated	-	48.6a	21.3a	28.2a

Means followed by the same letter are not significantly different (P>0.05).

Table 17. Whitefly nymph densities at intervals following each application, Fall 2015

		Whitefly Immatures / cm²				
Treatment	**Rate/ac**	**Egg**	**Small nymph**	**Large nymph**	**Total nymphs**	**Eclosed pupae**
Assail 30WG	5.3 oz	7.0a	1.4bc	0.5bc	1.9bc	0.0b
Pyrifluquinazone	3.2 oz	3.9ab	0.5c	0.1cd	0.6c	0.0b
Sequoia	4.5 oz	7.7a	5.5ab	1.1b	6.6b	0.1b
Exirel+ DyneAmic	20 oz	2.4abc	1.2bc	0.2cd	1.4bc	0.0b
Exirel+ NanoTech	20 oz	1.6c	0.9bc	0.0d	0.9c	0.1b
Scorpion	7 oz	2.2bc	0.3c	0.1cd	0.4c	0.0b
Sivanto	10.5 oz	2.4abc	1.0bc	0.1cd	1.1c	0.0b
Untreated	-	3.6ab	9.4a	4.9a	14.3a	2.7a

Means followed by the same letter are not significantly different (P>0.05).

Table 18. Incidence of CYSDV following insecticide treatments on fall melons, 2015

			CYSDV Incidence	
Treatment	**Rate/ac**	**Avg. Adults**	**Sep 24** (total symptomatic leaves)	**Oct 12** (% of leaves infected)
Assail 30WG	5.3 oz	6.9b	9.8b	47.5b
Pyrifluquinazone	3.2 oz	3.1c	4.8bc	35.0c
Sequoia	4.5 oz	5.7bc	14.8ab	52.5b
Exirel+ DyneAmic	20 oz	5.3bc	10.5b	68.8a
Exirel+ NanoTech	20 oz	4.0bc	11.0b	70.0a
Scorpion	7 oz	3.5bc	5.0bc	28.8c
Sivanto	10.5 oz	3.5bc	3.3c	30.0c
Untreated	-	21.2a	25.5a	-*

Means followed by the same letter are not significantly different (P>0.05).
*all plots in the untreated check completely collapsed to vine decline prior to this evaluation, but were heavily infected with CYSDV (> 90%) on 5 Oct.

C. New Experimental Foliar Compound – Spring and Fall

Research procedures: Cantaloupe plots planted with ‘Navigator’ were established on 17 Apr, 2015 and plots planted with ‘Alaniz Gold’ were established on 14 Aug, 2015 at the Yuma Agricultural Center. Plots were managed similarly to local growing practices. Plots consisted of one 84-inch bed, 45 ft long with a 7 buffer between each plot. The study was designed as a randomized complete block design with 4 replicates / treatment. The treatments are shown in the tables below. In each trial, two foliar spray applications were made (25 May and 11 Jun in the spring trial; 4 and 23 Sep in the fall trial). The foliar spray treatments were applied with a CO_2 sprayer that delivered 23.6 GPA at 50 psi, using 2 – TX18 ConeJet nozzles per bed. All foliar treatments included an adjuvant Dyne-Amic at 0.25% v/v. Assessments of whiteflies were conducted similar to soil insecticide trials above. CYSDV was not evaluated in these trials.

Research Summary: The objective of this trial was to compare the new experimental compound EXP_2415 as a foliar spray against whitefly adults and CYSDV relative to current standards. Whitefly pressure was comparable in both trials, and EXP_2415 provided as good as or better knockdown and residual control of whitefly adults as the standards (Venom, Assail, Exirel). Similarly, the experimental compound provided as good as or better control of whitefly nymphs. We stretched the spray intervals to 14-19 days to examine residual control of both adults and nymphs, thus reliable estimates of CYSDV were not possible. However, given the consistent knockdown/residual ault control observed, it is speculated that EXP_2415 should suppress virus transmission when applied aggressively. In addition, EXP_2415 provided significant CYSDV suppression in the soil systemic trials. Future studies with this new exciting compound will be designed to examine CYSDV suppression.

Spring Trial

Table 19. Knockdown and residual activity of insecticides against whitefly adults, Spring 2015

Spray # 1 *(25 May)*

		Avg. Whitefly Adults / Sample			
		1 DAA1	3 DAA1	7 DAA1	14 DAA1
Treatment	**Rate/ac**	**26 May**	**28 May**	**1 Jun**	**8 Jun**
EXP_2415	-	4.1c	0.9c	1.3c	2.3a
Assail 30SG	4 oz	5.4c	2.8b	3.5b	5.1a
Exirel	16 oz	10.2b	2.2bc	2.1bc	3.7a
Venom	3 oz	3.4c	1.3bc	1.7bc	3.6a
Untreated	-	22.3a	10.9a	7.9a	4.7a

Spray # 2 *(11 Jun)*

		Avg. Whitefly Adults / Sample			
		1 DAA2	3 DAA2	7 DAA2	14 DAA2
Treatment	**Rate/ac**	**12 Jun**	**14 Jun**	**18 Jun**	**25 Jun**
EXP_2415	-	1.2c	3.7d	9.2d	16.6d
Assail 30SG	4 oz	2.4b	10.0b	41.3b	76.5ab
Exirel	16 oz	1.8bc	5.2cd	19.0c	42.7c
Venom	3 oz	1.5bc	6.5bc	27.1bc	45.9bc
Untreated	-	7.4a	41.9	109.4a	107.3a

Means followed by the same letter are not significantly different (P>0.05).

Table 20. Whitefly nymph densities at intervals following each application, spring 2015

		Whitefly Large Nymphs / cm^2				
Treatment	**Rate/ac**	**7 DAA-1**	**14 DAA-1**	**7 DAA-2**	**14-DAA-2**	**21 DAA-2**
EXP_2415	-	0.3b	0.5c	0.1b	0.1b	1.6c
Assail 30SG	4 oz	0.9b	3.7ab	0.1b	0.2b	6.2b
Exirel	16 oz	0.1b	1.1b	0.0b	0.1b	3.2c
Venom	3 oz	0.5b	5.2ab	0.1b	0.2b	4.3b
Untreated	-	3.2a	9.2a	1.3a	3.2a	12.1a

Means followed by the same letter are not significantly different (P>0.05).

Fall Trial

Table 21. Knockdown and residual activity of insecticides against whitefly adults, fall 2015

Spray # 1 (4 Sep)

		Avg. Whitefly Adults / Sample			
		1 DAA1	3 DAA1	7 DAA1	14 DAA1
Treatment	**Rate/ac**	**5 Sep**	**7 Sep**	**11 Sep**	**18 Sep**
EXP_2415	-	-	3.3c	2.5c	12.7b
Assail 30SG	4 oz	-	6.8b	4.8b	18.8b
Exirel	16 oz	-	7.9b	2.0c	20.4b
Venom	3 oz	-	2.2c	3.3bc	16.6b
Untreated	-	-	32.2a	9.7a	46.6a

Spray # 2 (23 Sep)

		Avg. Whitefly Adults / Sample			
		1 DAA2	3 DAA2	7 DAA2	14 DAA2
Treatment	**Rate/ac**	**24 Sep**	**26 Sep**	**30 Sep**	**7 Oct**
EXP_2415	-	3.8c	1.7b	3.0c	1.8c
Assail 30SG	4 oz	4.4bc	2.7b	10.0b	4.7b
Exirel	16 oz	5.7b	2.0b	5.0bc	3.9bc
Venom	3 oz	3.0bc	1.4b	4.7bc	3.9bc
Untreated	-	87.5a	29.8a	33.8a	40.1a

Means followed by the same letter are not significantly different (P>0.05).

Table 22. Whitefly nymph densities at intervals following each application, spring 2015

		Whitefly Large Nymphs / cm^2				
Treatment	**Rate/ac**	**7 DAA-1**	**14 DAA-1**	**7 DAA-2**	**14-DAA-2**	**Avg.**
EXP_2415	-	0.0	0.0b	0.4a	0.2b	0.1b
Assail 30SG	4 oz	0.0	0.4b	0.4a	0.6b	0.3b
Exirel	16 oz	0.0	0.8b	0.1a	0.2b	0.1b
Venom	3 oz	0.0	0.1b	0.2a	0.4b	0.1b
Untreated	-	0.0	2.7a	3.8a	5.3b	2.4a

Means followed by the same letter are not significantly different (P>0.05).

III. FOLIAR ALTERNATIVES DURING BLOOM FOR POLLINATOR PROTECTION

Research procedures: Cantaloupe plots planted with 'Navigator' were established at the Yuma Agricultural Center on 24 Apr, 2015 and managed similarly to local growing practices. Plots consisted of one 84-inch bed, 45 ft long with a 7 buffer between each plot. The study was designed as a randomized complete block design with 4 replicates / treatment. The treatments are shown in the tables below. A single foliar spray applications was made on 12 Jun shortly after the onset of bloom. The foliar spray was applied with a CO_2 sprayer that delivered 23.6 GPA at 50 psi, using 2 – TX18 ConeJet nozzles per bed. All foliar treatments included an adjuvant Dyne-Amic at 0.25% v/v.

Research Summary: We conducted a preliminary trial in 2015 in response to US EPAs recent proposal to place additional mandatory pesticide label restrictions on a number of key products that would prohibit the application of acutely toxic pesticides during the time crops are in bloom and commercial bees have been placed in or near fields for pollination services. Unfortunately for melon producers, the proposed list of products effected includes all of the pyrethroids, organophosphates, carbamates and neonicotinoid insecticides. Also included are Exirel, Radiant, Success, Sequoia, Abamectin, Proclaim, and Avaunt. Thus, the objective of this preliminary trial was to determine the efficacy of alternative foliar insecticides that have low toxicity against honeybees (not on the EPAs proposed list) for whitefly knockdown control on melons during bloom. Results of the trial are below and are not encouraging. We tested in particular Fulfill and Coragen because they are known to have some activity against whiteflies and are not considered toxic to honey bees. Unfortunately, neither of these compounds were toxic to whitefly adults either, regardless of whether used in combination or at a 2X rate. On a positive note, Sivanto (a bee-safe product) was efficacious in this trial, much like we saw in previous efficacy trials. As noted before, it is not currently registered for use in melons as a foliar spray due to concerns with phyto. However, we did not observe any phyto in this trial. Future research will explore the use of Sivanto during bloom when bees are present in rotation to determine whether the crop injury is acceptable.

		Avg. Whitefly Adults / Sample			
		1 DAA1	3 DAA1	7 DAA1	
Treatment	**Rate/ac**	**13 Jun**	**15 Jun**	**19 Jun**	**Avg.**
Fulfill	2.75 oz	15.3b	49.4a	39.9ab	34.8ab
Fulfill	5.5 oz	13.9b	35.6ab	38.2ab	29.2bc
Coragen	7.5 oz	16.7b	31.5b	36.2ab	28.2bc
Coragen	15 oz	13.0b	32.6ab	29.2b	24.8c
Fulfill+Coragen	2.75+7.5 oz	15.0b	40.5ab	34.9ab	30.2bc
Fulfill+Coragen	5.5+15 oz	17.5b	39.1ab	47.3a	34.6ab
Sivanto	14.0 oz	0.5c	5.8c	9.6c	5.6d
UTC	-	23.7a	45.7ab	51.1a	40.2a

Means followed by the same letter are not significantly different (P>0.05).

IV. EVALUATION OF ALTERNATIVE INSECTICIDES FOR DIAZINON AND BIFENTHRIN

Seed Corn Maggot Efficacy with In-furrow treatments

Research Procedures: The purpose of this study was to evaluate the efficacy of several experimental insecticides applied as in-furrow sprays against seed corn maggots (SCM) in spring melons. This experiment was conducted at UA's Yuma Agricultural Center, in the spring of 2015. One week before planting, a 0.5 acre block of broccoli was incorporated into the soil so that the decaying plant matter would attract SCM females to infest the test site. The field was planted with melon seed 'Olympic Gold' at a precise density on 12 Mar, 2015. Seeds were hand planted at a spacing of 6 in. for a total 50 seeds per row. Plots consisted of one row 25-ft long and rows were spaced 84 inches apart (n=200 seeds / treatment). An attempt was made to ensure that depth of seeds was consistent at 0.75 inches. All insecticides were applied as in-furrow sprays at planting using a single-row-boom equipped with 1 flat fan nozzle (8004VS) and calibrated to deliver 9 gpa at 40 psi. The sprays were applied in the furrow over the seed in a 0.5-1" band after seed placement. Seeds were immediately covered with soil following insecticide application. A combination of bone and blood meal was placed in a narrow band over the row to further attract SCM females at a rate of 400 g per 25-ft row. The experimental design included the in-furrow spray treatments plus a non-treated control arranged in a randomized complete block design replicated 4 times.

Stand counts were taken in the entire length of each plot on 21, 25, and 29 Mar to assess plant emergence. Only emerged seedling plants were counted. At 17 DAP (29 Mar) the number of plants in each plot that had 2-fully expanded true leaves were recorded. Additionally, seeds were dug up along with the soil surrounding them in 5 areas within each row to inspect for SCM damaged seeds, non-germinated seeds, and SCM larvae and pupae. Analysis of variance ANOVA was performed where treatments were modeled as fixed effects and replicates were modeled as a random effect. The response variables (percent emerged plants, damaged seeds and percent of plants at the 2 leaf stage) were subjected to arcsine square-root transformation before analysis. Actual untransformed data are presented in the figures. Treatment means were separated using the LSMEANS test ($P < 0.05$)

Research Results: Conditions were ideal for maggot pressure and the beds were irrigated twice prior to emergence. SCM pressure was very heavy in the trial; the most we've seen in years. In the untreated check, less than 15% of the seeds emerged. We estimated that 95% of the non-emerged seed had been damaged by SCM. EXP_2450 (High rate), Endigo, Capture LFR (standard) and Verimark had significantly greater stand counts (~80%) than the untreated check and provided the most consistent control of SCM in this trial. These treatments also had the lowest percentage of damaged seed from SCM. Seedling emergence in the reaming treatments were lower and more variable. Stand counts in the Sivanto treatment did not differ from the untreated check. Counts of plants with 2 fully expanded true leaves at 17 DAP showed that plant growth among all treatments was greatest for EXP_2450, Endigo and Capture LFR and Verimark plots. Plants in the treatments that had low percentages of 2-lf plants also had high levels of damaged seeds suggesting that maggots may have been feeding on roots and within stems of these plants as well. Based on these and previous studies, in-furrow sprays of pyrethroids currently offer the most cost-effective protection for melons from SCM. EXP2450 is still under development and it is uncertain when it will be available for commercial use.

Treatment	Rate/ac	Stand counts (% seedling emergence) 21-Mar	25-Mar	29-Mar	% SCM [1] damaged seeds *(29 Mar)*	% Plants at 2-lf stage *(29 Mar)*
EXP_2450	Hi rate	81.6a	83.7a	83.8a	58bc	82a
Endigo	4.5 oz	72.0a	80.1a	80.1a	83abc	76ab
Capture LFR	8.5 oz	71.9ab	79.0a	80.1a	50c	71abc
Verimark	13.5 oz	71.4ab	78.1a	78.6a	42c	70abc
Belay	12 oz	64.3abc	68.4ab	68.4ab	67abc	62bc
EXP_2450	Low rate	63.3abc	68.9ab	66.8abc	50c	63bc
Entrust	7 oz	60.0abc	62.8abc	67.4abc	60c	60c
Pyganic 5.0	17 oz	46.9bcd	50.0bc	47.9bcd	100a	41d
Vydate	2 pts.	41.3cde	42.3bcd	39.3de	100a	37de
Torac	21 oz	33.1def	39.8cd	40.3cde	93a	34de
Sivanto	14 oz	24.5ef	25.5de	24.0ef	100a	23ef
Untreated	-	12.8f	14.3e	13.8f	95a	14f

Means followed by the same letter are not significantly different (P>0.05).

[1] Five, non-emerged seeds from each replicate were examined. Seeds were considered damaged if larvae or pupae were found in or near the seed coat, or the seed embryo has been fed on. Seed was considered non-damaged if the seed embryo had not been fed on had not germinated, or had germinated but did not emerge.