CALIFORNIA MELON RESEARCH BOARD

2014 Final Report

January 1, 2014 to December 31, 2014

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 cause problems in commercial production of fall cantaloupes in the desert. Whitefly infestations and CYSDV incidence were very heavy this year, and in fact were unusually high on spring melons. The need for foliar and soil alternatives for whitefly control are still great, particularly considering the absence of endosulfan, the heavy dependence on neonicotinoids, and issues surrounding pollinators.

- Experimental work in 2014 focused on determining the reliability of several foliar and soil insecticides for providing rapid control of whitefly adults on cantaloupes. In many trials we were able to show a strong correlation between control provided by key foliar insecticides and significant reductions in CYSDV Incidence. The results of our studies this year allow us to recommend several foliar alternatives, as well as a new soil insecticide alternative, that should allow desert growers to effectively control whiteflies until resistant or tolerant melon varieties become available.

- Spring and fall cantaloupe trials in 2014 clearly showed that a core of foliar insecticides are or will soon be available that will provide suppressive activity against whiteflies and CYSDV. These include the neonicotinoids Venom/ Scorpion and Assail which have been standards for the past few years. Exirel (cyazypyr) was registered this fall and showed good activity comparable to the standards. Sequoia (sulfoxaflor) was registered in 2014 and though not quite as good as the standard, does provide good knockdown activity. The most promising foliar compound is pyrifluquinazon which is likely 12-18 months from a registration. By far this is the most consistently efficacious product for suppressing CYSDV. Given the industries reliance on neonicotinoids, these products will be quite useful for resistance management.

- Soil insecticides were extensively evaluated this year. Sivanto (*flupyradifurone)* is expected to be available for use in desert melons in early 2015. Our studies showed that Sivanto, applied as an at-planting treatment delayed CYSDV incidence comparable to the Venom standard. Furthermore, when incorporated within a foliar spray program with products discussed above, Sivanto provided whitefly control, CYSDV suppression and yields comparable to the standard Venom. Unfortunately, in our trials this year Verimark (soil formulation of Cyazypyr) did not perform similarly to either Venom or Sivanto.

RESEARCH PROCEDURES AND RESULTS

I. Foliar Insecticide Alternatives

A. Spring Melons – Neonicotinoid Alternatives for Whitefly Adults / CYSDV

Research procedures: Cantaloupe plots planted with 'Sol Dorado' were established at the Yuma Agricultural Center on 20 Mar, 2014 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 Apr 29 and May 14 and 26. The foliar spray treatments were applied with a CO_2 sprayer that delivered 22.5 GPA at 50 psi, using 2 – TX18 ConeJet nozzles per bed. All foliar treatments included an adjuvant Dyne-Amic at 0.25% v/v.

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 the terminal area of the plants for 3 seconds. Containers with adults were taken into the laboratory, placed in a freezer for 24 hours after which the number of adults/ plant was recorded. Immature densities were estimated once on June 9 by sampling 10 plants / plot, where 3 leaves per plant were collected from the 5^{th}, 10^{th} and 15^{th} nodes nearest 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 on June 9 by recording the number of leaves that expressed symptoms of the virus and yellow interveinal chlorosis consistent with CYSDV infection in 35 ft within each plot. All data were subjected to ANOVA and treatment means were separated using the LSMEANS test ($P < 0.05$). Because of heterogeneity of mean variances, data for whiteflies were log transform (mean+1) prior to ANOVA. Actual non-transformed are shown in the tables and graphs.

Research Summary: The objective of this trial was to compare neonicotinoid alternatives as foliar sprays against whitefly adults and relative suppression of CYSDV symptoms. Whitefly abundance and CYSDV incidence was very high in 2014; the highest observed to date. Most of the products provided excellent knockdown of adults and residual up to 7 days. Among the neonicotinoids, Venom/Scorpion and Assail provided the most consistent control of adults as well as immatures. Although Sequoia provided some knockdown activity it did not appear to provide as consistent control. Endigo was the weakest of all the products treated where it often did not provided significant control. In terms of CYSDV incidence, we observed a significant reduction in the number of symptomatic leaves among the neonicotinoid treatments, where only the Endigo was not different from the non-treated check. Furthermore, we observed a positive association with a products ability to reduce adult numbers and CYSDV incidence. The results of this trial are consistent with previous trials that support the recommendation of Venom/Scorpion, Assail and Sequoia as foliar alternatives for controlling whitefly adults in an effort to reduce CYSDV incidence.

Table 1. Knockdown and residual activity of insecticides against whitefly adults, Spring 2014

Spray # 1 *(Apr 29)*		**Avg. Whitefly Adults / Sample**			
		1 DAA1	3 DAA1	7 DAA1	10 DAA1
Treatment	**Rate/ac**	**30-Apr**	**2-May**	**6-May**	**9-May**
Venom	4.0 oz	0.2abc	0.3a	2.0a	3.5a
Scorpion	7.0 oz	0.0c	0.4a	1.7a	3.1a
Assail	4.0 oz	0.3abc	0.4a	1.9a	3.3a
Assail	5.3 oz	0.0c	0.5a	2.6a	4.0a
Endigo	4.5 oz	0.1bc	0.9a	3.3a	4.7a
Sequoia	4.5 oz	0.4ab	1.3a	3.0a	3.2a
Non-treated	-	0.7a	1.0a	2.5a	5.3a

Spray # 2 *(May 14)*		**Avg. Whitefly Adults / Sample**			
		1 DAA2	3 DAA2	7 DAA2	10 DAA2
Treatment	**Rate/ac**	**15-May**	**17-May**	**21-May**	**24-May**
Venom	4.0 oz	0.6e	0.5cd	0.7c	1.8e
Scorpion	7.0 oz	1.0de	0.4d	1.0c	2.0de
Assail	4.0 oz	1.6cd	1.4bc	2.3b	3.2cd
Assail	5.3 oz	1.6cd	0.5cd	1.0c	2.6de
Endigo	4.5 oz	4.8a	5.8a	3.1ab	8.5a
Sequoia	4.5 oz	2.6bc	2.4b	3.8a	4.6bc
Non-treated	-	4.5a	9.7a	4.9a	6.4ab

Spray # 3 *(May 26)*		**Avg. Whitefly Adults / Sample**			
		1 DAA3	3 DAA3	7 DAA3	11 DAA3
Treatment	**Rate/ac**	**27-May**	**29-May**	**2-Jun**	**6-Jun**
Venom	4.0 oz	2.0e	2.1d	9.2c	68.3a
Scorpion	7.0 oz	2.9d	2.3d	12.3bc	63.5a
Assail	4.0 oz	5.3c	8.4b	16.8b	97.5a
Assail	5.3 oz	3.5cd	3.5c	14.7b	59.9a
Endigo	4.5 oz	18.1ab	38.1a	35.3a	57.1a
Sequoia	4.5 oz	11.9b	12.2b	67.2a	58.7a
Non-treated	-	23.6a	57.2a	54.7a	57.0a

Table 2. Whitefly immature densities at 14 Days following the 3rd application, spring 2014

		Whitefly Immatures / cm^2				
Treatment	**Rate/ac**	**Egg**	**Small nymph**	**Large nymph**	**Total nymphs**	**Eclosed pupae**
Venom	4.0 oz	23.05a	1.2bc	0.4de	1.6c	0.0b
Scorpion	7.0 oz	35.2a	0.75c	0.3e	0.9c	0.0b
Assail	4.0 oz	29.1a	2.4b	1.4bc	3.8c	0.0b
Assail	5.3 oz	40.6a	1.3bc	0.6cd	1.9c	0.0b
Endigo	4.5 oz	28.45a	10.4a	1.9b	12.3b	0.1b
Sequoia	4.5 oz	26.5a	7.9a	2.1b	10.1b	0.1b
Non-treated	-	24.05a	14.8a	6.5a	21.4a	1.8a

Table 3. Incidence of CYSDV following insecticide treatments on spring melons, 2014

Treatment	Rate	Seasonal Avg. Whitefly per sample	CYSDV Incidence (symptomatic lvs per 35 ft)
Venom	4.0 oz	7.1d	33.0b
Scorpion	7.0 oz	7.0d	32.0b
Assail	4.0 oz	11.1c	44.5b
Assail	5.3 oz	7.4d	54.3b
Endigo	4.5 oz	14.2ab	83.8 a
Sequoia	4.5 oz	13.3b	49.0b
Non-treated	-	18.4a	87.5 a

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

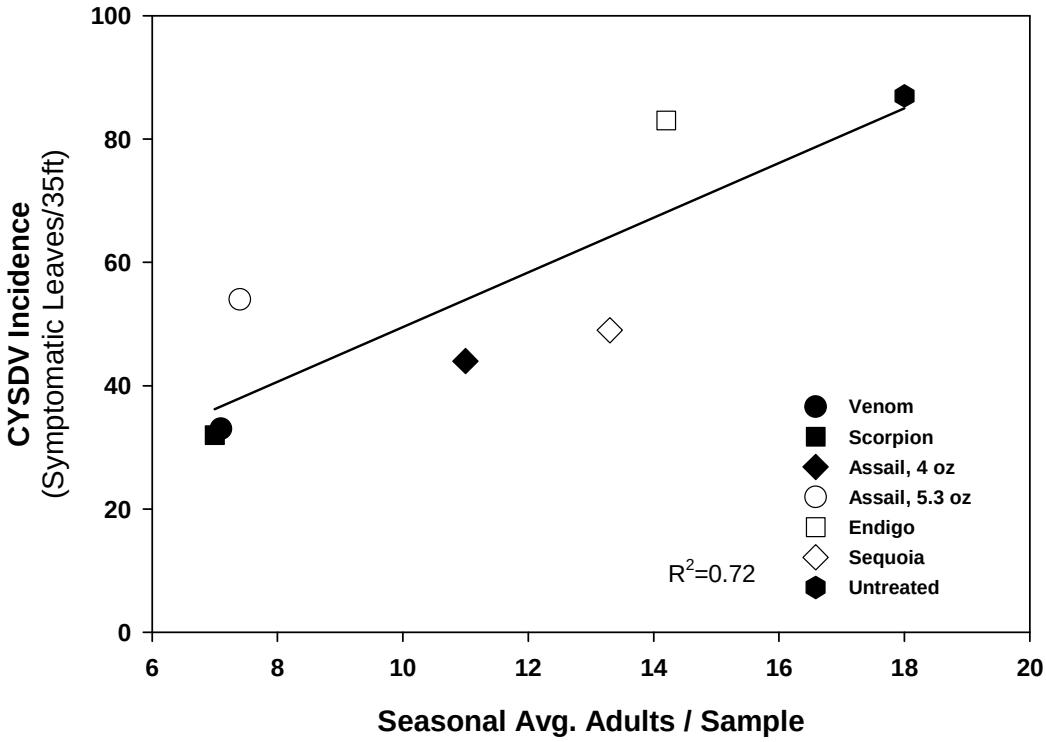

Figure 1. Association between whitefly adult abundance, as determined by insecticide treatments and CYSDV incidence on spring melons 2014.

I. Foliar Insecticide Alternatives

B. Spring Melons – Experimental Alternatives for Whitefly Adults / CYSDV

Research procedures: Cantaloupe plots planted with 'Sol Dorado' were established at the Yuma Agricultural Center on 20 Mar, 2014 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 Apr 28 and May 13 and 27. The foliar spray treatments were applied with a CO_2 sprayer that delivered 22.5 GPA at 50 psi, using 2 – TX18 ConeJet nozzles per bed. All foliar treatments included an adjuvant Dyne-Amic at 0.25% v/v. Whitefly adults, immatures and CYSDV incidence were evaluated at various intervals following each application using the sampling method described in the above study. Data were analyzed using the same procedures as above.

Research Results: Similar to the previous trial, adult pressure and CYSDV were high for a spring trial. The objective of this trial was to evaluate the efficacy of newer compounds against the industry standard foliar insecticides (Venom). Overall, pyrfluquinazon provided the best overall control of adults, immatures and suppression of CYSDV symptoms following foliar sprays. In this trial it performed significantly better than the standard Venom treatment. Exirel (Cyazypyr) provided control of whiteflies and CYSDV comparable to the Venom treatment. The Sequoia was less effective against the adults but provided comparable CYSDV suppression to the standard. Based on the seasonal averages, we observed a strong positive association with these products ability to reduce adult numbers and the suppression of CYSDV symptoms. However, neither Miteus (an experimental miticide) nor the Fulfill+Actigard treatments provided acceptable whitefly control or CYSDV suppression. The results of this trial are encouraging for managing whitefly adults as Exirel was registered this past fall and Pyrifluquinazon is anticipated in 12-18 months.

Table 4. Whitefly immature densities at 14 Days following the 3rd application, spring 2014

		Whitefly Immatures / cm^2				
Treatment	**Rate/ac**	**Egg**	**Small nymph**	**Large nymph**	**Total nymphs**	**Eclosed pupae**
Miteus	2 pts	43.7ab	24.7a	6.9a	31.6a	0.7b
Sequoia	4.5 oz	39.1ab	10.5b	1.0b	11.5b	0.0c
Fulfill+Actigard	2.8+1 oz	24.0b	10.9b	6.8a	17.7ab	0.2bc
Exirel	20 oz	56.7a	4.1c	0.2b	4.3bc	0.0c
Pyrifluquinazon	3.2 oz	9.7c	0.8d	0.4b	1.2d	0.0c
Venom	4 oz	40.7ab	2.9c	0.9b	3.8cd	0.0c
Non-treated	-	46.1a	19.7a	9.5a	29.1a	1.5a

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

Table 5. Knockdown and residual activity of insecticides against whitefly adults, Spring 2014

Spray # 1 ***(Apr 28)***

		Avg. Whitefly Adults / Sample			
		1 DAA1	3 DAA1	7 DAA1	10 DAA1
Treatment	**Rate/ac**	**30-Apr**	**2-May**	**6-May**	**9-May**
Miteus	2 pts	0.5ab	0.3a	2.6a	4.1a
Sequoia	2.8+1 oz	1.1a	0.2a	2.9a	3.5a
Fulfill+Actigard	20 oz	0.9a	0.1a	2.1ab	3.3a
Exirel	3.2 oz	0.1c	0.0a	1.4b	2.4a
Pyrifluquinazon	4 oz	0.1c	0.0a	2.5a	4.2a
Venom	-	0.9a	0.3a	3.5a	4.4a
Non-treated	-	0.5ab	0.3a	2.6a	4.1a

Spray # 2 ***(May 13)***

		Avg. Whitefly Adults / Sample			
		1 DAA2	3 DAA2	7 DAA2	10 DAA2
Treatment	**Rate/ac**	**15-May**	**17-May**	**21-May**	**24-May**
Miteus	2 pts	1.1bc	5.8a	4.7b	8.2a
Sequoia	4.5 oz	0.9bcd	1.7b	3.8b	5.4ab
Fulfill+Actigard	2.8+1 oz	1.9ab	7.4a	8.0a	8.6a
Exirel	20 oz	0.8cd	0.7c	0.9cd	1.6c
Pyrifluquinazon	3.2 oz	0.3e	0.9c	0.5d	1.7c
Venom	4 oz	0.5de	0.6c	1.5c	2.9bc
Non-treated	-	3.8a	7.5	9.9a	10.8a

Spray # 3 ***(May 27)***

		Avg. Whitefly Adults / Sample			
		1 DAA3	3 DAA3	7 DAA3	11 DAA3
Treatment	**Rate/ac**	**27-May**	**29-May**	**2-Jun**	**6-Jun**
Miteus	2 pts	41.9a	53.8a	15.1ab	29.7bc
Sequoia	4.5 oz	6.7b	15.2b	10.6b	26.9abc
Fulfill+Actigard	2.8+1 oz	32.2a	55.2a	14.0b	13.6bc
Exirel	20 oz	4.2b	3.1c	3.2c	52.9a
Pyrifluquinazon	3.2 oz	1.0c	1.2d	1.4d	13.6c
Venom	4 oz	1.6c	1.5d	4.7c	28.4abc
Non-treated	-	53.8a	89.5a	24.3a	34.6ab

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

Table 6. Incidence of CYSDV following insecticide treatments on spring melons, 2014

Treatment	Rate	Seasonal Avg. Whitefly per sample	CYSDV Incidence (symptomatic leaves per 35 ft)
Miteus	2 pts	14.0 b	87.5ab
Sequoia	4.5 oz	6.4c	57.0bc
Fulfill+Actigard	2.8+1 oz	12.4b	68.0bc
Exirel	20 oz	6.1d	52.0c
Pyrifluquinazon	3.2 oz	2.0e	30.0d
Venom	4 oz	4.0d	58.0c
Non-treated	-	20.2e	107.8a

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

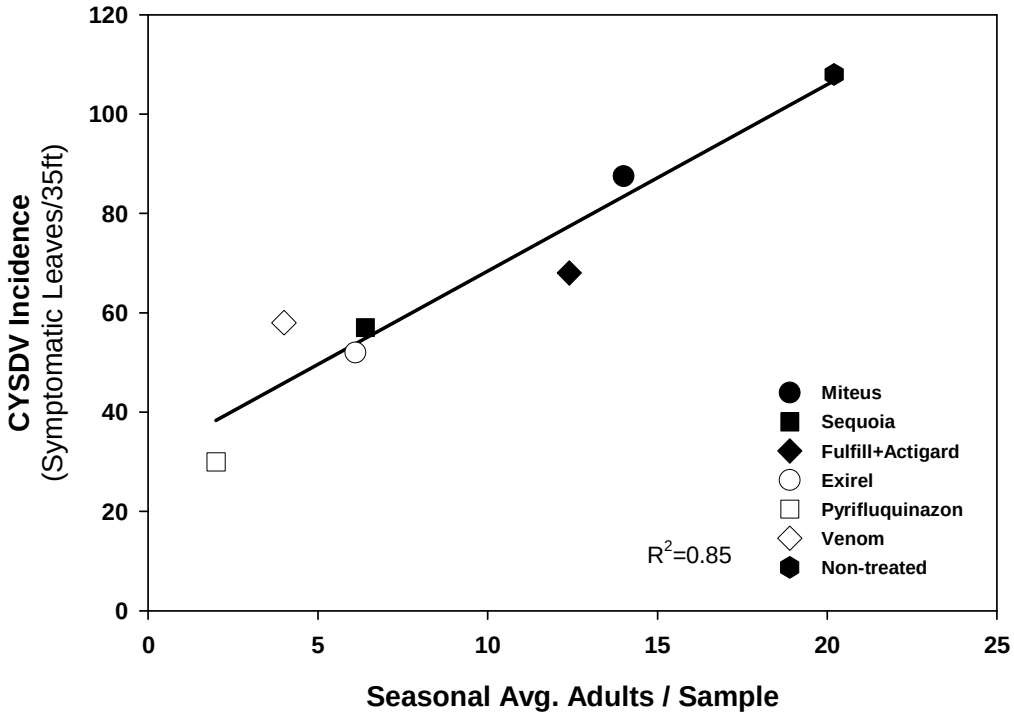

Figure 2. Association between whitefly adult abundance as determined by insecticide treatments and CYSDV incidence on spring melons 2014.

I. Foliar Insecticide Alternatives

C. Fall Melons – Experimental Alternatives for Whitefly Adults / CYSDV

Research procedures: Cantaloupe plots planted with 'Navigator' were established at the Yuma Agricultural Center on 15 Aug, 2014 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 and rates are shown in the tables below. All treatments, except the non-treated control, were treated with a Venom soil application at planting time applied 3" directly below the seed line in 20 GPA total volume. Three foliar spray treatments were applied on Aug 28, and Sep 5 and 19 as a broadcast spray at 22.5 GPA at 50 psi using 4 -TX18 Conejet nozzles per bed. All spray treatments included an adjuvant Dyne-Amic at 0.25% v/v. Whiteflies and CYSDV incidence were evaluated at various intervals using the sampling methods described for the previous spring foliar trials above.

Research Results: In this fall trial, under heavier whitefly adult pressure and CYSDV incidence, we evaluated the top products from our spring trials for efficacy and CYSDV suppression. Similar to the spring trials, the pyrifluquinazon and Exirel provided adult control at as good as or better levels than the standard (Scorpion). The Venom at-plant soil treatment certainly helped in control of whiteflies initially. This soil and foliar combination allowed all of the spray treatments including Assail and Sequoia to significantly reduce virus incidence relative to the non-treated control. This information indicates that alternatives exist or will in the near futuer that should help growers manage CYSDV in the absence of endosulfan.

Table 7. Knockdown and residual activity of insecticides against whitefly adults, Fall 2014

Spray # 1 ***(Aug 28)***		**Avg. Whitefly Adults / Sample**			
		Pre-spray	*1 DAA1*	*3 DAA1*	*7 DAA1*
Treatment	**Rate/ac**	**27-Aug**	**29-Aug**	**1-Sep**	**4-Sep**
Exirel	20 oz	-	3.3b	21.7bc	5.9b
Pyrifluquinazon	3.2 oz	-	4.6b	11.9c	3.8b
Assail 70 WP	3.4 oz	-	8.5b	31.8b	7.1b
Assail 70 WP	2.3 oz	-	7.1b	31.9b	8.5b
Scorpion	7 oz	-	5.7b	19.9bc	3.1b
Sequoia	4.5 oz	-	4.4b	24.2bc	6.1b
Non-treated	-	45.2	43.0a	83.9	63.3b

Table 7. continued.

Spray # 2 *(Sep 5)*		Avg. Whitefly Adults / Sample			
		1 DAA2	*4 DAA2*	*7 DAA2*	*14 DAA2*
Treatment	**Rate/ac**	**6-Sep**	**9-Sep**	**12-Sep**	**19-Sep**
Exirel	20 oz	2.5b	7.0bc	6.7b	19.3b
Pyrifluquinazon	3.2 oz	0.5d	4.8c	2.7c	18.3b
Assail 70 WP	3.4 oz	1.7bc	9.3b	5.8b	22.6b
Assail 70 WP	2.3 oz	0.8cd	8.5b	7.4b	31.4b
Scorpion	7 oz	1.0bcd	6.0bc	4.5bc	20.7b
Sequoia	4.5 oz	1.4bc	7.5bc	5.6b	19.0b
Non-treated	-	29.1a	24.8a	30.1a	165.6a

Spray # 3 *(Sep 19)*		Avg. Whitefly Adults / Sample			
		1 DAA3	*3 DAA3*	*7 DAA3*	*14 DAA3*
Treatment	**Rate/ac**	**20-Sep**	**22-Sep**	**26-Sep**	**4-Oct**
Exirel	20 oz	17.7b	8.5b	6.1c	3.2de
Pyrifluquinazon	3.2 oz	3.7e	1.5c	1.8d	2.0e
Assail 70 WP	3.4 oz	4.8de	6.2b	6.0c	7.0cd
Assail 70 WP	2.3 oz	10.0c	8.2b	7.7bc	10.2bc
Scorpion	7 oz	5.9d	6.8b	4.2c	6.5bc
Sequoia	4.5 oz	12.4bc	15.4b	10.2b	13.3b
Non-treated	-	103.2a	196.4a	242.1a	59.5a

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

Table 8. Incidence of CYSDV following insecticide treatments on fall melons, 2014

			CYSDV Incidence (Avg. no. leaves with YIVC symptoms/35 row ft)	
Treatment *	**Rate**	**Avg. Adults / Sample**	**1-Oct**	**10-Oct**
Exirel	20 oz	9.2b	0.5bc	52.0b
Pyrifluquinazon	3.2 oz	5.0b	0.0c	43.5b
Assail 70 WP	3.4 oz	10.1b	0.8bc	74.0b
Assail 70 WP	2.3 oz	12.0b	5.0a	80.5b
Scorpion	7 oz	7.6b	0.3bc	35.3b
Sequoia	4.5 oz	10.8b	1.8b	67.0b
Non-treated	-	90.5a	7.8a	162.3a

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

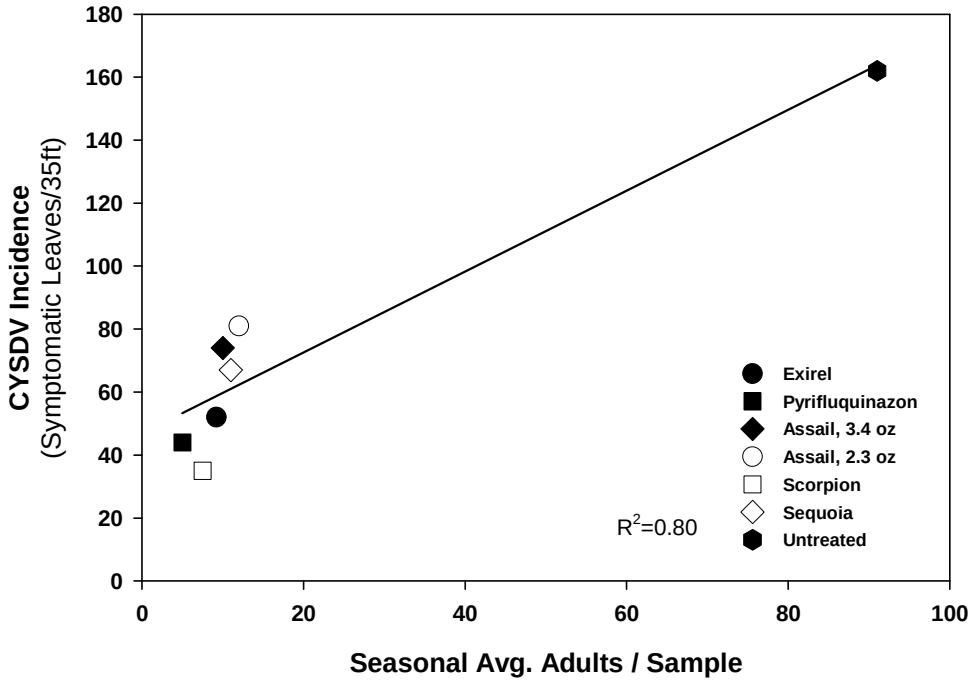

Figure 3. Association between whitefly adult abundance as determined by insecticide treatments and CYSDV incidence on spring melons 2014.

II. Soil Insecticide Alternatives

A. Spring Melons – Alternatives for Whitefly Immatures / CYSDV

Research procedures: Cantaloupe plots planted with 'Sol Dorado' were established at the Yuma Agricultural Center on Apr 22, 2014 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 and rates are shown in the tables below. All treatments, except the non-treated control, were treated with soil application 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 were not monitored during the trial, but whitefly immatures and CYSDV incidence were evaluated at various intervals using the sampling methods described above.

Research Results: Whitefly pressure was heavy during this spring trial. The most important information derived from this study was that Sivanto provided control of whitefly immatures and reduced CYSDV incidence comparable to the standard Venom in the absence of any foliar treatments. Based on the lower egg counts, Sivanto, like Scorpion, is also providing adult control early in plant growth. Additionally, this trial showed for a second year that Verimark, did not provide control of whiteflies or CYSDV relative to either Venom or Sivanto. Furthermore, the other neonicotinoid treatments (Admire Pro, Belay, Durivo) provided inconsistent immature whitefly control and only marginal suppression of CYSDV.

Table 9. Whitefly immature densities following at plant, soil applications on spring melons, 2014

Soil Treatment	Rate/ac	Whitefly Eggs /cm^2 21-May	29-May	6-Jun	13-Jun	23-Jun	30-Jun	Avg.
Verimak	13.5 oz	2.9ab	14.4b	1.1ab	12.2ab	20.7a	6.4a	9.6ab
Sivanto	28 oz	1.0bc	3.5de	0.3bc	6.2bc	17.5a	5.9a	5.7cd
Venom	6 oz	0.5c	2.5e	0.1c	4.0c	13.3a	5.6a	4.1d
Durivo	13 oz	1.3bc	12.3b	0.5bc	16.3ab	22.8a	6.0a	9.8ab
Belay	12 oz	2.2ab	9.0bc	1.0ab	8.8bc	20.1a	5.2a	7.7bc
Admire Pro	10.5 oz	0.9bc	5.9cd	0.5bc	5.4bc	14.2a	7.9a	5.8bc
UTC		5.0a	30.3a	3.8a	30.9a	28.8a	4.9a	17.3a

Soil Treatment	Rate/ac	Whitefly Nymphs /cm^2 21-May	29-May	6-Jun	13-Jun	23-Jun	30-Jun	Avg.
Verimak	13.5 oz	0.3	2.3bc	10.8b	11.5bc	21.4abc	22.3a	11.4b
Sivanto	28 oz	0.0	1.4c	0.6b	5.3bc	12.6bcd	26.1a	7.7bc
Venom	6 oz	0.1	1.4c	0.2b	3.2c	5.6d	15.7a	4.4c
Durivo	13 oz	0.1	2.5bc	7.1bc	14.3ab	23.4abc	24.1a	11.9b
Belay	12 oz	0.5	4.4a	5.4bcd	10.2bc	15.9bcd	23.8a	10.0b
Admire Pro	10.5 oz	0.1	1.4c	4.9cd	4.4c	11.5cd	19.6a	7.0bc
UTC		0.3	3.5a	18.7a	21.6a	27.3a	31.5a	17.2a

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

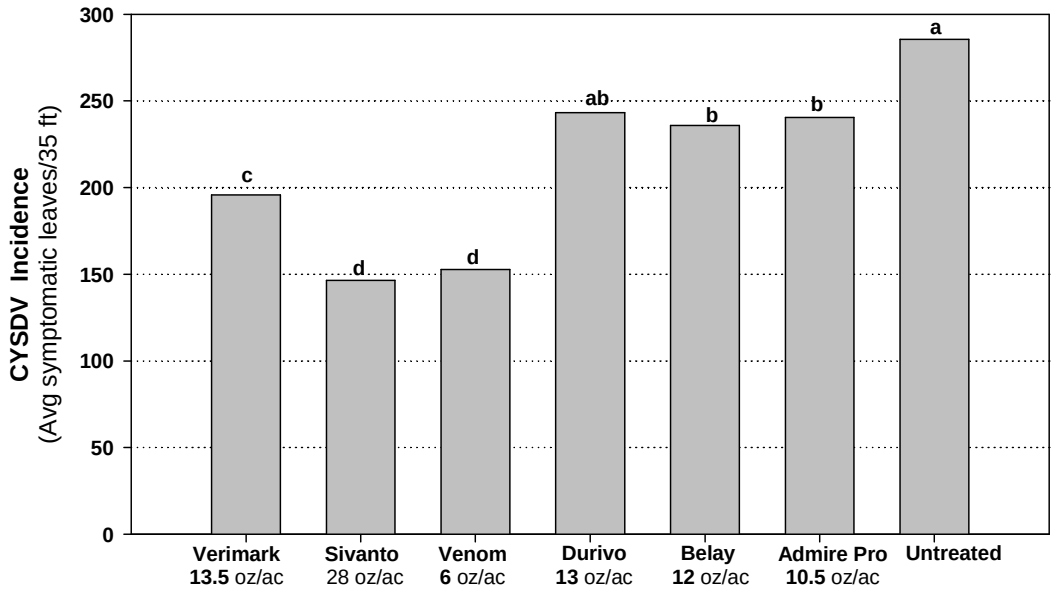

Figure 4. CYSDV Incidence on melons treated with at-plant, soil insecticides Spring 2014

II. Soil Insecticide Alternatives

B. Fall Melons – Drip and Shank Applications for Whitefly Immatures / CYSDV

Application through Drip Irrigation. *Research procedures*: Cantaloupe plots planted with 'Navigator' were established at the Yuma Agricultural Center on 15 Aug, 2014 and managed similarly to local growing practices. 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 soil insecticide application through the drip tape 10 days after planting (1-2 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. No additional insecticides were applied to the plots. Whiteflies and CYSDV incidence were evaluated at various intervals using the sampling methods described above.

Research Results**:** The goal of this trial was to evaluate Sivanto and Verimark applied to melons through drip irrigation. The data clearly shows that Sivanto, particularly at the 28 oz rate, significantly reduced whitefly eggs on melons for more than 30 days. This suggests that the compound has activity on adults much like Venom does. Furthermore, it provided control of nymphs comparable to the Venom standard. Similarly, Sivanto significantly reduced the early onset of CYSDV symptoms (40 days after application) comparable to Venom in the absence of additional soil applications and foliar sprays. In contrast, Verimark did not provide economic control of whiteflies or CYSDV. We used a lower rate in this trial (10.3, instead of 13.5 oz) because of the high cost of the product (>$1000/gal). We had hoped that reducing the cost a little lower would be more palatable to growers. Unfortunately, we conclude that this rate is too low for either whitefly or CYSDV management.

Table 9. Whitefly immature densities following drip chemigation on fall melons, 2014

		Whitefly Eggs /cm^2					
Soil		*5 DAA*	*12 DAA*	*19 DAA*	*26 DAA*	*33 DAA*	*40 DAA*
Treatment	**Rate/ac**	**3-Sep**	**10-Sep**	**17-Sep**	**24-Sep**	**1-Oct**	**8-Oct**
Verimak	10.3 oz	72.0a	10.3a	19.3a	26.2ab	39.4a	54.8a
Venom	6 oz	16.8b	1.0b	3.9b	9.7d	10.4c	49.6a
Sivanto	21 oz	18.9b	4.6b	7.3b	18.3bc	31.9ab	44.3a
Sivanto	28 oz	17.4b	1.9b	6.2b	14.1cd	15.9bc	35.2a
UTC	-	83.3a	8.3a	18.1a	33.2a	39.1a	22.7a

		Whitefly Nymphs /cm^2					
Soil		*5 DAA*	*12 DAA*	*19 DAA*	*26 DAA*	*33 DAA*	*40 DAA*
Treatment	**Rate/ac**	**3-Sep**	**10-Sep**	**17-Sep**	**24-Sep**	**1-Oct**	**8-Oct**
Verimak	10.3 oz	1.8a	35.3b	13.0ab	21.7a	24.5a	51.9a
Venom	6 oz	0.6a	5.5c	1.7c	4.8b	11.0a	35.8a
Sivanto	21 oz	0.1a	6.1c	4.0bc	14.6ab	23.7a	36.8a
Sivanto	28 oz	1.2a	4.3c	2.0c	8.7b	15.4a	29.4a
UTC	-	2.3a	50.5a	21.3a	25.2a	31.9a	29.2a

Table 8. Incidence of CYSDV on Oct 8 (40 DAA) in fall melons treated with soil insecticides via drip chemigation, 2014

		CYSDV Incidence (Mean symptomatic leaves / 50 ft.)		
Soil Treatment	**Rate/ac**	**Pale Interveinal Chlorosis**	**Yellow Interveinal Chlorosis**	**Total Infected leaves**
Verimak	10.3 oz	162.3a	29.8ab	192.1a
Venom	6 oz	76.0b	12.3b	88.3b
Sivanto	21 oz	70.3b	10.3b	80.6b
Sivanto	28 oz	59.3b	13.3b	72.6b
UTC	-	140.8a	40.5a	181.3a

Application by Shank, At-Plant Application. *Research procedures:* Cantaloupe plots planted with 'Navigator' were established adjacent to the drip irrigated plots at the Yuma Agricultural Center on 15 Aug, 2014 and managed similarly to local growing practices. 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 soil application 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 were not monitored during the trial, but whitefly immatures and CYSDV incidence were evaluated at various intervals using the sampling methods described above.

Research Results**:** We conducted this study adjacent to the drip study and the goal of this trial was to evaluate Sivanto and Verimark applied to melons as a standard shank application. Overall, the results were quite similar to the drip study; only Sivanto provided whitefly control and CYSDV suppression comparable to Venom. Verimark simply did not provide adequate whitefly activity at this rate. Furthermore, based on these results the proposed anti-feedant activity for this Verimark does not appear to be valid as a soil systemic application.

Table 9. Whitefly immature densities following shank, at-plant applications on fall melons, 2014

		Whitefly Eggs /cm^2					
Soil		*15 DAP*	*22 DAP*	*29 DAP*	*36 DAP*	*43 DAP*	*50 DAP*
Treatment	**Rate/ac**	**3-Sep**	**10-Sep**	**17-Sep**	**24-Sep**	**1-Oct**	**8-Oct**
Verimak	10.3 oz	49.2b	5.8b	13.1ab	29.4ab	39.1a	47.9a
Venom	6 oz	8.8c	2.8c	2.9b	12.8c	19.2a	24.2a
Sivanto	21 oz	11.2c	2.6c	7.8b	16.0bc	28.4a	37.0a
Sivanto	28 oz	12.9c	1.8c	7.7b	14.4bc	23.3a	35.3a
UTC	-	97.6a	12.3a	22.9a	41.1a	63.0a	50.3a

Table 9. continued

Soil Treatment	Rate/ac	Whitefly Nymphs /cm^2 15 DAP 3-Sep	22 DAP 10-Sep	29 DAP 17-Sep	36 DAP 24-Sep	43 DAP 1-Oct	50 DAP 8-Oct
Verimak	10.3 oz	1.0a	27.1b	11.4b	16.7ab	28.0a	31.0a
Venom	6 oz	1.2a	4.3b	7.9b	3.6d	16.0a	25.7a
Sivanto	21 oz	0.0a	9.6b	9.3b	13.2bc	21.2a	41.4a
Sivanto	28 oz	0.1a	4.1b	4.8b	7.8cd	21.5a	30.1a
UTC	-	2.2a	56.7a	23.1a	21.0a	41.3a	43.8a

Table 10. Incidence of CYSDV on Oct 8 (40 DAA) in fall melons treated with soil insecticides shank, at-plant applications, 2014

Soil Treatment	Rate/ac	CYSDV Incidence (Mean symptomatic leaves / 50 ft) Pale Interveinal Chlorosis	Yellow Interveinal Chlorosis	Total Infected leaves
Verimak	10.3 oz	168.0a	5.2b	173.3a
Venom	6 oz	81.3b	1.6c	82.9b
Sivanto	21 oz	110.3b	2.3c	112.1b
Sivanto	28 oz	79.5b	1.0c	80.0b
UTC	-	158.3a	13.1a	171.4a

II. Soil Insecticide Alternatives

C. Fall Melons – Soil Placement of Venom and Verimark for Whitefly / CYSDV

Research procedures: Cantaloupe plots planted with 'Naviagtor' were established at the Yuma Agricultural Center on Aug 15, 2014 and managed similarly to local growing practices. Plots consisted of a single 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. Two, at-planting soil placements were compared, the first was the standard soil injection below the seedline at two volumes, and the other was as an in-furrow spray. Injection treatments were applied 3" below the seed line prior to seed placement in either 10 or 20 GPA total volume. The in-furrow spray was applied at 10 GPA using a flat-fan nozzle to apply a ½ inch band directly in the seed furrow after the seed was dropped. Seed placement was at ½ inch below soil surface. Plots were established with overhead sprinkler irrigation. Two foliar sprays of Assail (5 oz) + Brigade (6 oz) were applied to the plots on Aug 27 and Sep 4. A side dress application of Venom (6 oz) was shanked into the soil on both sides of the plants (14" from seed-line) at a depth of 6" and immediately incorporated via furrow irrigation to all treatments but the non-treated check. Whiteflies and CYSDV incidence were evaluated at various intervals using the sampling methods described for the previous spring foliar trials above.

Research Results: Based on the poor performance of Verimark in previous trials, we attempted to determine if a different delivery of the compound at planting could improve its activity on melons.

Thus, we compared Verimark (13.5 oz; top of the label) using three different placements/volumes to the standard Venom application (shanked at-plant in 10 gpa total volume). All treatments received a Venom side-dress application and 2 foliar spray prior to side-dress in an attempt to gain seasonal effects of these treatments. We hypothesized that the in-furrow application of Verimark at a high volume would make the product readily available to the plant upon germination and emergence. However, the results clearly showed that none of the Verimark treatments significantly reduced adult numbers prior to the side-dress application, suggesting that either insufficient amounts of the material are not being taken up through the roots or that it is not effective even at the high rates against adults. Egg densities also suggest that fewer eggs were being deposited relative to the non-treated check, but still at higher densities than the standard Venom. A similar response for nymph densities was observed. We did observe a significant reduction in the number of CYSDV symptomatic leaves in the Verimark plots, but virus incidence did not vary among the Verimark treatments, and was significantly higher than the Venom at-plant, shank application at 10 gpa standard application. All of the Venom treatments provided similar levels of control and CYSDV suppression.

Table 11. Adult whitefly counts at various intervals following foliar and soil insecticide applications, Fall 2014

		Whitefly Adults / Sample				
At-plant, Soil Treatment (oz/ac)	**Application method (gpa)**	**28-Aug**	**5-Sep**	**12-Sep**	**23-Sep**	**Avg.**
Verimark (13.5)	Shank (20)	20.4a	1.7b	5.5b	24.7b	13.0b
Verimark (13.5)	Shank (10)	24.1a	1.2bc	4.3bc	20.7bc	12.6b
Verimark (13.5)	In-furrow (20)	25.6a	1.2bc	5.1bc	25.5b	14.3b
Venom (6)	Shank (20)	9.4b	0.7c	2.9c	15.1cd	7.0c
Venom (6)	Shank (10)	11.3b	0.8bc	2.7c	13.7d	7.1c
Venom (6)	In-furrow (20)	8.1a	0.7c	4.4bc	12.6d	6.4c
Non-treated	-	33.6a	12.0a	17.2a	77.3a	35.0a

* all treatments, except non-treated control, received a side-dress application of Venom (6 oz) on Sep 5; all treated plots were sprayed with foliar applications of Assail+Briage on Aug 27 and Sep 4.

Table 12. Whitefly immature densities following at-plant applications on fall melons, 2014

		Whitefly Eggs / Sample				
At-plant, Soil Treatment (oz/ac)	**Application method (gpa)**	**28-Aug**	**5-Sep**	**12-Sep**	**23-Sep**	**Avg.**
Verimark (13.5)	Shank (20)	19.8b	22.9a	1.2bcd	5.1b	12.2b
Verimark (13.5)	Shank (10)	15.0b	18.6a	1.5ab	6.3b	10.3b
Verimark (13.5)	In-furrow (20)	10.4b	19.7a	1.6ab	7.2b	9.7b
Venom (6)	Shank (20)	3.4c	4.4b	1.0bcd	5.4b	3.6c
Venom (6)	Shank (10)	2.7c	1.8c	0.3d	5.1b	2.4d
Venom (6)	In-furrow (20)	1.7c	2.4c	0.5cd	3.9b	2.1d
Non-treated	-	46.3a	33.7a	4.0a	17.4a	25.3a

Table 12. continued

At-plant, Soil Treatment (oz/ac)	Application method (gpa)	Whitefly Nymphs / Sample				
		28-Aug	5-Sep	12-Sep	23-Sep	Avg.
Verimark (13.5)	Shank (20)	0.0a	10.1b	1.7b	1.3b	3.3b
Verimark (13.5)	Shank (10)	0.0a	9.5b	1.6b	1.5b	3.2b
Verimark (13.5)	In-furrow (20)	0.0a	10.3b	1.7b	1.7b	3.4b
Venom (6)	Shank (20)	0.0a	1.5c	0.6b	1.2b	0.8c
Venom (6)	Shank (10)	0.0a	0.9c	0.1b	1.4b	0.6c
Venom (6)	In-furrow (20)	0.0a	0.7c	0.3b	1.3b	0.6c
Non-treated	-	0.5a	31.5a	11.2a	4.4a	11.8a

* all treatments, except non-treated control, received a side-dress application of Venom(6 oz) on Sep 5; all treated plots were sprayed with foliar applications of Assail+Briagde on Aug 27 and Sep 4.

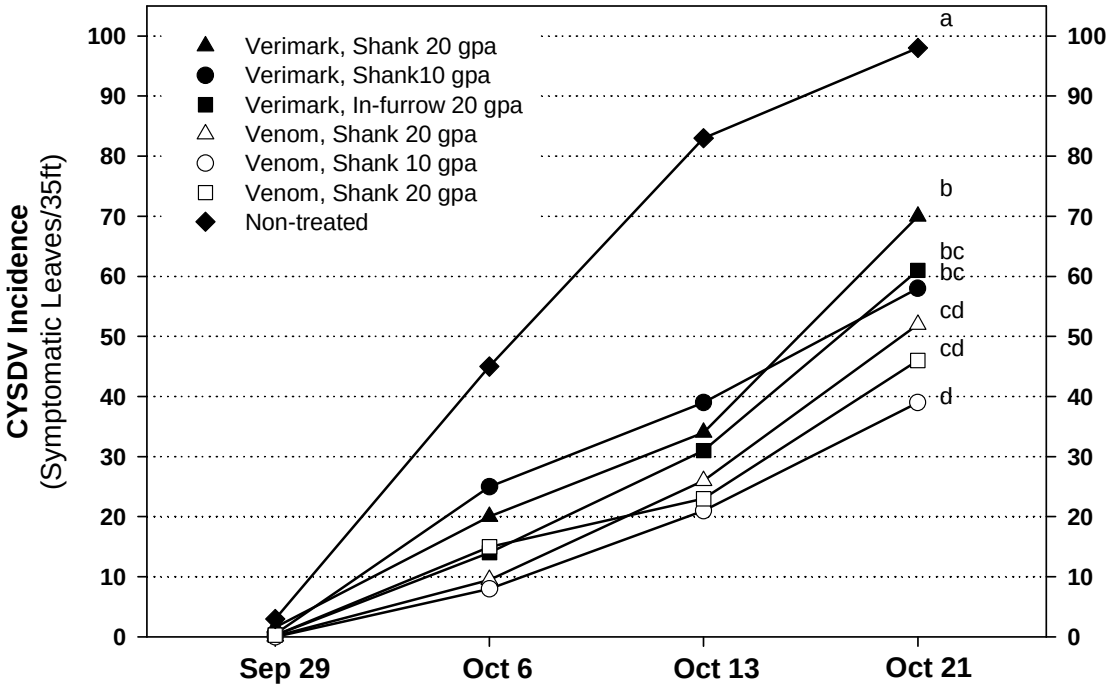

Figure 5. CYSDV Incidence on melons grown under an various soil application Fall 2014

III. Soil and Foliar Insecticide Programs

A. Spring Melons – Soil and Foliar Management Programs of Whitefly / CYSDV

Research procedures: Cantaloupe plots planted with 'Sol Dorado' were established at the Yuma Agricultural Center on Apr 22, 2014 and managed similarly to local growing practices. Plots consisted of one 84-inch bed, 100 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. The soil treatments were applied at planting by injecting each insecticide in a 10 GPA final solution, 3" below the seed line. A side dress application of insecticide was not applied. Foliar spray treatments were applied on May 22, 28 and Jun 5 and 12 as a broadcast spray at 22.5 GPA at 50 psi using 4 -TX18 Conejet nozzles per bed. All spray treatments included an adjuvant Dyne-Amic at 0.25% v/v. Populations of whitefly adults and immatures were evaluated at various intervals following each application using the sampling method described above. CYSDV incidence was estimated once (Jun 15), but yield estimates were not made due to collapse of all plots to *Monosporascus cannonballus* and heavy CYSDV incidence in the plots not receiving foliar sprays.

Soil Treatment	Foliar Sprays (4X)
Venom, 6 oz	Non-treated
Sivanto, 28 oz	Non-treated
Verimark, 13.5 oz	Non-treated
Non-treated	Non-treated
Venom, 6 oz	Treated
Sivanto, 28 oz	Treated
Verimark, 13.5 oz	Treated
Non-treated	Treated

Foliar spray dates	Insecticides applied (rate/ac)
(1) May 22	Exirel (20 oz)
(2) May 28	Venom (4 oz) + Brigade (6 oz)
(3) Jun 5	Assail (4 oz) + Brigade (6 oz)
(4) Jun 12	Pyrifluquinazon (3.2 oz)

Research Results: WF population pressure and CYSDV incidence was very high for a spring trial. The purpose of this trial was to evaluate the three soil alternatives with and without foliar sprays. Variability in whitefly numbers across the test plots resulted in no differences in adult numbers following the first two spray applications among all the soil treatments. Following the 3rd and 4th sprays, only the soil treatments receiving sprays had significantly lower adult numbers than the non-treated check. Similarly, when averaged across all samples, all of the foliar spray-treated, soil treatments had fewer whitefly adults. When CYSDV estimates were taken on June 15, all soil treatments had significantly fewer symptomatic leaves than the non-soil treated, non-sprayed treatment. Among the non-sprayed soil treatments, Sivanto and Venom provided significantly better CYSDV suppression than the Verimark treatment. Among Sprayed treatments, Venom had significantly lower levels of CYSDV than the Verimark treatment. This trial further validated that for the most part, Sivanto provided whitefly control and virus reduction comparable to Venom; whereas Verimark did not.

Table 13. Adult counts at various intervals following foliar and soil insecticide applications, Spring 2014

		Whitefly Adults / Sample					
		6 DAA1	*6 DAA2*	*6 DAA3*	*6 DAA4*	*13 DAA4*	
Soil Treatment	**Foliar Sprays (4X)**	**28-May**	**4-Jun**	**11-Jun**	**18-Jun**	**25-Jun**	**Avg.**
Venom	Non-treated	6.1a	8.0a	108.2ab	31.5abc	57.3	42.2abcd
Sivanto	Non-treated	13.1a	15.3a	138.0a	42.8a	58.3	53.1abc
Verimark	Non-treated	13.2a	18.9a	112.3ab	37.9ab	39.1	44.3ab
Non-treated	Non-treated	24.5a	23.5a	187.1a	53.6a	62.5	70.2a
Venom	Treated	8.3a	4.2a	31.0c	9.5bc	48.8	20.3de
Sivanto	Treated	7.7a	8.3a	40.5c	6.5c	26.4	17.9e
Verimark	Treated	11.4a	13.8a	52.3bc	9.1bc	27.1	22.7cde
Non-treated	Treated	14.7a	18.5a	47.3c	10.3bc	56.0	29.4bcde

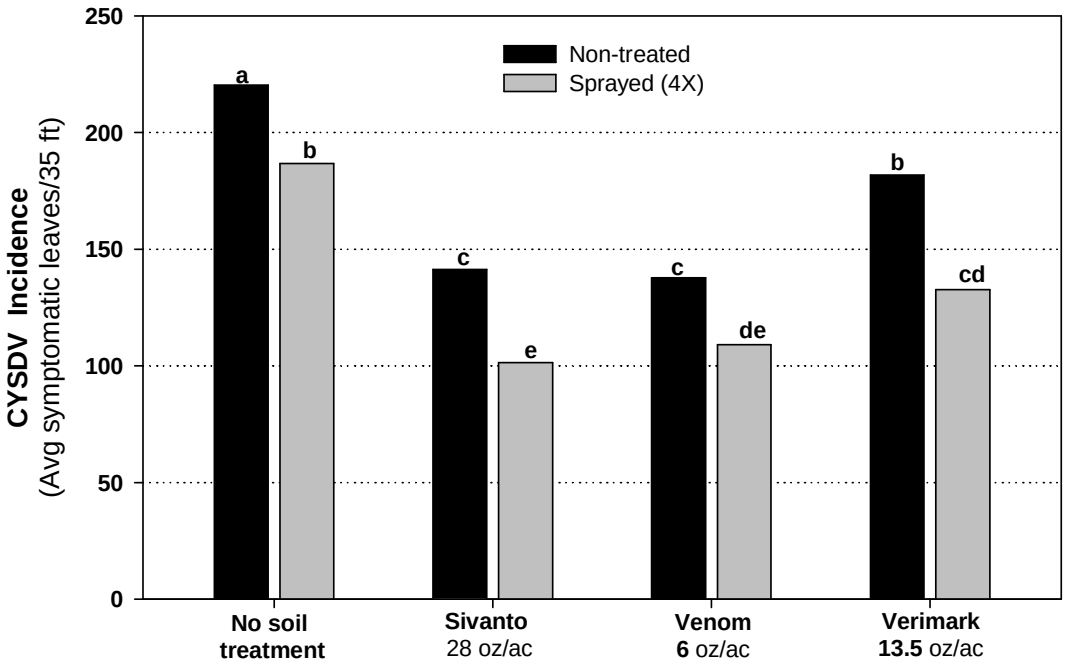

Figure 6. CYSDV Incidence (Jun 15) on melons following foliar and soil insecticide applications Spring 2014

II. Soil and Foliar Insecticide Programs

A. Fall Melons – Soil and Foliar Management Programs of Whitefly / CYSDV

Research procedures: Cantaloupe plots planted with 'Sol Dorado' were established at the Yuma Agricultural Center on 15 Aug, 2013 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 and rates are shown in the tables below. The soil treatments were applied at planting by injecting each insecticide in a 10 GPA final solution, 3" below the seed line. A second soil application of Venom was made on 9 Sep as a side dress application to all the soil treatments. The compounds were shanked into the soil at 20 GPA on both sides of the plants (14" from seed-line) at a depth of 6" and immediately incorporated via furrow irrigation. Six foliar spray treatments were applied as a broadcast spray at 22.5 GPA at 50 psi using 4 -TX18 Conejet nozzles per bed. All spray treatments included an adjuvant Dyne-Amic at 0.25% v/v.

At-plant, Soil Treatment (rate)	Side-dress (rate/ac)	Foliar Treatment
Venom, 6 oz	Venom, 6 oz	Sprayed (6X)
Verimark, 13.5 oz	Venom, 6 oz	Sprayed (6X)
Sivanto, 28 oz	Venom, 6 oz	Sprayed (6X)
Non-treated	Non-treated	Sprayed (6X)
Non-treated	Non-treated	Non-treated

Spray Date	Plant Stage	Foliar insecticides applied
27-Aug	2 lf	Sequoia, 4.5 oz +Brigade, 6.2 oz
1-Sep	4 lf	Exirel, 20 oz +Brigade 6.2 oz
7-Sep	7-8lf	Assail, 5.3 oz +Brigade, 6.2 oz
13-Sep	Bloom	Exirel, 20 oz +Brigade 6.2 oz
20-Sep	Fruit	Assail + Fulfill, 3 oz + Danitol, 12 oz
28-Sep	Netted	Assail+Vetica, 20 oz

Populations of whitefly adults were evaluated at various intervals following each application using the sampling method described above. CYSDV incidence was estimated four times prior to harvest. Yields were estimated by harvesting all full-slip melons in 12 row ft within each plot. Plots were harvested 6 times over a 2 week period beginning Oct 22. Fruit yields were measured by harvesting and recording the number of mature melons /plot and classifying their numbers by carton size (9, 12, 15, and 18/23). % Sugar levels (Brix) for all medium and large (carton 9-15) fruit from each plot on each harvest date were recorded using a standard refractometer. Sooty mold (%) was also recorded for each melon.

Research Results: The purpose of this trial was to evaluate a standard fall whitefly/CYSDV management program using three different soil alternatives, and the same conventional insecticide spray regime. We also included a treatment which did not receive any soil applications, but rather,

only foliar sprays. The standard consisted of at-plant and side dress soil application of Venom, followed by multiple spray applications with conventional insecticides at 5-7 d intervals.

Early in the study, whitefly populations and CYSDV incidence were lighter than previous years, but came on heavy about mid-season. Prior to the 3rd spray and side-dress application, whitefly adult numbers were generally lower in the Venom and Sivanto plots. However, following the side-dress application adult numbers were reduced comparably in all sprayed treatments relative to the non-treated check. Averaged across the trial, whitefly numbers did not differ significantly in the Venom and Sivanto treatments. In contrast, whitefly numbers did not differ statistically between the Verimark plots and plots only receiving foliar sprays. Similarly, the lowest CYSDV incidence was found in the Venom and Sivanto treatments. Virus in the Verimark treatment was not different from the foliar sprayed-only treatment suggesting that the Verimark had minimal impact on adults feeding. Yields further showed that Verimark did not provide the same level of CYSDV suppression as either the experimental Sivanto treatments or the Venom standard. From this study, in addition the other work conducted in 2014, we can conclude that (A) Sivanto can be considered a viable alternative to the standard Venom at-plant application. A registration for Sivanto is anticipated before the fall of 2015, and (B) Verimark (Cyazypyr) as a soil treatment should not be considered as a replacement for Venom. However, the foliar formulation of cyazypyr (Exirel), performed well in these studies and will likely play a key role in foliar management programs for WF adults and CYSDV.

Table 14. Adult counts at various intervals following foliar and soil insecticide applications, Spring 2014

	Whitefly Adults / Sample						
	3-DAA1	*3-DAA2*	*4-DAA3*	*5 DAA-4*	*3-DAA5*	*6-DAA6*	
Soil + Foliar Treatment	**27-Aug**	**1-Sep**	**8-Sep**	**15-Sep**	**20-Sep**	**30-Sep**	**Avg.**
Venom + Foliar Program*	23.2c	7.1d	2.2b	2.8c	5.4b	1.0b	6.9d
Sivanto + Foliar Program*	24.8bc	9.6cd	3.3b	8.3b	5.4b	0.6b	8.7cd
Verimark + Foliar Program*	44.9abc	14.4b	2.5b	4.8bc	4.8b	1.1b	12.1bc
Foliar Program only	50.9ab	13.1bc	4.8b	5.9b	7.0b	1.0b	13.8b
Non-treated check	77.8a	43.3a	12.9a	44.0a	65.9a	6.0a	41.6a

* Only the Venom, Verimark and Sivanto at-plant, soil treatments received a side dress application of Venom (6 oz) on Sept 5.

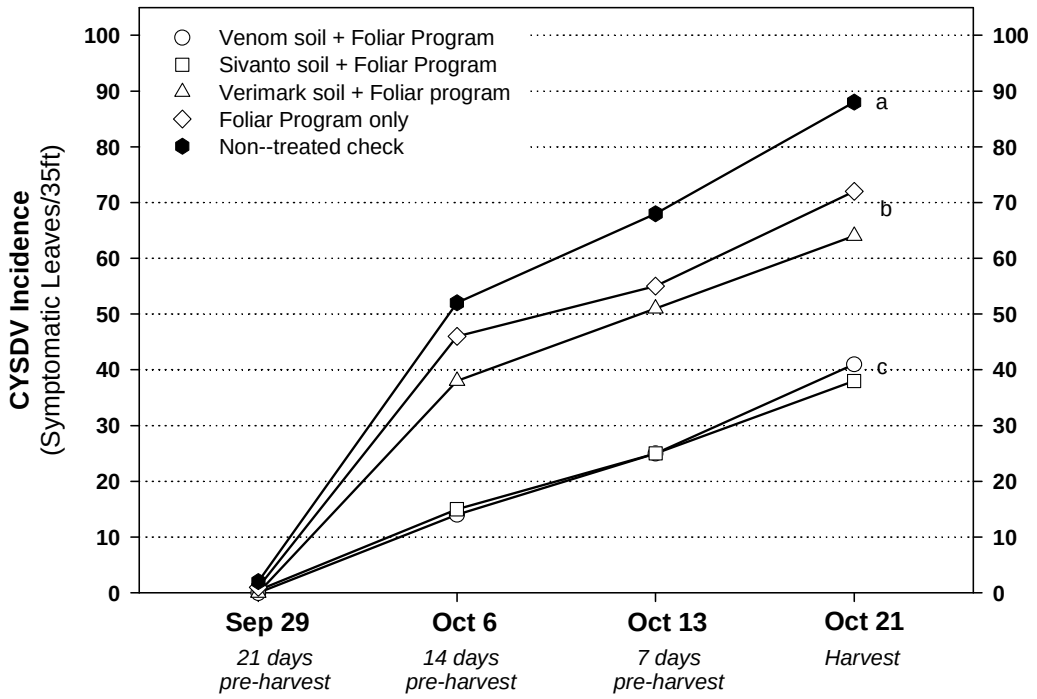

Figure 7. CYSDV Incidence on melons grown under an intensive soil and foliar insecticide management program, Fall 2014

Table 14. Yield and Melon Quality for Soil+Foliar Treatments, Spring 2014

	Yield (Avg. Fruit / 12 row ft)				**Fruit Quality**	
Soil + Foliar Treatment	**Large** Carton 9/12	**Medium** Carton 15	**Small** Carton 18/23	**Total Melons**	**Sooty mold** (%)	**Sugar** (%)
Venom + Foliar Program*	13.6a	6.0a	8.5b	28.0a	0b	10.1a
Sivanto + Foliar Program*	13.0a	4.8a	8.8b	26.5a	0b	10.0a
Verimark + Foliar Program*	5.5b	5.0a	14.0a	24.5a	0b	9.3a
Foliar Program only	3.0b	5.3a	9.5ab	17.8b	0b	9.6a
Non-treated check	1.3b	3.3a	7.0b	11.5b	25.1a	7.8a

* Only the Venom, Verimark and Sivanto at-plant, soil treatments received a side dress application of Venom (6 oz) on Sept 5.