CALIFORNIA MELON RESEARCH BOARD
2018 Final Report

January 1, 2018 to December 31, 2018

PROJECT TITLE:

Evaluation of Insecticide Alternatives for Whiteflies and CYSDV in Melons

PRINCIPLE INVESTIGATOR:

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SUMMARY OF RESEARCH RESULTS:

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

- Whitefly management continues to be a research priority for desert cantaloupes and studies identifying alternatives to neonicotinoids and diamides in melons was very productive this season. The need for new insecticides remains critical considering the reliance on neonicotinoids and regulatory issues surrounding pollinator protection.

- Adult infestations and CYSDV incidence were moderate-heavy in both spring and fall melon crops. Several trials were designed to exam new insecticide alternatives for knockdown and residual control of whitefly adults on cantaloupes including: PQZ (pyrifluquinazon), Sefina (inscalis), Cormoran (acetamiprid+novaluron) and Harvanta (cyclaniliprole). Results from these trials will allow us to update and develop IPM guidelines to assist melon growers in using the new insecticides for whitefly control and CYSDV suppression.

- Preliminary trials showed that Cormoran failed to provide consistent whitefly efficacy and additional testing will be necessary before the product can be recommended. Furthermore, trials also showed that the new diamide Harvanta is clearly not a whitefly insecticide. However, research this year showed that PQZ and Sefina appear to be excellent foliar alternatives for whitefly/CYSDV management in desert cantaloupes. Both consistently provided excellent adult control and CYSDV suppression. Since both products recently received USEPA registrations, we focused our Fall trials this year on trying to determine their best fit in early season adult whitefly control. When used in a program approach with foliar and soil standards, both PQZ and Sefina were very effective in significantly suppressing CYSDV and preventing yield/quality losses.

- Research with soil insecticides Venom and Sivanto in soil shank trials and with western shippers and Harper varieties showed that Sivanto prime (28 oz) applied at-planting consistently controlled whiteflies and delayed CYSDV incidence comparable to the industry standard, Venom when used in association with a foliar program approach using PQZ and Sefina.

I. EVALUATION OF NEW FOLIAR INSECTICIDES

A. Spring Foliar Insecticide - - *Comparative Efficacy of PQZ*

***Research procedures*:** Cantaloupe plots planted with 'Olympic Gold' were established on 25 Apr, 2018 at the Yuma Agricultural Center. The trial was managed similarly to local growing practices. Plots consisted of one 84-inch bed, 40 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. Three foliar sprays were applied on 29 May and 6 and 18 Jun with a CO_2 operated boom sprayer at 20.5 GPA @ 40 psi. A broadcast application was delivered through 4 TXVS-18 ConeJet nozzles per bed. An adjuvant, Dyne-Amic was applied at 0.25% vol/vol to all treatments. The exception was the PQZ (1X) treatment that only received a single spray on 29 May.

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 following application (DAA), 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 were recorded. Immature densities were estimated weekly following each application by sampling 5 plants / plot, where 3 leaves per plant were collected from the 5th, 10th and 15th node locations distant from 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 measure by recording the number of leaves that expressed symptoms of pale interveinal chlorosis (PIVC) and yellow interveinal chlorosis (YIVC) consistent with CYSDV infection in 40 ft of each plot at various intervals prior to harvest. 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.

Summary: The objective of this trial was to compare the efficacy of a newly registered compound PQZ against neonicotinoid and diamide insecticides commonly used for control of adult whiteflies and CYSDV on melons. Table 1 shows that the PQZ treatment applied 3 times provided as good as or better knockdown and residual control of adults as the standards (Venom, Exirel) following each application. The PQZ treatment applied only once (1X) provided residual control comparable to the diamide and neonicotinoid treatments. The addition of Courier with PQZ did not enhance PQZ's adult activity. This was expected since Courier is an IGR with primary activity against nymphs. That the addition of Courier did not enhance PQZ control of nymphs indicates the strong effectiveness of PQZ against all whitefly lifestages (Table 2). Furthermore, the PQZ (3X) treatment provided nymph control comparable to Exirel, which is considered the industry standard for nymph control. Not surprising, the PQZ (1X) treatment did not control nymphs comparable the other treatments. CYSDV infection was high in this trial and all of PQZ treatments significantly reduced the incidence of CYSDV symptoms comparable to Venom (Tables 3). This was expected for PQX (3X) treatments, but surprised that a single PQZ (1X) application was capable of providing significant CYSDV suppression, particularly since the diamides Exirel and Minecto Pro did not significantly suppress virus incidence. PQZ is a neurotoxic feeding blocker, and appears to be an effective anti-feedant compound which is critical for suppression CYSDV. It will be an effective addition to growers Whitefly/CYSDV management programs in 2019.

Table 1. Knockdown and residual activity of new foliar insecticides against WF adults, Spring 2018

		Avg. Whitefly adults / Sample					
		30-May	*1-Jun*	*5-Jun*	*7-Jun*	*9-Jun*	*13-Jun*
Treatment	**Rate/ac**	**1 DAA1**	**3 DAA1**	**7 DAA1**	**1 DAA2**	**3 DAA2**	**7 DAA2**
Exirel	13.6 oz	18.2 a	20.9ab	9.5 bc	7.0 b	3.3 b	8.1 b
Minecto Pro	10 oz	11.6 a	22.8ab	19.3 ab	9.0 b	9.2 b	12.4 b
PQZ (1 X)	3.2 oz	2.7 bc	7.4b	5.3 c	10.1 b	19.1 ab	16.8 b
PQZ (3 X)	3.2 oz	2.6 c	8.5b	2.3 c	0.7 c	1.5 b	2.0 c
PQZ + Courier	3.2+12.5 oz	1.9 c	14.7 ab	4.3 c	1.2 c	2.6 b	4.2 bc
Venom	4 oz	3.9 bc	11.9ab	10.7 bc	1.2 c	3.8 b	8.5 b
Assail 35SG	8 oz	3.3 bc	12.1ab	18.0 ab	3.7 b	4.3 b	8.1 b
Untreated		11.0 a	41.2a	46.0 b	50.9 a	42.9 a	54.3 a

		Avg. Whitefly adults / Sample			
		19-Jun	*21-Jun*	*25-Jun*	**Trial**
Treatment	**Rate/ac**	**1 DAA3**	**3 DAA3**	**7 DAA3**	**Avg.**
Exirel	13.6 oz	2.8 cd	3.0 cd	4.1 b	8.5 bc
Minecto Pro	10 oz	7.1 bc	4.6 cd	4.3 b	11.2 b
PQZ (1 X)	3.2 oz	18.5 b	12.4 b	7.1 ab	12.0 b
PQZ (3 X)	3.2 oz	1.4 d	1.2 d	1.7 b	2.4 d
PQZ + Courier	3.2+12.5 oz	2.7 cd	3.5 cd	2.4 b	4.1 cd
Venom	4 oz	5.2 cd	4.8 bc	10.4 ab	6.7 bc
Assail 35SG	8 oz	5.4 bcd	5.1 bc	17.1 ab	8.6 bc
Untreated		125.3 a	70.3 a	53.2 a	55.0 a

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

Table 2. Whitefly immature densities averaged across all sample dates, spring 2018

		Avg. Whitefly immatures /cm^2 / leaf			
Treatment	**Rate/ac**	**Eggs**	**Small nymphs**	**Large nymphs**	**Total nymphs**
Exirel	13.6 oz	7.0b	2.2cd	0.1b	2.3cd
Minecto Pro	10 oz	12.0b	3.2bc	0.4b	3.6bc
PQZ (1 X)	3.2 oz	9.3b	8.7b	3.4a	12.1b
PQZ (3 X)	3.2 oz	1.4c	1.1d	0.1b	1.2d
PQZ + Courier	3.2+12.5 oz	1.9c	1.2d	0.1b	1.3d
Venom	4 oz	4.4b	2.1bcd	0.2b	2.3cd
Assail 35SG	8 oz	7.5b	2.3bcd	0.3b	2.6cd
Untreated	-	21.8a	16.1a	6.0a	22.1a

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

Table 3. Incidence of CYSDV in melons treated with foliar insecticides, spring 2018.

			CYSDV Incidence (Avg. CYSDV symptomatic leaves / 40 ft)		
			12-Jun		25-Jun
Treatment	**Rate/ac**	**Avg. Adults**	**PIVC**	**YIVC**	**YIVC**
Exirel	13.6 oz	8.5 bc	15.8 a	0.0 a	179.9 a
Minecto Pro	10 oz	11.2 b	9.0 a	0.0 a	175.8 a
PQZ (1 X)	3.2 oz	12.0 b	15.5 a	0.0 a	112.5 b
PQZ (3 X)	3.2 oz	2.4 d	20.5 a	0.5 a	95.0 b
PQZ + Courier	3.2+12.5 oz	4.1 cd	15.3 a	0.0 a	102.8 b
Venom	4 oz	6.7 bc	10.3 a	0.0 a	114.5 b
Assail 35SG	8 oz	8.6 bc	15.0 a	0.0 a	118.0 b
Untreated	-	55.0 a	30.3 a	1.0 a	188.0 a

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

B. Spring Foliar Insecticide - - *Comparative Efficacy of PQZ and Cormoran*

***Research procedures*:** Cantaloupe plots planted with 'Olympic Gold' were established at the Yuma Agricultural Center on 25 Apr, 2017 and managed similarly to local growing practices. Plots consisted of one 84-inch bed, 40 ft long with a 7 buffer between each plot. The study was designed as a randomized complete block design with 4 replicates / treatment. Three foliar sprays were applied on 31 May, and 11 and 21 Jun with a CO_2 operated boom sprayer at 40 psi and 23.5 gpa. A broadcast application was delivered through 2 TXVS-18 ConeJet nozzles per bed. An adjuvant, Dyne-Amic (Helena Chemical Co.), was applied at 0.25% vol/vol to all treatments. Assessments of whitefly adults and immatures, and CYSDV incidence were conducted similar to the trial above.

Summary: The objective of this trial was to compare PQZ and Cormoran against the conventional standards for control of whitefly adults and relative suppression of CYSDV symptoms. In addition, we wanted to determine if increasing the Assail rate would improve adult efficacy. Table 4 shows the results of knockdown and residual control of adults following each application. PQZ was clearly as efficacious as the industry standard neonicotinoid Venom, and consistently more active than Exirel. In contrast, Cormoran (an in-can mixture of Assail, 3.5 oz and Diamond, 12 oz) did not consistently provide good adult control compared to untreated control. The increased Assail rate of 8 oz provided better control of adult whiteflies than the standard 5.3 oz rate. The higher Assail rate also provided better control of nymphs comparable to PQZ, Exirel and Venom (Table 5). Nymph densities in the Cormoran treatment were not significantly different from the untreated. Further, all the spray treatments, except Cormoran, significantly reduced CYSDV incidence at harvest (25-Jun) (Table 6). This was not surprising since Assail component of the in-can mixture was very low (3.5 oz). What was not surprising was that Assail applied at a much higher rate (8 oz) provided significant adult control and CYSDV suppression. Again, PQZ showed that it can provide adult control better than many of the alternative and suppress virus comparable to the standards.

Table 4. Knockdown and residual activity of foliar insecticides against adults, Spring 2018.

		Avg. Whitefly adults / Sample				
Treatment	**Rate/ac**	**1 DAA-1 1-Jun**	**4 DAA-1 4-Jun**	**7 DAA-1 7-Jun**	**1 DAA-2 12-Jun**	**3 DAA-2 14-Jun**
Assail	5.3 oz	6.8ab	5.2bc	12.9ab	4.4bcd	3.2bc
Assail	8 oz	6.4b	3.7cd	7.2ab	1.3cd	1.8bcd
Comoran	12 oz	11.7ab	17.7ab	12.1ab	5.5b	4.2b
Exirel	20 oz	8.1ab	1.2cd	1.0c	3.3bcd	1.9cde
PQZ	3.2 oz	2.1b	0.6d	0.8c	0.9d	0.7e
Venom	4 oz	1.9b	1.1cd	1.8c	1.9cd	0.8de
Untreated	-	25.0b	44.6a	27.8a	29.8a	27.6a

		Avg. Whitefly adults / Sample			
Treatment	**Rate/ac**	**7 DAA-2 18-Jun**	**1 DAA-3 22-Jun**	**4 DAA-3 28-Jun**	**7 DAA-3 29 Jun**
Assail	5.3 oz	22.5bc	14.4bc	5.0ab	3.2ab
Assail	8 oz	8.4cd	9.1bcd	4.4ab	2.4ab
Comoran	12 oz	50.2ab	27.0ab	14.5a	9.9a
Exirel	20 oz	4.3cd	5.2cd	2.1b	2.5ab
PQZ	3.2 oz	3.5d	2.6d	2.0b	1.5b
Venom	4 oz	5.5cd	9.9cd	2.1b	3.1ab
Untreated	-	102.6a	57.7a	31.4a	4.3a

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

Table 5. Whitefly immature densities averaged across all sample dates, spring 2018.

		Avg. Whitefly immatures /cm^2 / leaf			
Treatment	**Rate/ac**	**Eggs**	**Small nymphs**	**Large nymphs**	**Total nymphs**
Assail	5.3 oz	5.6abc	6.4ab	0.5bcd	6.9b
Assail	8 oz	5.4bc	1.3bc	0.2cd	1.5c
Comoran	12 oz	18.8a	14.7a	1.6bc	16.3a
Exirel	20 oz	3.5c	1.1bc	0.1d	1.2c
PQZ	3.2 oz	2.8c	0.4c	0.2d	0.6c
Venom	4 oz	2.1c	2.1c	0.1d	2.2c
Untreated	-	14.2a	8.3a	4.8a	13.1a

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

Table 6. Incidence of CYSDV in melons treated with foliar insecticides, spring 2018.

			CYSDV Incidence *(Avg. CYSDV symptomatic leaves / 40 ft)*		
			12-Jun		25-Jun
Treatment	**Rate**	**Avg. Adults**	**PIVC**	**YIVC**	**YIVC**
Assail	5.3 oz	8.6 bc	13.5 a	0.0 a	118.5 bc
Assail	8 oz	4.9 cd	10.8 a	0.0 a	79.5 c
Comoran	12 oz	17.0 ab	16.0 a	0.0 a	138.0 ab
Exirel	20 oz	3.3 cde	15.0 a	0.3 a	95.5 bc
PQZ	3.2 oz	1.6 e	12.5 a	0.0 a	93.3 bc
Venom	4 oz	3.1 de	13.0 a	0.8 a	88.0 bc
Untreated	-	39.0 a	16.8 a	0.5 a	190.8 a

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

C. Spring Foliar Insecticide *-- Comparative Efficacy of PQZ and Sefina*

***Research procedures*:** Cantaloupe plots planted with 'Olympic Gold' were established at the Yuma Agricultural Center on 25 Apr, 2018 and managed similarly to local growing practices. Plots consisted of one 84-inch bed, 40 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. Three foliar sprays were applied on 1, 12 , and 22 Jun with a CO_2 operated boom sprayer at 20.5 GPA @ 40 psi. A broadcast application was delivered through 4 TXVS-18 ConeJet nozzles per bed. The SP2700 at 11 oz/acre was added only to the Program 2 treatment on each of the 3 sprays. An adjuvant, Dyne-Amic was applied at 0.25% vol/vol to all treatments. Assessments of whitefly adults and CYSDV incidence were conducted similar to the trial above.

Summary: The objective of this trial was to compare two newly registered insecticides, PQZ and Sefina, against whitefly adults relative to current standards. PQZ and Sefina are selective homopteran feeding blockers similar in activity to Fulfill (IRAC group 9). However, both of these new compounds are much more efficacious against whiteflies than Fulfill. The recommended label rate for Sefina is 14 oz, unfortunately, an incorrect rate of 7 oz was applied during the study. Consequently, Sefina did not perform as expected and did not provide consistent efficacy against adults or suppression of CYSDV compared with PQZ. However, at this reduced rate Sefina provided comparable control to Exirel, but neither product provided significant suppression of CYSDV during the study. In contrast, PQZ provided the most effective control of adults and had significantly lower CYSDV incidence than the untreated control. Because of the error in applying the correct rate, it is difficult to draw conclusions concerning Sefina's efficacy in this study. PQZ on the other hand continues to provide impressive whitefly control and CYSDV suppression.

Table 7. Knockdown and residual activity of foliar insecticides against adults, Spring 2018.

		Avg. Whitefly adults / Sample				
		3-DAA1	*6-DAA1*	*10-DAA1*	*1-DAA2*	*3-DAA2*
Treatment	**Rate/ac**	**4-Jun**	**7-Jun**	**11-Jun**	**13-Jun**	**15-Jun**
Sivanto HL	5 oz	1.0cde	1.5 bc	3.5 b	0.9 bcd	1.1 bc
Venom	4 oz	0.1 e	0.7 bc	1.6 b	0.6cd	0.7 bc
PQZ	3.2 oz	0.7 cde	0.3 c	1.3 b	0.6 cd	0.8 bc
Sefina	7 oz	10.7 ab	2.3 b	2.8 b	2.3 bc	4.0 b
Exirel	20 oz	4.5 bc	2.6 b	3.3 b	3.1 b	1.2 bc
Untreated	-	23.2 a	20.6 a	16.4 a	16.5a	30.2 a

		Avg. Whitefly adults / Sample			
		8-DAA2	*3-DAA3*	*6-DAA3*	*11-DAA3*
Treatment	**Rate/ac**	**20-Jun**	**25-Jun**	**28-Jun**	**3-Jul**
Sivanto HL	5 oz	19.4 abc	3.1 bc	2.3 ab	3.8 ab
Venom	4 oz	16.1 bc	4.5 bc	3.1 ab	2.7 ab
PQZ	3.2 oz	5.3 cd	0.8 c	1.3 b	0.6 c
Sefina	7 oz	31.3 ab	5.2 ab	4.5 ab	2.0 abc
Exirel	20 oz	7.5 cd	1.9 bc	2.1 b	1.2 bc
Untreated	-	71.5 a	19.6 a	6.9 a	4.8 a

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

Table 8. Incidence of CYSDV in melons treated with foliar insecticides, spring 2018.

			Avg. CYSDV symptomatic leaves / 40 ft		
			12-Jun	*28-Jun*	*6-Jul*
Treatment	**Rate/ac**	**Avg. Adults**	**PIVC**	**YIVC**	**YIVC**
Sivanto HL	5 oz	4.0 bc	8.3 a	92.5 b	170.3 b
Venom	4 oz	3.3 cd	11.8 a	106.0 ab	200.0 b
PQZ	3.2 oz	1.3 d	17.5 a	95.8 b	202.0 b
Sefina	7 oz	7.2 b	16.0 a	127.3 ab	237.5 ab
Exirel	20 oz	3.0 bc	18.5 a	130.5 ab	238.8 ab
Untreated	-	23.3 a	19.0 a	163.5 a	296.5 a

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

D. Fall Foliar Insecticides - *Comparative Efficacy of New Products*

***Research procedures*:** Cantaloupe plots planted with 'Olympic Gold' were established at the Yuma Agricultural Center on 4 Aug, 2018 and managed similarly to local growing practices. Plots consisted of one 84-inch bed, 40 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. Three foliar sprays were applied on 31 Aug, and 10 & 18 Sep with a CO_2 operated boom sprayer at 20.5 GPA @ 40 psi. A broadcast application was delivered through 4 TXVS-18 ConeJet nozzles per bed. An adjuvant, Dyne-Amic was applied at 0.25% vol/vol to all treatments. No soil insecticides were applied at-planting in the trial.

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 following application (DAA), 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. CYSDV incidence was measure three times by recording the number of leaves that expressed symptoms of pale interveinal chlorosis (PIVC) or yellow interveinal chlorosis (YIVC) consistent with CYSDV infection in 40 ft of each plot at various intervals prior to harvest. At harvest maturity (~12 Oct) the percentage of leaves in each plot with CYSDV symptomatic leaves was estimated. 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.

Summary: The objective of this fall trial was to evaluate the efficacy of several insecticides that we compared in the spring against whiteflies and CYSDV. This included the new IRAC Group 9 Selective Feeding Blockers (Sefina and PQZ), the Group 28 diamides containing cyantraraniliprole (Exirel, and Minecto Pro) and the new cyclaniliprole (Harvanta), and the new Group 4 neonicotinoid mixture (Cormoran). Similar to the spring results, all of the foliar spray treatments significantly reduced whitefly adults compared to the untreated check, except for Harvanta (Table 9-10). According to the manufacturer, Harvanta will provide suppression of whiteflies. In this trial however, it did not control adults or suppress CYSDV. Despite significantly reducing adult numbers, neither Exirel or Minecto Pro was effective in preventing CYSDV incidence at harvest. Compared to the spring trial, Cormoran provided significantly better adult control and suppression of CYSDV comparable to Sivanto, Venom and Assail. PQZ provided the overall best control, and among the two Group 9 feeding blockers, provided more consistent adult knockdown and residual than Sefina. However, both were equally effective in preventing CYSDV infection. The results of this trial are very encouraging for several reasons. First, growers now have two new effective products to manage CYSDV, Sefina and PQZ. Secondly, Cormoran performed much better in this trial than in spring. However, more evaluation needs to be conducted to determine whether it will be a reliable alternative. Assail performed much better in the fall 2018 than in previous years. Sivanto continues to show impressive results when sprayed onto foliar. In this trial minimal phytotoxicity was observed following each application of the HL formulation when rates were kept at or below 5 oz. Finally, results for Exirel and Minecto Pro were disappointing and further demonstrates the inconsistency in virus suppression we've observed with this active ingredient over the past several years.

Table 9. Knockdown and residual activity of foliar insecticides against adults, Fall 2018

1st Application

		Mean Adults / Sample		
		1-DAA1	*3-DAA1*	*7-DAA1*
Treatment	**Rate / ac**	**1-Sep**	**3-Sep**	**7-Sep**
Exirel	20 oz	2.2 abc	7.8 ab	7.6 a
Minecto Pro	10 oz	5.1 a	9.8 ab	11.4 a
Harvanta	16 oz	3.2 abc	13.2 ab	11.2 a
Sivanto HL	5 oz	0.7 bc	5.0 b	8.0 a
PQZ	3.2 oz	0.3 c	8.1 ab	3.2 b
Sefina	14 oz	3.2 abc	8.1 ab	7.1 ab
Assail 30 SG	5.3 oz	1.1 abc	4.4 b	8.5 a
Cormoran	4.5 oz	1.5 abc	14.2 ab	7.9 a
Venom	4 oz	0.7 bc	6.6 ab	6.7 ab
Untreated	-	5.8 a	21.4 a	9.7 a

2nd Application

		Mean Adults / Sample		
		1-DAA2	*3-DAA2*	*7-DAA2*
Treatment	**Rate / ac**	**11-Sep**	**13-Sep**	**17-Sep**
Exirel	20 oz	5.5 bc	2.1 bc	1.9 b
Minecto Pro	10 oz	8.9 b	5.3 ab	6.7 b
Harvanta	16 oz	14.5 ab	14.6 a	54.0 a
Sivanto HL	5 oz	2.4 cd	1.1 cd	2.8 b
PQZ	3.2 oz	1.1 d	0.3 d	2.0 b
Sefina	14 oz	5.1 bc	2.0 bc	4.6 b
Assail 30 SG	5.3 oz	2.4 cd	1.6 bc	2.7 b
Cormoran	4.5 oz	7.0 bc	2.4 bc	6.7 b
Venom	4 oz	4.7 bc	1.0 cd	2.7 b
Untreated	-	45.4 a	23.3 a	29.6 a

3rd Application

		Mean Adults / Sample		
		1-DAA3	*3-DAA3*	*7-DAA3*
Treatment	**Rate / ac**	**19-Sep**	**21-Sep**	**25-Sep**
Exirel	20 oz	1.4 bc	0.9 c	4.3 cd
Minecto Pro	10 oz	5.7 b	3.1 bc	16.5 b
Harvanta	16 oz	43.9 a	83.4 a	166.7 a
Sivanto HL	5 oz	0.7c	1.0 c	3.2 d
PQZ	3.2 oz	0.5 c	1.3 bc	3.4 d
Sefina	14 oz	3.8 b	4.2 b	13.1 bc
Assail 30 SG	5.3 oz	1.2 bc	1.6 bc	5.8 bcd
Cormoran	4.5 oz	2.4 bc	2.0 bc	13.1 bcd
Venom	4 oz	1.0 c	1.0 c	3.5 d
Untreated	-	48.1 a	66.6 a	108.5 a

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

Table 10. Incidence of CYSDV in melons treated with foliar insecticides, fall 2018.

Treatment	Rate/ac	Seasonal Avg. Adults	CYSDV Incidence (Mean symptomatic leaves / 40 ft) 28-Sep PIVC	28-Sep YIVC	5-Oct YIVC	% CYSDV Infection at Harvest
Exirel	20 oz	3.7 cde	101.3 a	8.3 a	221.5 ab	61.3 a
Minecto Pro	10 oz	8.0 b	102.3 a	3.8 a	216.3 ab	63.8 a
Harvanta	16 oz	44.9 a	85.8 a	2.0 a	191.0 ab	68.8 a
Sivanto HL	5 oz	2.7 de	47.0 a	2.5 a	68.8 c	4.6 b
PQZ	3.2 oz	2.2 e	29.5 a	0.0 a	64.8 c	2.9 b
Sefina	14 oz	5.3 cd	49.0 a	1.5 a	89.5 bc	3.9 b
Assail 30 SG	5.3 oz	3.3 cde	54.8 a	1.3 a	91.8 abc	5.3 b
Cormoran	4.5 oz	6.3 bcd	40.5 a	0.8 a	94.3 abc	7.5 b
Venom	4 oz	3.1 de	64.3 a	1.0 a	114.0 abc	11.5 b
UTC	-	39.8 a	99.8 a	9.8 a	224.3 a	75.0 a

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

E. Fall Foliar Insecticides - *PQZ and Sefina in Program Approach*

***Research procedures*:** Cantaloupe plots planted with 'RML 7920' were established on 7 Aug, 2018 at the Yuma Agricultural Center. Plots consisted of one 84-inch bed, 40 ft long with a 7 buffer between each plot. The study was designed as a randomized complete block design with 4 replicates / treatment. The foliar treatments and rates are shown in the tables below. All treatments, except the untreated control, were treated with a single soil shank injection of Sivanto prime (28 oz) at planting time applied 3" directly below the seed line in 10.5 GPA total volume. A side dress application of Venom (6 oz) was made on 27 Aug to all treatments but the untreated check. The side dress treatment 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. Four foliar sprays were applied with a CO_2 operated boom sprayer at 40 psi and 20.5 gpa. A banded (50%) broadcast application was delivered through 2 TXVS-18 ConeJet nozzles per bed on the first 2 sprays, followed by full broadcast application on the final 4 sprays. An adjuvant, Dyne-Amic was applied at 0.25% vol/vol to all treatments (see tales below for products applied and timing). A spray of Courier (13.63 oz) was applied only to the untreated plot on 5 Sep to prevent immature population development. An additional blanket spray on all plots, including the UTC, was made on 24 Sep with Courier (13.6 oz) and Assail (8 oz) to prevent immature development and vine collapse in the untreated control before harvest.

Assessments of whitefly adults and CYSDV incidence were conducted similar to the trial above. Plots were harvested 6 times beginning Oct 12. Fruit yields were measured by harvesting and recording the number of mature melons/plot and classifying their numbers by carton size (9, 12, 15, 18 and 23). % Sugar levels (Brix) from 2-3 fruit in each plot on each harvest date were recorded using a digital refractometer. Sooty mold (%) was also recorded for each melon. 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.

Treatments (spray sequence)

	1) Aug 21	**2) Aug 28**	**3) Sep 5**	**4) Sep 13**
1	**PQZ**, 3.2 oz	**PQZ**, 3.2 oz	**Venom**-4 oz	**Exirel**-20 oz
2	**Sefina**-14 oz	**Sefina**-14 oz	**Venom**-4 oz	**Exirel**-20 oz
3	**PQZ**, 3.2 oz	**Sefina**-14 oz	**PQZ**, 3.2 oz	**Sefina**-14 oz
4	**Sefina**-14 oz	**PQZ**, 3.2 oz	**Sefina**-14 oz	**PQZ**, 3.2 oz
5	**Venom**-4 oz	**Exirel**-20 oz	**Venom**-4 oz	**Exirel**-20 oz

Summary: The objective of this trial was to evaluate the effectiveness of PQZ and Sefina when used in a program approach (see table above). All five of the spray programs evaluated were augmented with at-planting, and side-dress applications of Sivanto prime and Venom, respectively. The first two treatments compared PQZ and Sefina applied back to back and followed by Venom and Exirel sprays. We also compared alternations of both products where used in rotation with themselves. These 4 spray programs were compared to a grower standard program using a Venom-Exirel rotation. Figure 1 shows that PQZ tended to provide better knockdown of adults regardless of which program it was applied in. However, in terms of residual control, both PQZ and Sefina provided comparable results. When averaged across samples, all of the programs significantly reduced adults compared to the untreated check (Table 11), but overall the PQZ -Venom-Exirel program provided the most consistent control. All spray programs significantly reduced CYSDV incidence at harvest, and the PQZ and Sefina programs provided significantly better suppression than the alternating Venon-Exirel program (Table 11). Similarly, yield data shows that large fruit in the Venon-Exirel program did not differ from the untreated control (Table 12). In contrast, the PQZ and Sefina programs had significantly more large fruit per plot than the untreated control. In terms of fruit quality, only the PQZ and Sefina followed by Venom and Exirel programs had significantly high % Brix levels than the untreated control. These results suggest that either Sefina or PQZ can be used in programs with grower standards Exirel and Venom to provide effective adult control and CYSDV suppression, as opposed to use only in rotation with themselves. Technically, Sefina and PQZ have the same mode of action and thus should not be rotated with each other. However, Sefina is in subgroup 9D and PQZ in 9B, and in the absence of other alternative modes of action these products can be rotated. Furthermore, the results of this study show that these Group 9 alternatives to the neonicotinoids and dimaides will be a welcomed addition to the desert growers IPM programs.

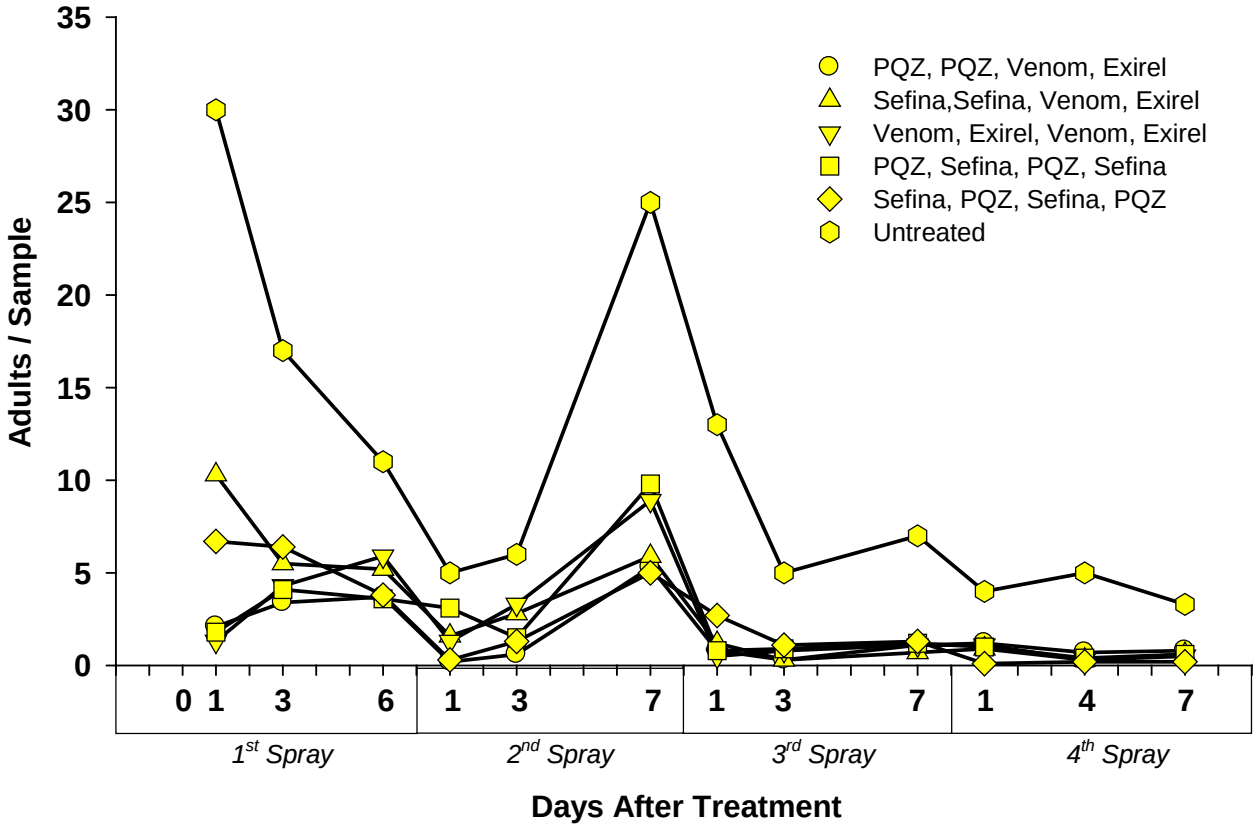

Figure 1. Adult whitefly abundance relative to spray programs, fall 2018**.**

Table 11. Incidence of CYSDV in melons treated with foliar insecticides, fall 2018.

Treatment *(Order in which product applied)*	Avg. Adults	CYSDV Incidence *(Mean YIVC symptomatic leaves / 50 ft)* 27-Sep	5-Oct	12-Oct	% CYSDV at Harvest
PQZ - PQZ - Venom - Exirel	1.7d	1.3 bc	21.5 b	60.0 c	16.0 c
Sefina - Sefina - Venom - Exirel	2.9bc	5.3 abc	29.5 b	78.3 c	21.8 c
PQZ - Sefina - PQZ - Sefina	2.4cd	13 bc	26.8 b	73.5 c	20.6 c
Sefina - PQZ - Sefina - PQZ	2.3cd	0.8 bc	19.5 b	48.0 c	14.9 c
Venom - Exirel - Venom - Exirel	2.4cd	7.5 a	51.8 ab	156.3 b	47.2 b
Untreated	10.7a	8.3 ab	97.0 a	244.8 a	77.4 a

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

Table 12. Fruit yields and quality for cantaloupes treated with foliar and soil insecticides, fall 2018.

	Avg. Fruit / 15 row ft			
Treatment *(Order in which product applied)*	**Large** [a]	**Small** [b]	**Total Fruit**	**Brix (%)**
PQZ - PQZ - Venom - Exirel	17.8 a	11.8 a	29.5 a	10.6 a
Sefina - Sefina - Venom - Exirel	18.0 a	11.5 a	29.5 a	10.3 ab
PQZ - Sefina - PQZ - Sefina	17.8 a	11.3 a	29.0 a	9.6 abc
Sefina - PQZ - Sefina - PQZ	18.8 a	16.8 a	35.5 a	9.7 abc
Venom - Exirel - Venom - Exirel	14.3 ab	14.8 a	29.0 a	9.3 bc
Untreated	7.8 b	22.5 a	30.3 a	8.4 c

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

[a] Large fruit = carton 6, 9 and 12s ; [b] Small = carton 15s and smaller

II. SOIL AND FOLIAR INSECTICIDE PROGRAM

*A. Fall Melons – Soil Insecticide * Variety Management Program*

***Research procedures*:** Cantaloupe plots planted with 'Expedition' and 'Caribbean King' were established on 7 Aug, 2017 at the Yuma Agricultural Center. Plots consisted of one 84-inch bed, 60 ft long with a 7 buffer between each plot. The study was designed as a randomized split-plot design with 4 replicates / treatment. Varieties were main plots and soil treatments were sub plots. The soil and foliar 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 (treatments listed below). On Aug 27, 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. Six foliar sprays were applied with a CO_2 operated boom sprayer at 50 psi and 23.5 gpa. A banded (50%) broadcast application was delivered through 2 TXVS-18 ConeJet nozzles per bed on the first 2 sprays, followed by full broadcast application on the final 4 sprays. An adjuvant, Dyne-Amic was applied at 0.25% vol/vol to all treatments (see tales below for products applied and timing).

Adult populations were estimated using a leaf turn method of counting all adults present on the 3rd - 4th terminal leaf. On each sample date flowing application (DAA), 5 separate plants from each replicate were sampled. CYSDV incidence was measure by recording the number of leaves that expressed symptoms of the virus and yellow interveinal chlorosis consistent with CYSDV infection in 60 ft within each plot at various interval after injection (DAA). At harvest, the percent of leaves in the plot infected with CYSDV were estimated. CYSDV incidence was estimated four times prior to harvest. Yields were estimated by harvesting all mature melons in 25 row ft within each plot. Plots were harvested 6 times over a 2-week period beginning Oct 15. Fruit yields were measured by harvesting and recording the number of mature melons /plot and classifying their numbers by carton size: (large

- 6, 9, 12) and (small- 15, 18, 23). % Sugar levels (Brix) for 3-5 large fruit from each plot on each harvest date were recorded using a standard refractometer.
Sooty mold (%) was also recorded for each melon.

At-plant, Soil Treatment	Side-dress	Foliar Treatments
Venom (6 oz)	Venom (6 oz)	(see below)
Sivanto (28 oz)		

Spray Date	Plant Stage	Foliar insecticides applied
21-Aug	3 lf	Venom, 4 oz + Sniper, 5 oz
28-Aug	5 lf	PQZ, 3.2 oz
5-Sep	1st bloom	PQZ, 3.2 oz
13-Sep	1st fruit	Exirel, 20 oz +Sniper, 5 oz
20-Sep	Fruit	Sefina, 14 oz
26-Sep	Netted	Assail, 5.3 oz + Courier, 13.6 oz

Summary: Similar trials were conducted the last 2 years and provided some very useful information. The purpose of this trial was to evaluate for a third season a standard fall whitefly/CYSDV management program comparing soil application of Sivanto and Venom at planting and augmented with the same conventional foliar insecticide spray regime. This year we incorporated both PQZ and Sefina in our foliar spray program. We conducted the trial on two different melon varieties (the western shipper 'Olympic Gold'; and the Harper LSL 'Caribbean King') to also exaamine varietal differences in CYSDV and yield responses. Whitefly populations were initially heavy early, but gradually decreased throughout the trial. Following each spray application adult numbers were reduced comparably in sprayed treatments relative to the non-treated check in both varieties (Figure 2). Averaged across the trial, whitefly numbers did not differ significantly in the Venom and Sivanto treatments, regardless of melon variety. Similarly, CYSDV incidence was significantly lower in the soil treated plots compared to the untreated, and virus incidence did not differ among the two soil treatments. The significant suppression of CYSDV symptoms resulted in yield differences between the soil treatments and the untreated control. Venom and Sivanto plots, regardless of variety, had significantly more larger melons and higher Brix levels than the untreated check. The number of large fruit and Brix levels did not differ among the two soil treatments, nor did the Brix Levels differ among varieties. We anticipated that Brix would be higher in the Caribbean King as in previous studies, but this was likely an experimental error in our judgement of proper harvest maturity of the Harper variety. From this study, in addition to similar studies in 2016 and 2017, we can strongly conclude that Sivanto can now be considered a viable soil applied alternative to the standard Venom at-plant application. Unlike in the previous studies, the Harper variety did not provide an edge over the western shippers for maintaining sugar under similar levels of CYSDV and whitefly pressure. Finally, the addition of PQZ and Sefina in this program approach allowed us to better understand how to maintain CYSDV incidence at very low levels in both melon varieties.

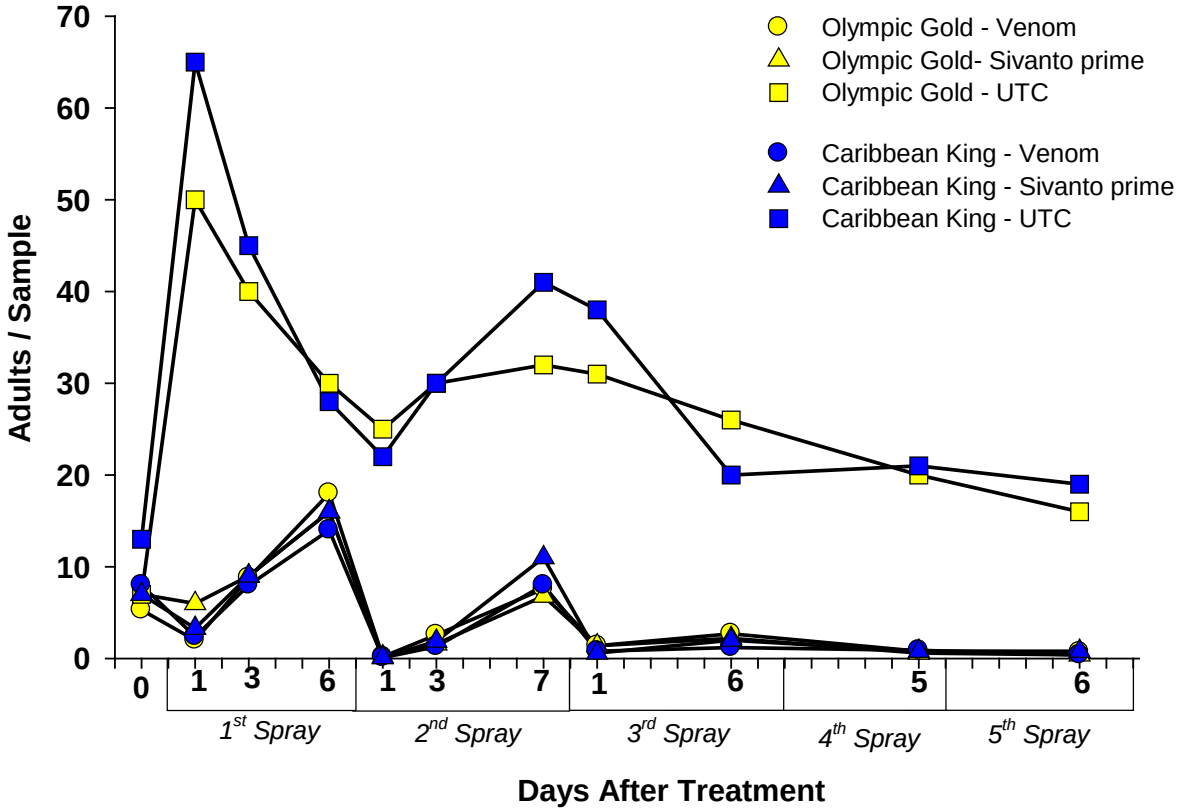

Figure 2. Adult whitefly abundance relative to spray programs, fall 2018**.**

Table 12. Incidence of CYSDV in two melons varieties treated with foliar and soil insecticides, fall 2018.

		CYSDV Incidence *(Mean YIVC symptomatic leaves / 50 ft)*			**% CYSDV Infection** *(% of plot expressing CYSDV symptoms)*		
Soil Treatment	***Melon Variety***	**27-Sep**	**5-Oct**	**12 Oct (Harvest)**	**27-Sep**	**5-Oct**	**12 Oct (Harvest)**
Venom	*Olympic Gold*	3.5 abc	19.3 bc	69.3 b	1.0 b	2.5 c	4.4 b
Sivanto prime	*Olympic Gold*	2.5 bc	8.0 c	62.8 b	0.8 b	1.4 c	4.3 b
Untreated	*Olympic Gold*	20.0 a	103.5 a	376.0 a	8.3 a	37.5 a	68.8 a
Venom	*Caribbean King*	0.8 bc	4.8 cd	61.3 b	0.9 b	0.8 c	3.5 b
Sivanto prime	*Caribbean King*	0.0 c	0.8 d	68.0 b	0.6 b	0.9 c	5.8 b
Untreated	*Caribbean King*	5.3 ab	40.5 ab	427.5 a	8.0 a	26.9 b	78.8 a

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

Table 13. Fruit yields and quality for two melons varieties treated with foliar and soil insecticides, fall 2017.

		Avg. Fruit / 15 row ft			
Soil Treatment	***Variety***	**Large** [a]	**Small** [b]	**Total Fruit**	**Brix (%)**
Venom	Olympic Gold	16.3 a	5.3 b	21.5 a	11.4 ab
Sivanto prime	Olympic Gold	16.0a	5.3 b	21.3 a	11.8 a
Untreated	Olympic Gold	2.5 b	16.0 a	18.5 a	8.8 c
Venom	Caribbean King	15.0 a	4.8 b	19.8 a	12.3 a
Sivanto prime	Caribbean King	15.8 a	3.3 b	19.0 a	12.2 a
Untreated	Caribbean King	6.5 a	10.8 ab	17.3 a	10.6 b

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

[a] Large fruit = carton 6, 9 and 12s ; [b] Small = carton 15s and smaller