CALIFORNIA MELON RESEARCH BOARD
2016 Final Report

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PROJECT TITLE:

Evaluation of Insecticide Alternatives for Whiteflies and CYSDV in Melons

PRINCIPLE INVESTIGATOR:

John C. Palumbo
Yuma Agricultural Center, Dept. of Entomology, University of Arizona, Yuma, Arizona

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.

- Whiteflies and CYSDV continue to be problematic for producers of fall cantaloupes and honeydews. Whitefly infestations and virus incidence were moderate in spring melon crops in 2016, but unseasonably light on fall melons. This project was designed to discover and develop new insecticide alternatives for whitefly and CYSDV management. The need for new products is critical considering the reliance on neonicotinoids and regulatory issues surrounding pollinator protection.

- Experiments in 2016 evaluated novel foliar and soil insecticides for rapid knockdown and long residual control of whitefly adults on cantaloupes. Based on a number of trials conducted, we have developed new recommendations for use of foliar and soil insecticides to assist melon growers in controlling whiteflies and CYSDV until new alternatives become available.

- Research showed that a number of core of foliar insecticides will provide suppressive activity against whiteflies and CYSDV including Venom and Scorpion, and to a lesser extent, Exirel. The efficacy of Assail was inconsistent this year, a trend also noticed by PCAs and growers. Fortunately, several experimental alternatives showed good activity. Sivanto applied as a foliar spray provided excellent control and adequate crop safety at 10 oz/ac, but does not currently have a foliar label on melons. The most promising near-term foliar alternative is PQZ (pyrifluquinazone), but is likely 18-24 months from a federal registration. Long-term, a new experimental compound UAEXP 15-9 has activity against whiteflies and CYSDV comparable to the standards, but is still under development and is likely several years from commercial availability.

- Research with soil insecticides in both drip chemigation and soil shank trials showed that Sivanto (28 oz) applied at-planting or via chemigation consistently controlled whiteflies and delayed CYSDV incidence comparable to Venom. A new soil insecticide formulation UAEXP 24-8 displayed excellent activity and provided whitefly control and CYSDV suppression as good as Sivanto and Venom when applied as a soil shank or chemigation treatment.

I. SOIL INSECTICIDES ALTERNATIVES

A. Drip Chemigation, Fall 2016

***Research procedures*:** Cantaloupe plots planted with 'Expedition' were established on 19 Aug, 2015 at the Yuma Agricultural Center. The trial was managed similarly to local growing practices. Plots consisted of one 84-inch bed, 60 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 (1-2 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. 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. 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 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 50 ft within each plot at various interval after injection (DAA). 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 for a 2nd year the efficacy of Sivanto and a new experimental compound (UEXP-24-8) against Venom and other soil insecticides for control of whiteflies and CYSDV when applied to melons through drip irrigation. The data clearly shows that Sivanto and UAEXP 24-8, significantly reduced whitefly adults and nymphs on melons comparable to the Venom standard (Tables 1-2). These results corroborate our results from last year that showed both of these compounds clearly reduced adult feeding and immature population build-up. Similarly, they significantly reduced the incidence of CYSDV symptoms comparable to Venom in the absence of any additional soil applications or foliar sprays (Tables 3). 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. We're not sure about how UAEXP 24-8 prevents virus transmission, but may be a result of quick adult mortality rather than feeding cessation. Because the compound is still in early stages of development, not much is known about it yet. Both of these compounds are viable soil alternatives to Venom for early season whitefly control in melons. In contrast, again for a 3rd year, Verimark and Admire Pro did not provide significant control of whiteflies or CYSDV. Neither of these products appears to be a viable soil insecticide alternative for CYSDV management under our fall desert melon growing conditions.

Table 1. Whitefly adult abundance following drip chemigation on fall melons, 2016

		Adult / Sample			
Treatment	**Rate/ac**	**7-DAA**	**15 DAA**	**22 DAA**	**32DAA**
UAEXP-24-8	-	1.8c	5.5b	1.0b	22.5a
Admire Pro	10.5 oz	8.3ab	14.1a	5.2ab	31.2a
Sivanto	28 oz	3.2bc	12.5a	4.4ab	19.5a
Verimark	13.5 oz	12.0ab	21.7a	6.8ab	25.6a
Venom	6 oz	3.4bc	12.0a	2.4b	24.1a
Untreated	-	20.5a	16.8a	11.4a	20.5a

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

Table 2. Whitefly nymph densities following drip chemigation on fall melons, 2016

		Total nymphs / cm^2						
Treatment	**Rate**	**7-DAA**	**15 DAA**	**22 DAA**	**32DAA**	**40 DAA**	**48 DAA**	**Avg.**
UAEXP-24-8	-	0.8b	0.8c	1.6c	5.1b	21.9a	23.2b	8.9d
Admire Pro	10.5 oz	1.9ab	5.8ab	9.8ab	22.0ab	56.0a	49.8ab	24.2abc
Sivanto	28 oz	1.6ab	2.0bc	5.4b	10.4ab	26.1a	28.4b	12.3cd
Verimark	13.5 oz	1.6ab	11.7a	17.9a	36.2a	58.3a	81.1a	34.5ab
Venom	6 oz	2.8ab	2.6bc	6.1ab	8.5ab	18.5a	54.0ab	15.4bc
Untreated	-	5.1a	15.2a	18.1a	29.3a	37.1a	101.3a	36.5a

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

Table 3. Incidence of CYSDV in fall melons treated with soil insecticides, fall 2016

		CYSDV Incidence (No. symptomatic leaves / 50 ft)		
Treatment	**Rate**	**20 DAA**	**35 DAA**	**50 DAA**
UAEXP-24-8	-	1.5b	56.8c	50.3c
Admire Pro	10.5 oz	13.0a	203.0a	176.8a
Sivanto	28 oz	1.0b	55.5c	56.5c
Verimark	13.5 oz	5.5b	166.5ab	141.5a
Venom	6 oz	4.3b	87.0bc	81.3bc
Untreated	-	4.0b	124.8abc	137.8ab

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

B. Shank at-plant Injection, Fall 2016

Research procedures: Cantaloupe plots planted with 'Expedition' were established on 19 Aug, 2016 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 (days after planting [DAP]) using the sampling methods described in the above drip chemigation trial.

Summary: The objective of this trial was similar to the drip trials and was conducted adjacent to the drip study using similar experimental plot designs. Although, insect and CYSDV numbers varied between the drip and shank trials, the results were quite similar in both application systems. In essence, only Sivanto and the EXP_2415 provided whitefly control and CYSDV suppression comparable to the industry standard, Venom (Tables 4-6). Plots in the untreated check, Verimark and Admire Pro treatments were more heavily infested with whiteflies and collapsed to vine decline before yield estimates could be made. Finally, based on the three years of conducting these drip and shank studies, it is concluded that Sivanto is a viable soil, at-plant insecticide alternative to Venom; when registered UAEXP 24-8 is likely to also be a viable alternative. Unfortunately, Verimark and Admire Pro are not capable of providing adequate CYSDV suppression and can't be considered as viable soil alternatives.

Table 4. Whitefly adult abundance following shank at-plant application on fall melons, 2016

		Adults / Sample			
Treatment	**Rate/ac**	**12 DAP**	**20 DAP**	**28 DAP**	**35 DAP**
UAEXP-24-8	-	1.5ab	4.4a	3.8a	4.2a
Admire Pro	10.5 oz	1.9a	15.1a	7.6a	6.2a
Sivanto	28 oz	1.4ab	5.4a	8.0a	6.6a
Verimark	13.5 oz	2.3a	17.8a	8.2a	6.2a
Venom	6 oz	0.7b	3.2a	4.2a	3.7a
UTC	-	2.0a	15.8a	6.6a	5.8a

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

Table 5. Whitefly nymph abundance following shank at-plant application on Fall melons, 2016

		Total nymphs / cm^2					
Treatment	**Rate**	**20 DAP**	**27 DAP**	**36 DAP**	**46 DAP**	**54 DAP**	**Avg.**
UAEXP-24-8	-	0.2b	3.6bc	2.4cd	7.1b	23.4a	7.3bc
Admire Pro	10.5 oz	0.6b	5.6abc	4.7bc	11.4b	37.2a	11.9b
Sivanto	28 oz	0.4b	4.9bc	3.4cd	10.2ab	27.8a	9.6b
Verimark	13.5 oz	0.7ab	14.8ab	12.7a	12.2ab	30.1a	14.1a
Venom	6 oz	0.2b	2.4c	1.4d	6.1b	18.6a	5.8c
UTC	-	2.1a	14.7a	11.5ab	34.5a	39.0a	20.3a

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

Table 6. Incidence of CYSDV in fall melons treated with soil insecticides, Fall 2016

		CYSDV Incidence (No. symptomatic leaves / 50 ft)		
Treatment	**Rate**	**30 DAP**	**40 DAP**	**50 DAP**
UAEXP-24-8	-	1.5c	52.0bc	118.5bc
Admire Pro	10.5 oz	14.0a	157.5a	259.3a
Sivanto	28 oz	1.0c	17.8d	69.8c
Verimark	13.5 oz	10.0ab	130.8a	226.5a
Venom	6 oz	2.0bc	37.0cd	92.5c
UTC	-	2.3bc	107.8ab	209.0ab

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

II. FOLIAR INSECTICIDE ALTERNATIVES

A. Spring Foliar Insecticide - Trial I

***Research procedures*:** Cantaloupe plots planted with 'Olympic Gold' were established at the Yuma Agricultural Center on 27 Apr, 2016 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. Three foliar sprays were applied on 19 and 30 May, and 13 Jun 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 spray. An adjuvant, Dyne-Amic, was applied at 0.25% v/v to all treatments. Assessments of whitefly adults and immatures, and CYSDV incidence were conducted similar to the trials above. A crop safety phytotoxicity rating was made for each product following the second and third applications using the following index: 1-no observable damage; 2- very slight damage with an occasional leaf with marginal necrosis; 3-Damage acceptable with obvious marginal necrosis and chlorotic spotting on an occasional older leaf; 4- Damage not acceptable with marginal necrosis on numerous leaves with heavy chlorotic spotting on leaves.

Summary: The objective of this trial was to compare standard and unregistered insecticides as foliar sprays for control of whitefly adults and relative suppression of CYSDV symptoms. Most of the products provided excellent knockdown of adults and residual control up to 7 days following the third application. Venom, Sivanto and PQZ (pyrfluquinazon) provided consistent adult control (Tables 7), and when averaged across all sprays, PQZ provided the most consistent level of adult control. Assail was inconsistent in this trial at both the 8.0 and 5.3 oz rate. All products, especially Exirel at the 20 oz rate, provided excellent control of nymphs (Table 8). In terms of CYSDV incidence, Venom (4 oz), both rates of Sivanto, the 8 oz rate of Assail, and PQZ were the only treatments to significantly reduced CYSDV incidence at harvest maturity (Table 9). Unfortunately, Sivanto is not labeled for foliar use on cantaloupe/honeydews due to potential phytotoxicity on melon foliage. In this trial we observed marginal phytotoxicity on older foliage at the 10 oz rate; the 14 oz rate was not as safe following 3 applications (Table 10). It is felt that the 10 oz rate may be acceptable to western melon growers. Although PQZ has been submitted for registration, it is still 18-24 months from a federal label. However, the manufacturer has indicated an interest in pursuing a Section 18 registration.

Table 7. Knockdown and residual activity of foliar insecticides against whitefly adults, Spring 2016

		Avg. Whitefly adults / Sample					
		1 DAA-1	4 DAA-1	7 DAA-1	1 DAA-2	3 DAA-2	7 DAA-2
Treatment	**Rate/ac**	**20-May**	**23-May**	**26-May**	**31-May**	**2-Jun**	**6-Jun**
Exirel	20.5 oz	1.2b	3.7a	3.2a	2.0abc	1.4b	11.7a
Exirel	15.0 oz	4.0ab	3.3a	3.4a	4.3ab	1.8ab	10.0a
Sivanto	14.0 oz	1.6b	3.1a	4.2a	0.7cd	1.3b	10.3a
Sivanto	10.5 oz	1.5b	2.9a	6.9a	0.7cd	1.7b	11.8a
Assail	8.0 oz	1.6b	4.4a	5.4a	0.6cd	1.8ab	14.4a
Assail	5.3 oz	1.7b	3.4a	3.8a	1.1bcd	1.6ab	9.6a
Venom	4.0 oz	0.7b	2.4a	3.0a	0.6cd	1.1b	9.0a
Venom	3.0 oz	1.2b	3.0a	5.0a	0.2d	0.7b	10.4a
PQZ	3.2 oz	1.4b	2.1a	2.4a	0.4cd	0.7b	6.0a
Untreated	-	5.7b	7.3a	6.1a	5.4a	7.0a	18.5a

		Avg. Whitefly adults / Sample					
		11 DAA-2	1 DAA-3	3 DAA-3	7 DAA-3	10 DAA-3	14 DAA-3
Treatment	**Rate/ac**	**10-Jun**	**14-Jun**	**16-Jun**	**20-Jun**	**23-Jun**	**27-Jun**
Exirel	20.5 oz	14.4ab	7.2b	3.3b	15.1bcde	41.9bc	57.5ab
Exirel	15.0 oz	7.8ab	7.1b	3.7b	10.4cde	25.0bc	56.4ab
Sivanto	14.0 oz	6.5ab	1.7c	1.2b	9.4de	19.4bc	27.5ab
Sivanto	10.5 oz	3.2ab	3.6bc	2.1b	7.9de	28.7bc	57.5ab
Assail	8.0 oz	10.7ab	5.2bc	4.1b	32.4b	65.7ab	109.4a
Assail	5.3 oz	14.9ab	4.1bc	4.2b	22.6bc	49.5bc	73.6a
Venom	4.0 oz	9.2ab	4.4bc	3.1b	19.4bcd	36.7bc	69.8a
Venom	3.0 oz	10.2ab	3.2bc	3.9b	18.0bcde	52.2bc	67.9a
PQZ	3.2 oz	3.0b	3.9bc	3.7b	8.5e	13.9c	18.8b
Untreated	-	26.6a	38.6a	44.1a	117.9a	199.2a	99.7a

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

Table 8. Whitefly immature densities at 14 days after the 3rd application, spring 2016.

		Whitefly nymphs /cm2 / leaf			
Tmt	**Rate/ac**	**5th leaf**	**10th leaf**	**15th leaf**	**Avg.**
Exirel	20.5 oz	0.0b	0.3b	0.1c	0.1b
Exirel	15.0 oz	0.0b	0.4b	0.2bc	0.2b
Sivanto	14.0 oz	0.0b	0.3b	0.5bc	0.3b
Sivanto	10.5 oz	0.0b	0.6b	0.7bc	0.4b
Assail 30SG	8.0 oz	0.0b	0.9b	0.9b	0.6b
Assail 30SG	5.3 oz	0.2b	1.4b	0.8bc	0.8b
Venom	4.0 oz	0.0b	0.6b	0.6bc	0.4b
Venom	3.0 oz	0.1b	1.2b	1.0b	0.8b
PQZ	3.2 oz	0.0b	0.3b	0.3bc	0.2b
Untreated	-	2.2a	19.0a	22.9a	14.7a

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

Table 9. Incidence of CYSDV in melons treated with foliar insecticides, spring 2016.

			CYSDV Incidence (No. symptomatic leaves / 45 ft)	
Treatment	**Rate/ac**	**Avg. Adults**	**PIVC - Jun 16**	**YIVC - Jul 1**
Exirel	20.5 oz	13.5bc	17.0a	94.5a
Exirel	15.0 oz	11.4bc	5.3a	83.8ab
Sivanto	14.0 oz	9.7cd	5.3a	40.5d
Sivanto	10.5 oz	10.7bcd	0.8a	30.3d
Assail	8.0 oz	21.3b	3.3a	47cd
Assail	5.3 oz	15.8bc	7.8a	96.5ab
Venom	4.0 oz	13.2bcd	3.0a	47.8cd
Venom	3.0 oz	14.6bcd	3.5a	76.5abc
PQZ	3.2 oz	5.4d	3.0a	53.3bcd
Untreated	-	48.0a	14.8a	111.3a

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

Table 10. Crop safety rating for melons treated with foliar insecticides, spring 2016.

		Crop Safety Rating	
		14 DAA-2	**7 DAA-3**
Treatment	**Rate/ac**	**13-Jun**	**21-Jun**
Exirel	20.5 oz	1.0c	1.0b
Exirel	15.0 oz	1.0c	1.0b
Sivanto	14.0 oz	**2.8a**	**3.0b**
Sivanto	10.5 oz	**1.9b**	**2.6b**
Assail	8.0 oz	1.0c	1.0b
Assail	5.3 oz	1.0c	1.0b
Venom	4.0 oz	1.0c	1.0b
Venom	3.0 oz	1.0c	1.0b
PQZ	3.2 oz	1.0c	1.0b
Untreated	-	1.0c	1.0b

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

B. Spring Foliar Insecticide - Trial II

***Research procedures*:** Cantaloupe plots planted with 'Olympic Gold' were established at the Yuma Agricultural Center on 27 Apr, 2016 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. Three foliar sprays were applied on 17 May, 1 and 17 Jun 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 spray. An adjuvant, Dyne-Amic was applied at 0.25% vol/vol to all treatments. Assessments of adults and immatures, CYSDV incidence and Crop Safety were conducted similar to the trials above.

Summary: The objective of this trial was to compare the new experimental foliar compound UAEXP 15-9 against whitefly adults and CYSDV relative to current standards. UAEXP 15-9 provided as good as or better knockdown and residual control of whitefly adults as Venom, Sivanto, Exirel (Table 11). Similarly, the experimental compound provided as good as or better control of whitefly nymphs (Table 12). Because of the consistent adult knockdown observed with UAEXP 15-9, it provided significant suppression of CYSDV symptoms at harvest stage comparable with Venom and Sivanto (Table 13). Exirel and Movento did not significantly reduce CYSDV. Crop safety evaluations at 5 days following the 3rd application showed Sivanto at the 14 oz rate caused very marginal crop safety and likely would not have been acceptable to many growers. As mentioned above both UAEXP 15-9 and Sivanto are not currently labeled for use on cantaloupes and honeydews.

Table 11. Knockdown and residual activity of foliar insecticides against whitefly adults, Spring 2016

		Avg. No. Whitefly Adults / Sample				
		3 DAA-1	*7 DAA-1*	*14 DAA-1*	*3 DAA-2*	*5 DAA-2*
Treatment	**Rate**	**20-May**	**24-May**	**31-May**	**3-Jun**	**6-Jun**
UAEXP-15-9	-	1.0b	3.7a	3.7a	2.6b	4.2b
Venom	4.0 oz	1.7ab	5.7a	6.8a	3.0b	3.5b
Sivanto	14.0 oz	2.2ab	5.7a	4.3a	3.0b	6.5ab
Exirel	20.5 oz	1.6ab	4.4a	3.8a	7.6b	7.0ab
Movento	5.0 oz	3.6ab	4.6a	2.8a	23.6a	7.1ab
Untreated	-	6.0a	5.9a	5.4a	35.7a	15.8a

		Avg. No. Whitefly Adults / Sample				
		7 DAA-2	*14 DAA-2*	*3 DAA-3*	*7 DAA-3*	*14 DAA-3*
Treatment	**Rate**	**8-Jun**	**15-Jun**	**20-Jun**	**24-Jun**	**31-Mar**
UAEXP-15-9	-	2.4f	6.2b	3.8c	17.2b	11.8a
Venom	4.0 oz	6.8bcd	7.6ab	6.1c	36.2ab	55.0a
Sivanto	14.0 oz	3.5def	6.1b	4.2c	21.8b	26.7a
Exirel	20.5 oz	8.4abc	12.5ab	5.9c	37.9ab	39.1a
Movento	5.0 oz	6.0bcde	9.5ab	25.5b	56.1ab	29.4a
Untreated	-	17.3a	30.4a	120.2a	112.3a	33.1a

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

Table 12. Whitefly immature densities melons treated with foliar insecticides, spring 2016.

		Avg. large nymphs/ cm^2				
Treatment	**Rate/ac**	**14 DAA-1**	**7 DAA-2**	**14 DAA-2**	**7-DAA3**	**14 DAA-3**
UAEXP-15-9	-	0.0a	0.0b	0.5b	0.5bc	1.0b
Venom	4.0 oz	0.0a	0.0b	1.9ab	1.2bc	2.6b
Sivanto	14.0 oz	0.0a	0.0b	0.7b	0.7bc	1.9b
Exirel	20.5 oz	0.0a	0.4b	4.1ab	0.1c	1.5b
Movento	5.0 oz	0.0a	0.1b	2.9ab	0.9b	4.6b
Untreated	-	0.1a	4.3a	6.7a	8.6a	35.2a

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

Table 13. Incidence of CYSDV in melons treated with foliar insecticides, spring 2016.

			CYSDV Incidence (No. symptomatic leaves / 45 ft)	
Treatment	**Rate**	**Avg. Adults**	**17-Jun**	**1-Jul**
UAEXP-15-9	-	5.6d	2.0a	28.8bc
Venom	4.0 oz	13.2bc	7.5a	31.3bc
Sivanto	14.0 oz	8.4cd	6.0a	20.0c
Exirel	20.5 oz	12.8bc	5.5a	48.5abc
Movento	5.0 oz	16.8b	3.3a	55.5ab
Untreated	-	38.2a	0.8a	95.3a

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

Table 14. Crop safety rating for melons, spring 2016.

Treatment	**Rate**	**5 DAA-3**
UAEXP-15-9	-	1.0b
Venom	4.0 oz	1.0b
Sivanto	14.0 oz	**3.4a**
Exirel	20.5 oz	1.0b
Movento	5.0 oz	1.0b
Untreated	-	1.0b

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

C. Fall Foliar Insecticide - Trial I

***Research procedures*:** Cantaloupe plots planted with 'Expedition' were established at the Yuma Agricultural Center on 19 Aug, 2016 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. Two foliar sprays were applied on 8 and 23 Sep 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 spray, followed by full broadcast application on the second spray. An adjuvant, Dyne-Amic was applied at 0.25% vol/vol to all treatments. Assessments of adults and immatures, CYSDV incidence and Crop Safety were conducted similar to the trials above.

Summary: The objective of this trial was similar to the spring trial to compare the new experimental foliar compound UAEXP 15-9 against whitefly adults and CYSDV. In the fall trial we included PQZ instead of Movento. Similar to the results from the spring trial, UAEXP 15-9 provided as good as or better knockdown and residual control of whitefly adults as Venom, Sivanto, Exirel (Table 15). Both UAEXP 15-9 and PQZ provided the most consistent adults knockdown and residual control. Similarly, the experimental compound provided as good as or better control of whitefly nymphs (Table 16). All of the foliar treatments provided significant suppression of CYSDV compared to the untreated control, and UAEXP 15-9 provided significant suppression of CYSDV symptoms comparable to Venom and Sivanto (Table 17). Crop safety evaluations at 7 days following the 3rd application showed that the UAEXP 15-9 caused no phytotoxicity to melons plants (Table 18), unlike Sivanto at the 14 oz rate that caused significant marginal necrosis to several leaves. Overall, as a foliar alternative UAEXP 15-9 offers great potential as an effective tool against whiteflies and CYSDV.

Table 15. Knockdown and residual activity of foliar insecticides against whitefly adults, Fall 2016

		Whitefly Adults / Sample				
Treatment	**Rate**	***1 DAA1***	***3 DAA1***	***7 DAA1***	***11 DAA1***	***14 DAA1***
UAEXP-15-9	-	4.3b	2.7b	1.8d	4.8b	1.8c
Venom	4 oz	3.2b	4.3ab	3.5cd	8.5ab	3.6abc
Sivanto	14 oz	6.1b	7.1ab	9.2b	6.9b	2.8bc
PQZ	3.2 oz	4.85b	2.9b	2.5cd	4.2b	1.5c
Exirel	20 oz	36.5a	9.3ab	7.7bc	11.6ab	7.8ab
Untreated	-	92.8a	28.8a	15.9a	23.4a	9.7a

		Whitefly Adults / Sample				
Treatment	**Rate**	***1 DAA2***	***3 DAA2***	***7 DAA2***	***14 DAA2***	**Avg.**
UAEXP-15-9	-	1.0c	0.8c	2.2b	2.3b	3.1d
Venom	4 oz	2.5bc	6.7b	10.7b	8.4b	4.6bc
Sivanto	14 oz	1.7bc	2.7bc	10.0b	8.5b	6.4b
PQZ	3.2 oz	0.9c	5.0b	2.3b	2.3b	3.2cd
Exirel	20 oz	3.8b	2.7bc	5.7b	5.7b	14.5b
Untreated	-	16.1a	59.1a	444.5a	215.4a	34.1a

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

Table 16. Whitefly immature densities melons treated with foliar insecticides, Fall 2016.

		Mean whitefly immatures / cm^2				
Treatment	**Rate**	**Egg**	**SN**	**LN**	**Eclo**	**Total imm**
UAEXP-15-9	2 oz	0.3c	0.5c	0.1b	0.0a	0.6c
Venom	4 oz	3.1b	3.7b	0.4b	0.0a	4.0b
Sivanto	14 oz	1.4bc	1.3bc	0.4b	0.0a	1.4bc
PQZ	3.2 oz	0.4c	0.5c	0.4b	0.0a	0.9c
Exirel	20 oz	1.2bc	0.7c	0.3b	0.0a	0.9c
Untreated		40.4a	41.4a	12.5a	0.3a	53.3a

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

Table 17. Incidence of CYSDV in melons treated with foliar insecticides, fall 2016.

		CYSDV Incidence (No. symptomatic leaves / 45 ft)	
		3-Oct	**13-Oct**
Treatment	**Rate/ac**	**PIVC + YIVC**	**YIVC**
UAEXP-15-9	2 oz	49.8b	53.5bc
Venom	4 oz	37.3b	48.8c
Sivanto	14 oz	41.0b	56.0bc
Pyrifluqinazon	3.2 oz	58.0b	66.3bc
Exirel	20 oz	101.0a	93.8b
Untreated	-	140.3a	153.5a

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

Table 18. Crop safety rating for melons, fall 2016.

Treatment	**Rate**	**7 DAA-2**
UAEXP-15-9	-	1.0b
Venom	4.0 oz	1.0b
Sivanto	14.0 oz	**3.0a**
Exirel	20.5 oz	1.0b
Movento	5.0 oz	1.0b
Untreated	-	1.0b

D. Fall Foliar Insecticide - Trial II

***Research procedures*:** Cantaloupe plots planted with 'Expedition' were established at the Yuma Agricultural Center on 19 Aug, 2016 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. Two foliar sprays were applied on 14 Sep and 3 Oct 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 spray, followed by full broadcast application on the second spray. An adjuvant, Dyne-Amic was applied at 0.25% vol/vol to all treatments. Assessments of adults and immatures were conducted similar to the trials above.

Summary: The objective of this trial was to compare the efficacy of a new formulation of dinotefuran (Certador) to Venom which is also a dinotefuron formulation against whitefly adults and nymphs. The results indicated that both dinotefuran formulations provided comparable knockdown and residual control of adults and nymphs. The primary difference between how the two products are formulated is that Venom is a wettable granule (70%) and Certador is a soluble liquid (4.0 lb AI/gal). The most interesting result from this study was that Assail failed to provide comparable levels of consistent adult control as we have seen in previous years. Anecdotally, PCAs and growers have made similar observation, especially this past year. Future studies to track this decline in Assail efficacy will be continued.

Table 19. Knockdown and residual activity of foliar insecticides against whitefly adults, Spring 2016

		Adults / Leaf			
Treatment	**Rate**	**1 DAA-1**	**3 DAA-1**	**7 DAA-1**	**14 DAA-1**
Assail	5.3 oz	20.8b	13.1b	6.9b	36.3b
Certador	26 oz	6.3c	3.0c	5.4b	30.9b
Venom	4 oz	5.9c	2.5c	5.0b	26.6b
Untreated	-	47.2a	28.6a	20.2a	72.0a

		Adults / Leaf			
Treatment	**Rate**	**3 DAA-2**	**7 DAA-2**	**14 DAA-2**	**Avg.**
Assail	5.3 oz	28.8c	30.3b	29.0bc	23.2b
Certador	26 oz	19.5b	13.5c	20.5cd	14.2c
Venom	4 oz	17.2b	10.7c	18.8d	12.4c
Untreated	-	99.2a	87.4a	84.3a	62.7a

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

Table 20. Whitefly immature densities melons treated with foliar insecticides, fall 2016.

		Average nymphs cm2			
Treatment	**Rate**	**21-Sep**	**28-Sep**	**10-Oct**	**17-Oct**
Assail	5.3 oz	0.3a	5.7ab	2.0b	9.2ab
Certador	26 oz	0.1a	2.1b	0.6c	0.7c
Venom	4 oz	0.0a	2.7b	0.2c	1.9bc
Untreated	-	2.9a	19.5a	28.7a	32.3a

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

III. FOLIAR ALTERNATIVES DURING BLOOM FOR POLLINATOR PROTECTION /CROP SAFETY

A. Spring Trial -Sivanto and Other Alternatives

***Research procedures*:** Cantaloupe plots planted with 'Olympic Gold' were established at the Yuma Agricultural Center on 27 Apr, 2016 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. Two foliar sprays were applied on 6 Jun (early bloom-1st fruit set) and 14 Jun (full bloom-2" melons) with a CO_2 operated boom sprayer at 50 psi and 23.5 gpa. A broadcast application was delivered through 2 TXVS-18 ConeJet nozzles per bed. An adjuvant, Dyne-Amic, was applied at 0.25% v/v to all treatments. Assessments of whitefly adults were conducted similar to the trials above. A crop safety phytotoxicity rating was made for each product following each application using the following index: 1-no observable damage; 2- very slight damage with an occasional leaf with marginal necrosis; 3-Damage acceptable with obvious marginal necrosis and chlorotic spotting on an occasional older leaf; 4- Damage not acceptable with marginal necrosis on numerous leaves with heavy chlorotic spotting on leaves.

Summary: We continued this trial in 2016 to address the 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, as well as a number of other important products. Thus, the objective of this trial was to determine the efficacy of alternative foliar insecticides for whitefly control on melons during bloom that have low toxicity against honeybees (not on the EPAs proposed list). Results of the trial were not encouraging. Fulfill, Coragen and Miteus were presumed to have activity against whiteflies and are not considered toxic to honey bees. However, none of these compounds provided adequate knockdown or residual control of adults (Table 21). Only Sivanto and Assail (neonicotinoid) provided what would be considered acceptable control of whitefly adults. 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 phytotoxicity. Result of our crop safety rating were encouraging, particularly for the 10 oz rate where signs of marginal necrosis and necrotic spotting were considered light (Table 22).

Table 21. Knockdown and residual activity of foliar insecticides against whitefly adults, Spring 2016

		Adults / Sample						
		1 DAA-1	3 DAA-1	7 DAA-1	1 DAA-2	3 DAA-2	7 DAA-2	
Treatment	Rate/ac	7-Jun	9-Jun	13-Sep	15-Jun	17-Jun	21-Jun	Avg.
Sivanto	14 oz	1.8c	0.4c	5.6c	3.1b	4.6c	15.7b	5.2d
Sivanto	10 oz	1.5c	1.3b	9.0c	5.0b	5.2bc	13.7b	5.9d
Assail	5.3 oz	4.2bc	2.3b	13.4bc	4.6b	9.8b	28.8b	10.5c
Coragen	7.5 oz	16.5a	13.4a	27.8ab	52.5a	72.4a	83.2a	44.3b
Fulfill	2.8 oz	19.2a	11.4a	39.5a	107.5a	118.8a	144.8a	73.5ab
Miteus	2 pts	13.9ab	14.6a	37.9a	54.5a	69.6a	110.9a	50.2b
Untreated	-	21.9a	19.1a	47.5a	72.8a	129.2a	179.8a	78.4a

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

Table 22. Crop safety rating for melons, spring 2016.

		Crop Safety Rating	
		7 DAA-1	7 DAA-2
Treatment	Rate/ac	13-Jun	21-Jun
Sivanto	14 oz	**2.4a**	**2.8a**
Sivanto	10 oz	**2.0a**	**2.3b**
Assail	5.3 oz	1.0b	1.0c
Coragen	7.5 oz	1.0b	1.0c
Fulfill	2.8 oz	1.0b	1.0c
Miteus	2 pts	1.0b	1.0c
UTC		1.0b	1.0c

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

B. Fall Trial -Sivanto Spray Timing/Frequency on Crop Safety

***Research procedures*:** Cantaloupe plots planted with 'Expedition' were established at the Yuma Agricultural Center on 19 Aug, 2016 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. A total of 4 sprays were applied based on plant phenology. Application (A) was applied pre-bloom at the 2-3 leaf stage on 2 Sep; Application (B) was made at pre-bloom at the 5-6 leaf stage on 9 Sep; Application (C) was made during bloom when melons were 2" in diameter on 22 Sep, and Application (D) was made during early netting stage on 2 Oct. The table below shows the timing and frequency of Sivanto (10 oz)

treatments. An industry standard treatment was included and plots were treated as follows: (A) Venom, 4 oz; (B) Exirel, 15 oz; (C & D) Assail, 5.3 oz. An adjuvant, Dyne-Amic, was applied at 0.125% v/v to all treatments. All applications were made with a CO_2 operated boom sprayer at 50 psi and 23.5 gpa. A broadcast application was delivered through 2 TXVS-18 ConeJet nozzles per bed. A crop safety phytotoxicity rating was made like previous trials above.

Summary: Based on the spring trial, this study was designed to determine how spray timing and frequency of Sivanto at 10 oz affected crop safety. This involved making 1 or 2 applications during the pre-bloom stage as well as during Bloom-Fruit set. We compared the phytotoxicity to melon leaves after sprays were made during both crops stages. The results are interesting and showed that 2 pre-bloom applications made when plants were relatively small resulted in acceptable damage to melon leaves (Table 23). Furthermore, as the plants continued to grow during fruit set, the damage eventually disappeared; essentially the plant outgrew the marginal necrosis on leaves. However, applications made during the bloom-fruit set period caused significant phytotoxicity. This study suggests that Sivanto can be safely used to control Whiteflies and CYSDV when plants are young, but growers take risks of significant phytotoxicty if applications are made after plants begin setting fruit.

Table 23. Crop safety rating for melons treated with Sivanto at pre-bloom and fruit set, spring 2016.

			Crop Safety Rating			
			Pre-bloom		Bloom/Fruit set	
Treatment	Timing	Application Timing	6 DAA-A	6 DAA-B	6 DAA-C	6 DAA-D
Sivanto-10 oz	Pre-bloom	A	2.0a	1.0b	1.0b	1.0b
Sivanto-10 oz	Pre-bloom	AB	2.0a	2.0a	1.0b	1.3b
Sivanto-10 oz	Fruit set	C	1.0b	1.0b	**3.5a**	2.8a
Sivanto-10 oz	Fruit set	CD	1.0b	1.0b	**3.3a**	**3.6a**
Sivanto-10 oz	Pre & Fruit set	ABCD	2.0a	2.0a	**3.5a**	**3.3a**
Standards	Pre & Fruit set	ABCD	1.0b	1.0b	1.0b	1.0b
Untreated	-	-	1.0b	1.0b	1.0b	1.0b

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

IV. SOIL AND FOLIAR INSECTICIDE PROGRAMS

*Fall Melons – Soil Insecticide * Variety Management Program*

***Research procedures*:** Cantaloupe plots planted with 'Expedition' and 'Caribbean King' were established on 19 Aug, 2016 at the Yuma Agricultural Center. Plots consisted of one 84-inch bed, 75 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

At-plant, Soil Treatment (rate)	Side-dress (rate/ac)	Foliar Treatments
Venom (6 oz)	Venom (6 oz)	Sprayed 6 times
Sivanto (28 oz)		
UAEXP-8-16		

Spray Date	Plant Stage	Foliar insecticides applied
1-Sep	2 lf	Scorpion - 7 oz
7-Sep	4 lf	PQZ - 3.2 oz + Dicipline- 6 oz
12-Sep	6-8 lf	Exirel - 20 oz + Dicipline- 6 oz
19-Sep	Early bloom	Assail - 5.3 oz +Danitol - 14 oz
26-Sep	1st fruit set	PQZ - 3.2 oz + Danitol 14 oz
10/12	Early netting	Assail (5.3 oz) +Courier (20 oz)

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). 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 3^{rd} -4^{th} 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 50 ft within each plot at various interval after injection (DAA). At harvest, the percent of leaves in the plot infected with CYSDV were estimated. 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 25 row ft within each plot. Plots were harvested 6 times over a 2 week period beginning Oct 29. 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.

Summary: The purpose of this trial was to evaluate a standard fall whitefly/CYSDV management program comparing Sivanto and Venom to the experimental UAEXP 24-8 using the same conventional foliar insecticide spray regime. We conducted the trial on two different melon varieties (the western shipper “Expedition” and the harper “Caribbean King”) to examine differences in CYSDV and Yield responses. Whitefly populations were lighter than what we’ve seen in previous years, but came on heavy about later during fruit set. Prior to and after the 1^{st} spray, whitefly adult numbers were significantly lower in the UAEXP 24-8 compared with the untreated check. Following the side-dress

application adult numbers were reduced comparably in all soil-sprayed treatments relative to the non-treated check in both varieties (Table 24). Averaged across the trial, whitefly numbers did not differ significantly in the Venom, Sivanto or UAEXP 24-8 treatments. Similarly, CYSDV incidence was significantly lower in the soil treated plots compared to the untreated, regardless of melon variety. Further, CYSDV incidence did not differ among the three soil treatments. In the Expedition variety, all treatments reduced CYSDV incidence by greater than 65% at harvest. In the Caribbean King, virus reduction was slightly greater, particularly for Sivanto (~80%). The significant suppression of CYSDV symptoms resulted in large yield differences between the soil treatments and the untreated control. All treatments, regardless of variety, had significantly larger melons and higher Brix levels. The number of large fruit and Brix levels did not differ among the soil treatments, but Brix Levels as expected were higher in the harper variety. From this study, in addition to a similar study in 2014, we can conclude that Sivanto can be considered a viable soil applied alternative to the standard Venom at-plant application. Furthermore, UAEXP clearly holds promise as a soil alternative comparable to what growers now expect from Venom. Although the Caribbean King variety did not have significantly lower whitefly numbers or virus incidence than Expedition, the Harper variety definitely had higher sugar levels in the marketable fruit.

Table 24. Activity of foliar and soil insecticides by variety against whitefly adults, Spring 2016

		Adults / Leaf						
Soil Treatment	**Variety**	**Pre-spray**	**4 DAA1**	**4 DAA2**	**4 DAA3**	**5 DAA4**	**5 DAA5**	**Trial Avg.**
Venom	**Expedition**	2.3ab	40.0ab	5.3b	5.5b	4.6b	1.1b	9.8b
Sivanto		2.3ab	69.2ab	10.5b	9.2b	4.2b	3.0b	16.4b
UAEXP 24-8		1.1b	24.9b	4.0b	5.5b	4.9b	1.6b	7.0b
Untreated		5.1a	90.8a	24.9a	30.1a	15.7a	21.3a	31.3a

		Adults / Leaf						
Soil Treatment	**Variety**	**Pre-spray**	**4 DAA1**	**4 DAA2**	**4 DAA3**	**5 DAA4**	**5 DAA5**	**Trial Avg.**
Venom	**Caribbean King**	1.1b	39.2a	6.5bc	6.6b	5.0a	1.5b	9.9b
Sivanto		1.4b	65.6a	8.5b	9.1b	6.5a	1.6b	15.4b
UAEXP 24-8		1.5b	14.1b	4.1c	6.3b	5.0a	1.5b	5.4b
Untreated		7.2a	49.2b	37.7a	30.5a	12.3a	23.3a	26.7a

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

Table 25. Incidence of CYSDV in two melons varieties treated with foliar and soil insecticides, fall 2016.

Soil Treatment	Variety	CYSDV Incidence (No. symptomatic leaves / 50 ft)			% CYSDV Infection at Harvest
		21-Sep	3-Oct	12-Oct	
Venom	Expedition	0.0b	67.7b	108.3b	25.0b
Sivanto		0.0b	56.3b	102.0b	25.0b
UAEXP 24-8		0.3b	61.0b	101.0b	26.8b
Untreated		4.7a	161.0a	246.3a	80.0a

Soil Treatment	Variety	CYSDV Incidence (No. symptomatic leaves / 50 ft)			% CYSDV Infection at Harvest
		21-Sep	3-Oct	12-Oct	
Venom	Caribbean King	0.0b	35.3b	56.7b	20.0b
Sivanto		0.2b	35.3b	48.7b	15.0b
UAEXP 24-8		0.0b	49.0b	78.0b	28.3b
Untreated		1.7a	153.7a	202.0a	73.3a

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

Table 26. Fruit yields and quality for two melons varieties treated with foliar and soil insecticides, fall 2016.

Soil Treatment	Variety	Avg. Fruit / 25 row ft			
		Large	Small	Total Fruit	Brix (%)
Venom	Expedition	31.8a	5.5ab	37.3a	9.2a
Sivanto		32.8a	1.8b	34.5a	9.5a
UAEXP 24-8		29.5a	4.0b	33.5a	9.3a
Untreated		14.8b	14.0a	28.8a	6.4b

Soil Treatment	Variety	Avg. Fruit / 25 row ft			
		Large	Small	Total Fruit	Brix (%)
Venom	Caribbean King	25.5a	8.3a	33.8a	12.4a
Sivanto		27.0a	8.5a	35.5a	12.0a
UAEXP-8-16		27.8a	7.8a	35.5a	12.1a
Untreated		16.5b	13.0a	29.5a	10.2b

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