Arizona Department of Agriculture

AILRC Grants Program – Final Report for 2022

Project 22-03

Project Title **Western Flower Thrips Insect Management in Desert Lettuce**

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Location of Research: Yuma Valley Agricultural Center

Project Goals and Objectives

Western flower thrips (WFT) is one of the most economically important pests that infests desert lettuce because of the cosmetic scarring they cause on marketable lettuce. PCAs have traditionally been able to prevent feeding damage on leaves with a limited number of insecticides. However, that recently changed. A new thrips vectored tospovirus, *Impatiens Necrotic Spot Virus* (INSV) was found infecting plants in Yuma lettuce last spring and threatens to make WFT control even more important, and likely more difficult. PCAs and growers must now be very concerned with preventing WFT from feeding and colonizing young plants as they are the primary vector of INSV in lettuce, and if not properly controlled, can result in widespread outbreaks of the virus like growers experienced in Salinas in the past year.

Transmission and infection by INSV is quite unlike other insect transmitted viruses we see in the desert. For example, mosaic viruses found in spring melons and the yellows virus we see infecting fall melons each fall (CYSDV) are transmitted and acquired by adult aphids and whiteflies. In contrast, INSV is transmitted by the adult WFT, but is acquired by the immature larvae. Consequently, control of both adults and larvae is essential if infection by INSV is to be prevented.

Normally, PCAs required 2-3 insecticide sprays each season to adequately manage WFT and prevent damage to lettuce. For the most part, they have been able to accomplish this with two insecticide products, Radiant and Lannate. However, with MRL issues associated with Lannate, alternatives for effectively controlling WFT are now minimal. Furthermore, cultural control practices such as sanitation will likely become more important to suppress overall WFT numbers. Unfortunately, we do not have a complete grasp on how WFT survives outside of lettuce, particularly on weeds. This is important since it has already been shown that weeds (cheeseweed, purslane, nettleleaf goosefoot and sowthistle) collected from Tacna and Bard this summer were found to be infected with INSV. These weeds may serve as reservoirs for both thrips and INSV throughout the year, particularly if WFT reproduce on them.

The long-range objective of this work is to better understand the local life history and seasonality of WFT on crops and weeds found within the Yuma cropping system to better understand their movement onto lettuce each season and to predict their occurrences. In addition, this project will begin examining new and existing insecticide products and application methods that may be useful to growers and PCAs in reducing the threat of INSV. The data generated from this project is intended to help us better understand thrips population dynamics in the desert and how this may influence insecticide management and INSV epidemiology.

Methods and Materials

I. Monitoring Thrips Activity in Crops and Weeds

The goal of this study was to determine which plant hosts have the greatest abundance of thrips during the lettuce growing season, and which of them can serve as a reproductive host for thrips. This was determined by measuring adult and larval thrips abundance on a bi-weekly basis. Host plants monitored when they were in production include lettuce, celery (INSV hosts), broccoli, cauliflower, alfalfa, cotton, melons, durum wheat, Sudan grass, Teff grass and several weeds. All crops were sampled within a 1-mile area of each other. WFT were monitored every two weeks from 1 field on representative crops found in 5 sites throughout Yuma including: Tacna, Dome Valley, North Gila Valley, South Yuma Valley and Yuma Ag Center. WFT were sampled using a common sampling procedure to all host plants – beat pan sampling. This allowed us to collect both adults and larvae from all plants to determine host suitability. At each site and for each crop, we sampled plants from 1 field where numbers of thrips from 5 plants / location were recorded. Relative thrips numbers were measured by beating plants vigorously against a screened pan (12-inch x 7-inch x 2-inch) 5-6 times. A 6-inch by 6-inch yellow sticky card is placed inside of the pan to catch the dislodged thrips. Sticky cards are then taken to the laboratory where adults and larvae are counted under magnification. We also placed yellow sticky cards around lettuce fields to monitor adult movement, and also include yellow sticky trap data from traps included in our Areawide Trapping Network that are near the monitoring locations.

II. Vacuum Sampling Western Flower Thrips from Lettuce and Brassica Transplants

Adult western flower thrips (WFT) are collected from transplants using a modified vacuum method that employed a DeWALT DCV517 ½ gallon cordless portable vacuum which was fitted with cloth-screened 150 ml containers to capture and retain vacuumed adults (see images). On each collection date, samples were collected from individual transplant trays of lettuce, cauliflower, and broccoli located either on tables in the nursery or from trays removed from bins in the field just prior to transplanting. Vacuuming was conducted by make 5 passes across each tray (lengthwise), slowly passing over the tray and contacting the upper 1/3 of the plants during the process. On each sample date, we sampled 160-200 trays of lettuce (40 plants / container from 4-5 locations in the nursery) and 80-120 trays of cauliflower/broccoli (40 plants / container from 2-3 locations). Containers with vacuumed WFT are then placed in ice chest and transported to the laboratory. Once in the lab, containers are placed in a refrigerator for short period (no more than 8 hrs), after which adults and larvae are removed from vials, counted, and placed in 100 microliters (µl) of DNA/RNA Shield (Zymo Research) and then stored n the freezer (-20 °C) for testing for INSV via PCR later.

We also monitored the incidence of INSV during the 2021-2022 produce season by surveying lettuce throughout the area beginning in October. We specifically began searching for INSV in areas where known lettuce transplants were being grown and then expanded our survey within a 5-mile area surrounding them. We estimated % INSV field incidence by counting the number of incected in 3 beds by 100 ft in 2 locations in each field. We confirmed the presence of INSV by sampling a single representative plant in each field using Immunostrip test kits (AgDia).

III. Insecticide Efficacy

All trials were planted at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42-inch centers. Stand establishment was achieved using overhead sprinkler irrigation and furrow irrigated thereafter. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Numbers of western flower thrips (WFT) from 5 plants per replicate were recorded at various sample dates following each application (DAA).

Relative thrips numbers were measured by removing plants and beating them vigorously against a screened pan (12-inch x 7-inch x 2-inch) for a predetermined time (10 s). A 6-inch by 6-inch sticky card was placed inside of the pan to catch the dislodged WFT. Sticky cards were then taken to the laboratory where adult and larvae were counted. Because of heterogeneity of mean variances, WFT 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 and graphs. Below are specifics for trials conduced in 2021-22.

Nipsit seed: Nipsit-treated and untreated "Del Sol" Solid King' was planted and germinated on three wet dates 22 Sep 2021, Oct 19, 2021 and Feb 23, 2022. All seed was planted at a 2" spacing. Nipsit seed was provided by the manufacture (Valent). No additional insecticides were applied.

Drip chemigation: 'Valley Heart' was planted and germinated on 22 Sep 2021. The drip chemigation treatments were applied through the drip tape on Oct 20 and Nov 3. The tape was placed 6" below the seed line and the system was set up to deliver 0.67 gpm/100 ft of tape at 8 psi. The 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 ~25 minutes, followed by another 3 hrs of irrigation to flush the lines and irrigate the plots. Plants were sampled at the 4-leaf stage for thrips densities. No additional insecticides were applied.

At-planting, shank applications: 'Solid King' was planted and germinated on three wet dates 22 Sep 2021, Oct 19, 2021 and Feb 23, 2022. . All treatments were applied to the soil at planting as a sub-surface soil injection (SSI). The SSI treatments were injected 1.5" below each seedline at planting using a modified fertilizer shank in a total water volume of 20.5 GPA. No additional insecticide applications were applied.

Foliar Insecticides: Romaine' Valley Heart' was direct seeded on 19 Jan, 2022. Two applications were made on 1 and 15 Mar with a CO_2 pressurized boom sprayer that delivered a broadcast application at 50 psi and 26.5 gpa through 2 TXVS-18 ConeJet nozzles per bed. An adjuvant, Dyne-Amic, was added to all treatments at 0.25%v/v. Prespray thrips counts were 1.4 adults and 0.7 larvae / plant.

Results

I. Monitoring Thrips Activity in Crops and Weeds

WFT peaked during the late spring in both 2021 and 2022. All crop and weed hosts sampled contained both adult and larvae, indicating they all served as reproductive hosts. When sampling for WFT across all crops and locations, it was not surprising that alfalfa harbored the largest abundance of both adults and larvae. Alfalfa seed and hay crops were particularly attractive to thrips when blooming (Figures 1 and 3). Among the summer crops, Alfalfa and Sudan grass had peak abundance of WFT per plant in May and June (Table 1). However, WFT could easily be found reproducing in cotton and melon crops in Apr and May. During the winter months, alfalfa and lettuce had the largest number of thrips, albeit significantly lower than during the warmer months. Among the produce crops, lettuce supported more than 5-fold higher numbers than broccoli, cauliflower of celery.

Weeds were also a major reproductive host of WFT, particularly in the spring moths. Among the weeds sampled during the produce season, little mallow, London rocket and nettleleaf goosefoot were favored by WFT (Figure 3 and Table 2). During the summer months, little mallow and goosefoot supported the largest WFT abundance. WFT abundance varied by growing region as well. During the lettuce growing season, WFT abundance was greatest in the Roll area and least in the Gila Valley during November (Figure 2). During the spring at the end of the season, WFT were particularly abundant in Dome Valley, and least abundant in Wellton consistent with lettuce abundance. Trapping data showed similar trends in WFT abundance (Figure 4). Thrips movement, as measured by the yellow sticky traps, peaked in November in Roll and during March, particularly abundant in Yuma Valley, Gila Valley and Roll.

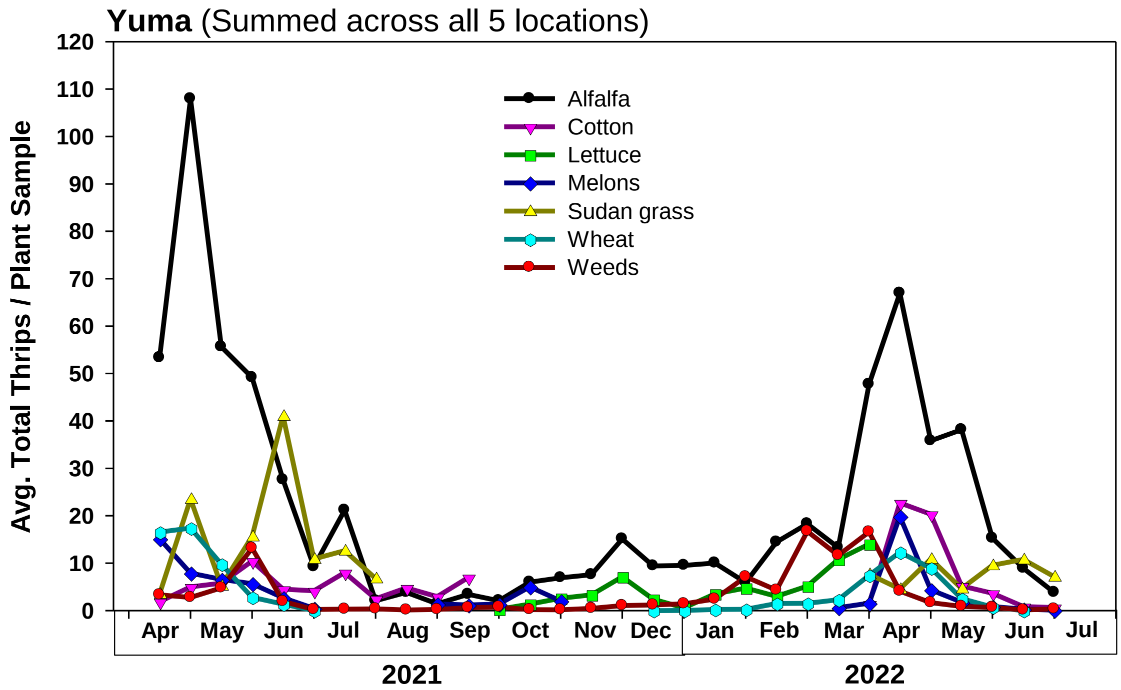


Figure 1.

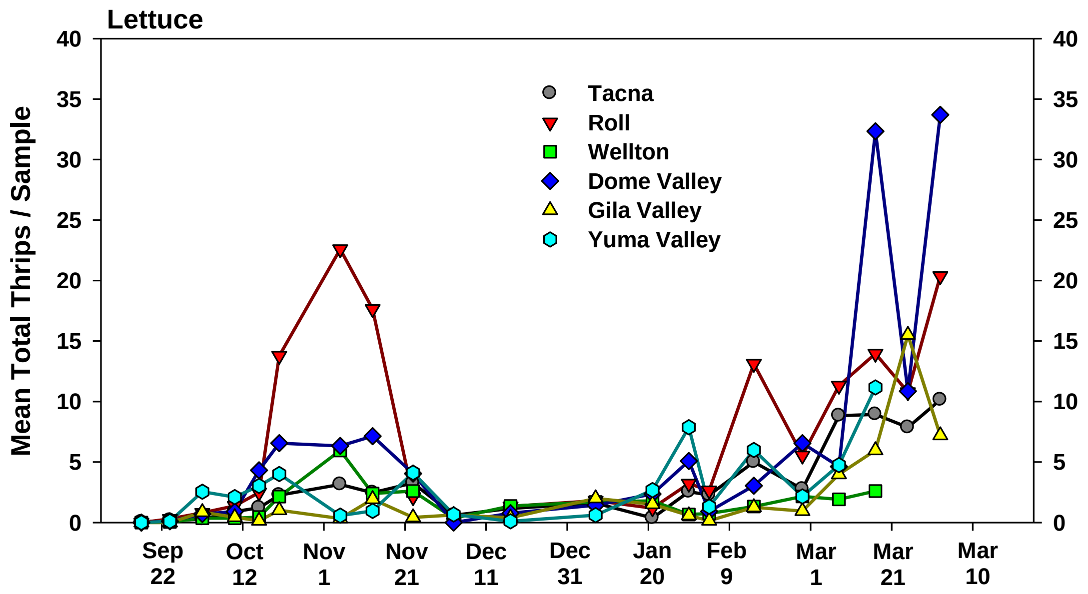


Figure 2.

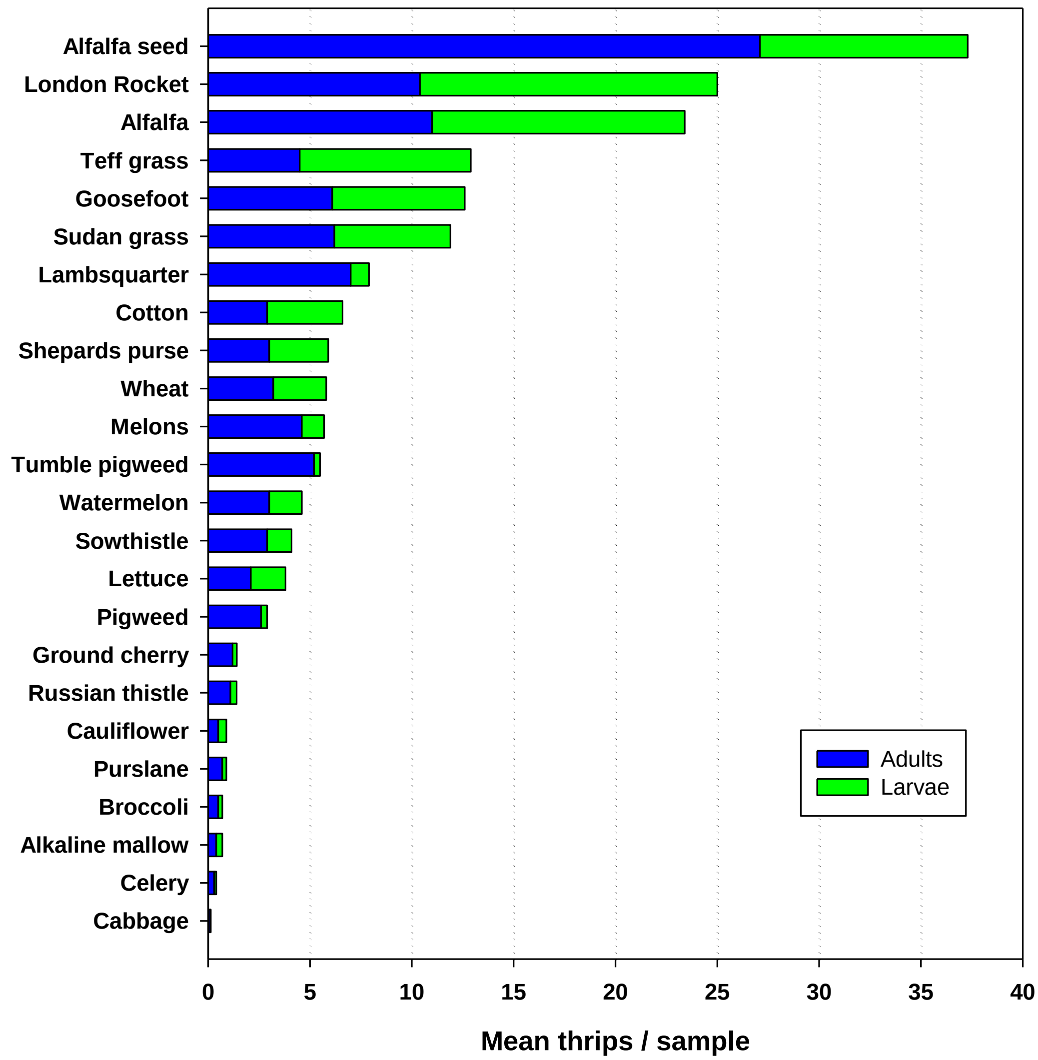

Alfalfa seed
London Rocket
Alfalfa
Teff grass
Goosefoot
Sudan grass
Lambsquarter
Cotton
Shepards purse
Wheat
Melons
Tumble pigweed
Watermelon
Sowthistle
Lettuce
Pigweed
Ground cherry
Russian thistle
Cauliflower
Purslane
Broccoli
Alkaline mallow
Celery
Cabbage
Adults
Larvae
0
5
10
15
20
25
30
35
40
Mean thrips / sample

Figure 3.

Table 1.

Crop	Avg WFT / Plant Sep-Mar	Avg WFT / Plant Apr-Aug	Peak abundance
Celery	0.3	-	November
Cauliflower	0.9	-	February
Broccoli	0.7	-	March
Lettuce	**4.5**	**-**	**March**
Watermelon	-	4.7	May
Cantaloupe	2.2	5.2	April
Cotton	-	6.3	May
Durum wheat	0.8	6.7	May
Sudan grass	**-**	**11.6**	**June**
Alfalfa	**9.4**	**32.2**	**May**

Table 2.

Weed species	Avg WFT / Plant Sep-Mar	Avg WFT / Plant Apr-Aug	Peak abundance
Little mallow	4.7	**32.4**	**May**
London Rocket	**24.7**	-	**Mar**
Needleleaf goosefoot	**11.2**	**11.1**	**Mar**
Palmer amaranth	3.8	4.8	May
Lambsquarter	7.8	-	Apr
Annual sowthistle	2.5	4.6	May
Shepherd’s purse	5.8	-	Jan
Tumble pigweed	-	5.1	June
Ground Cherry	1.1	3.7	June
Russian thistle	-	2.1	July
Alkali mallow	0.2	0.9	May
Purslane	0.3	0.8	May

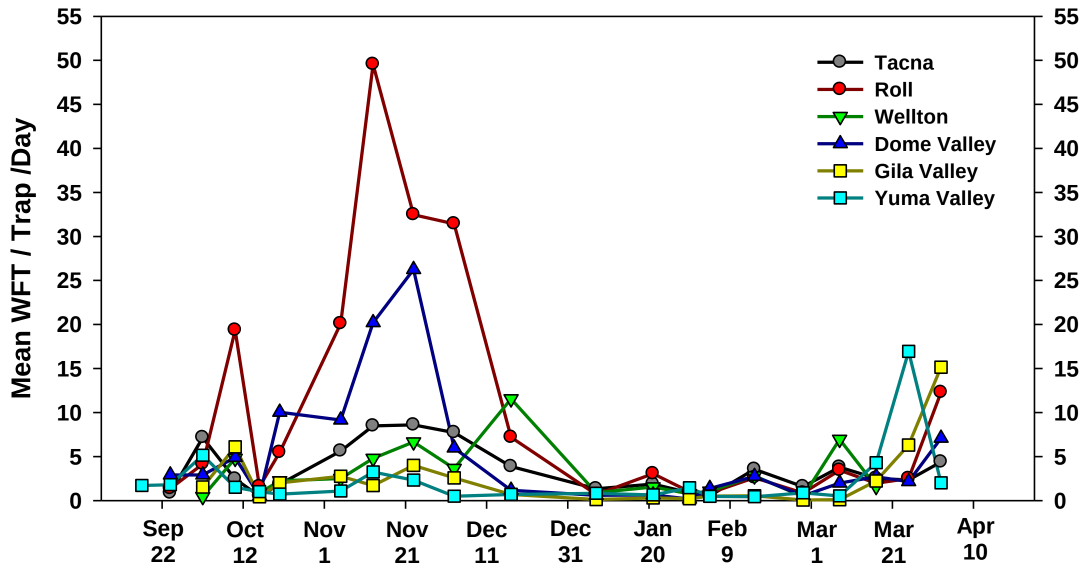


Figure 4.

II. Vacuum Sampling Western Flower Thrips from Lettuce and Brassica Transplants

Sampling of lettuce and cauliflower transplants began as plants arrived in mid-September at a single nursery in the Gila Valley. All transplants sampled were grown in Salinas and transported to Yuma. Samples were collected 24-48 hrs after arrival and before treatment with systemic insecticides in the nursery. Both WFT adults and larvae were collected from the lettuce and cauliflower transplants with abundance greatest during late Sep and early Oct (Figure 5 and 6). WFT numbers were higher in the lettuce, exceeding more than 50 WFT per sample on several samples, but were also found in the cauliflower plants. In 7 of the 10 samples collected from lettuce, adults infected with INSV were found in the lettuce, and only a single sample showed infected adults in the cauliflower. However, these findings are significant and conclusively showed that INSV entered the desert in fall of 2021 via lettuce and brassica transplants. Prior to 2021, INSV had never been detected in Yuma. This also supports our contention that INSV does not bridge the summer gap between seasons on weeds.

Although we did not test lettuce transplants for INSV from this nursery, we were certain that some proportion of them were infected when planted in the field. To test this we surveyed known fields receiving lettuce transplants, both organic and conventional. We found that of 15 transplanted fields surveyed in the fall of 2021, 8 of them had INSV infected plants (Figure 7). We continued to sample these and surrounding direct-seeded lettuce fields throughout the remainder of the spring. Surprisingly, we found that INSV in direct-seeded lettuce next to or near all of the 15 transplanted fields. This further suggests that incoming lettuce serves as a point source for infected WFT and plants. Overall, we sampled a total of 243 lettuce fields for INSV and found INSV infected plants in 166 fields. The average incidence of INSV in fields was below 1% but a few direct-seeded fields (n=15) were found with >3% infection (Figure 8). The highest number of INSV infected fields were found in Tacna, Roll and Wellton in or near organic ranches (Table 3).

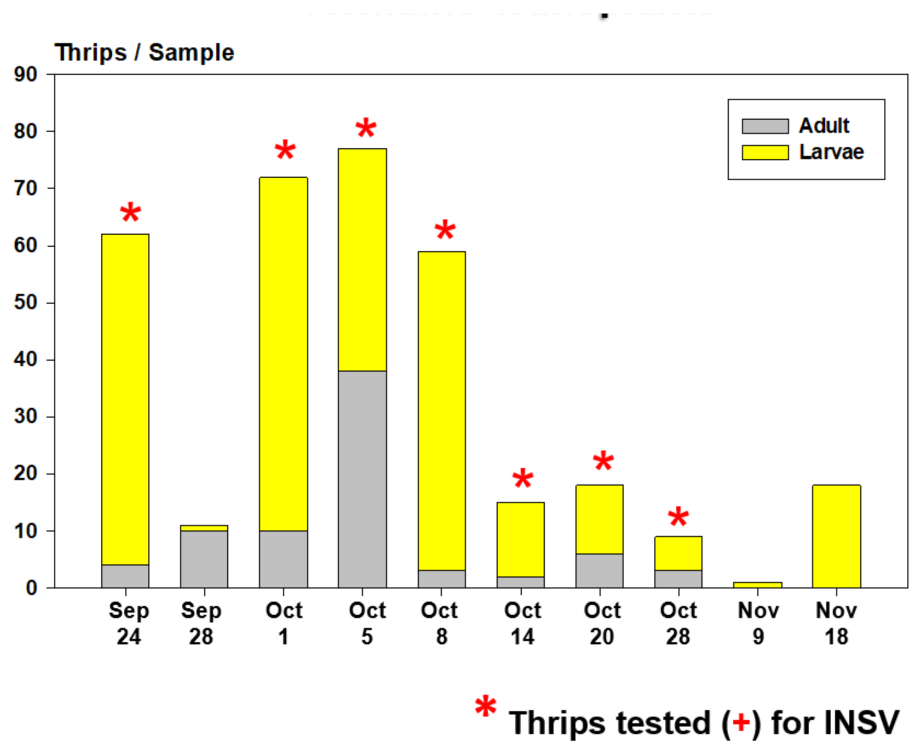


Figure 5.

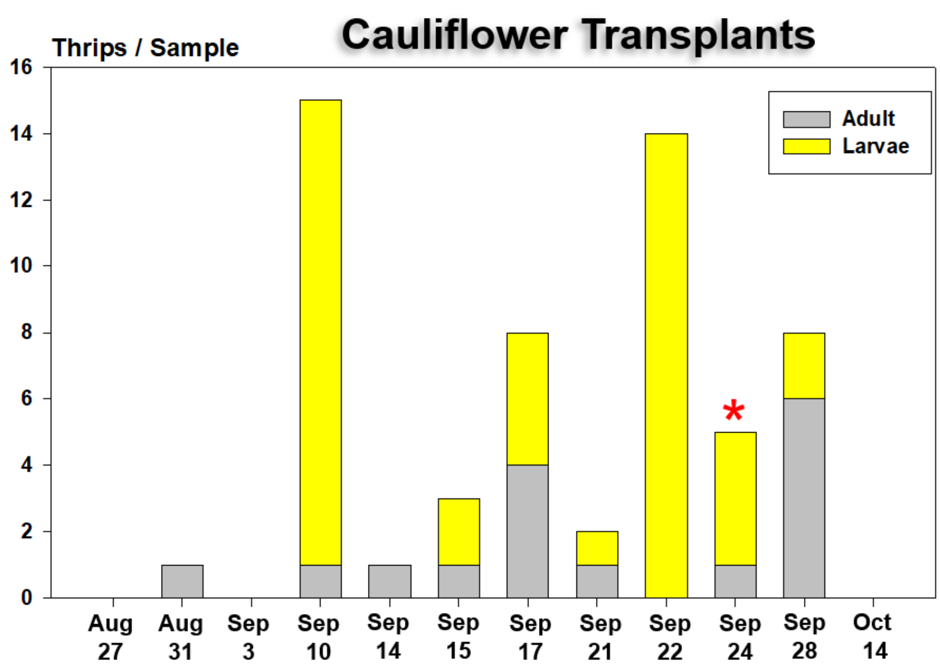
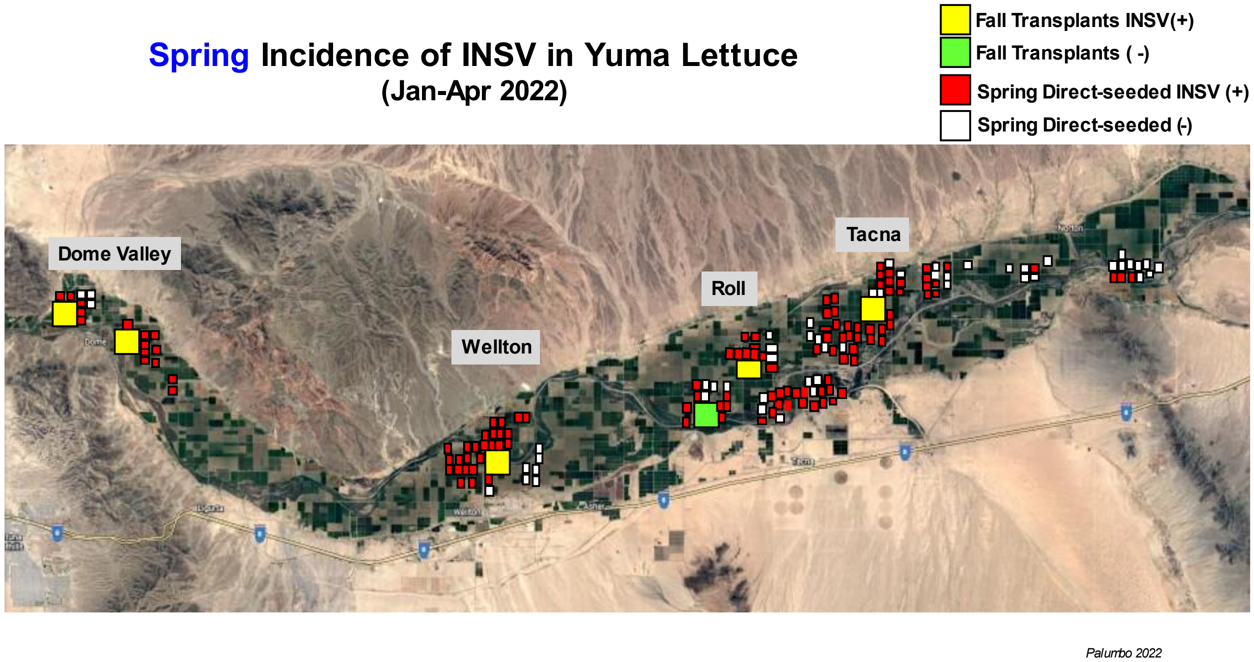


Figure 6.


Spring Incidence of INSV in Yuma Lettuce
(Jan-Apr 2022)
Fall Transplants INSV(+)
Fall Transplants (-)
Spring Direct-seeded INSV (+)
Spring Direct-seeded (-)
Dome Valley
Wellton
Roll
Tacna
Palumbo 2022

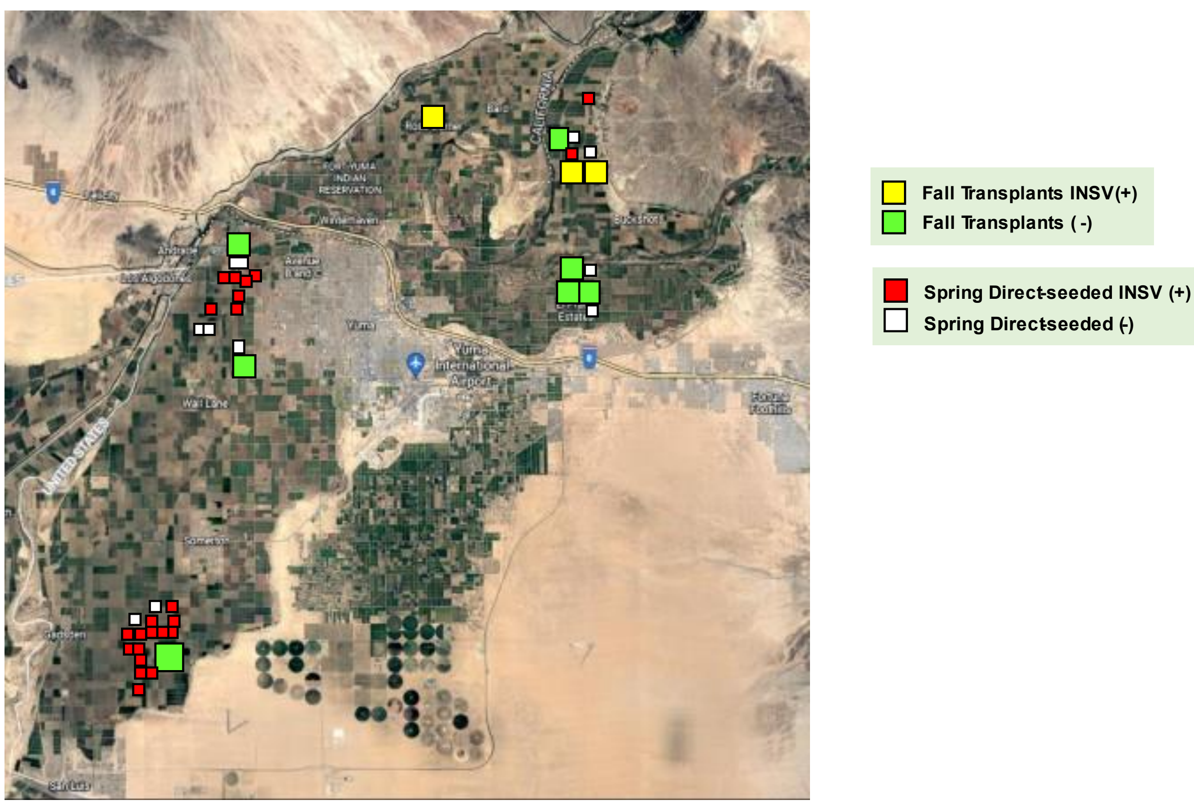

Fall Transplants INSV(+)
Fall Transplants (-)
Spring Direct-seeded INSV (+)
Spring Direct-seeded (-)

Figure 7.

Table 3

Location	Infect fields/ Total fields	Avg % INSV Field Incidence	Min - Max
Dome Valley	20/22	0.45	0.0 -3.2
Gila Valley	3/13	0.55	0.0 -6.7
Roll	20/30	0.25	0.0 - 0.8
Tacna	80/111	0.51	0.0 - 8.3
Wellton	26/32	1.29	0.0 - 6.9
Yuma Valley	17/26	0.55	0.0 - 2.7

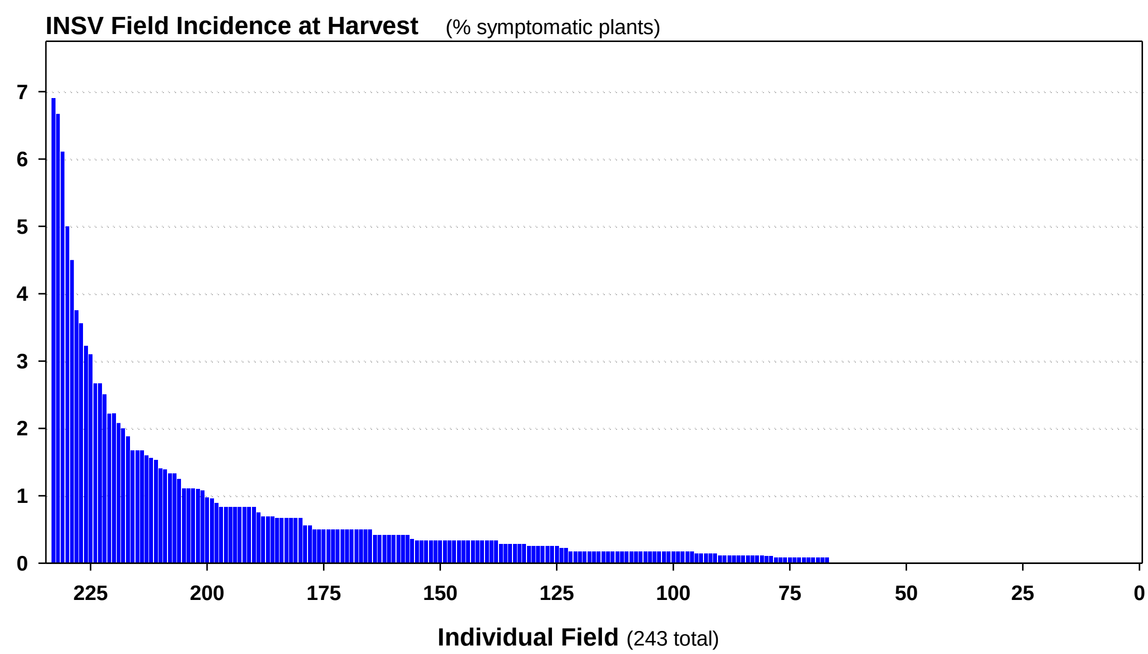


Figure 8.

III. Insecticide Efficacy

Nipsit seed: Three separate trials were planted with pelleted Nipsit lettuce, a clothianidin seed treatment. Earlier trials with flea beetles in lettuce showed that the treated seed could protect the plants for 14-21 days. The number of WFT were low in the fall trials but were about 5-fold higher in the spring trial. Our results showed that Nipsit did not significantly reduce WFT adult and larvae numbers for the duration of the trials (2-lf stage to 10-lf stage) (Figure 9). This is not surprising given the small amount of active ingredient on the seed, in addition to our results below with Belay (clothianidin) applied in the soil.

Drip chemigation: There was some indication out of Mexico that Beleaf (flonicamid) had soil systemic activity and would possibly control WFT via drip chemigation. We have observed WFT suppression with Beleaf at 2.8 oz/ac in foliar spray trials. However, following 2 drip applications at 14-day intervals we saw no control with Beleaf applied as a soil systemic (Figure 10). Similarly, the neonicotinoids Admire Pro and Belay did not significantly reduce WFT adults or larvae. However, Verimark (cyantraniliprole) did significantly reduce WFT compared to the untreated check. Unfortunately, the level of control (suppression) by Verimark via drip was not effective to prevent plant scarring or INSV.

At-planting, shank applications: The same insecticide products applied above in the drip chemigation trial were applied at-planting in these trials. The neonicotinoids and Beleaf were ineffective. However, Verimark significantly reduced WFT larvae in each of the three lettuce trials at levels that are economically effective (Figure 12). The treatment was particularly impressive in Trial 3 (Feb wet day) with higher WFT pressure. Verimark is an effective soil systemic insecticide against whiteflies and worms, and under these conditions shows promise for early season control of WFT and INSV, particularly when used in association of foliar spray applications.

Foliar Insecticides: This foliar spray trial compared the standard foliar insecticides (Radiant and Lannate) with alternative products known to suppress WFT (Minecto Pro, Torac and Beleaf). In addition, we included the new experimental product, Isocycloseram, which has previously show WFT activity. Following 2 sprays at 15 day intervals, the results clearly demonstrated that the alternative provided only suppression of adult WFT compared to the standards, but the Isocylcloseram provided as good as or better adult control than the standards (Table 4). A similar trend was observed for WFT larvae (Table 5). These results corroborate previous trials showing that isocycloseram has long residual control of WFT similar to Radiant and Lannate. We suspect that when this new insecticide becomes available to growers in 1-2 years that it will be a great rotational partner for Radiant, and will further resduce the industries reliance on Lannat.

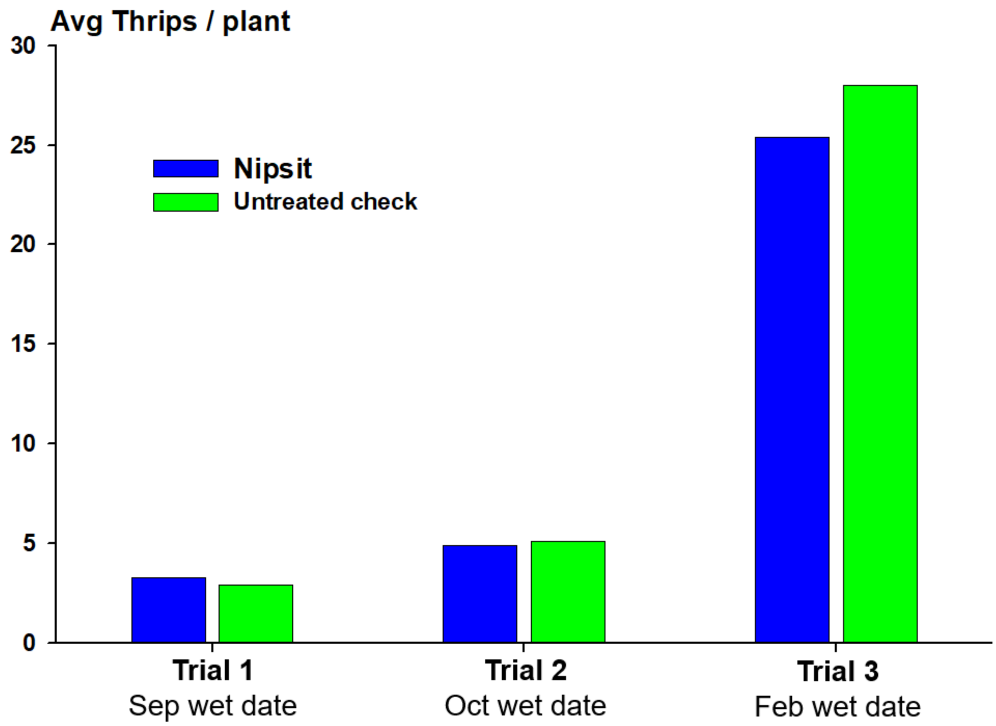


Figure 9.

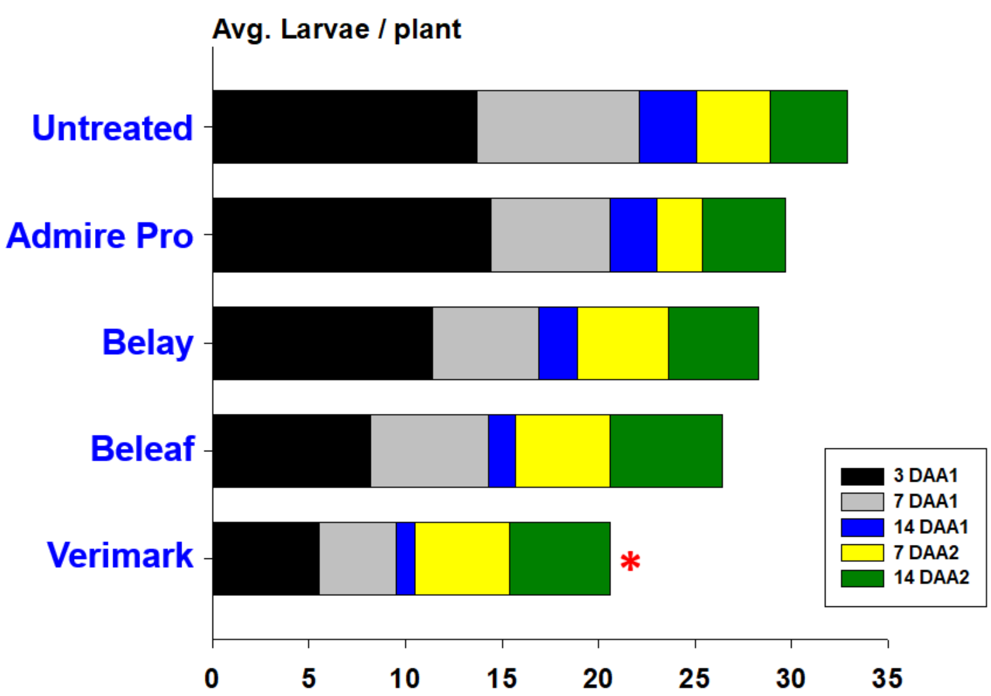


Figure 10.

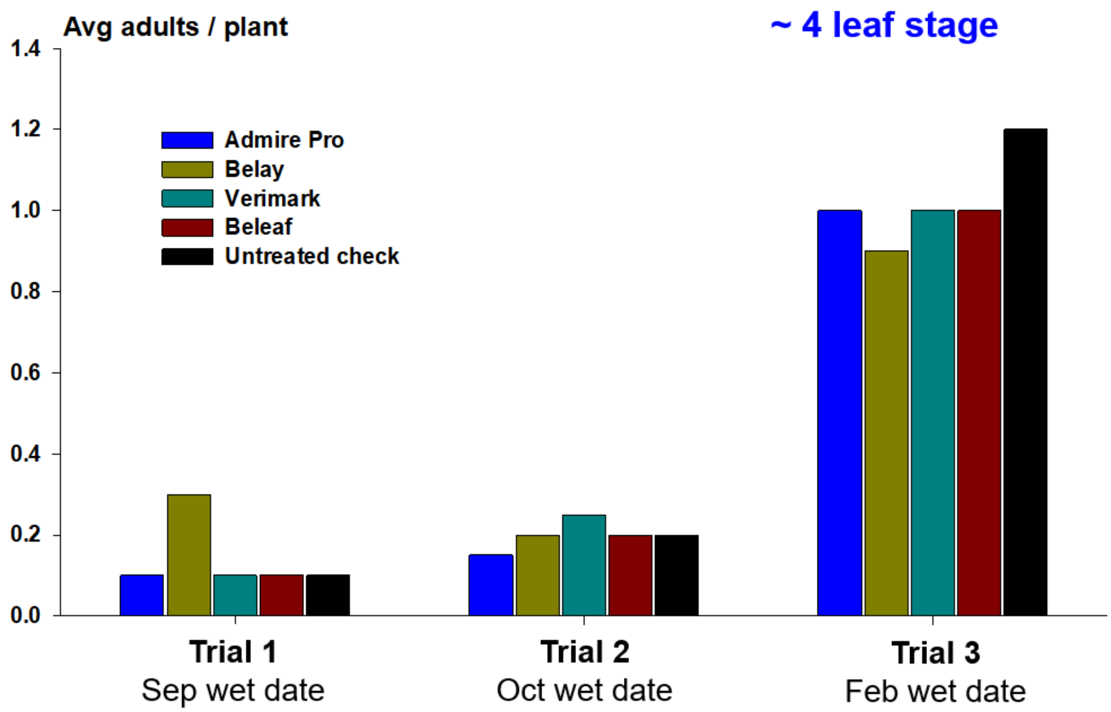


Figure 11

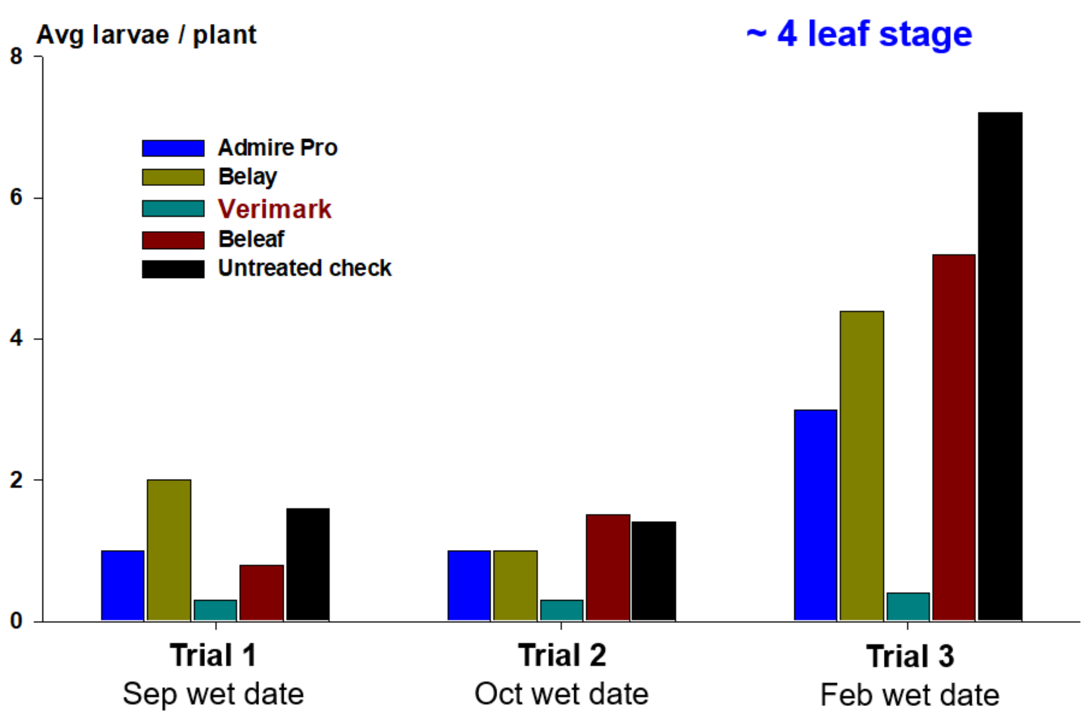


Figure 12.

Table 4

Treatment	Rate	WFT Adults / Plant															
		3 DAA1 **4-Mar**		7 DAA1 **8-Mar**		10 DAA1 **11-Mar**		14 DAA1 **14-Mar**		3 DAA2 **18-Mar**		8 DAA2 **23-Mar**		15 DAA2 **30-Mar**		**Trial Avg**	
Isocycloseram	3.1	0.3	b	0.8	b	2.4	bc	8.3	ab	4.1	bc	5.1	d	19.4	b	5.7	e
Isocycloseram	4.1	0.4	b	0.7	b	1.6	c	5.8	b	3.2	c	5.7	d	23.2	ab	5.8	e
Minecto Pro	10 oz	1.7	ab	1.4	b	5.6	ab	11.9	a	10.3	abc	15.6	ab	29.3	ab	10.8	b
Radiant	7 oz	0.6	b	0.6	b	3.8	abc	11.5	a	7.1	abc	5.3	d	24.4	ab	7.6	de
Lannate SP	0.8 lb	0.5	b	1.1	b	3.4	abc	12.3	a	5.6	abc	8.3	c	29.5	ab	8.7	cd
Torac	21 oz	1.2	b	1.0	b	4.2	abc	11.2	a	5.0	bc	11.4	bc	29.0	ab	9.0	bcd
Beleaf	2.85	0.7	b	1.2	b	3.5	abc	14.1	a	10.0	ab	19.3	a	32.4	a	11.6	bc
UTC	-	5.6	a	6.7	a	8.1	a	13.1	a	13.3	a	16.1	ab	21.3	ab	12.0	a

Table 5

Treatment	Rate	3 DAA1 **4-Mar**		7 DAA1 **8-Mar**		10 DAA1 **11-Mar**		14 DAA1 **14-Mar**		3 DAA2 **18-Mar**		8 DAA2 **23-Mar**		15 DAA2 **30-Mar**		**Trial Avg**	
		WFT Larvae / Plant															
Isocycloseram	3.1	0.6	b	2.0	b	2.2	bc	7.6	bc	2.1	cd	5.4	cd	21.6	cd	5.9	c
Isocycloseram	4.1	1.3	ab	2.5	ab	1.8	c	4.9	c	0.9	d	5.1	cd	11.3	de	3.9	cd
Minecto Pro	10 oz	3.8	a	2.0	b	10.0	ab	16.8	ab	9.7	bc	42.9	a	42.5	bc	18.2	b
Radiant	7 oz	0.3	b	1.5	b	1.3	c	4.0	c	1.0	d	3.2	d	11.0	e	3.2	d
Lannate SP	0.8 lb	0.6	b	1.7	b	2.2	bc	8.1	bc	3.6	cd	9.3	bc	23.4	cd	7.0	c
Torac	21 oz	3.1	a	4.3	ab	3.3	abc	9.5	bc	3.6	bcd	31.2	ab	32.1	c	12.4	b
Beleaf	2.85	1.6	ab	2.8	ab	3.7	abc	14.3	b	10.7	b	40.8	a	70.1	ab	20.5	b
UTC	-	3.5	a	7.5	a	11.3	a	35.9	a	50.1	a	99.9	a	106.3	a	44.9	a