Management of Western Flower Thrips in Head Lettuce with Conventional and Botanical Insecticides

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Abstract

Studies were conducted in three independent field trials to evaluate the efficacy of conventional and botanical insecticides against western flower thrips in head lettuce. Trials were conducted in spring lettuce under moderate and heavy populations pressures. Actara and Avaunt, two new experiential insecticides did not significantly control adults and provided only marginal activity against the larvae when applied alone. Combination of these products with either Lannate or Warrior significantly enhanced control, but usually not greater than that shown from the Lannate or Warrior applied alone. Several botanical products were evaluated (azadirachtin, pyrethrins, crop oils and garlic). Unfortunately, none of the botanical products significantly reduced thrips numbers to economically acceptable levels of control. Similar to previous studies, our results suggest that even the most efficacious products appeared to maintain thrips populations at constant levels and not necessarily reducing their numbers. More research needs to be conducted to determine the proper timing of applications to achieve optimal thrips using both conventional and botanical insecticides.

Introduction

Western flower thrips, *Frankiniella occidentalis*, have rapidly become important pests in head lettuce production. This thrips species is polyphagous and appears to have a wide host range in most vegetable producing areas. They primarily occur in large numbers on lettuce during the cooler growing parts of the season (Jan-Mar), and can build up to high numbers very rapidly. Adults often migrate onto lettuce crops during the winter months as weeds and other host plants dry down or are harvested. Under mild-warm temperatures, thrips reproduce quickly on lettuce. Thrips are considered a pest because of the cosmetic damage they cause to cap leaves on lettuce heads and the contamination in mature heads by thrips adults and nymphs. Grower tolerance for thrips damage and contamination has recently become very low in naked and film wrapped head lettuce. Consequently, PCAs treat often to prevent thrips from becoming established on heads before harvest. In the past few years, it has become more difficult to maintain thrips numbers at low levels. This may be in part due to their cryptic nature, hiding in the leaf margins and low in the plant allowing them to avoid many of the contact insecticides used for control. Thrips control in lettuce has become economically important and unfortunately, little is known about their management. This study was conducted to determine the efficacy of conventional and new insecticide compounds against thrips in spring lettuce under variable population pressure and growing conditions. In addition, several botanical products that could be used in certified organic lettuce production were evaluated as well.

Materials and Methods

Trial 1 - Experimental Insecticides: The field trial was conducted at the University of Arizona Yuma Agricultural Center. Lettuce 'Diamond' was direct seeded 1 Dec into double row beds on 42 inch centers. Plots consisted of 4 beds, 60 feet long with a two bed buffer between the plots. Plots were arranged in a randomized

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complete block design with four replications. Insecticide treatments and rates used in the trial are found in Table 1.

The foliar spray treatments were applied in 25 GPA total volume at 40 psi. A spreader/sticker was used in all treatments (DyneAmic at 0.25% v/v). Three, disc-type cone nozzles were used per bed. Three applications were made on 3, 10, 15 March. Evaluation of thrips control was based on the number of live adults and nymphs per plant sampled from the center 2 rows of each replicate at intervals following each application. Samples were taken on 1, 6, 9, 15, 19, and 22 March. Numbers of thrips adults and larvae from 8 plants per replicate were recorded on each sample. Samples were taken by removing plants and beating them vigorously against a screened pan for a predetermined duration. Inside of the pan was a sticky trap to catch the dislodged thrips. Sticky traps were then taken to the laboratory where adult and larvae were counted. Percentage reduction of thrips compared with the untreated control was calculated following the formula given by Henderson & Tilton (1955).

Trial 2 - Botanical Insecticides: The field trial was conducted at the University of Arizona Yuma Agricultural Center. Lettuce 'Diamond' was direct seeded 2 Dec into double row beds on 42 inch centers. Plots consisted of 4 beds, 60 feet long with a two bed buffer between the plots. Plots were arranged in a randomized complete block design with four replications. Insecticide treatments and rates used in the trial are found in Table 1.

The foliar spray treatments were applied in 25 GPA total volume at 40 psi. A spreader/sticker was used only in the Conventional Rotation (DyneAmic at 8 oz/acre). Three, disc-type cone nozzles were used per bed. Three applications were made on 2, 9, 14 March. .Evaluation of thrips control was based on the number of live adults and nymphs per plant sampled from the center 2 rows of each replicate at intervals following each application. Samples were taken on 28 Feb, 6, 9, 14, 17, and 21 March. Numbers of thrips adults and larvae from 5-8 plants per replicate were recorded on each sample. Samples were taken by removing plants and beating them vigorously against a screened pan for a predetermined duration. Inside of the pan was a sticky trap to catch the dislodged thrips. Sticky traps were then taken to the laboratory where adult and larvae were counted. Percentage reduction of thrips compared with the untreated control was calculated following the formula given by Henderson & Tilton (1955).

Table 1. Description of treatments and rates used in trials 1 and 2, YAC, Spring 2000.

Trial 1 - Experimental Insecticides		**Trial 2 - Botanical Insecticides**	
Treatment	**Rate (product/acre)**	**Treatment**	**Rate (product/acre)**
Actara 25W	4.5 oz	Neemix + Comate	1 pt + 4 oz
Actara +Warrior	3.0 oz +3.8 oz	Ecozin +Comate	10 oz + 4 oz
Actara +Lannate	3.0 oz + 0.8 lb	Pyrellin + Comate	1.5 pt + 4 oz
Success	6.0 oz	Enviropel + Tomahawk	32 oz + 12 oz
Success +Warrior	4.0 oz + 3.8 oz	Neemix + Trilogy	1 pt + 32 oz
Success +Lannate	4.0 oz + 0.8 lb	Neemix + Enviropel + Tomahawk	1 pt + 32 oz + 12 oz
Lannate SP	0.8 lb	Neemix + Trilogy + Tomahawk+ Pyrellin	1 pt + 32 oz + 12 oz +1.5 pt
Warrior T	3.8 oz	Ecozin + Enviropel+Tomahawk	10 oz + 32 oz + 12 oz
Avaunt	3.5 oz	Pyrellin + Enviropel + Tomahawk	1.5 pt + 32 oz + 12 oz
Avaunt +Warrior	3.5 oz + 3.8 oz	Comate (0.25%)	8 oz
Avaunt +Lannate	3.5 oz + 0.8 lb	Conventional Rotation	
Lannate + Warrior	0.8 lb + 3.8 oz	1st) Success 2nd) Lannate + Warrior 3rd) Success + Warrior	6.0 oz 0.8 lb + 3.8 oz 4.0 oz + 3.8 oz

Trial 3 - Late-season Lettuce. Lettuce 'Beacon' was direct seeded 15 Jan into double row beds on 42

inch centers. Plots consisted of 4 beds, 60 feet long with a two bed buffer between the plots. Plots were arranged in a randomized complete block design with four replications. Insecticide treatments and rates used in the trial are found in the table below. The foliar spray treatments were applied in 33 GPA total volume at 40 psi. A spreader/sticker was used only in the first four treatments (DyneAmic at 8 oz/acre), none was used in treatment 5); and comate at 0.125% v/v was used in the remaining treatments. Three, disc-type cone nozzles were used per bed. Three applications were made on 23 March, and 1 and 6 April. Evaluation of thrips control was based on the number of live adults and nymphs per plant sampled from the center 2 rows of each replicate at intervals following each application. Samples were taken on23, 27 and 30 March, and 4 and 12 April. Numbers of thrips adults and larvae from 5-8 plants per replicate were recorded on each sample. Samples were taken by removing plants and beating them vigorously against a screened pan for a predetermined duration. Inside of the pan was a sticky trap to catch the dislodged thrips. Sticky traps were then taken to the laboratory where adult and larvae were counted. Percentage reduction of thrips compared with the untreated control was calculated following the formula given by Henderson & Tilton (1955).

Treatment	Rate (product/acre)
1. Actara 25W	4.5 oz
2. Success	6.0 oz
3. Lannate + Warrior	0.8 lb + 3.8 oz
4. *Provado Rotation*	
Provado+ Lannate	3.75 oz + 0.8 lb
Provado+Thiodan	3.75 oz + 32 oz
Provado+Mustang	3.75 oz+ 4.2 oz
5. Diatect / Sulfur	6 lbs + 3 pts
6. Mpede	2.6 qts
7. Hot Pepper Wax	2 gal

Results and Discussion

Trial 1 - Experimental Insecticides: Thrips species in all of theses this studies were predominantly western flower thrips, *Frankiniella occidentalis*. Both adult and nymph populations were moderate-high at the beginning of the study (< 20 adults/ plant and > 80 larvae / plant; plants were in the early heading stage). In previous trials , Avaunt showed some activity against thrips, and Actara has been shown to have activity on other thrips species. However, when applied as individual compounds in head lettuce, they did not significantly control WFT adults and provided only marginal activity against the larvae (Tables 2-4). Combination of either Lannate and Warrior with these compounds significantly enhanced control, but usually not significantly greater than either the Lannate or Warrior applied alone (Figure 1). In contrast, the combinations of reduced rates of Success (4.0 oz) with Lannate or Warrior provided similar control as Success applied alone at a higher rates. Consequently, all three Success treatments controlled thrips similarly to the Lannate + Warrior combination.

Trial 2 - Botanical Insecticides: Because of the recent interest in certified organic lettuce production we evaluated several botanical formulations of azadirachtin (Neemix and Ecozin), pyrethrin (pyrellin), Garlic (Enviropel), and crop oil concentrates (Trilogy, Comate) which supposedly have activity against WFT. Adult and larval populations were moderate to high (> 100 total thrips; plants were in the early heading stage). Unfortunately none of the products provided much residual activity against either thrips adults or larvae (Table 5). Of the botanicals insectcides evaluated, the Comate and Neemix + Comate, provided the most consistent activity. However, neither treatment provided greater than 25% reduction of total thrips (Figure 2). This may have been a result of marginal

insecticide efficacy of these botanical compounds, or because control became more difficult as the season progressed due to migration and increased plant size. This latter point is illustrated by the marginal control found in the conventional rotation (Table 5).

Trial 3. Late Season Lettuce. This trial was conducted on late- planted lettuce that was allowed to harbor large numbers of thrips prior to spraying. The number of thrips were high at the initiation of the test (> 110 /plant; plants were in the early heading stage) and almost tripled in the check by the completion of the test. Only the Lannate + Warrior and Success treatments provided significant adult activity, but did not prevent the population from increasing to very high numbers (Table 1). Actara and the Provado rotations appeared to reduce larval and total thrips numbers when compared with the untreated check (Table 2). Unfortunately, Lannate/Warrior and Success were the only treatments to actually prevent larval population from increasing. Although these materials appeared to control nymphs better than adults, our data may not reflect the rapid development of nymphs or the immigration of adults from surrounding fields during the study. Unfortunately, the botanical products significantly reduce thrips numbers when compared with the untreated check (Figure 3). We had hopes that the Diatect (diatomaceous earth and pyrethrins) and sulfur (flowable) would have activity as aqueous sprays. We speculate whether these products would be more active applied as dusts.

Conclusions. Of the new products tested, only Success had activity as a stand alone product. Although Actara and Avaunt combinations were efficacious, their cost-effectiveness is questionable when considering the availability of other compounds (ie Admire, Success). However, Actara combinations similar to what were used in these studies may have utility in head lettuce because of activity against aphids. Similarly, Avaunt combinations may be useful because of the compounds excellent activity against worms. Overall, thrips control in all of these studies was moderately acceptable at best. Part of this may be due to the fact that large numbers of WFT were allowed to become established in large, heading plants before the spray treatments were initiated. In addition, we have experienced in previous trials that plant size and temperature are important factors contributing to insecticide efficacy. The larger the plant, the more difficult it is to obtain good coverage underneath the leaf and near the base of the plant where larvae and adults inhabit. The 1999/2000 growing season in Yuma was unusually warm, and thrips built up to very large numbers due to the high temperatures driving their development. Consequently, even the most efficacious products appeared to maintain thrips populations at constant levels and not necessarily reducing their number. Thus, more research needs to be conducted to determine the proper timing and frequency of applications to achieve optimal thrips using both conventional and botanical insecticides.

Acknowledgment

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Table 2. Trial 1 - Adult Thrips Abundance on Head Lettuce Treated with Conventional and Experimental Insecticide Combinations, Yuma Agric. Center, Spring 2000.

Treatment	Mean No. Adults / Plant					
	6 March	9 March	15 March	19 March	22 March	Average
Actara 4.5 oz	14.8 ab	21.5 ab	27.2 ab	21.6 ab	24.0 a	21.8 ab
Actara 3.0 oz + Warrior 3.8 oz	8.7 bc	16.0 bc	13.6 e	30.4 a	17.2 a	17.7 bc
Actara 3.0 oz +Lannate 0.7 lb	5.1 c	9.9 c	14.3 de	7.6 bc	24.8 a	12.3 cd
Avaunt 3.5 oz	15.9 ab	25.5 a	33.8 a	20.2 ab	24.1 a	23.9 a
Avaunt 3.5 oz +Warrior 3.8 oz	8.3 bc	15.1 bc	11.8 e	3.6 c	9.2 a	9.6 d
Avaunt3.5 oz +Lannate 0.7 lb	5.6 c	10.9 c	23.6 bcd	4.4 c	23.6 a	13.6 cd
Success -6.0 oz	6.6 c	16.3 bc	23.7 bc	4.4 c	16.4 a	13.5 cd
Success -4.0 oz +Warrior 3.8 oz	6.7 c	11.7 c	13.4 e	3.2 c	19.6 a	10.9 d
Success -4.0 oz +Lannate 0.7 lb	3.5 c	15.4 bc	14.7 cde	8.0 bc	27.2 a	13.8 cd
Lannate -0.9 lb	4.5 c	11.8 c	16.7 cde	11.2 bc	11.2 a	11.0 d
Warriror 3.8 oz	5.3 c	12.4 c	9.5 e	8.0 bc	12.0 a	9.4 d
Lannate 0.75 +Warrior 3.5 oz	3.7 c	10.5 c	9.7 e	7.6 bc	24.4 a	11.1 d
Untreated	18.7 a	26.5 a	35.8 a	22.0 ab	22.4 a	25.0 a

Precount samples taken on 1 March: *18.25 adults/plant;*
Applications made on March 3, 10, and 15
Means followed by the same letter are not significantly different ANOVA($LSD_{p>0.05}$)

Table 3. Trial 1 - Thrips Larvae Abundance on Head Lettuce Treated with Conventional and Experimental Insecticide Combinations, Yuma Agric. Center, Spring 2000.

	Mean No. Larvae / Plant					
Treatment	**6 March**	**9 March**	**15 March**	**19 March**	**22 March**	**Average**
Actara 4.5 oz	31.9 ab	34.1 a	19.5 a	12.0 bc	23.2 b	24.1 b
Actara 3.0 oz + Warrior 3.8 oz	23.0 bc	34.9 a	16.1 a	9.6 bcd	13.2 bc	19.4 cd
Actara 3.0 oz +Lannate 0.7 lb	21.9 bc	23.2 bc	13.1 a	6.0 bcd	7.2 c	14.3 efg
Avaunt 3.5 oz	33.0 ab	35.0 a	18.8 a	25.0 ab	34.7 ab	29.3 ab
Avaunt 3.5 oz +Warrior 3.8 oz	32.2 ab	30.2 ab	15.8 a	6.8 bcd	15.2 bc	20.0 bcd
Avaunt3.5 oz +Lannate 0.7 lb	23.3 bc	23.1 bc	16.0 a	8.4 bcd	14.8 bc	17.1 de
Success -6.0 oz	14.9 c	19.4 c	11.5 a	5.6 bcd	9.2 bc	12.1 g
Success -4.0 oz +Warrior 3.8 oz	21.5 bc	23.7 bc	17.5 a	5.6 bcd	13.2 bc	16.4 def
Success -4.0 oz +Lannate 0.7 lb	14.4 c	21.5 bc	11.8 a	3.6 bcd	11.2 bc	12.5 fg
Lannate -0.9 lb	14.3 c	21.5 bc	11.9 a	1.2 d	5.6 c	10.9 g
Warriror 3.8 oz	32.8 ab	29.6 ab	18.7 a	12.4 b	15.2 bc	21.7 bc
Lannate 0.75 +Warrior 3.5 oz	20.2 bc	24.2 bc	15.2 a	2.7 cd	9.2 bc	14.3 efg
Untreated	42.3 a	27.8 abc	24.7 a	33.2 a	46.4 a	34.8 a

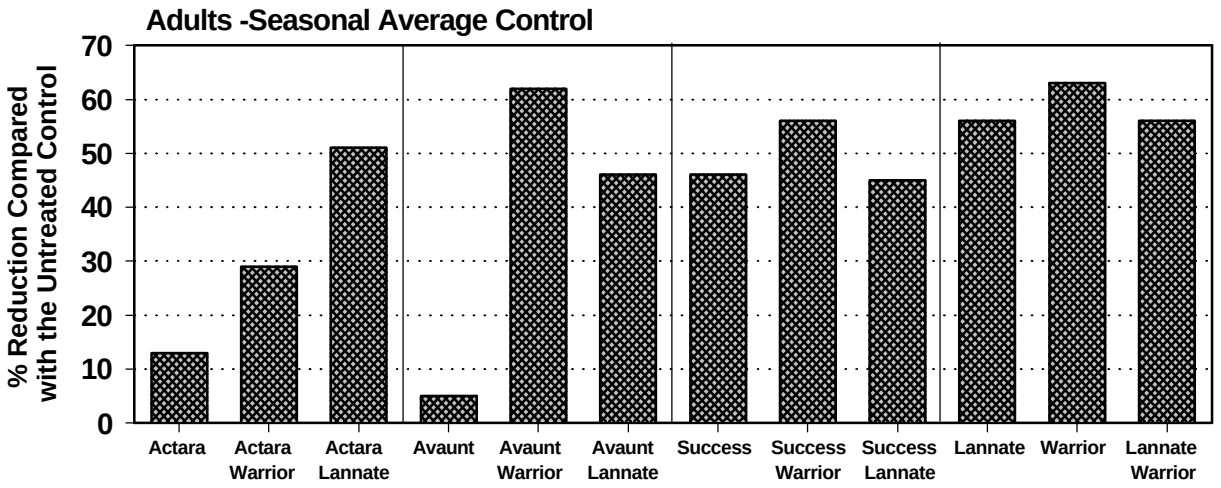
Precount samples taken on 1 March: *80.8 larvae/plant;*
Applications made on March 3, 10, and 15
Means followed by the same letter are not significantly different ANOVA($LSD_{p>0.05}$)

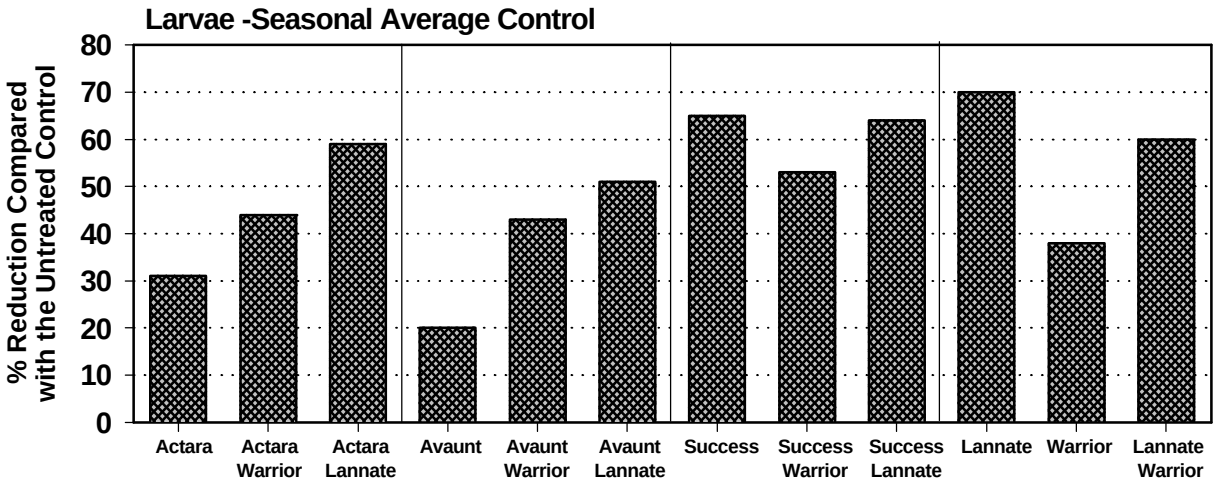
Table 4. Trial 1 - Total Thrips Abundance on Head Lettuce Treated with Conventional and Experimental Insecticide Combinations, Yuma Agric. Center, Spring 2000.

	Mean No. Total Thrips / Plant					
Treatment	**6 March**	**9 March**	**15 March**	**19 March**	**22 March**	**Average**
Actara 4.5 oz	46.7 ab	55.3 a	46.6 ab	33.6 bc	47.2 ab	45.9 b
Actara 3.0 oz + Warrior 3.8 oz	31.7 bcde	50.9 ab	29.7 cd	40.0 ab	30.4 bc	36.5 c
Actara 3.0 oz +Lannate 0.7 lb	27.1 cde	33.1 c	27.4 cd	13.6 d	32.0 bc	26.7 de
Avaunt 3.5 oz	48.9 ab	60.5 a	52.6 ab	45.2 ab	58.8 ab	53.2 ab
Avaunt 3.5 oz +Warrior 3.8 oz	40.5 bc	45.3 abc	27.6 cd	10.4 d	24.4 bc	29.6 cd
Avaunt3.5 oz +Lannate 0.7 lb	28.9 bcde	34.1 c	39.7 bc	12.8 d	38.4 bc	30.8 cd
Success -6.0 oz	21.5 de	36.7 c	35.2 bcd	10.0 d	25.6 bc	25.6 de
Success -4.0 oz +Warrior 3.8 oz	28.2 cde	35.4 c	30.9 cd	8.8 d	32.8 bc	27.3 de
Success -4.0 oz +Lannate 0.7 lb	17.9 e	36.9 c	26.5 cd	11.6 d	38.4 bc	26.3 de
Lannate -0.9 lb	18.7 e	33.3 c	28.5 cd	12.4 d	16.8 c	22.0 e
Warriror 3.8 oz	38.1 bcd	42.0 bc	28.2 cd	20.4 cd	27.2 bc	31.2 cd
Lannate 0.75 +Warrior 3.5 oz	23.9 cde	34.7 c	24.9 d	10.2 d	33.6 bc	25.5 de
Untreated	61.0 a	54.3 a	60.2 a	55.2 a	68.8 a	59.9 a

Precount samples taken on 1 March: *99.0 total thrips/plant;*
Applications made on March 3, 10, and 15
Means followed by the same letter are not significantly different ANOVA($LSD_{p>0.05}$)

Figure 1. Thrips Control in Head Lettuce with New Insectcide Active Ingrediants, YAC, Spring 2000





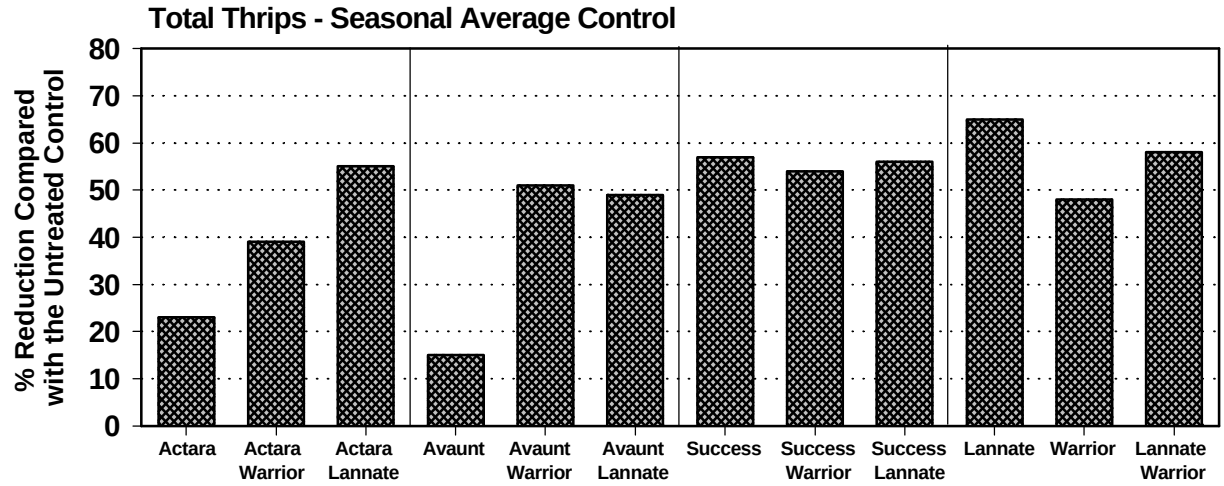


Table 5. Trial 2 - Thrips Abundance on Head Lettuce Treated with Botanical Insecticide Combinations, Yuma Agric. Center, Spring 2000.

	Mean No. Thrips / Plant								
	March 6th (4 DAT1)			March 9th (7 DAT 1)			March 14th (5 DAT 2)		
Treatment	**Adult**	**Larvae**	**Total**	**Adult**	**Larvae**	**Total**	**Adult**	**Larvae**	**Total**
Neemix+Comate	26.2 cde	48.1 ab	74.3 abc	33.8 abc	44.1 a	77.9 a	17.6 a	22.8 a	40.4 a
Ecozin+Comate	28.5 abcd	57.5 ab	85.9 ab	32.0 abc	38.7 a	70.7 a	36.4 a	34.0 a	70.4 a
Pyrellin+Comate	33.9 a	47.1 ab	81.0 abc	36.7 abc	38.6 a	75.3 a	42.8 a	36.0 a	78.8 a
Enviropel	25.6 de	49.9 ab	75.5 abc	35.2 abc	45.6 a	80.8 a	36.8 a	19.2 a	56.0 a
Neemix+Trilogy	23.7 de	37.5 abc	61.2 bc	36.4 abc	54.0 a	90.4 a	33.6 a	30.8 a	64.4 a
Neemix+Enviropel	26.5 bcde	45.3 ab	71.9 abc	28.0 c	47.6 a	75.6 a	31.2 a	20.4 a	51.6 a
Neemix+Trilogy+Pyrellin+Enviropel	32.7 ab	60.0 a	92.3 a	42.4 ab	46.4 a	88.8 a	27.6 a	37.6 a	65.2 a
Ecozin+Enviropel	25.1 de	46.7 ab	71.7 abc	29.2 bc	52.0 a	81.2 a	30.8 a	24.4 a	55.2 a
Pyrellin+Enviropel	32.0 abc	47.2 ab	79.3 abc	42.8 a	51.0 a	94.4 a	47.6 a	34.0 a	81.6 a
Comate	20.9 e	36.2 bc	57.1 cd	38.0 abc	44.4 a	82.4 a	21.2 a	22.0 a	43.2 a
Conventional Rotation	10.6 f	22.2 c	32.8 d	10.4 d	16.8 b	27.2 b	25.6 a	14.4 a	40.0 a
Untreated	26.4 cde	42.6 abc	70.0 abc	33.6 abc	41.6 a	75.2 a	52.8 a	36.0 a	88.8 a

Precount samples: 20.5 adults/plant; 84.17 larvae / plant; 104.3 total thrips/plant

Table 5. Trial 2 - cont.

	Mean No. Thrips / Plant								
	March 17th (3 DAT3)			March 21st (7 DAT 3)			Seasonal Average		
Treatment	**Adult**	**Larvae**	**Total**	**Adult**	**Larvae**	**Total**	**Adult**	**Larvae**	**Total**
Neemix+Comate	22.4 a	32.0 ab	54.4 bc	5.2 a	9.6 a	14.8 a	21.0 cd	31.3 ab	52.4 d
Ecozin+Comate	31.2 a	32.8 ab	64.0 abc	7.6 a	20.4 a	28.0 a	27.1 abc	36.7 a	63.8 abc
Pyrellin+Comate	369.0 a	35.2 ab	71.2 ab	7.2 a	15.6 a	22.8 a	31.3 a	34.5 ab	65.8 abc
Enviropel	33.2 a	44.4 a	77.6 a	8.4 a	18.0 a	26.4 a	27.8 abc	35.4 ab	63.3 abc
Neemix+Trilogy	22.0 a	22.4 bc	44.4 cd	7.2 a	12.0 a	19.2 a	24.6 abc	31.3 ab	55.9 cd
Neemix+Enviropel	31.2 a	32.8 ab	64.0 abc	12.8 a	13.2 a	26.0 a	25.9 abc	31.9 ab	57.8 bcd
Neemix+Trilogy+Pyrellin+Enviropel	40.8 a	35.6 ab	76.4 ab	7.6 a	8.0 a	15.6 a	30.2 ab	37.4 a	67.7 ab
Ecozin+Enviropel	31.2 a	34.4 ab	65.6 abc	9.2 a	18.4 a	27.6 a	25.1 abc	35.1 ab	60.3 abcd
Pyrellin+Enviropel	30.4 a	31.6 ab	62.0 abc	4.4 a	18.0 a	22.4 a	31.5 a	36.5 ab	67.9 a
Comate	24.4 a	33.2 ab	57.6 abc	10.4 a	10.8 a	21.2 a	22.9 bc	29.3 b	52.3 d
Conventional Rotation	18.8 a	10.4 c	29.2 d	5.2 a	10.4 a	15.7 a	14.1 d	14.8 c	29.9 e
Untreated	27.6 a	46.4 a	74.0 ab	6.0 a	19.2 a	25.2 a	29.3 ab	37.2 a	66.4 ab

Precount samples: 20.5 adults/plant; 84.17 larvae / plant; 104.3 total thrips/plant

Figure 2. Thrips Control in Head Lettuce with Biorational/Organic Insecticides, YAC, Spring 2000

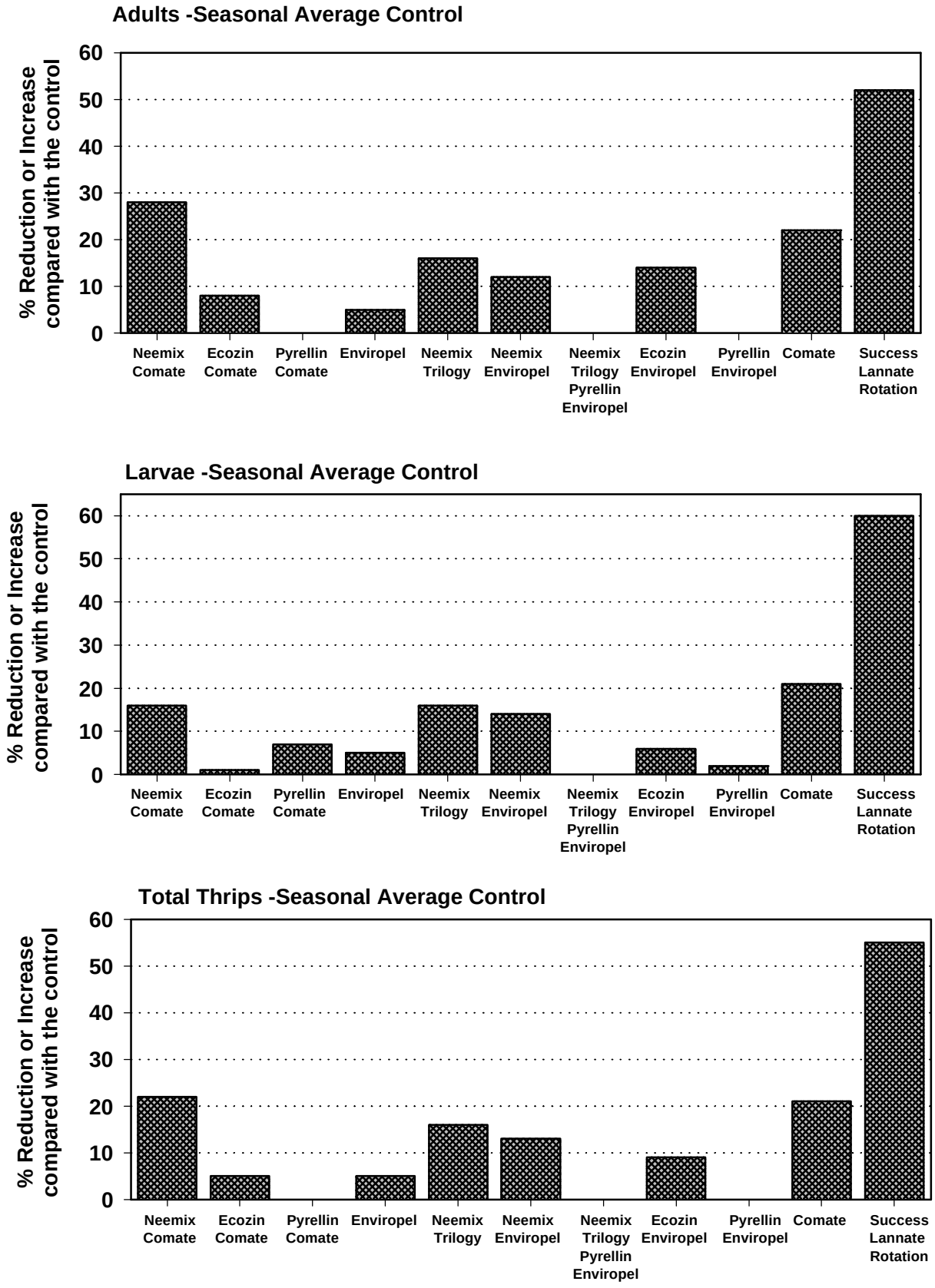


Table 6. Trial 3 - Adult Thrips Abundance on Head Lettuce Treated with Conventional and Organic Insecticides, Yuma Agric. Center, Spring 2000.

	Mean No. Adults / Plant				
Treatment	**27 Mar**	**30 Mar**	**4 Apr**	**12 Apr**	**Average**
Lannate +Warrior	22.8 de	50.2 e	24.8 d	124.8 c	55.7 c
Success	30.3 c	61.6 cde	41.2 c	137.6 bc	67.6 b
Actara	29.1 cd	66.3 bcd	55.6 bc	207.6 a	90.1a
Provado Rotation	22.2 e	57.9 de	62.8 abc	186.4 ab	83.3 ab
Diatect +Sulfur	61.7 a	77.6 bc	86.4 ab	138.5 bc	91.0 a
M-Pede	46.7 b	72.3 bcd	77.2 ab	140. bc	84.5 ab
Hot Pepper Wax	58.3 ab	86.5 b	82.4 ab	140.4 bc	92.3 a
Untreated	69.0 a	109.3 a	87.9 a	107.2 c	93.3 a

Precount samples taken on 23 March: *20.9 adults/plant;* Applications made on 23 March, 1 and 6 April.
Means followed by the same letter are not significantly different ANOVA($LSD_{p>0.05}$)

Table 7. Trial 3 - Thrips Larvae Abundance on Head Lettuce Treated with Conventional and Organic Insecticides, Yuma Agric. Center, Spring 2000.

	Mean No. Larvae / Plant				
Treatment	**27 Mar**	**30 Mar**	**4 Apr**	**12 Apr**	**Average**
Lannate +Warrior	115.3 a	153.2 cd	55.6 c	116.4 c	110.5 d
Success	144.4 a	141.7 d	53.2 c	95.6 c	108.7 d
Actara	178.3 a	223.1 abc	100.4 b	240.4 b	185.3 bc
Provado Rotation	126.6 a	167.8 bcd	66.0 bc	315.6 ab	169.2 c
Diatect +Sulfur	183.2 a	222.4 abc	208.4a	276.8 ab	222.0 a
M-Pede	204.2 a	237.6 ab	171.6 a	258.8 ab	217.5 ab
Hot Pepper Wax	156.1 a	235.7 ab	184.0 a	371.6 a	237.2 a
Untreated	168.2 a	259.6 a	195.1 a	257.5 ab	219.0 a

Precount samples taken on 1 March: *93.4 adults/plant;* Applications made on 23 March, 1 and 6 April.
Means followed by the same letter are not significantly different ANOVA($LSD_{p>0.05}$)

Table 8. Trial 3 - Total Thrips Abundance on Head Lettuce Treated with Conventional and Organic Insecticides, Yuma Agric. Center, Spring 2000.

	Mean No. Total Thrips / Plant				
Treatment	**27 Mar**	**30 Mar**	**4 Apr**	**12 Apr**	**Average**
Lannate +Warrior	138.1 d	203.4 d	80.4 d	241.2 cd	166.0 c
Success	174.7 cd	203.3 d	94.4 cd	233.2 d	176.4 c
Actara	207.2 bc	289.3 bc	156.0 b	448.0 ab	275.1 ab
Provado Rotation	148.8 d	225.9 cd	128.8 bc	502.0 a	251.4 b
Diatect +Sulfur	244.9 a	300.0 b	294.8 a	415.3 ab	313.5 a
M-Pede	250.9 a	309.9 ab	248.8 a	402.3 ab	303.1 ab
Hot Pepper Wax	214.4 ab	322.1 ab	266.4 a	512.0 a	328.7 a
Untreated	237.2 a	368.9 a	282.9 a	367.7 b	313.8 a

Precount samples taken on 1 March: *114.1 adults/plant;* Applications made on 23 March, 1 and 6 April.
Means followed by the same letter are not significantly different ANOVA($LSD_{p>0.05}$)

Figure 2. Thrips Control in Head Lettuce with Biorational/Organic Insecticides, YAC, Spring 2000