

# Impact and Management of Western Flower Thrips on Romaine Lettuce

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## **Abstract**

*A season-long study was conducted to evaluate the efficacy of several conventional, experimental and bio-based insecticide combinations used in rotation against western flower thrips (WFT) in romaine lettuce. Results from this study showed that several insecticide rotational programs provided good control of WFT populations throughout the season. Adult abundance peaked just prior to the fourth spray on 28 March, whereas larvae numbers peaked about 2 weeks earlier on March 13. Fluctuations of larval and adult populations observed from weekly samples suggests that greater than 3 WFT generations developed during the experimental period. Averaged across all sample dates, the Success, Lannate and Warrior based rotations maintained adult and larval populations at significantly lower levels than all other treatments. The Bio-based, organic rotations (Neem/Garlic/COC/Sulfur/Diatect) did not differ from the untreated check. Percentage reduction of WFT larvae and adults compared with the untreated control was significantly greater following sprays which contained Success combinations. Consistent with reduction in WFT numbers, the Success/Lannate/Warrior, and Dimethoate based rotations resulted in significantly greater yields and less damage. Regression analysis suggests that larvae and total thrips abundance more consistently describes the variation measured in plant weights. Overall, this preliminary data further indicates that maintaining WFT abundance at low levels is important for maintaining romaine yield and quality.*

## **Introduction**

Western flower thrips (WFT), *Frankiniella occidentalis*, have rapidly become important pests in desert 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. When temperatures are warm during the spring, WFT reproduce quickly on lettuce.

WFT are considered a pest because of the cosmetic damage they cause to leaves on lettuce plants and the contamination in mature plants romaine grown by WFT adults and larvae. Grower tolerance for thrips damage and contamination has recently become very low in field packed romaine and hearts. Consequently, PCAs may treat often to prevent WFT from becoming established on plants 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. Because thrips control in lettuce has become important just recently, not much is known about their management. This study was conducted to determine the potential of several insecticide rotational strategies against WFT in spring romaine, and to document the impact of WFT infestations on romaine yields and quality.

## Materials and Methods

**Experimental Insecticides:** A field trial was conducted at the University of Arizona Yuma Agricultural Center. Romaine ‘King Louie’ 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. Treatments consisted of the following chemical rotations:

Chemical Rotation	Spray #1 (2/29)	Spray #2 (3/13)	Spray #3 (3/22)	Spray # 4 (3/29)	Spray #5 (4/6)	Spray #6 (4/12)
Actara/Provado	Actara 4.5 oz Warrior 3.5 oz	Provado 3.75 oz Endosulfan 1 qt	Actara 4.5 oz Lannate 0.8 lb	Provado 3.75 oz Lannate 0.8 lb	Lannate 0.8 lb Mustang 4.0 oz	Actara 4.5 oz Mustang 4.0 oz
Dimethoate	Dimethoate 12 oz Warrior 3.8 oz	Dimethoate 12 oz Lannate 0.8 oz	Dimethoate 12 oz Endosulfan 1 qt	Dimethoate 12 oz Lannate 0.8 oz	Sulfur 3 pts	Success 4 oz Mustang 4.0 oz
Success/Lannate/ Garlic/Sulfur	Success 4 oz Tomahawk 12 oz Enviropel 32 oz	Lannate 1.0 lb Tomahawk 12 oz Enviropel 32 oz	Success 4 oz Sulfur 3 pts	Lannate 0.8 lb Sulfur 3 pts	Sulfur 3 pts Tomahawk 12 oz Enviropel 32 oz	Lannate 0.8 lb Tomahawk 12 oz Enviropel 32 oz
Success/ Lannate+Warrior	Success 6 oz	Lannate 1.0 lb Warrior 3.8 oz	Success 6 oz	Lannate 1.0 lb Warrior 3.8 oz	Success 4 oz Sulfur 3 pts	Lannate 1.0 lb Mustang 4.2 oz
Success+Lannate/ Lannate	Success 4 oz Lannate 0.8 lb	Lannate 0.6 lb Warrior 3.0 oz	Success 4 oz Lannate 0.8 lb	Lannate 0.6 lb Warrior 3.0 oz	Success 4 oz Lannate 0.8 lb	Lannate 0.6 lb Mustang 3.8 oz
Success+Warrior/ Lannate	Success 4 oz Warrior 3.5 oz	Lannate 0.8 lb Warrior 3.5 oz	Success 4 oz Warrior 3.5 oz	Lannate 0.8 lb Warrior 3.5 oz	Success 4 oz Mustang 4.0 oz	Lannate 0.8 lb Mustang 4.0 oz
Neem/Garlic/ Sulfur/Diatect	Neemix 1 pt Trilogy 32 oz Tomahawk 12 oz Enviropel 32 oz	Neemix 1 pt Pyrellin 1.5 pt Tomahawk 12 oz Enviropel 32 oz	Sulfur 4 pts	Diatect V 5 lbs Sulfur 3 pts	Diatect V 5 lbs Tomahawk 12 oz Enviropel 32 oz	Neemix 1 pt Trilogy 32 oz
Neem/COC/ Sulfur/Diatect	Neemix 1 pt Comate 4 oz	Neemix 1 pt Pyrellin 1.5 pt Trilogy 32 oz	Diatect V 6 lbs Comate 4 oz	Comate 12 oz	Diatect V 5 lbs Sulfur 3 pts	Ecozin 10 oz Comate 8 oz

All foliar sprays were applied in 25 GPA total volume at 40 psi. Three, disc-type cone nozzles were used per bed. A total of six foliar sprays were applied on dates shown in the table above. 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. Numbers of thrips from 5-8 plants per replicate were recorded on each sample date. Abundance of WFT was measured 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 WFT adults and larvae. Sticky traps were then taken to the laboratory where adult and immature thrips were counted.

Yield estimates were taken at harvest on 19 April. Five consecutive plants from two, randomly selected locations in each replicate were sampled (10 plants / replicate). Whole plant weight samples were recorded for each plant. Plants were then trimmed down to remove naturally senescent leaves and leaves containing excessive scarring on leaf tissue and bronzing on midribs due to WFT feeding. Plants were then re-weighed to reflect the number of marketable plants.

WFT counts were transformed  $\log_{(n+0.5)}$  prior to analysis of variance to stabilize variances which were found to be heterogenous. Untransformed means are presented in figures and tables. Percentage reduction of thrips compared with the untreated control was calculated following the formula given by Henderson & Tilton (1955) for each treatment following the first four applications. Average WFT abundance on each sample date, yields and quality data at harvest were analyzed as a one-way analyses of variance (PROC GLM, SAS Institute), with means compared where appropriate using the Ryan-Einot-Gabriel-Welsch multiple F-test (P=0.05) (PROC GLM, SAS Institute). To measure the impact of WFT on plant growth, whole plant weights were regressed against the average number of WFT during the growing season using PROC GLM, (SAS Institute). To measure the impact of WFT on plant quality, trimmed plant weights were regressed against the average number of WFT during the growing season.

## Results and Discussion

WFT were very abundant in the Yuma Area during 1999/2000, coincident with an unusually warm, dry winter. This was clearly evident by the high numbers of WFT adults and larvae sampled in untreated plots during the study (Tables 1-3). Adult abundance peaked just prior to the fourth spray on 28 March, whereas larvae numbers peaked about 2 weeks earlier on March 13. Fluctuations of larval and adult populations shown in the tables suggests that greater than 3 WFT generations developed during the experimental period.

Based on the seasonal WFT numbers averaged across all sample dates, the Success+Lannate / Lannate and Success +Warrior/ Lannate based rotations maintained adult populations at significantly lower levels than all other treatments (Table 1). Unfortunately, the Bio-based, organic rotations (Neem/Garlic/COC/Sulfur/Diatect) did not differ from the untreated check. Similarly, the Success and Lannate based rotations provided the most significant amount of suppression against WFT larvae (Table 2). However, WFT larvae numbers in the Provado/Actara, Dimethoate, and the organic based rotations were lower than the untreated check. These trends were fairly consistent throughout the season. Overall when considering total WFT numbers (adults and larvae combined), the Success, Warrior, and Lannate rotations were superior to the other treatments (Table 3). The organic based rotations did however provide some suppression of WFT when compared with numbers found in the untreated check.

Percentage control of WFT following the the first four applications is shown in Figures 1-4. Reduction in WFT adults and larvae was measure over a 13-d period following the first application (Fig 1). Adult suppression was effective for only a 7-d period regardless of insecticides applied. This is in part due to the migratory nature of WFT and the presence of newly emerged adults. However, the Success/Warrior and Dimethoate/Warrior combinations provided >70% reduction at 7 -d. Significant suppression of WFT larvae was observed at 13 DAT, particularly in the Success combinations. Similarly, reduction of total WFT was significantly greater in plots treated with the Success combinations.

WFT control following the second application appeared to be more variable (Figure 2). Reduction of adult WFT was greatest at higher rates of Lannate/Warrior combinations. Larval reduction was considerable lower for all treatments, where residual control was observed in only the higher rates of the Lannate/Warrior combination. Similarly, the high rate of Lannate +Warrior provided the greatest residual control of total WFT. Following the third application, adult and larval control varied widely among treatments (Fig 3). However, the Diatect +Comate treatment provided about 30% residual control at 7 DAT. Reduction of WFT following the fourth application was poor for all treatments, not exceeding 40% control of total WFT in any treatment (Fig 4). This occurred in part due to the increased plant size and the closing up of plant terminal growth. WFT numbers declined in the untreated control due to excessive damage, rendering the plants unattractive for feeding and reproduction. Consequently, percentage reduction in all spray treatments was low following the fifth and sixth applications.

Measurements of whole and trimmed romaine plants at harvest showed that WFT had a significant impact on plant growth, yields and quality (Figure 5 and 6). The high WFT abundance measured in the check resulted in a significant reduction in whole plant weights. This further validates our suspicion that extended periods of WFT feeding to romaine can cause significant plant weight loss. Although both organic based treatments provided similar levels of WFT control, the garlic based treatment resulted in less initial weight loss. Consistent with WFT numbers, the Success/Lannate/Warrior and Dimethoate based rotations resulted in significantly greater plant weights (Fig 5A). When leaves were trimmed to remove thrips damage, these same treatments resulted in significantly bigger plants with more foliage compared with the untreated check and organic based rotations (Fig 5B). The Actara/Provado rotation did not differ from the check. Although significantly better than the check, plants in the Success/Lannate/Garlic/Sulfur treatment sustained more damage than the plants grown under the Success/Lannate/Warrior and Dimethoate based rotations. Figure 6 shows the general relationships between WFT infestation levels and damage on romaine plant growth and quality. Regression analysis suggests that larvae and total thrips abundance more consistently described the variation measured in plant weights. Overall, this preliminary data further indicates that maintaining WFT abundance at low levels is important for maintaining romaine yield and quality.

In conclusion, although Actara /Provado based rotations provided significantly better WFT control than the untreated check, these treatments did not provide the same level of control, or yields as the Success/Lannate/Warrior based rotations. We had hoped that these rotations would provide economic WFT control because of the demonstrated efficacy of these compounds against aphids in lettuce. Similarly, additions of garlic and sulfur combinations to Success or Lannate significantly reduced WFT numbers during the season. Unfortunately, these combinations did not prevent significant WFT damage. The organic based rotations of sulfur, garlic, pyrethrins, crop oil, and azadirachtin failed to provide commercially acceptable yields and quality when used similarly to the other conventional products. We are uncertain whether this level of control and associated damage is acceptable under organic production standards. In contrast, rotations of Success/Lannate/Warrior combinations provided the greatest yield responses and least amount of damage. Furthermore, we demonstrated that this could be accomplished with reduced rates of active ingredients. Similar WFT control has been observed in head lettuce, and presently these compounds are the main components in our Lettuce IPM programs for WFT control.

**Table 1. Adult Thrips Abundance on Romaine Treated with Alternative Spray Rotations, Yuma Agricultural Center, Spring 2000.**

Chemical Rotation	Mean No. of Adults / Plant										
	3 Mar	8 Mar	13 Mar	16 Mar	20 Mar	24 Mar	28 Mar	3 Apr	11 Apr	19 Apr	Avg.
Actara/Provado	5.7 c	5.1 d	15.4 a	12.8 abc	15.6 a	12.8 bc	16.8 de	15.2 cd	11.2 bc	21.6 a	13.3 bc
Dimethoate	5.8 c	3.9 d	12.4 a	7.2 cde	7.6 a	19.6 abc	27.6 bcd	15.2 cd	25.6 a	22.8 a	14.8 b
Success/Lannate/Garlic/Sulfur	4.8 cd	5.5 cd	17.2 a	4.8 e	6.8 a	28.0 ab	22.8 bcd	17.6 cd	20.4 ab	16.8 a	14.5 bc
Success/ Lannate+Warrior	4.7 cd	6.7 cd	20.4 a	6.0 de	3.2 a	18.4 abc	19.2 cde	15.2 cd	16.0 abc	14.4 a	12.4 c
Success+Lannate/ Lannate	2.5 d	6.3 cd	15.6 a	8.0 cde	7.2 a	7.6 c	17.6 de	15.2 cd	9.2 c	12.0 a	10.1 d
Success+Warrior/ Lannate	2.1 d	3.8 d	13.2 a	4.4 e	3.2 a	5.6 c	10.0 e	14.0 d	11.2 bc	15.2 a	8.3 d
Neem/Garlic/Sulfur/Diatect	13.3 b	9.1 bc	13.2 a	11.6 bcd	9.2 a	32.8 a	45.6 a	26.8 bc	10.0 c	19.6 a	19.1 a
Neem/COC/Sulfur/Diatect	15.2 b	10.5 b	16.4 a	14.4 ab	11.2 a	34.0 a	33.6 abc	38.8 a	18.0 abc	18.4 a	21.0 a
Untreated	18.7 a	15.5 a	11.2 a	18.0 a	9.6 a	29.0 ab	38.4 ab	34.4 ab	17.2 abc	17.6 a	21.0 a

Precount samples taken on 28 Feb: 15.4 adults / plant; Means followed by the same letter are not significantly different ANOVA(LSD<sub>p>0.05</sub>)

**Table 2. Thrips Larvae Abundance on Romaine Treated with Alternative Spray Rotations, Yuma Agricultural Center, Spring 2000.**

Chemical Rotation	Mean No. of Larvae / Plant										
	3 Mar	8 Mar	13 Mar	16 Mar	20 Mar	24 Mar	28 Mar	3 Apr	11 Apr	19 Apr	Avg.
Actara/Provado	28.8 ab	42.1 bc	145.2 ab	52.4 c	34.8 a	50.8 cd	52.0 bc	28.0 cd	42.0 de	46.4 ab	52.3 c
Dimethoate	30.4 ab	46.3 ab	132.4 abc	68.8 bc	36.4 a	38.4 d	31.2 cd	30.4 c	84.4 bcd	56.8 a	55.5 c
Success/Lannate/Garlic/Sulfur	20.1 bc	29.1 c	103.6 bcd	50.0 c	25.2 a	60.4 cd	21.6 d	24.4 cd	76.8 cde	45.6 ab	45.6 cd
Success/ Lannate+Warrior	16.7 bc	31.7 c	113.6 bcd	51.2 c	13.6 a	43.2 d	18.4 d	14.4 d	48.4 de	27.2 bc	37.8 d
Success+Lannate/ Lannate	12.2 c	23.5 c	87.6 cd	54.8 c	32.4 a	37.2 d	28.4 cd	20.4 cd	35.2 e	18.8 c	35.0 d
Success+Warrior/ Lannate	16.9 bc	31.5 c	69.2 d	59.6 c	14.4 a	32.8 d	15.6 d	21.2 cd	46.8 de	29.6 bc	33.8 d
Neem/Garlic/Sulfur/Diatect	33.9 a	64.5 ab	147.2 ab	96.8 b	39.6 a	74.0 bc	64.8 ab	82.4 a	129.2 ab	48.0 ab	78.0 b
Neem/COC/Sulfur/Diatect	34.7 a	63.3 ab	157.2 ab	97.2 b	50.4 a	96.0 b	69.6 ab	62.4 b	142.8 a	62.8 a	83.6 b
Untreated	35.0 a	81.7 a	186.4 a	161.2 a	44.8 a	126.4 a	92.0 a	86.8 a	116.8 ab	46.8 ab	97.8 a

Precount samples taken on 28 Feb: *13.6 larvae / plant*; Means followed by the same letter are not significantly different ANOVA(LSD  $p>0.05$ )

**Table 3. Total Thrips Abundance on Romaine Treated with Alternative Spray Rotations, Yuma Agricultural Center, Spring 2000.**

Chemical Rotation	Mean No. of Total Thrips / Plant										Avg.
	3 Mar	8 Mar	13 Mar	16 Mar	20 Mar	24 Mar	28 Mar	3 Apr	11 Apr	19 Apr	
Actara/Provado	34.5 cd	47.1 c	161.6 ab	65.2 d	50.4 a	63.6 de	68.8 bc	43.2 b	53.2 d	68.0 ab	65.6 c
Dimethoate	36.2 bcd	50.3 bc	144.8 abc	76.0 cd	44.0 a	58.0 de	58.8 cd	45.6 b	110.0 abc	79.6 a	70.3 c
Success/Lannate/Garlic/Sulfur	24.9 de	34.7 c	120.8 bcd	54.8 d	32.0 a	88.4 cd	44.4 cd	42.0 b	97.2 bcd	62.4ab	60.1 cd
Success/ Lannate+Warrior	21.4 de	38.4 c	134.0 bcd	57.2 d	16.8 a	61.6 de	37.6 cd	29.6 b	64.4 cd	41.6 bc	50.3 de
Success+Lannate/ Lannate	14.7 e	29.8 c	103.2 cd	62.8 d	39.6 a	44.8 e	46.0 cd	35.6 b	44.4 d	30.8 c	45.2 e
Success+Warrior/ Lannate	19.0 e	35.3 c	82.4 d	64.0 d	17.6 a	38.4 e	25.6 d	35.2 b	58.0 cd	44.8 bc	42.0 e
Neem/Garlic/Sulfur/Diatect	47.2 abc	75.5 ab	160.4 ab	108.4 bc	48.8 a	106.8 bc	110.4 a	109.2 a	139.2 ab	67.6 ab	97.1 b
Neem/COC/Sulfur/Diatect	49.9 ab	73.7 ab	173.6 ab	111.6 b	61.6 a	130.0 ab	103.2 ab	101.2 a	160.8 a	81.2 a	104.7 b
Untreated	53.7 a	97.3 a	197.6 a	179.2 a	54.4 a	155.2 a	130.4 a	120.8 a	134.0 ab	64.4 ab	118.7 a

Precount samples taken on 28 Feb: 28.9 thrips adults and larvae / plant; Means followed by the same letter are not significantly different ANOVA(LSD  $p>0.05$ )

Figure 1. Control of WFT Following the First Application in Romaine Lettuce, YAC, Spring 2000.

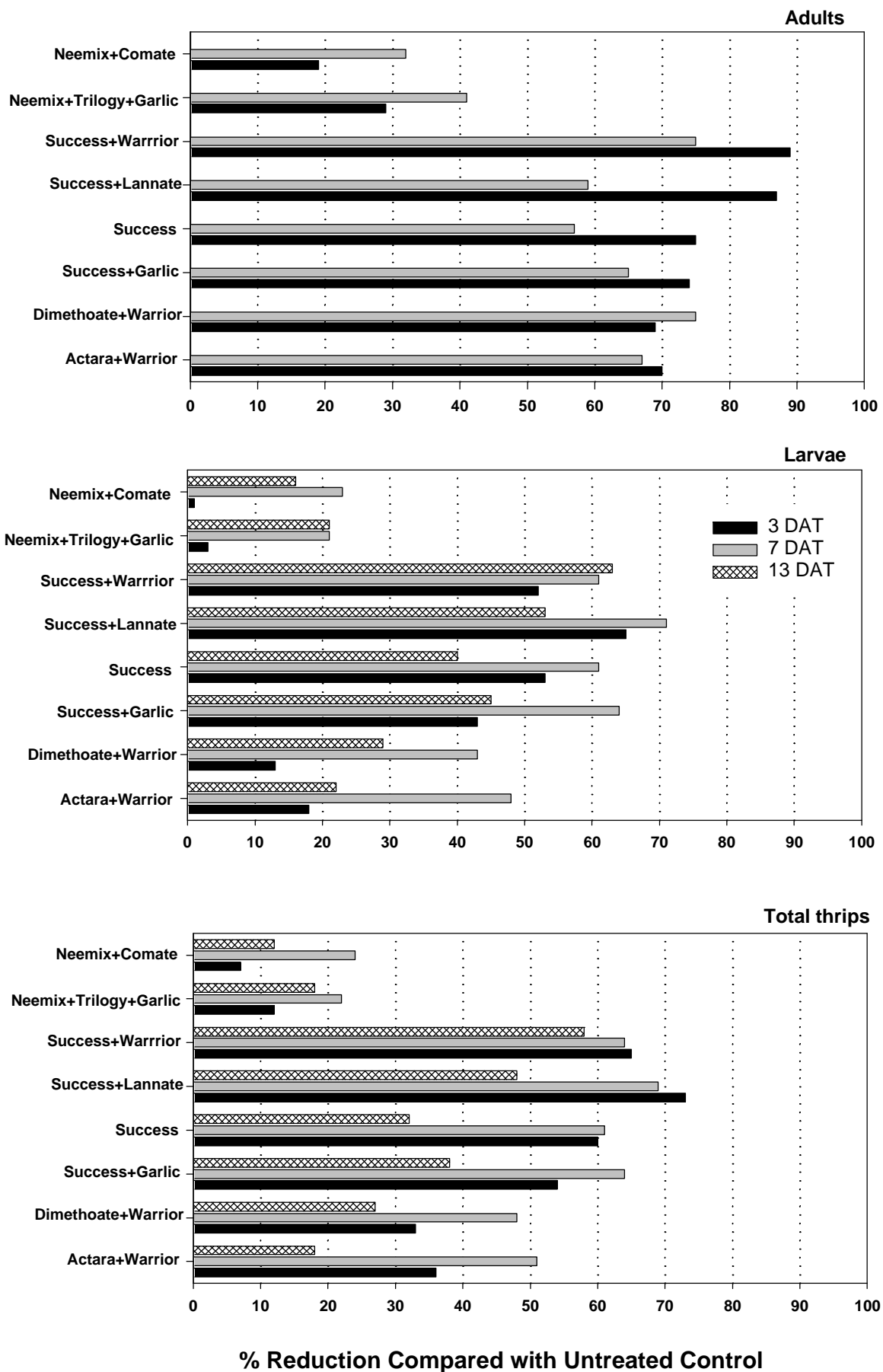


Figure 2. Control of WFT Following the Second Application in Romaine Lettuce, YAC, Spring 2000.

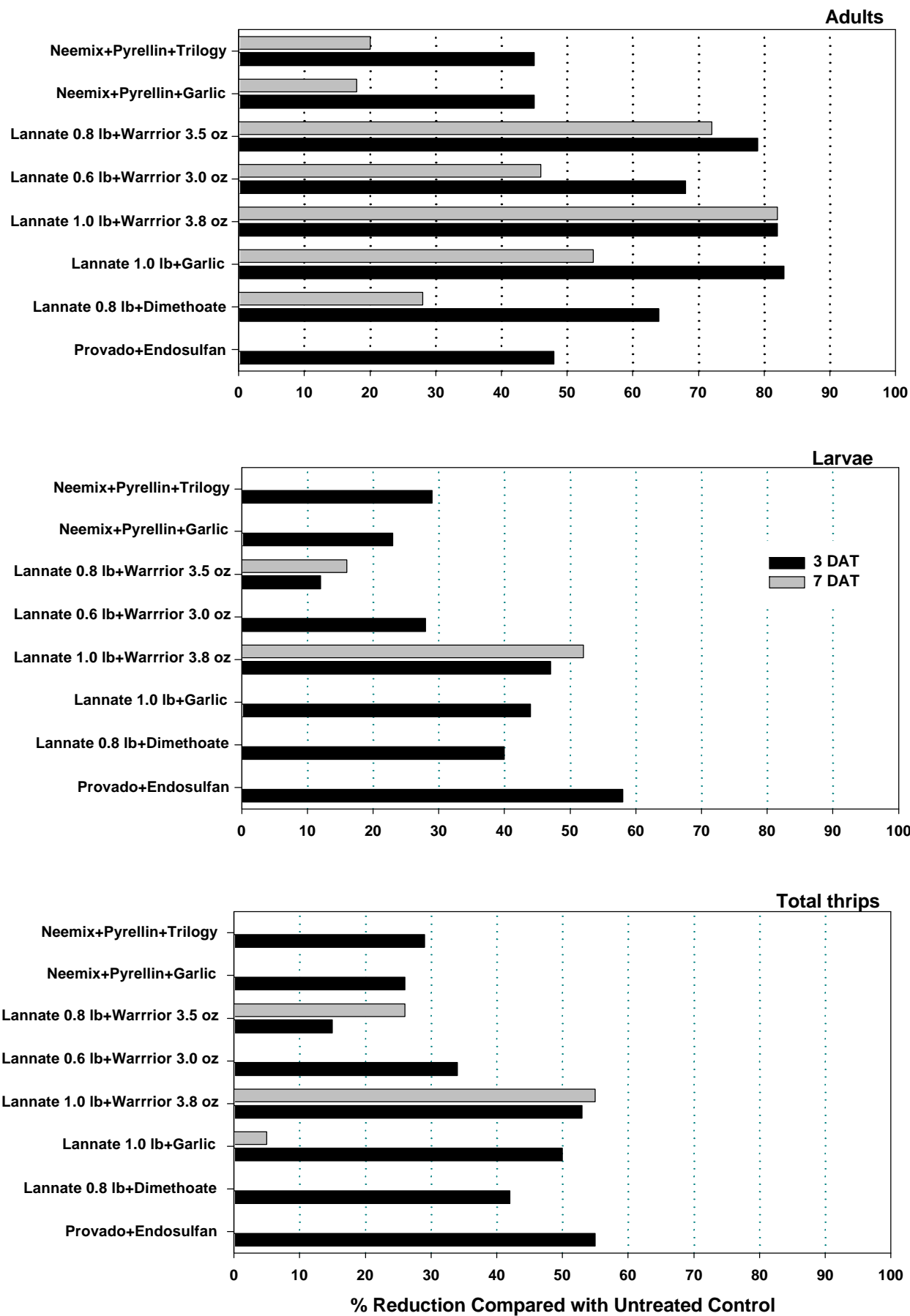
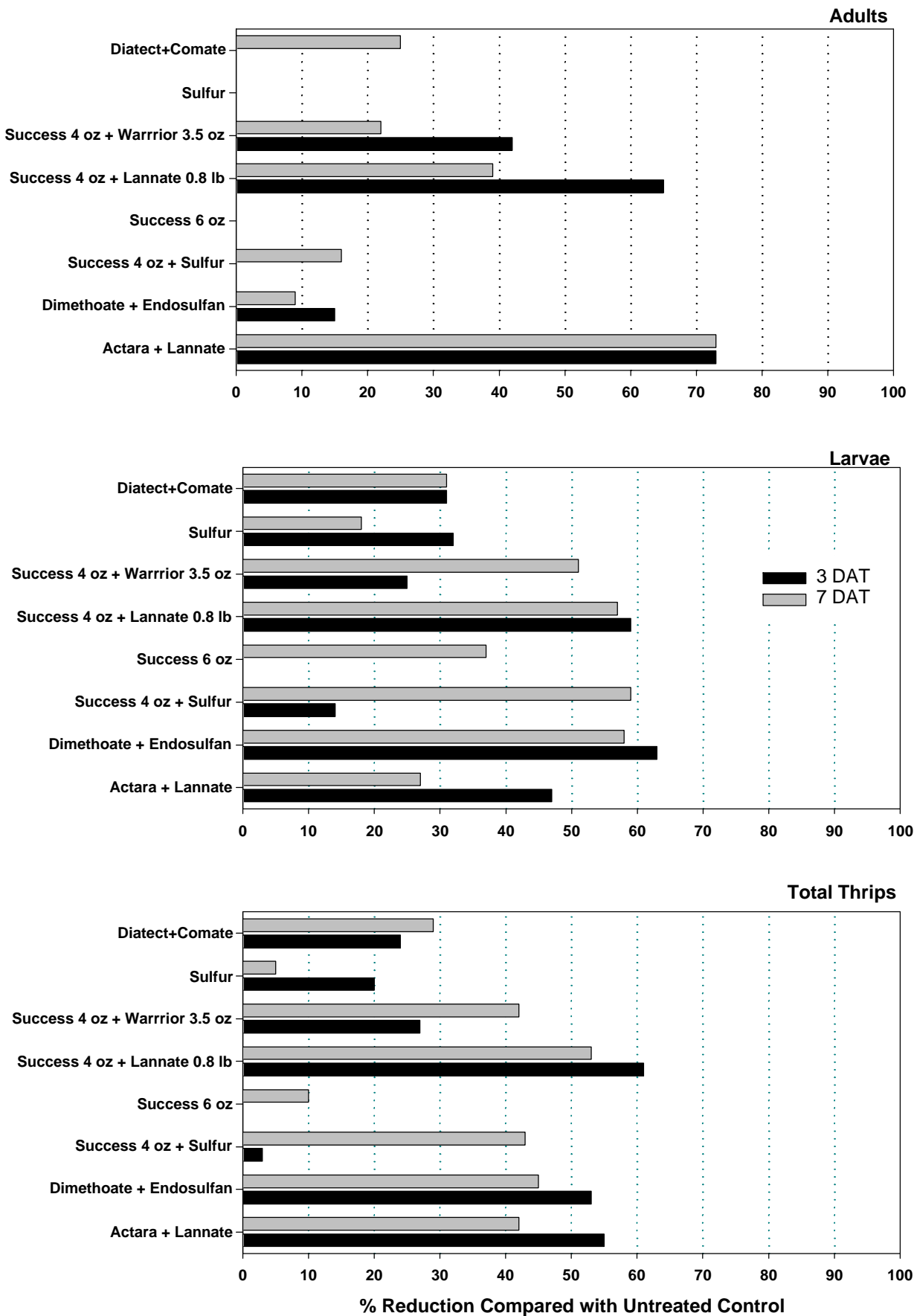


Figure 3. Control of WFT Following the Third Application in Romaine Lettuce, YAC, Spring 2000.



ure 4. Control of WFH Following the Fourth Application in Romaine Lettuce, YAC, Spring 2000.

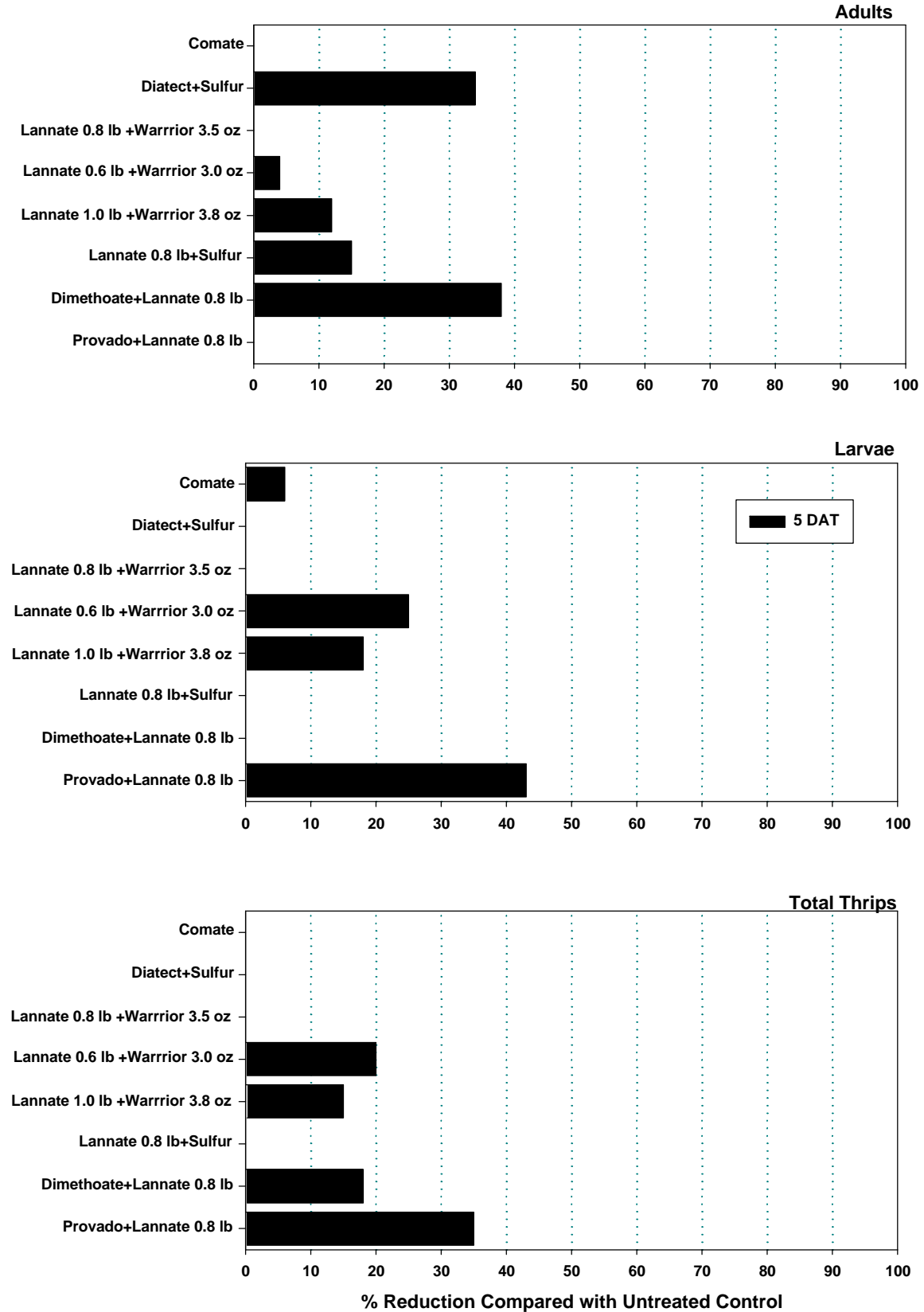


Figure 5. Harvest Evaluation of WFT Damage on Plant Growth (A) and Quality (B) of Romaine Lettuce Grown Under Several Chemical Rotations, YAC, Spring 2000.

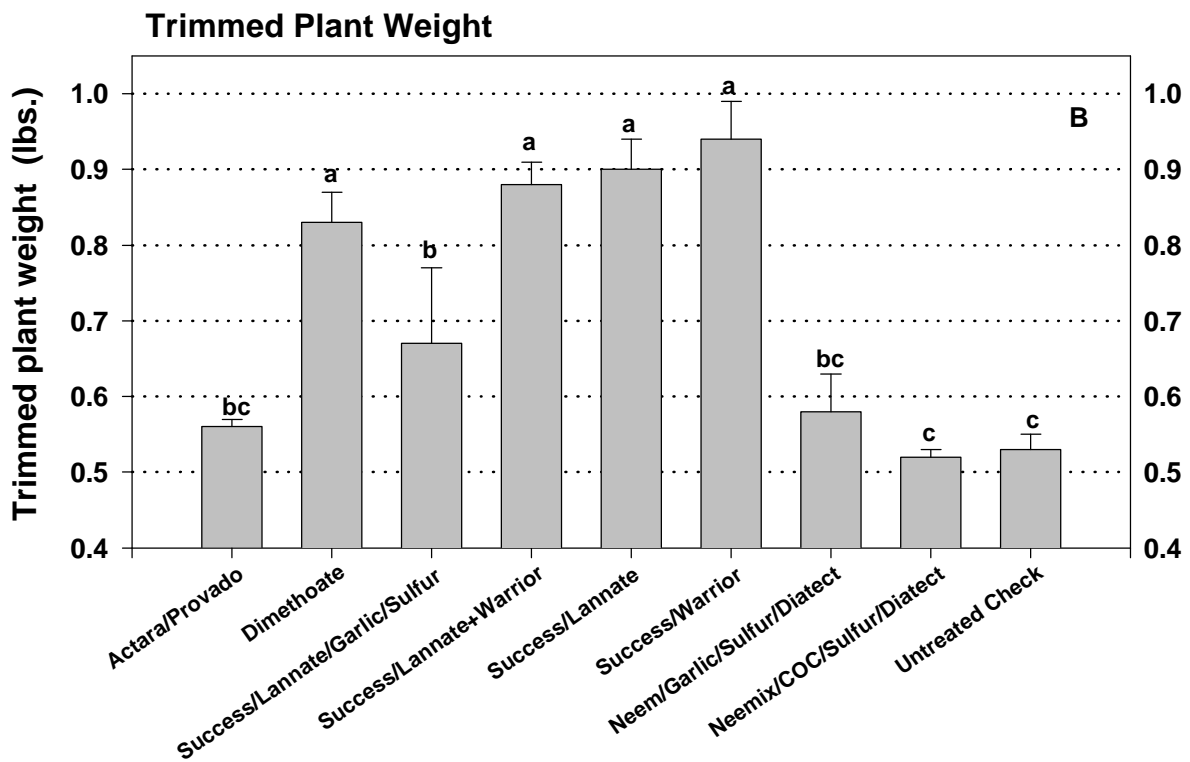
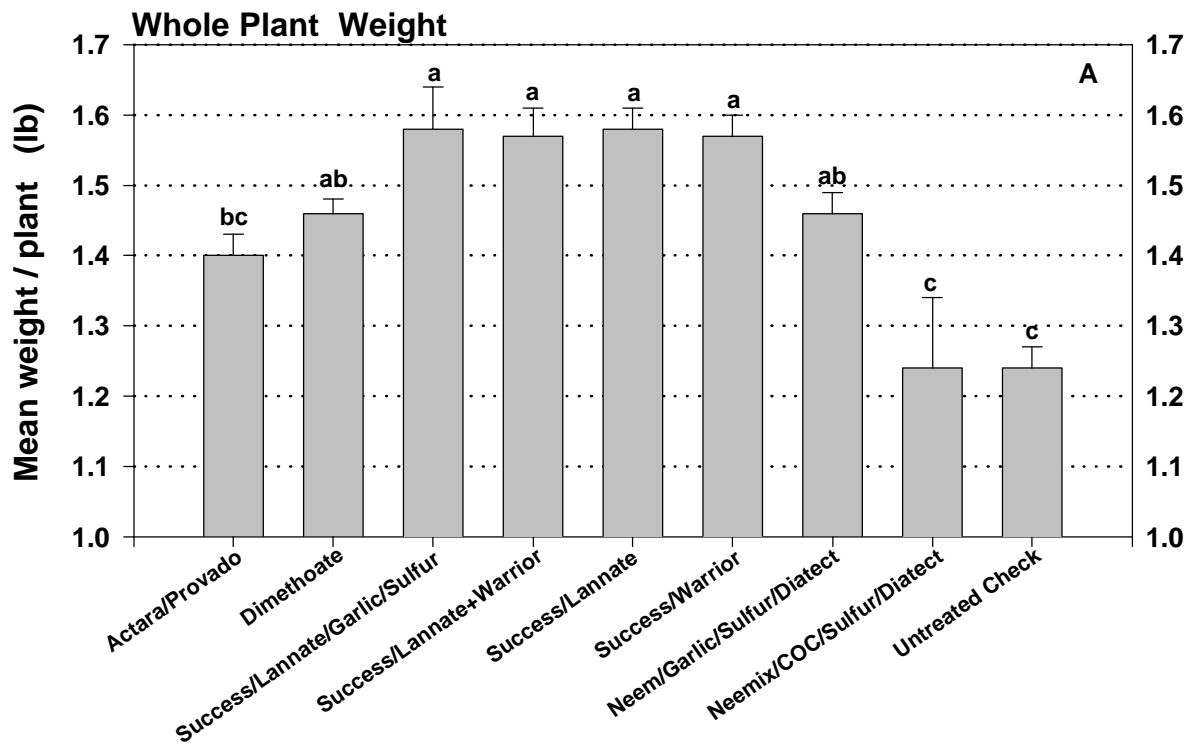


Figure 6. Relationships Between WFT Infestation and Romaine Lettuce Yields;  
 (A,B,C)- Impact of WFT on Plant Growth;  
 (D,E,F) - Impact of WFT Feeding Damage on Quality

