

Tank Mixing New Insecticide Chemistries with a Pyrethroid Insecticide for Control of Lepidopterous Pests in Head Lettuce, 1997

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Abstract

Confirm, Success and Proclaim were evaluated for lepidopterous insect control in lettuce with and without the addition of Mustang 1.5EW. Success and Proclaim used alone were highly efficacious toward cabbage looper and Heliiothinae and did not appear to benefit greatly from the addition of Mustang. However, Confirm's activity towards Heliiothinae was significantly improved by the addition of Mustang. Additionally, on large framed plants where coverage is difficult, Confirm benefitted from the addition of a pyrethroid for control of loopers.

Introduction

During 1997, Arizona pest control advisors (PCAs) and growers had the opportunity to utilize Success (spinosad) and Confirm (tebufenozide) for control of beet armyworms *Spodoptera exiqua* (Hübner) in leafy vegetables. However, over the past two years, cabbage loopers, *Trichoplusia ni* (Hübner), and Heliiothinae larvae have been the most common lepidopterous pests infesting Arizona lettuce. Previous field trials with these new insecticides have suggested that some of these insecticides may not provide adequate control of cabbage looper or Heliiothinae under certain conditions. Most of these new insecticides are most active if ingested. Thus, coverage is critical for adequate control. Since cabbage looper and Heliiothinae are more cryptic feeders than beet armyworm, control may be difficult; especially on large plants. The objective of this study was to evaluate control of cabbage looper and Heliiothinae larvae in lettuce with new insecticide chemistries used alone and tank mixed with a pyrethroid.

Materials and Methods

Head lettuce, 'Empire' was direct seeded into double rows on 42-in beds on 26 August at the Yuma Valley Agricultural Center, Yuma, AZ. Plots were 4 beds X 25 ft, bordered on each side by 2 blank beds and on each end by 8 ft alleys. The test was a randomized complete block design, with 4 replicates. Treatments included Mustang 1.5EW (zeta-cypermethrin) at 3.84 oz/ac, Confirm 2F (tebufenozide) at 6 oz/az, Success (Spinosad) at 4 oz/ac, Proclaim 5SG (emamectin benzoate) at 0.0075 lbs-ai/ac and 0.01 lbs-ai/ac. Tank mixes included Confirm at 6 oz/ac + Mustang at 2.56 oz/ac, Success at 4 oz/ac + Mustang at 2.56 oz/ac, and Proclaim at 0.0075 lbs-ai/ac + Mustang at 2.56 oz/ac. All treatments included Latron CS-7 spreader sticker at 0.125 gal/ac.

Treatments were sprayed using a tractor mounted sprayer. The boom covered 4 rows, with 3 hollow cone TXV-4 nozzles per row, one centered over the bed and two on angled drops on each side of the bed. The sprayer was calibrated to deliver 20 gallons per acre at 40 psi. The tractor traveled at 3 mph. Treatments were applied on 22 Sept, 3, 10 and 25 Oct, and 12 Nov.

Insect densities were estimated by counting the number of small and large cabbage looper, beet armyworm and

Heliiothinae larvae from 15 plants per plot. The percentage of plants infested with eggs of each species was also estimated. Evaluations were made 5 to 6 DAT (days after treatment), additional evaluations were sometimes a at 3 and 10-12 DAT.

At harvest on 25 Nov, ten plants were randomly selected from the middle two beds of each plot and rated for damage and marketability. Damage ratings were based on a 1-5 scale was used where; 1 = no damage, 2 = minor damage to the wrapper leaves, 3 = minor damage to the head, 4 = significant damage to the wrapper leaves and 5 = significant damage to the head.

All data were analyzed using a general linear model, and an F protected ($P < 0.05$) LSD for means separation.

Results and Discussion

The lettuce in this research trial was thinned on 15 Sept and the first insecticide application was made on 22 Sept. At that time, both beet armyworms and cabbage loopers were extremely numerous. However, Yuma was hit by hurricane Nora three days later resulting in a high volume of precipitation and high winds. We were not able to enter the field to make evaluations until 3 Oct, 11 DAT (days after treatment). Because of the wash off and physical impact on the worm populations we could not detect any differences among treatments (Table 1). Additionally, although beet armyworm populations were estimated in the trial, their density was low and there were never any significant differences among treatments. Thus the beet armyworm data is not presented.

Six days following application 2, all treatments contained significantly fewer large cabbage looper than the untreated (Table 2). Among the insecticide treatments Mustang contained more large loopers than Success, Proclaim, Success + Mustang and Proclaim + Mustang. Against large Heliiothinae, Mustang, Confirm, and Confirm + Mustang were the only treatments that failed to differ from the untreated.

Three days following application 3, the treatments containing Confirm or Proclaim at the low rate did not differ from the untreated (Table 3). Confirm is known to be a slow acting material requiring up to five days to induce mortality. All insecticide treatments contained fewer large cabbage loopers 3 DAT than the untreated. By 6 DAT, only Success, Success + Mustang and Proclaim + Mustang differed from the untreated in small cabbage loopers, suggesting that these treatments may offer slightly better residual activity towards loopers. However, small loopers in the slower acting Confirm plots may have not had time to die. By 12 DAT, all the insecticide treatments contained fewer small loopers than the untreated, and only Mustang failed to differ from the untreated in large loopers. There were no significant differences among treatments in the number of Heliiothinae larvae 3 and 12 DAT, application 3 (Table 4). However at 6 DAT, Confirm alone failed to differ from the untreated.

Results following applications 4 and 5 were similar (Table 4 and 5). All of the insecticide treatments contained fewer large cabbage loopers than the untreated. However, on 30 Oct on large headed plants, Confirm alone did not perform as well as Confirm + Mustang, or the other new chemistries with and without Mustang. Although the activity of Confirm on loopers on large headed lettuce warrants concern, this observation was not consistent (Table 6). Heliiothinae populations at this time were low so those data are not reported. Based on damage ratings and percent marketable heads, it appears that Confirm does benefit from the addition of a pyrethroid when Heliiothinae are present or large numbers of loopers are present on large headed lettuce (Table 7).

Overall, Mustang used alone provided inconsistent cabbage looper control. Confirm when used alone appeared to offer adequate looper control early in the season, but may benefit from the addition of the pyrethroid late in the season. Confirm was weak on Heliiothinae and should not be used without the addition of an efficacious tank mix partner. Neither Success nor Proclaim seemed to benefit greatly from the addition of Mustang. However, from observations in commercial fields, the addition of a pyrethroid to Success when applied by air to large framed plants may enhance looper control.

Table 1. Mean number of immature cabbage loopers and Heliiothinae per lettuce plant 03 Oct (10-12 leaf stage), 11 DAT application 1.

| Treatments ^a | Cabbage Loopers | | | Heliiothinae | | |
|-------------------------|-----------------|--------------|--------------|--------------|--------------|--------------|
| | % Eggs | Small larvae | Large larvae | % Eggs | Small larvae | Large larvae |
| Untreated | 5.0 a | 0.13 a | 0.40 a | 0.0 a | 0.10 a | 0.05 a |
| Mustang 1.5 EW | 3.0 a | 0.10 a | 0.18 a | 0.0 a | 0.03 a | 0.03 a |
| Confirm | 3.0 a | 0.10 a | 0.30 a | 0.0 a | 0.03 a | 0.00 a |
| Success | 5.0 a | 0.13 a | 0.08 a | 0.0 a | 0.03 a | 0.00 a |
| Proclaim (L) | 0.0 a | 0.13 a | 0.45 a | 0.0 a | 0.03 a | 0.03 a |
| Proclaim (H) | 0.0 a | 0.13 a | 0.48 a | 0.0 a | 0.03 a | 0.00 a |
| Confirm + Mustang | 5.0 a | 0.13 a | 0.40 a | 0.0 a | 0.03 a | 0.05 a |
| Success + Mustang | 0.0 a | 0.15 a | 0.33 a | 0.0 a | 0.10 a | 0.15 a |
| Proclaim + Mustang | 5.0 a | 0.13 a | 0.30 a | 0.0 a | 0.05 a | 0.00 a |

Means in a column followed by the same letter are not significantly different; ANOVA, F protected LSD (P < 0.05).

^aMustang (zeta-cypermethrin) at 3.84 oz/ac, Confirm = (tebufenozide) at 6 oz/ac, Success (spinosad) at 4 oz/ac, Proclaim (L) (emamectin benzoate) at 0.0075 lbs-ai/ac, Proclaim (H) at 0.01 lbs-ai/ac, Confirm at 6 oz/ac + Mustang at 2.56 oz/ac, Success at 4 oz/ac + Mustang at 2.56 oz/ac, Proclaim at 0.0075 lbs-ai/ac + Mustang at 2.56 oz/ac. All treatments included Latron CS-7 spreader sticker at 0.125 gal/ac.

Table 2. Mean number of immature cabbage loopers and Heliothinae per lettuce plant 09 Oct (14-15 leaf stage), 6 DAT application 2.

| Treatments ^a | Cabbage Loopers | | | Heliothinae | | |
|-------------------------|-----------------|--------------|--------------|-------------|--------------|--------------|
| | % Eggs | Small larvae | Large larvae | % Eggs | Small larvae | Large larvae |
| Untreated | 10.0 a | 0.07 a | 0.25 a | 0.0 a | 0.03 a | 0.12 a |
| Mustang 1.5 EW | 5.0 a | 0.02 a | 0.12 b | 0.0 a | 0.00 a | 0.04 ab |
| Confirm | 2.0 a | 0.02 a | 0.03 bc | 0.0 a | 0.10 a | 0.10 a |
| Success | 5.0 a | 0.03 a | 0.00 c | 0.0 a | 0.00 a | 0.00 b |
| Proclaim (L) | 0.0 a | 0.02 a | 0.00 c | 0.0 a | 0.00 a | 0.00 b |
| Proclaim (H) | 4.0 a | 0.03 a | 0.00 c | 0.0 a | 0.00 a | 0.00 b |
| Confirm + Mustang | 5.0 a | 0.08 a | 0.05 bc | 0.0 a | 0.02 a | 0.04 ab |
| Success + Mustang | 7.0 a | 0.02 a | 0.00 c | 0.0 a | 0.00 a | 0.00 b |
| Proclaim + Mustang | 0.0 a | 0.00 a | 0.00 c | 0.0 a | 0.00 a | 0.00 b |

Means in a column followed by the same letter are not significantly different; ANOVA, F protected LSD (P < 0.05).

^aMustang (zeta-cypermethrin) at 3.84 oz/ac, Confirm = (tebufenozide) at 6 oz/ac, Success (spinosad) at 4 oz/ac, Proclaim (L) (emamectin benzoate) at 0.0075 lbs-ai/ac, Proclaim (H) at 0.01 lbs-ai/ac, Confirm at 6 oz/ac + Mustang at 2.56 oz/ac, Success at 4 oz/ac + Mustang at 2.56 oz/ac, Proclaim at 0.0075 lbs-ai/ac + Mustang at 2.56 oz/ac. All treatments included Latron CS-7 spreader sticker at 0.125 gal/ac.

Table 3. Mean number of immature cabbage loopers per lettuce plant (medium heads), application 3.

| Treatments ^a | 13 Oct, 3 DAT | | | 16 Oct, 6 DAT | | | 22 Oct, 12 DAT | | |
|-------------------------|---------------|--------------|--------------|---------------|--------------|--------------|----------------|--------------|--------------|
| | % Eggs | Small larvae | Large larvae | % Eggs | Small larvae | Large larvae | % Eggs | Small larvae | Large larvae |
| Untreated | 8.0 a | 0.13 a | 0.20 a | 8.0 a | 0.08 a | 0.17 a | 18.0 a | 0.15 a | 0.10 ab |
| Mustang 1.5 EW | 2.0 a | 0.02 b | 0.07 b | 10.0 a | 0.07 a | 0.12 a | 10.0 ab | 0.03 b | 0.15 a |
| Confirm | 2.0 a | 0.13 a | 0.00 b | 2.0 a | 0.02 ab | 0.03 a | 0.0 b | 0.03 b | 0.03 b |
| Success | 2.0 a | 0.03 b | 0.00 b | 15.0 a | 0.00 b | 0.00 a | 5.0 b | 0.03 b | 0.03 b |
| Proclaim (L) | 5.0 a | 0.05 ab | 0.00 b | 5.0 a | 0.02 ab | 0.00 a | 3.0 b | 0.05 b | 0.00 b |
| Proclaim (H) | 5.0 a | 0.00 b | 0.00 b | 10.0 a | 0.02 ab | 0.02 a | 5.0 b | 0.00 b | 0.03 b |
| Confirm + Mustang | 2.0 a | 0.12 a | 0.02 b | 8.0 a | 0.07 a | 0.02 a | 5.0 b | 0.00 b | 0.00 b |
| Success + Mustang | 7.0 a | 0.00 b | 0.02 b | 12.0 a | 0.00 b | 0.12 a | 10.0 ab | 0.00 b | 0.00 b |
| Proclaim + Mustang | 2.0 a | 0.05 ab | 0.00 b | 4.0 a | 0.00 b | 0.03 a | 5.0 b | 0.03 b | 0.00 b |

Means in a column followed by the same letter are not significantly different; ANOVA, F protected LSD (P < 0.05).

^aMustang (zeta-cypermethrin) at 3.84 oz/ac, Confirm = (tebufenozide) at 6 oz/ac, Success (spinosad) at 4 oz/ac, Proclaim (L) (emamectin benzoate) at 0.0075 lbs-ai/ac, Proclaim (H) at 0.01 lbs-ai/ac, Confirm at 6 oz/ac + Mustang at 2.56 oz/ac, Success at 4 oz/ac + Mustang at 2.56 oz/ac, Proclaim at 0.0075 lbs-ai/ac + Mustang at 2.56 oz/ac. All treatments included Latron CS-7 spreader sticker at 0.125 gal/ac.

Table 4. Mean number of immature *Heliothinae* per lettuce plant (medium heads), application 3.

| Treatments ^a | 13 Oct, 3 DAT | | | 16 Oct, 6 DAT | | | 22 Oct, 12 DAT | | |
|-------------------------|---------------|--------------|--------------|---------------|--------------|--------------|----------------|--------------|--------------|
| | % Eggs | Small larvae | Large larvae | % Eggs | Small larvae | Large larvae | % Eggs | Small larvae | Large larvae |
| Untreated | 0.0 a | 0.02 a | 0.02 a | 0.0 a | 0.02 a | 0.10 a | 0.0 a | 0.00 a | 0.05 a |
| Mustang 1.5 EW | 0.0 a | 0.00 a | 0.02 a | 0.0 a | 0.00 a | 0.00 b | 0.0 a | 0.00 a | 0.05 a |
| Confirm | 0.0 a | 0.02 a | 0.00 a | 0.0 a | 0.02 a | 0.15 a | 0.0 b | 0.05 a | 0.05 a |
| Success | 0.0 a | 0.00 a | 0.02 a | 0.0 a | 0.00 a | 0.00 b | 0.0 a | 0.00 a | 0.00 a |
| Proclaim (L) | 0.0 a | 0.00 a | 0.00 a | 0.0 a | 0.00 a | 0.00 b | 0.0 a | 0.00 a | 0.03 a |
| Proclaim (H) | 0.0 a | 0.00 a | 0.00 a | 0.0 a | 0.00 a | 0.00 b | 0.0 a | 0.00 a | 0.00 a |
| Confirm + Mustang | 0.0 a | 0.00 a | 0.02 a | 0.0 a | 0.00 a | 0.00 b | 0.0 a | 0.00 a | 0.03 a |
| Success + Mustang | 0.0 a | 0.00 a | 0.00 a | 0.0 a | 0.00 a | 0.02 b | 0.0 a | 0.00 a | 0.03 a |
| Proclaim + Mustang | 0.0 a | 0.00 a | 0.00 a | 0.0 a | 0.00 a | 0.00 b | 0.0 a | 0.00 a | 0.00 a |

Means in a column followed by the same letter are not significantly different; ANOVA, F protected LSD ($P < 0.05$).

^aMustang (zeta-cypermethrin) at 3.84 oz/ac, Confirm = (tebufenozide) at 6 oz/ac, Success (spinosad) at 4 oz/ac, Proclaim (L) (emamectin benzoate) at 0.0075 lbs-ai/ac, Proclaim (H) at 0.01 lbs-ai/ac, Confirm at 6 oz/ac + Mustang at 2.56 oz/ac, Success at 4 oz/ac + Mustang at 2.56 oz/ac, Proclaim at 0.0075 lbs-ai/ac + Mustang at 2.56 oz/ac. All treatments included Latron CS-7 spreader sticker at 0.125 gal/ac.

Table 5. Mean number of immature cabbage loopers per lettuce plant (large heads / near harvest), application 4.

| Treatments ^a | 30 Oct, 5 DAT | | | 4 Nov, 10 DAT | | |
|-------------------------|---------------|--------------|--------------|---------------|--------------|--------------|
| | % Eggs | Small larvae | Large larvae | % Eggs | Small larvae | Large larvae |
| Untreated | 5.0 a | 0.02 a | 0.22 a | 3.0 a | 0.35 a | 0.25 a |
| Mustang 1.5 EW | 0.0 a | 0.10 a | 0.05 bc | 5.0 a | 0.13 a | 0.10 b |
| Confirm | 5.0 a | 0.08 a | 0.08 b | 3.0 a | 0.05 a | 0.00 b |
| Success | 3.0 a | 0.08 a | 0.00 c | 0.0 a | 0.08 a | 0.00 b |
| Proclaim (L) | 8.0 a | 0.22 a | 0.00 c | 0.0 a | 0.03 a | 0.00 b |
| Proclaim (H) | 0.0 a | 0.05 a | 0.00 c | 0.0 a | 0.08 a | 0.00 b |
| Confirm + Mustang | 0.0 a | 0.08 a | 0.00 c | 0.0 a | 0.18 a | 0.08 b |
| Success + Mustang | 3.0 a | 0.08 a | 0.00 c | 0.0 a | 0.05 a | 0.03 b |
| Proclaim + Mustang | 0.0 a | 0.03 a | 0.00 c | 3.0 a | 0.13 a | 0.08 b |

Means in a column followed by the same letter are not significantly different; ANOVA, F protected LSD ($P < 0.05$).

^aMustang (zeta-cypermethrin) at 3.84 oz/ac, Confirm = (tebufenozide) at 6 oz/ac, Success (spinosad) at 4 oz/ac, Proclaim (L) (emamectin benzoate) at 0.0075 lbs-ai/ac, Proclaim (H) at 0.01 lbs-ai/ac, Confirm at 6 oz/ac + Mustang at 2.56 oz/ac, Success at 4 oz/ac + Mustang at 2.56 oz/ac, Proclaim at 0.0075 lbs-ai/ac + Mustang at 2.56 oz/ac. All treatments included Latron CS-7 spreader sticker at 0.125 gal/ac.

Table 6. Mean number of immature cabbage loopers per lettuce plant (at harvest), application 5.

| Treatments ^a | 18 Nov, 6 DAT | | | 20 Nov, 8 DAT | | |
|-------------------------|---------------|--------------|--------------|---------------|--------------|--------------|
| | % Eggs | Small larvae | Large larvae | % Eggs | Small larvae | Large larvae |
| Untreated | 3.0 a | 0.08 a | 0.20 a | 0.0 a | 0.08 a | 0.18 a |
| Mustang 1.5 EW | 3.0 a | 0.03 a | 0.03 b | 0.0 a | 0.00 a | 0.05 b |
| Confirm | 0.0 a | 0.03 a | 0.00 b | 3.0 a | 0.03 a | 0.03 b |
| Success | 0.0 a | 0.00 a | 0.00 b | 0.0 a | 0.05 a | 0.03 b |
| Proclaim (L) | 0.0 a | 0.03 a | 0.03 b | 0.0 a | 0.03 a | 0.05 b |
| Proclaim (H) | 3.0 a | 0.00 a | 0.00 b | 0.0 a | 0.03 a | 0.03 b |
| Confirm + Mustang | 0.0 a | 0.03 a | 0.00 b | 0.0 a | 0.00 a | 0.03 b |
| Success + Mustang | 0.0 a | 0.00 a | 0.03 b | 0.0 a | 0.00 a | 0.00 b |
| Proclaim + Mustang | 0.0 a | 0.05 a | 0.03 b | 0.0 a | 0.00 a | 0.00 b |

Means in a column followed by the same letter are not significantly different; ANOVA, F protected LSD (P < 0.05).

^aMustang (zeta-cypermethrin) at 3.84 oz/ac, Confirm = (tebufenozide) at 6 oz/ac, Success (spinosad) at 4 oz/ac, Proclaim (L) (emamectin benzoate) at 0.0075 lbs-ai/ac, Proclaim (H) at 0.01 lbs-ai/ac, Confirm at 6 oz/ac + Mustang at 2.56 oz/ac, Success at 4 oz/ac + Mustang at 2.56 oz/ac, Proclaim at 0.0075 lbs-ai/ac + Mustang at 2.56 oz/ac. All treatments included Latron CS-7 spreader sticker at 0.125 gal/ac.

Table 7. Mean damage rating per plant and percentage of marketable heads at harvest 25 Nov.

| Treatments ^a | Damage Rating ^b | % Marketable Heads |
|-------------------------|----------------------------|--------------------|
| Untreated | 2.98 a | 37.50 c |
| Mustang 1.5 EW | 1.63 bc | 82.50 ab |
| Confirm | 1.80 b | 77.50 b |
| Success | 1.25 c | 95.00 a |
| Proclaim (L) | 1.55 bc | 87.50 ab |
| Proclaim (H) | 1.43 bc | 90.00 ab |
| Confirm + Mustang | 1.33 c | 92.50 ab |
| Success + Mustang | 1.53 bc | 85.00 ab |
| Proclaim + Mustang | 1.25 c | 97.50 a |

Means in a column followed by the same letter are not significantly different; ANOVA, F protected LSD ($P < 0.05$).

^aMustang (zeta-cypermethrin) at 3.84 oz/ac, Confirm = (tebufenozide) at 6 oz/ac, Success (spinosad) at 4 oz/ac, Proclaim (L) (emamectin benzoate) at 0.0075 lbs-ai/ac, Proclaim (H) at 0.01 lbs-ai/ac, Confirm at 6 oz/ac + Mustang at 2.56 oz/ac, Success at 4 oz/ac + Mustang at 2.56 oz/ac, Proclaim at 0.0075 lbs-ai/ac + Mustang at 2.56 oz/ac. All treatments included Latron CS-7 spreader sticker at 0.125 gal/ac.

^bDamage ratings based on a 1-5 scale with 1 = no damage, 2 = slight damage to wrapper, 3 = significant damage to wrapper, 4 = minor damage to head and 5 = significant damage to head.