Temporal and Diagnostic Mortality of Cabbage Looper Larvae to Selective Insecticides in Head Lettuce

John C. Palumbo

Abstract

Several new insecticide chemistries were evaluated and compared with standard chemistries for temporal and diagnostic mortality of cabbage looper in lettuce. Three field bioassays of small and large larval mortality were conducted at pre-thinning, thinning, and postthinning stages of lettuce. The compounds with translaminar activity (Alert, Success, and Proclaim) appear to be have the most rapid "knockdown activity" with 100% mortality consistently occurring by 1-2 DAT. Because of their rapid activity, a large proportion of larvae are found dead on the plants. The products that need to be ingested to cause larval mortality (Larvin, Confirm, Neemix, Crymax, Cryolite, MP 062) generally varied significantly in temporal mortality and in efficacy against larvae. Unlike the translaminar products, a large proportion of larvae on were often found missing from treated plants. The results of this study provide basic guidelines concerning the activity and assessment of the performance of these materials in the field. PCAs and growers will ultimately be able to develop specific use patterns for these materials within their individual lettuce pest management programs.

Introduction

The number of effective insecticides currently available to growers for insect control in desert lettuce production is relatively small compared with other crops. Furthermore, with the recent passage of the Food Quality Protection Act, the lettuce industry in Arizona could possibly be facing the loss of a number of important insecticides. A recent example would be the withdrawal of Phosdrin from the vegetable market. Fortunately, the loss of Phosdrin for aphid control on lettuce coincided with the registration of an effective alternative product (Admire). Consequently, there is speculation that some of the more broadly toxic compounds may be removed from the market in the next few years. The organophosphate and carbamate insecticides (ie. Lannate, Orthene, Larvin, Endosulfan, Monitor, Diazinon) are being targeted as prime candidates for reduced usage. As these older chemicals are lost, the introduction of replacement products that can live up to both regulatory and grower standards will be critical.

The Arizona vegetable industry is fortunate that there are several new insecticide chemistries currently being developed that offer novel modes of action and selective activity. Some of the most exciting breakthroughs in agricultural chemicals have come in the last few years with the development of several new classes of chemistry for the control of lepidopterous pests such as cabbage looper (CL). These insecticides are similar in that they are relatively selective for worms, and safe to use and apply. This has been achieved through both mode of action and type of activity. Of the compounds tested, most of them are new chemistries with independent modes of action (neurotoxic, metabolic, and insect growth regulators). Several posses translaminar activity, where the foliar spray penetrates the leaf surface providing toxicity through contact and ingestion. Many of the others that they be ingested to be toxic to larvae. For more details on these compounds refer "Review of New Insecticides Under Development for Vegetable and Melon Crops" found in this report. Although currently in the developmental stages, these new products will probably be available for use in lettuce in the next 1-2 years. The objectives of this study were to compare and document the temporal and diagnostic mortality of several new and currently available insecticides against beet armyworm larvae after they have been applied to lettuce in field and laboratory tests.

Materials and Methods

Lettuce, *Lactuca sativa* L., 'Empire' was direct seeded into double-row beds on 30 Aug at the Yuma Valley Agricultural Center, Yuma, Az. Each plot consisted of four, 30 ft long beds spaced 42 inches apart and bordered on each side by an untreated bed. Plots were arranged in a completely randomized block design with 4 replicates. Treatments, formulations and rates consisted of the following:

Treatment	Rate / acre
Lannate 90S	0.75 lb AI
Larvin 80DG	0.75 lb AI
Alert 2EC	0.15 lb AI
Confirm 2F	0.13 lb AI
Success 1.6DE	0.09 lb AI
Proclaim 0.16EC	0.0075 lb AI
Neemix 4.5EC	1 pt prod.
Crymax WDG	1 lb prod.
MP062 WDG[a]	0.065 lb AI
Prokil Cryolite[a]	10 lb prod.
Untreated control	--

[a] These products only tested in Trial 4.

Foliar applications of the treatments were made with a hand-held CO_2 sprayer operated at 50 psi, delivering 20 gal/ acre in a banded or directed, broadcast spray (Table 1). Spreader-sticker (Latron CS-7) was included in all spray treatments at a rate of 0.125% of the total volume. Three separate field trials were conducted. Mortality of cabbage looper larvae was investigated by marking plants within each sprayed replicate and making daily counts of larval mortality. Five individual plants in each replicate that contained at least 2 live larvae were identified and marked. A minimum of 10 larvae per replicate were used in the study. Marked plants were sampled by direct observation for the presence of dead, live or absent larvae for five consecutive days following each foliar application. Larvae were considered dead if they did not respond to touch or were visibly desiccated. Larvae were considered live if they responded to touch by moving. Larvae were considered missing if they could not be found on or beneath the plant during inspection. Field diagnostic mortality was calculated by determining the % dead, alive and missing larvae on tagged plants after the 5 day exposure to treated plants. Temporal mortality was calculated by dividing the number of dead and missing worms for each consecutive day from the total number of worms present at the beginning of the study. Data were converted to percent alive, dead or missing larvae and transformed using an arsine transformation. Differences between treatments was determined using a 1-way ANOVA and $LSD_{0.05}$.

Results and Discussion

Cabbage looper populations at YAC were very high in the fall of 1996. Consequently we were able to select a uniform sample for the study at each plant stage (Table 1). The results of each bioassay are discussed below:

Trial 1: *Small CL*. This was a prethinning application (2-3 leaves). The three translaminar compounds, Lannate and Larvin caused 100% mortality at 1 DAT. Total mortality was observed in the Crymax treatment at 3 DAT. The Confirm and Neemix treatments did not provide total mortality after 100 d. The cnontrol mortality was 16%. Dead worms on plants following application were most noticeable on the translaminar treatments (30-70%). No dead larvae were observed in the Larvin, Neemix or Crymax treated plants.

Trial 2: Small CL. This was a postthinning-preheading application. CL mortality was considerably lower in the first two days. At 3 DAT only Proclaim provided 1005 mortality. At 4 DAT, Alert, Success and Larvin had 100% mortality. Mortality in the other treatments did not exceed 86% in the other treatments. Control mortality was low (7%). Diagnostic mortality shows that the greatest % dead larvae on plants was on plants treated with the translaminar compounds.

Large CL. Temporal mortality was similar for large CL, with the exception that a 100% mortality was not observed on the Larvin treated plants. Control mortality was higher for large worms, presumably due to the great amount of feeding and subsequent movement off of damaged plants. Diagnostic mortality was also similar to that observed for small larvae.

Trial 3: *Small larvae.* This was a thinning application (3-4 leaves). Mortality was rapid (1-2 days) on plants treated with Proclaim, Alert, Success and MP062. Total mortality in the Larvin, Confirm and Crymax plots occurred at about 3-5 DAT, and did not occur in the other treatments. Diagnostic mortality shows that the greates number of dead larvae were found on plants treated with the translaminar compounds, Lannate and Cryolite. All of the worms were found missing from the Confirm, Neemix, Crymax abnd untreated plots. *Large larvae.* Temporal and diagnostic mortality were similar to the thinning trial with large larvae.

In summary, Industry has again developed several excellent tools for worm control in vegetable crops. Our study supports previous research demonstrating the excellent activity of these new chemistries against lepidopterous larvae in desert lettuce production. It also illustrates the differences in temporal activity among the new and standard insecticides. More importantly, this information provides basic guidelines for assessing the activity and performance of these materials. Upon registration, PCAs and growers will be able to develop use patterns for the insecticides specific to their individual pest management programs.

Table 1. Spray dates, application types, plant stages and larvae evaluated for the 3 field bioassays in head lettuce, YAC, Fall 1996.

Trial[a]	Spray date	Plant stage	CL larvae evaluated	Application
1	9/14/96	Prethinning (2-3 lvs)	small larvae (neonate & > 5-10 mm in length)	Banded, (8" band above each seedline. 15gpa).
2	10/15/96	Postthinning (8-10 lvs)	small & large larvae (> 10 mm)	Broadcast spray (42" beds), 20 gpa
3	10/8/96	Thinning (3-4 lvs)	small & large larvae	Broadcast spray (42" beds), 20 gpa

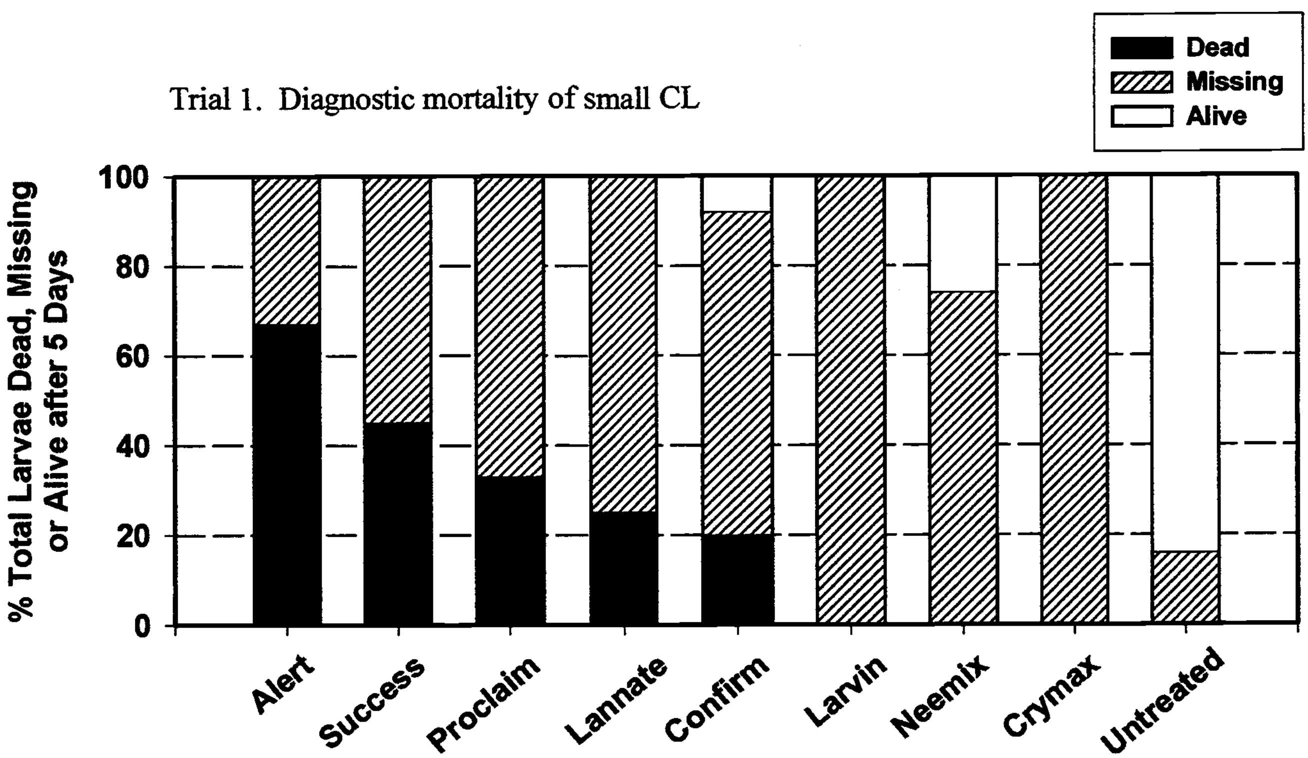
[a] All trials were conducted in separate plot areas., LB refers to laboratory bioassay.

Trial 1. Temporal Mortality of Small Cabbage Looper (CL) larvae on Lettuce -Prethinning stage (2-3 leaves/plant), treatments applied 9/14/96, wet date 8/30/96.

	% cumulative larval mortality , small CL				
Treatment	1 DAT[a]	2 DAT	3 DAT	4 DAT	5 DAT
Lannate	100 a	100 a	100 a	100 a	100 a
Larvin	100 a	100 a	100 a	100 a	100 a
Alert	100 a	100 a	100 a	100 a	100 a
Confirm	42 b	70 b	92 a	92 ab	92 ab
Success	100 a	100 a	100a	100 a	100 a
Proclaim	100 a	100 a	100 a	100 a	100 a
Neeminx	0 d	15 c	40 b	73 b	73 b
Crymax	33 bc	64 b	100 a	100 a	100 a
Untreated	11cd	11 c	16 b	16 c	16 c
P > F	0.0001	0.0001	0.0001	0.0001	0.0001

Means followed by the same letter are not significantly different (LSD, P<0.05).
[a] Days after treatment

Trial 1. Diagnostic mortality of small CL

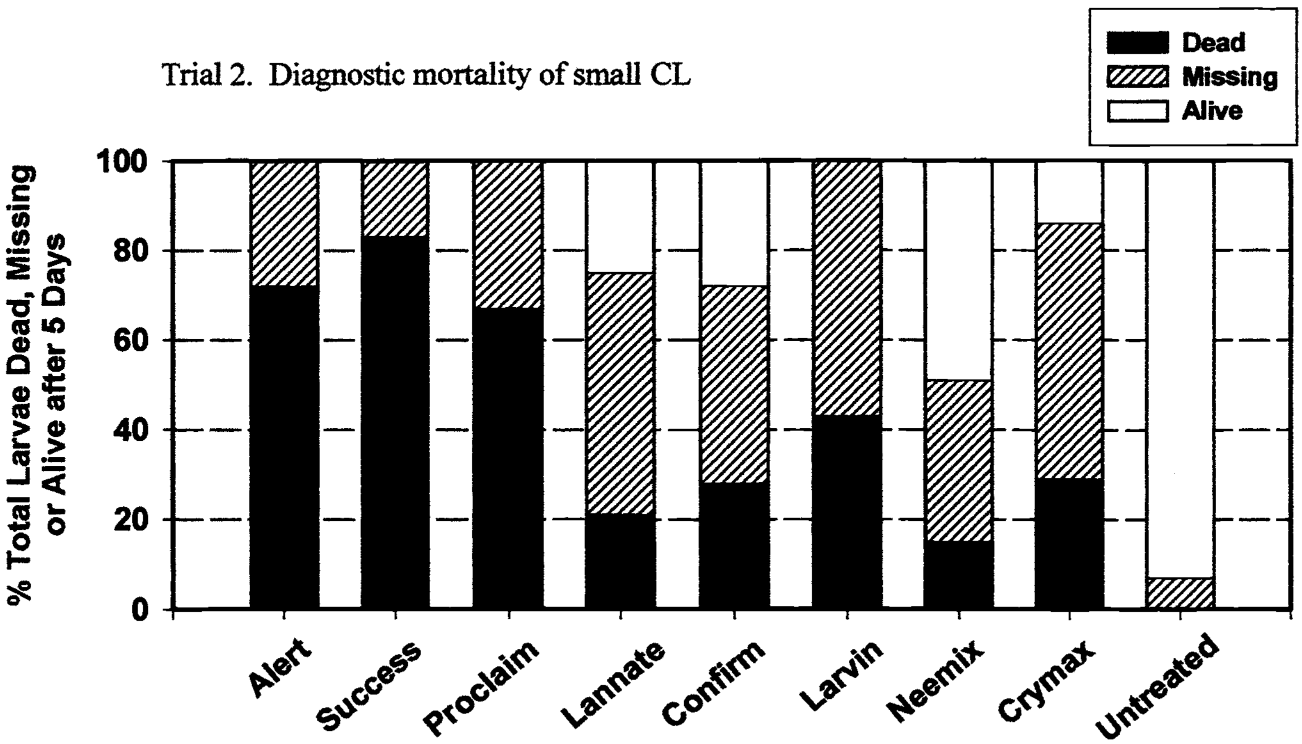


Trial 2. Temporal Mortality of small Cabbage Looper in Lettuce, Post-thinning stage (14-16 leaves/plant), treatments applied10/15/96, wet date 8/30/96.

	% cumulative larval mortality, small CL				
Treatment	1 DAT[a]	2 DAT	3 DAT	4 DAT	5 DAT
Lannate	51 b	64 bc	75 ab	75 ab	75 ab
Larvin	50 b	57 c	72 ab	100 a	100 a
Alert	78 ab	92 ab	98 a	100 a	100 a
Confirm	11 c	31 cde	67 ab	72 ab	72 ab
Success	85 a	90 a	98 a	100 a	100 a
Proclaim	87 a	87 a	100 a	100 a	100 a
Neeminx	6 c	14 de	25 c	40 c	51 b
Cryma x	16 c	36 cd	41 bc	68 bc	86 a
Untreated	0 c	0 e	7 c	7 d	7 c
P > *F*	0.0001	0.0001	0.0001	0.0001	

Means followed by the same letter are not significantly different (LSD, P<0.05).
[a] Days after treatment

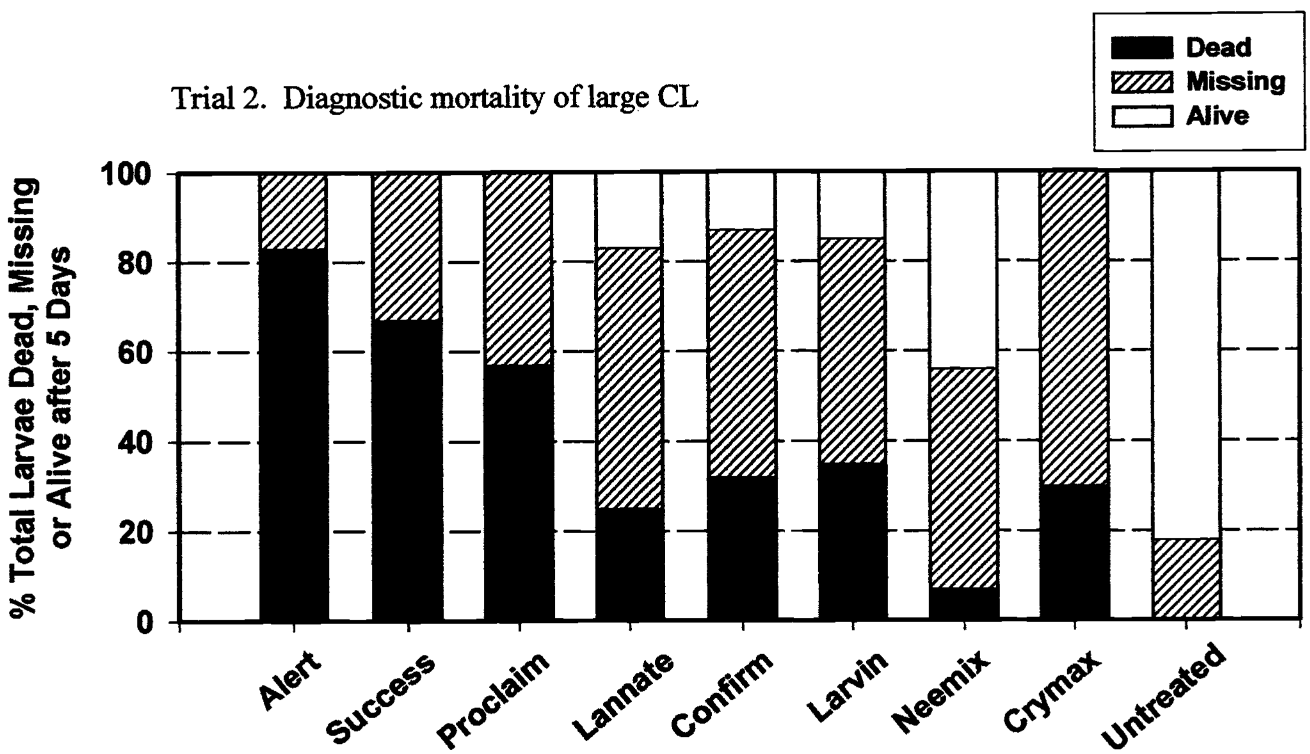
Trial 2. Diagnostic mortality of small CL



Trial 2. Temporal Mortality of large Cabbage Looper Lettuce, Post-thinning stage (14-16 leaves/plant), treatments applied 10/15/96, wet date 8/30/96.

Treatment	% cumulative larval mortality, large CL				
	1 DAT[a]	2 DAT	3 DAT	4 DAT	5 DAT
Lannate	25 bc	58 b	67 b	83 ab	83 a
Larvin	48 ab	70 ab	77 ab	85 ab	85 a
Alert	87 a	95 a	100 a	100 a	100 a
Confirm	7 c	52 b	76 ab	81 ab	86 a
Success	60 ab	80 ab	100 a	100 a	100 a
Proclaim	61 ab	82 ab	95 ab	100 a	100 a
Neeminx	0 c	12 c	30 c	56 c	56 b
Crymax	20 bc	59 b	80 ab	80 b	100 a
Untreated	0 c	0 c	7 c	7 d	18 c
P > F	0.003	0.0002	0.0002	0.0001	0.0001

Means followed by the same letter are not significantly different (LSD, P<0.05).
[a] Days after treatment

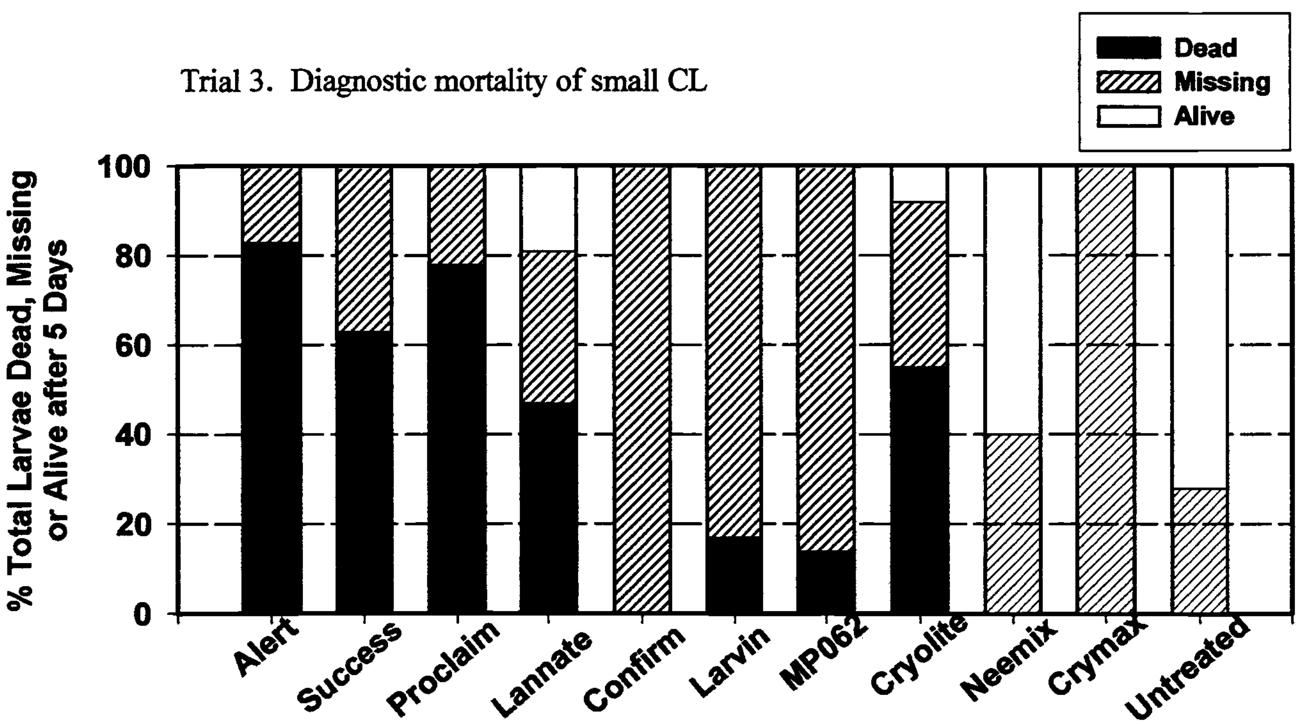


Trial 3. Temporal Mortality of small Cabbage Looper Larvae in Lettuce, Thinning stage (3-4 leaves/plant), treatments applied 10/8/96, wet date 9/21/96.

	% cumulative larval mortality, small CL				
Treatment	1 DAT[a]	2 DAT	3 DAT	4 DAT	5 DAT
Lannate	56 bc	80 a	80 a	80 b	80 b
Larvin	54 bcd	82 a	92 a	100 a	100 a
Alert	100 a	100 a	100 a	100 a	100 a
Confirm	20 de	38 b	100 a	100 a	100 a
Success	88 ab	100 a	100 a	100 a	100 a
Proclaim	100 a	100 a	100 a	100 a	100 a
DPX MP062	93 a	100 a	100 a	100 a	100 a
Cryolite	65 abc	92 a	92 a	92 ab	92 ab
Neeminx	0 c	10 bc	20 b	30 c	40 c
Crymax	47 c	78 a	88 a	88 ab	100 a
Untreated	0 c	6 c	22 b	22 c	28 c
P > F	0.0001	0.0001	0.0001	0.0001	0.0001

Means followed by the same letter are not significantly different (LSD, P<0.05).
[a] Days after treatment

Trial 3. Diagnostic mortality of small CL



Trial 3. Temporal Mortality of Large Cabbage Looper Larvae in Lettuce, Thinning stage (3-4 leaves/plant), treatments applied 10/8/96, wet date 9/21/96.

	% larval mortality, large CL				
Treatment	1 DAT[a]	2 DAT	3 DAT	4 DAT	5 DAT
Lannate	72 abc	72 a	72 ab	88 a	88 a
Larvin	8 de	84 a	92 a	92 a	92 a
Alert	100 a	100 a	100 a	100 a	100 a
Confirm	52 abcd	92 a	100 a	100 a	100 a
Success	84 ab	100 a	100 a	100 a	100 a
Proclaim	100 a	100 a	100 a	100 a	100 a
DPX MP062	56 abcd	83 a	100 a	100 a	100 a
Cryolite	44 abcd	88 a	88 a	88 a	88 a
Neeminx	0 e	28 b	44 b	84 a	84 a
Crymax	22 cde	22 b	66 ab	100 a	100 a
Untreated	0 e	22 b	33 b	33 b	44 b
P > *F*	0.003	0.0004	0.01	0.002	0.02

Means followed by the same letter are not significantly different (LSD, P<0.05).
[a]Days after treatment

Trial 3. Diagnostic mortality of large CL