EFFICACY OF SELECTED INSECTICIDES AGAINST THE BEET ARMYWORM, SPODOPTERA EXIGUA - FIELD AND LABORATORY EVALUATIONS

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Abstract

Three small plot efficacy studies were conducted to evaluate efficacy of selected currently registered and experimental insecticides against beet armyworm (BAW). The four experimental insecticides (Confirm, Pirate, Spinosad, Proclaim) generally provided increased efficacy as compared to federally registered insecticides. LD_{50} determinations conducted on field collected colonies and a susceptible laboratory colony of BAW indicated reduced susceptibility of field populations to the commonly used registered insecticides. Considerable variation in the response of these colonies to the experimental insecticides was also noted, suggesting that insecticidal resistance may become a problem with these insecticides as well.

Introduction

The beet armyworm (BAW), Spodoptera exigua (Hubner), is a sporadic pest of cotton in the Lower Rio Grande Valley (LRGV) of Texas. It is a more common problem in vegetable production in this same region. Because of the environment and cropping system in the LRGV, the BAW has the potential of reproducing throughout the year. Although BAW infestations in cotton are typically scattered both within and between fields when they occur, in 1995, cotton fields throughout the LRGV were heavily infested with population densities as high as 20 or more per foot of row in many fields. This heavy infestation, combined with a lack of adequate control measures when the problem first appeared, contributed greatly to the nearly complete loss of a crop which was already suffering from environmental stress and earlier pest problems.

These heavy infestations did offer an excellent opportunity to evaluate insecticides for efficacy against the BAW. Normal infestations of this pest are difficult to work with in efficacy studies because of the highly clumped nature of their distribution within fields. The populations encountered in the LRGV in 1995 were sufficiently high to mask clumping effects and provide an even distribution, allowing adequate efficacy evaluations in small plots.

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Three small plot studies were conducted in commercial cotton fields in the LRGV in 1995 to evaluate selected insecticides for efficacy against the BAW. In conjunction with these field studies, laboratory assays were conducted to determine the LD_{50}'s for selected insecticides against BAW colonies created with field collections and a susceptible lab colony.

Materials and Methods

Small plot efficacy studies were conducted in commercial cotton fields which were no longer being treated by the producers because of a lack of yield potential. In each test, plots measured 4 rows (on 40 in. centers) by 25 ft. Plots were arranged in a randomized complete block with four replications in all three tests. Applications were made with a CO_2 pressurized backpack sprayer (40 psi) in 10 GPA. Nozzle arrangement consisted of three TX5 hollow cone nozzles per row, with one nozzle over-the-top and one on each side of the row on drops. BAW larvae were sampled in each plot with the a standard beet sheet. Three feet of row were sampled on each of the middle two rows (six feet per plot) on each sample date. Larvae were classed as small (first to third instar) or large (fourth to sixth instar) and counted. Original plans were to follow all three tests for two weeks or longer to evaluate residual control. However, because the BAW generations were very synchronized, the populations within each test generally cycled out prior to a good evaluation of residual control. Larval counts were analyzed with the PROC ANOVA procedure of PC-SAS and means separated with DMRT (P=0.05).

The first efficacy study was conducted in a field near Lyford, Texas, during the first severe cycle of BAW. At the time this study was initiated, larvae in the field consisted primarily of fourth instar or larger. The two additional efficacy studies were conducted during the second cycle of BAW in a field near Mercedes, Texas. One study was designed to evaluate preventive treat-ments, which included insecticides we felt stood the best chance of working if applied when larvae were very young. The second study was initiated after eggs had hatched and larvae were present (although most were still small).

Treatments and rates in the two curative tests are listed in Tables 1 and 2. A single application of each treatment was made on 3 June in the Lyford test and larval populations were sampled on 5 and 7 June. In the Mercedes test, a single application of each treatment was made on 22 June and larval populations were monitored on 26 and 29 June. Silwet L-77 was added to all treatments at a rate of 8 oz. per 100 gallons of finished spray in both tests. Insecticides with federal labels for use on cotton in these two tests included Danitol 2.4EC, Monitor 4E, Lorsban 4E, Curacron 8E, Larvin 3.2F, Lannate 1.8EC, Ovasyn 1.5EC, and Dimilin 2F. Insecticides without federal labels for use on cotton (referred to hereafter as experimental) included Confirm 2F, Pirate 3SC/Alert 2SC (listed as Pirate in

tables), Spinosad 4F, Proclaim 0.016EC, and pyriproxyfen 0.83EC.

Treatments in the preventive test were applied on 16 and 21 June and included the addition of Silwet L-77 at a rate of 8 oz. per 100 gallons of final spray on 16 June. Treatments and rates (per acre) were:

1. Check
2. Design - 1 lb of product/application
3. Xentari - 1 lb of product/application
4. Spod-X - 100 ml of product/application
5. Dimilin 2F - 0.0625 lb AI 1st app.; 0.0312 lb AI 2nd app.
6. Confirm 2F - 0.125 lb AI on 6/16 (single app.)

Design and Xentari are Bacillus thuringiensis products. Spod-X contains a nuclear polyhedrosis virus specific for BAW. Dimilin and Confirm are insect growth regulators.

In addition to the field efficacy studies, LD_{50}'s were determined for selected insecticides for 5 colonies created from field collections of BAW and a susceptible laboratory colony. One of the field collections was conducted in a pepper field (Donna colony) and the remaining four were collected in cotton fields in the LRGV (Mercedes, Lyford, Weslaco) and Northern Mexico (Rio Bravo). LD_{50} determinations for field colonies were conducted on F_1 and F_2 generations. The susceptible laboratory colony was obtained from Zeneca, Richmond, CA and designated as the Dow-Zeneca colony.

LD_{50}'s were determined through standard techniques for topical treatment. Technical grade insecticides were applied on the dorsal surface of the thorax of third instar larvae (15 to 25 mg) in 1 μl of acetone. The insecticides evaluated and the rate ranges (as μg per larva) varied with colony but in general included Confirm (0.039-50), Spinosad (0.031-5), Lannate (0.78-50), Dimilin (0.78 - 12.5), Pirate (0.0625 - 2), Lorsban (0.78-50), Proclaim (0.003875 - 1), and Methyl Parathion (0.31 - 50). The rate range was extended when necessary due to insufficient or excessive mortality at rates tested. Mortality was monitored at 72 or 96 hours after treatment for all treatments except the growth regulators (Dimilin, Confirm) which were evaluated at 168 hours. A few of the insecticides tested are reported to have improved efficacy when ingested and topical applications may require greater doses; however, this data should still provide legitimate comparisons of responses of different colonies to these insecticides.

Results and Discussion

For all three field efficacy studies, only the analysis of total larvae (small and large together) will be presented. Results of the two studies conducted on established populations are presented in Tables 1 and 2. Larvae in the Lyford test were primarily large larvae at the time of treatment; whereas, 75% of larvae in the Mercedes field were classified small at the time of treatment (time of treatment corresponds with 2 DAT-2 in Table 3). However, both studies show similar results. In general, none of the federally labelled compounds as a single spray provided adequate control of BAW. The statistical grouping of treatments providing the greatest reduction of BAW on each date generally included Confirm, Pirate, Spinosad, Proclaim, and Dimilin in combination with Lorsban or Larvin. The numerical trends within these groupings generally indicated increased efficacy of the experimental insecticides. Addition of a feeding stimulant (Pheast) to Confirm did not affect efficacy (Table 1).

At 2 DAT in the Lyford test, the somewhat faster activity of Pirate and Proclaim is evident with the greatest numerical reduction in these two treatments. However, by 4 DAT in both tests, no statistical differences occur among the experimental insecticides and the Dimilin combinations. At 7 DAT in the Mercedes test, none of the experimental insecticides statistically separated from any of the Dimilin treatments, but numerical trends suggested improved efficacy with the experimental insecticides.

Larval counts in the preventive test at Mercedes also showed general trends for improved efficacy of the experimental insecticide (Confirm) over currently registered alternatives. The first treatment was applied as egg masses were hatching and prior to establishment of large larval populations, as evident by the large percentage of larvae classified as small up to 7 DAT-1 (Table 3, 2 DAT-2).

None of the treatments in the preventive test provided significant reduction in larval counts until 5 DAT-2; although, Confirm did show obvious numerical reductions on both of the earlier dates. Confirm also provided the greatest numerical reduction on the last two sample dates, but was not significantly different from Spod-X on either date or Dimilin on the last date. These latter two treatments provided obvious suppression of BAW in this test and would have likely had even greater impact on the next generation as larvae collected from these plots on the last sample date generally died prior to pupation or failed to emerge as adults (data not presented).

The LD_{50} values determined in the laboratory assays are shown in Table 4. Data for currently registered insecticides indicated obvious increases in LD50's in at least some of the field colonies as compared to the laboratory colony for all four insecticides. These results support the lack of efficacy noted in the field trials. This is particularly true for Lannate. This product has been used widely in the LRGV for control of BAW in vegetable crops for many years and field experience has indicated a reduction in efficacy of this product in the past few years.

Although the experimental insecticides provided good control of BAW in the field trials, the LD_{50} values suggested potential for development of resistance,

particularly with Confirm and Pirate. The LD_{50}'s for these two insecticides were significantly higher in all of the field colonies tested, compared to the susceptible colony. Possibly of more importance is the differences among the field colonies in their response to the experimental products. With the exception of Proclaim, all of the products tested showed increased LD_{50}'s, or an obvious decrease in mortality at the highest dose tested, in at least one of the field colonies. At this point, it is unknown if these levels of variation in susceptibility would result in decreased efficacy in the field, but they do indicate a potential for selection of a less susceptible population and possible insecticide resistance problems.

Table 1. Beet armyworm larval population densities following insecticide applications, Lyford, Texas, 1995.

Treatment	Rate (lb. AI/ac)	Larvae/6 ft of row 2 DAT	4 DAT
Check		33.8 a	19.3 a
Danitol	0.2	33.0 a	19.0 a
Curacron	1.0	31.5 a	15.0ab
Lorsban	1.0	16.5 bcd	13.5 ab
Lorsban+Ovasyn	1.0+0.125	19.3 bc	13.3 ab
Lorsban+Dimilin	1.0+0.0625	14.0 bcde	7.8 bc
Spinosad	0.062	21.8 b	7.8 bc
Proclaim	0.0075	7.0 de	4.0 c
Pirate	0.2	5.5 e	2.5 c
Confirm	0.125	12.3 bcde	1.5 c
Confirm+Pheast	0.125+1[a]	12.0 cde	1.3 c

Numbers within columns followed by the same letter are not significantly different (DMRT, P=0.05).
[a] Pheast rate is shown as lb. of formulated product per acre.

Table 2. Beet armyworm larval population densities following insecticide applications, Mercedes, Texas, 1995.

Treatment	Rate (lb AI/ac)	Larvae/6 ft of row 4 DAT	7 DAT
Check		18.3 ab	18.5 ab
Pyriproxyfen	0.039	22.3 a	29.8 a
Danitol+ Pyriproxyfen	0.188+ 0.039	22.8 a	29.8 a
Lannate	0.9	16.5 ab	15.3 bc
Dimilin	0.125	15.0 abc	13.3 bcd
Danitol+Monitor	0.188+0.5	12.5 bcd	10.3 bcd
Larvin+Ovasyn	0.9+0.125	8.8 cde	17.3 ab
Larvin+Dimilin	0.9+0.0625	7.3 def	11.5 bcd
Confirm	0.125	3.5 ef	1.5 cd
Spinosad	0.062	3.3 ef	3.0 cd
Pirate	0.2	0.8 f	1.0 d

Numbers within columns followed by the same l etter are not significantly different (DMRT, P=0.05).

Table 3. Beet armyworm population densities after preventive insecticide treatments, Mercedes, Texas, 1995.

Treatment	Larvae/6 feet of row 3 DAT-1	2 DAT-2	5 DAT-2	7 DAT-2
Check	22.5 a	27.5 a	25.0 ab	23.5 a
Design	15.3 a	37.0 a	36.5 a	21.3 a
Xentari	16.0 a	28.0 a	15.0 bc	15.8 ab
Spod-X	8.3 a	25.3 a	9.0 cd	8.8 bc
Dimilin	10.5 a	15.8 a	14.8 bc	8.0 bc
Confirm	3.3 a	6.3 a	0.8 d	3.0 c
% small larvae[a]	95.5	75.5	4.0	3.2

Numbers within columns followed by the same letter are not significantly different (DMRT, P=0.05)
[a] Calculated from larvae in the check plots only.

Table 4. Lethal dose 50 determinations for selected insecticides against beet armyworm, 1995.

Colony	LD_{50} (95% CI) - μg per larva[a] Lannate	Dimilin	Lorsban
Dow-Zeneca	5.48 (0.7-22.6)	89% at 0.095	0.48 (0.2-0.8)
Donna	10% at 50	5.03 (2.3->12.5)	19.91 (6.9->50)
Mercedes	22% at 50	54% at 12.5	15.13 (5.7->50)
Lyford	13% at 50	10% at 12.5	3.96 (2.3-6.0)
Weslaco	33% at 50	35% at 25	6.61 (4.7-9.4)
Rio Bravo	34% at 50	39% at 12.5	6.56 (4.6-9.7)
	Methyl P.	Confirm	Spinosad
Dow-Zeneca	1.02 (0.4-2.1)	82% at 0.0475	1.30 (0.3->5)
Donna	60% at 50 (33.5->50)	5.21 (3.5-7.9)	0.51 (0.2-0.8)
Mercedes	27.13	3.99 (7.1->100)	0% at 2.0 (1.7-7.6)
Lyford	19.73 (10.6-27.2)	64.35 (12.9->50)	4.63 (3.2-8.4)
Weslaco	35% at 50	11.86 (6.1-35.5)	1.17 (0.7-2.5)
Rio Bravo		2.99 (1.5-5.7)	2.21 (1.1->5)
	Pirate	Proclaim	
Dow-Zeneca	0.18 (0.12-0.26)	0.064 (0.02->1.0)	
Donna		0.034 (0.02-0.06)	
Mercedes	1.18 (0.8-2.0)	0.038 (0.03-0.09)	
Lyford	9% at 2.0	0.081 (0.05-0.1)	
Weslaco		0.037 (0.02-0.08)	
Rio Bravo	35% at 2.0 (1.2->2.0)	0.11 (0.06-0.2)	

[a] For tests with insufficient range of rates to determine the LD_{50}, or if the LD_{50} fell outside of the range tested, percent mortality at the maximum rate (if <50 % mortality occurred at the highest rate) or minimum rate (if >50 % mortality ocurred at the lowest rate) tested is indicated.