EFFICACY AND ECONOMIC RETURNS FROM VARIOUS INSECTICIDE COMBINATIONS APPLIED FOR TOBACCO BUDWORM CONTROL IN THE BRAZOS RIVER VALLEY

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Key Words: Tobacco budworm, Resistance management, Pyrethroids, Combinations, Partial budgeting

Abstract

A field efficacy evaluation revealed significant differences in efficacy among a few of the numerous insecticides or combinations of insecticides applied for Heliothis spp. control. An increasing proportion of TBW made up this field population during the test period. Partial budgeting revealed that the net returns gained from applying any treatment were directly proportional to the resulting yield obtained from that treatment.

Introduction

Cotton bollworm, Heliothis zea (Boddie), and tobacco budworm, Heliothis virescens (Fabr.), are important insect pests of cotton. Their management often requires using insecticides to suppress economically damaging populations of larvae. Since the late-1970s, synthetic pyrethroids have been the major insecticide class used for controlling Heliothis spp. in cotton. Allen et al. (1987) and Campanhola and Plapp (1987) reported difficulties in tobacco budworm (TBW) control with synthetic pyrethroids in parts of Texas since 1985. The latter authors also demonstrated pyrethroid synergism against resistant TBW using chlordimeform (Cdf) and other chemicals in laboratory bioassays. The field experiment reported here was conducted to compare a number of different insecticides and mixtures for efficacy against Heliothis spp. over a time period when the proportion of TBW in the local Heliothis spp. population was increasing, and also when the local TBW populations possessed an increasing frequency of genes conveying pyrethroid resistance (Plapp, unpublished data).

Materials and Materials

This research was conducted during the 1987 season near College Station, Texas at the Texas Agricultural Experiment Station Research Farm in Burleson County. Four acres of 'Stoneville 825' cotton were planted 9 April on rows spaced 40 inches apart. The cotton was treated with .125 lbs acephate/acre on 29 May for cotton fleahopper, and also with .5 lbs methyl parathion/acre on 17 and 22 June for boll weevil. The cotton was furrow irrigated 27 Jul. The field received scant rainfall during the experimental period, amounting to .56 total inches. Nineteen insecticide treatments and an untreated check (Table 1) were compared in a randomized block design with four replications. Plots were 12 rows wide and 45 feet long. Only the middle six rows were sprayed. Applications were made with a high-clearance, self-propelled sprayer using TX-3 hollow cone nozzles and calibrated to deliver 5.1 gal/acre. Insecticide applications commenced after the first major infestation of Heliothis (presumably H. zea) occurred in early July. Treatments were applied 13, 21 and 31 Jul, and 11 and 19 Aug. A post-treatment sample of secondary pests was made 13 Aug by inspecting 15 randomly selected leaves per plot and counting numbers of aphids and mites with a hand lens. Heliothis larval counts and cotton crop damage assessments were made prior to each application of insecticide treatments. Sampling consisted of counting the total number of squares (>1/3 grown) and bolls on plants in four separate 1-meter sections of row per plot and recording the number damaged by Heliothis larvae. In addition, larvae present on these fruits were counted. Cotton was hand harvested from four, randomly selected 1-meter sections of treated row per plot. The harvested cotton was extracted, ginned and weighed. Data were analyzed by analysis of variance, and means were separated using a standard multiple comparison procedure (Duncan 1955).

Treatment costs and yield data were used in a partial budgeting procedure described by Lacewell and Taylor (1980) to compare net returns among the treatments. A crop budget for cotton production in the Brazos River Valley (Extension Economists, Management 1987) was used in the analysis. All inputs were assumed to be identical except for insecticide related costs and harvest(including ginning, bags, andties) costs, which varied according to experimental treatment and plot yield, respectively. Gross returns (GR) per treatment were calculated by using average yield data from those respective plots, multiplied by locally received prices for lint and cottonseed ($0.69/lb lint and $88.20/ton seed). Cost values included: (1) a modified variable cost (VC) value composed of the crop budget total VC with an additional $3.00/acre irrigation cost minus the listed insecticide, insecticide application, and harvest costs; (2) estimated harvest cost (HC) as a function of actual plot yield and price/lb lint, and (3) the actual costs of the different insecticide combination treatments. The latter was calculated using local prices paid for the chemicals making up the combinations and their application. Net returns (NR) per treatment (above fixed costs) were then calulated: NR = GR - (modified VC) - (estimated HC) - (Treatment Cost).

Results and Discussion

A number of significant differences existed among the numerous treatments in mean seasonal larval densities, percent damaged squares, and percent damaged bolls (Table 2). Only some of these measurements correlated well with yield data, most notably treatments 1, 6, 7 and 9 (i.e. high levels of larvae and damage with low yields) and treatment 13 (i.e low levels of larvae and damage with a high yield). In addition, plots sprayed with treatments 3, 4, and 5 (consisting of pyrethroids or pyrethroid-Cdf combinations) resulted in apparently greater yields than many of the remaining treatments. Most treatments containing pyrethroids also resulted, however, in larger numbers of resurging aphids, with the exception of cypermethrin-acephate combinations (Table 3). Post-treatment levels of spider mites were negligible throughout the experiment. The data did not reveal any significant differences in yield between Cdf mixtures and equivalent amitraz mixtures, though the latter were associated with apparently lower yields. The advantage of combining cypermethrin+Cdf with thiodicarb (treatment 13) rather than acephate (treatment 9) was readily apparent from the significant difference in yield.

Differences in net returns were apparently much more affected by differences in yield than differential harvest or treatment costs (Table 4). Variations in yield produced proportional differences in gross economic returns which were much higher than the differences in harvest costs or treatments costs. Therefore, increases in net returns were in general directly proportional to increases in yield among the different treatments. This is explained in part by the assumption of all VC being constant across treatments and yields except for harvesting and insecticide treatments. Thus, based on this analysis, even though the insecticide costs of a triple combination (e.g. treatment 13: cypermethrin + thiodicarb + Cdf) were high, the corresponding negative effect on returns was outweighed by the positive effect of the high yield obtained with this insecticide treatment combination.

In conclusion, the combination of cypermethrin + thiodicarb + Cdf appeared to be a good alternative toxicant for control of late season, increasingly pyrethroid-resistant TBW. If it is assumed that the majority of test subjects over the experimental period were H. virescens (as suggested by Table 5) and that the frequency of resistant individuals was highest during this period (Plapp unpublished data), then the following can be concluded: 1) the cypermethrin + thiodicarb + Cdf mixture was clearly more effective against resistant TBW than were a number of other combinations, and 2) the superiority of Cdf over amitraz as a synergist was suggested, albeit not uniformly, by the results.

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Table 1. Numbered list of treatments.

NUMBER	TREATMENT	RATE lb AI/acre
1	Chlordimeform (Cdf)	.125
2	Cypermethrin (Cypr)	.04
3	Cypr+Cdf	.02 + .125
4	Cyhalothrin (Cyhl)	.025
5	Cyhl+Cdf	.0125 + .125
6	Acephate (Acph)	1.0
7	Acph+Cdf	.5 + .125
8	Cypr+Acph	.02 + .5
9	Cypr+Acph+Cdf	.02 + .5 + .125
10	Thiodicarb (Thio)	.6
11	Thio+Cdf	.4 + .125
12	Thio+Cypr	.4 + .02
13	Thio+Cypr+Cdf	.4 + .02 + .125
14	Cypr+Amitraz(Amtr)	.02 + .125
15	Thio+Cypr+Amtr	.4 + .02 + .125
16	Thio+Amtr	.4 + .125
17	Amtr	.125
18	Profenofos+cypr	.36 + .03
19	Profenofos+cypr	.48 + .04
20	Untreated Check	--

Table 2. Efficacy and yield data from cotton treated with different insecticides and insecticide combinations for control of *Heliothis* spp., Burleson County, Texas 1987.

TRMT. NO.	POST-TRMT. SEASONAL AVERAGE VALUES[2/] NO. LARVAE PER 1/1000 ACRE	PERCENT DAMAGED SQUARES	PERCENT DAMAGED BOLLS	YIELD lb lint /acre
1	3.1abc[1/]	8.5abc	5.8ab	424.8ed
2	2.2bc	9.4abc	6.6ab	643.7abcde
3	2.0c	14.3a	6.3ab	683.6abc
4	4.5a	7.7abc	5.4ab	754.7ab
5	3.7abc	7.4abc	6.1ab	710.9abc
6	3.5abc	7.9abc	8.9a	474.7cde
7	4.2ab	11.2abc	8.1ab	398.3e
8	3.3abc	7.2abc	5.1ab	638.2abcde
9	4.3ab	9.4abc	7.6ab	509.9bcde
10	2.8abc	7.3abc	6.7ab	576.3abcde
11	2.2bc	3.3bc	2.0b	579.8abcde
12	2.6abc	4.0bc	5.0ab	625.3abcde
13	1.7c	3.0c	4.5ab	823.5a
14	3.4abc	9.4abc	5.9ab	623.3abcde
15	2.5abc	5.9abc	5.1ab	625.8abcde
16	2.3bc	7.5abc	4.8ab	519.3bcde
17	3.2abc	11.9ab	7.1ab	576.8abcde
18	3.6abc	11.9ab	6.2ab	582.3abcde
19	3.6abc	10.4abc	5.8ab	672.6abcd
20	3.8abc	11.9ab	7.3ab	534.1bcde

1/Means within a column followed by a common letterare not significantly different (P=0.05;DMRT).

2/Treatments applied 13, 21 and 31 July; 11 and 19 Aug.

Table 3. Secondary pest response from cotton treated with different insecticides and insecticide combinations for control of *Heliothis* spp., Burleson Co., Texas 1987.

TRMT. NO.	AUG 13 POST-TREATMENT SAMPLE[2/] NO. PESTS COUNTED ON 15 LEAVES/PLOT APHIDS	MITES
1	113.6bcde[1/]	4.3ab
2	262.4bc	4.4ab
3	441.0ab	4.4ab
4	723.6a	0.5b
5	445.2ab	0.1b
6	27.6cde	0.4b
7	1.2de	0.4b
8	0.2e	0.7ab
9	0.6ed	7.6ab
10	44.1cde	0.0b
11	26.1cde	1.1ab
12	147.9bcd	5.5ab
13	28.5cde	4.4ab
14	73.9cde	2.2ab
15	24.1cde	1.0ab
16	86.5cde	0.1b
17	60.7cde	2.2ab
18	83.9cde	40.6a
19	104.4bcde	3.4ab
20	234.1bc	0.4b

1/Means within a column followed by a common letterare not significantly different (P=0.05;DMRT following transformation data. Original data used for table presentation.)

2/Treatments applied 13, 21 and 31 July; 11 and 19 Aug.

Table 4. Economic returns from cotton treated with different insecticides and insecticide combinations for control of *Heliothis* spp., Burleson County, Texas 1987.

TRMT. NO.	TREATMENT COSTS $$/acre[2/] (per application)	YIELD lb lint /acre	NET RETURNS $$/acre
13	10.14	823.5a[1/]	266.98
4	3.60	754.7ab	258.92
5	4.18	710.9abc	230.07
3	3.99	683.6abc	214.79
19	7.39	672.6abcd	191.78
2	3.22	643.7abcde	195.05
8	6.24	638.2abcde	176.69
15	10.14	625.8abcde	161.75
12	7.76	625.3abcde	161.45
14	3.99	623.3abcde	179.07
18	5.54	582.3abcde	147.08
11	8.53	579.8abcde	130.59
17	2.38	576.8abcde	159.62
10	9.22	576.3abcde	125.12
20	0.00	534.1bcde	158.72
16	8.53	519.3bcde	94.75
9	8.62	509.9bcde	88.78
6	9.27	474.7cde	63.30
1	2.38	424.8de	69.56
7	4.63	398.3e	42.56

1/Yield means within a column followed by a common letter are not significantly different (P=0.05;DMRT).

2/Treatments applied 13, 21 and 31 July; 11 and 19 Aug.

Table 5. Ratio of *Heliothis zea* to *Heliothis virescens* from weekly totals of light trap catches[1/] in the Brazos River Valley, Burleson County, Texas 1987.

DATE (By Week)	SPECIES RATIO H. zea / H. virescens
July 1 - July 4	11.1
July 5 - July 11	16.9
July 12 - July 18	3.0
July 19 - July 25	1.0
July 26 - Aug 1	0.9
Aug 2 - Aug 8	1.0
Aug 9 - Aug 15	0.5
Aug 16 - Aug 22	0.2
Aug 23 - Aug 29	0.2

[1/] 10 light traps per species, checked daily.