Insecticide Evaluation Studies, Safford Agricultural Center, 1999-2000

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Abstract

Three studies were conducted over the two year period to explore the effectiveness of using pyrethroid insecticides only vs. rotating insecticide chemistries between the pyrethroids and organophosphates on both long and short staple cotton varieties. These same treatments were also evaluated over Bt and non-Bt varieties. In the worst case scenario, where weather conditions prevented timely application of insecticides and effectiveness of insecticides applied, long staple cotton yielded around 1/3 bale per acre after six insecticide applications. Within 200 feet of this experiment, during the same cropping season, with the same insecticides applied, DP 90B (a Bt variety) produced 3 bales per acre. Details of these studies are contained in this report.

Introduction

Insect pressures are not as great in the high desert area of the Safford Valley as in the lower valleys in Arizona, partially because of climatic considerations and partially because of the strong IPM program that has been in place over the past 20 years. The concern is that the pink boll worm will build up resistances to the pyrethroids that are primarily used in the valley for its control and that our insect control practices are eliminating the beneficial insects that help to keep all of the harmful insects in check. This experiment was designed to look at the effects of several insect control systems, including the use of Bt cotton varieties.

Materials and Methods

Three different experiments will be described in this report. The first experiment was performed in 1999 and was designed to look at five different insecticide regimes on both long staple (Pima S-6) and short staple (DP 90) cotton. The second experiment was also performed in 1999 and took four of the insecticide regimes and applied them over DP 90 and DP 90B. The latter containing the Bt (*Bacillus thuringiensis*) gene. The third experiment took the Pyrethroid only and the Pyrethroid/Organophosphate treatments and applied them to non-replicated blocks of short staple cotton, Bt short staple cotton and long staple cotton. The test materials were applied using a JD 6000 high cycle spray rig that had been modified for use in small plots. Materials were mixed in 5 gallon, pressurizable containers and expelled using CO_2 gas. Approximately 20 gallons/acre of spray solution was applied per plot through flat fan TeeJet nozzles under 20 pounds of pressure. The crop history and treatments are described below:

<u>Crop History - 1999 Insecticide regimes</u>

Soil type: Pima silty clay variant
Previous crop: Cotton
Planting date: 15 April 1999 Planting rate: 25 lbs/ac Varieties: Pima S-6 and DP 90
Herbicide: Treflan preplant, Cotton Pro as a layby treatment
Fertilizer: 100 lbs/ac of urea side dressed 6/14 and 7/21

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Irrigation: Planted into moisture + 6 furrow irrigations (ca. 37 ac inches + 3.9 in. of rain)   Last irrigation: 7 Sep
Harvest: 1st pick: 11 November   2nd pick: none

Crop History - 1999 Insecticide x Bt

Soil type: Pima silty clay variant
Previous crop: Cotton
Planting date: 26 April 1999   Planting rate: 25 lbs/ac   Varieties: DP 90 and DP 90B
Herbicide: Treflan preplant, Cotton Pro as a layby treatment
Fertilizer: 100 lbs/ac of urea side dressed 6/17 and 7/21
Irrigation: Watered up + 7 furrow irrigations (ca. 37 ac inches + 3.9 in. of rain)   Last irrigation: 7 Sep
Harvest: 1st pick: 11 November   2nd pick: none

Crop History - 2000

Soil type: Pima clay loam variant
Previous crop: Cotton
Planting date: 13 April 2000   Planting rate: 25 lbs/ac   Varieties: HTO and DP 5690
Herbicide: Treflan preplant, Cotton Pro as a layby treatment
Fertilizer: 100 lbs/ac of urea side dressed 5/23 and 6/28
Irrigation: Planted into moisture + 7 furrow irrigations (ca. 51 ac inches + 3.3 inches of rain)   Last irrigation: 17 Aug
Harvest: 1st pick: 16 October   2nd pick: 4 November

Insecticide treatments are listed below in Tables 1, 2 and 3.. At harvest four plants were pulled from each plot and mapped to determine the effect of treatment on plant physiology.

Results and Discussion

In 1999 the pink bollworm pressure was very high, perhaps due to the numerous rainfall events. Rain fell nine times during the month of August, delaying some planned spray applications and reducing the effectiveness of others. Table 4 shows data from the long staple plots. The untreated check plots yielded 86 pound of lint per acre or around 1/6th of a bale of lint. This treatment had 91% of the bolls affected by pink bollworms. Many bolls on the 6th and 7th nodes were shed and the growth was rank, as shown by the plant height measurements. The pheromone + treatment only had pheromones applied the 1st three weeks of the treatment cycle, after which pyrethroids and organophosphate (OP) insecticides were applied. The yield was double that of the untreated check, but still not acceptable. More than 80% of the bolls were damaged and the 1st fruiting branch was 6.6. Like the untreated check, the growth was rank. The remaining three treatments had about the same percentage of boll damage and the plant characteristics were quite similar. The pyrethroid only treatments showed a higher yield than the organophosphate/pyrethroid rotation, but adding the insect growth regulators (IGR) to the mix increased the yields more. Since the IGR's only affected whiteflies, this may indicate that whiteflies are causing more yield loss than previously thought. There were plant population differences between treatments, but it is not felt that these differences were caused by the insecticide treatments. On the other hand the low population on the OP/pyrethroid treatment may have adversely affected the yields.

Table 5 contains the information from the short staple plots in the first trial. The untreated check and the pheromone + treatments were similar in effect to that described in the long staple case, even though the yields were more than twice as high. The other three treatments again were similar in percent boll damage and plant measurements but varied slightly in yield. In this case, the OP/pyrethroid treatment yielded higher than the other two. This may indicate that whiteflies were not as much a factor with short staple as with long staple. The highest yield being just over 1 bale per acre indicates that none of the treatments applied were effective in controlling yield loss. Again, erratic timing of the applications is blamed more than the products themselves.

The second experiment, involving the use of variety containing the Bt gene, took place within 200 feet of the first experiment and with essentially the same materials, applied at the same time, brought about very different results. Table 6 contains the data from this trial. The experimental design was a two way randomized complete block so the results are shown between the two varieties, DP 90 and DP 90B (with Bt gene), and across all insecticide treatments and by insecticide treatments, across varieties. The decision was made to treat both varieties with the same insecticides so the only difference between them was genetics. The yield effects were dramatic, a bale difference because of the Bt (*Bacillus thuringiensis)* gene. Even more dramatic is the difference between this experiment and the one only 200 feet away. The presence of the Bt gene in half of the plots kept the pink bollworm population from building up to uncontrollable levels. In the bottom part of Table 6 is the effects of insecticide treatment across varieties. The yield order is essentially the same as seen in the previous study, only the yields are 2.4 times greater. The percent boll damage is in the same order of magnitude as the previous study, but the damage inflicted was much less.

The experiment preformed in 2000 was a follow-up on the previous experiment with the addition of a long staple variety and a reduction to only two treatments, pyrethroid only and OP/pyrethroid rotation. It was done more as a demonstration with larger plots and only one replication. The results are found in Table 7. In common with the previous year's work, the OP/pyrethroid rotation treatment produced higher yields than the pyrethroid only treatment for the short staple varieties and just the opposite for the long staple cotton. Percent boll damage was much lower on the Bt variety than on the other two varieties and was inversely related to the yield. Other plant characteristics appeared to be more related to the variety than to the treatments applied.

From these experiments it is impossible to give definitive answer to all the questions that were being studied. More labor intensive studies must be performed. But, some trends seem to be developing that can possibly direct those who follow this line of research in this valley, they are: regardless of the insecticides used, control cannot be expected if timely applications can't be made; the pink bollworm pheromones don't seem to work in small plot settings; a rotation of insecticide chemistries in place of using strictly pyrethroids seems to pay dividends on short staple cotton; the reverse seems to be true on long staple cotton and lastly; in cases where high pink bollworm populations arise, the transgenic Bt trait in cotton is well worth the extra cost to acquire it.

Table 1. Insecticide applications by treatment and date, insecticide regime study, Safford Agricultural Center, 1999.

Trtmt/Date	29 July	12 Aug	19 Aug	25 Aug	6 Sept	14 Sept	Cost/A c
Long and Short Staple studies							
Check	none	none	none	none	none	none	$0.00
Pheromone+ OP/Pyr	Nomate 1.67 oz $18.26	Nomate 1.67 oz $18.26	Nomate 1.67 oz $18.26	Lorsba n 2 pts $12.50	Mustang 3.8 oz $9.05	Orthene 1 lb $9.90	$86.23
OP/ Pyrethroid rotation	Scout 3 oz $7.50	Scout 3 oz $7.50	Scout 3 oz $7.50	Scout 3 oz $7.50	Mustang 3.8 oz $9.05	Scout 3 oz $7.50	$46.55
OP/ Pyrethroid rotation	Scout 3 oz $7.50	Lorsba n 2 pts $12.50	Scout 3 oz $7.50	Lorsba n 2 pts $12.50	Mustang 3.8 oz $9.05	Orthene 1 lb $9.90	$58.95
IGR+OP/ Pyrethroid rotation	Scout 3 oz $7.50	Lorsba n 2 pts $12.50	Scout Applaud 3 oz 8 oz $7.50 $27.50	Lorsba n 2 pts $12.50	Mustang Knack 3.8 oz 8 oz $9.05 $35.91	Orthene 1 lb $9.90	$121.76

Table 2. Insecticide applications by treatment and date, insecticide regime by Bt study, Safford Agricultural Center, 1999.

Trtmt/Date	29 July	12 Aug	19 Aug	25 Aug	6 Sept	14 Sept	Cost/A c
Bt vs non-Bt study							
Check							$0.00
Pyrethroids only	Scout 3 oz $7.50	Scout 3 oz $7.50	Scout 3 oz $7.50	Scout 3 oz $7.50	Mustang 3.8 oz $9.05	Scout 3 oz $7.50	$46.50
OP/ Pyrethroid rotation	Scout 3 oz $7.50	Lorsba n 2 pts $12.50	Scout 3 oz $7.50	Lorsba n 2 pts $12.50	Mustang 3.8 oz $9.05	Orthene 1 lb $9.90	$58.95
IGR+OP/ Pyrethroid rotation	Scout 3 oz $7.50	Lorsba n 2 pts $12.50	Applaud 8 oz $27.50	Lorsba n 2 pts $12.50	Mustang Knack 3.8 oz 8 oz $9.05 $35.31	Orthene 1 lb $9.90	$114.26

Table 3. Insecticide applications by treatment and date, insecticide regime by Bt study, Safford Agricultural Center, 1999.

Treatment/Date		7/13	7/19	7/27	8/1	8/7	8/23	9/8	Cost
Variety	Treatmnt								
5690RR	1. pyre			Asana 9.6 oz $9.06	Warrior 5 oz $10.35	Warrior 5 oz $10.35	Warrior 5 oz $10.35	Dantl/Orth $20.62	$60.73
5690RR	2. OP/pyr			Asana 9.6 oz $9.06	Lorsban 2 pt $10.00	Lorsban 2 pt $10.00	Warrior 5 oz $10.35	Dantl/Orth $20.62	$60.03
655BRR	1. pyre			Asana 9.6 oz $9.06	Warrior 5 oz $10.35	Warrior 5 oz $10.35	Warrior 5 oz $10.35	Dantl/Orth $20.62	$60.73
655BRR	2. OP/pyr			Asana 9.6 oz $9.06	Lorsban 2 pt $10.00	Lorsban 2 pt $10.00	Warrior 5 oz $10.35	Dantl/Orth $20.62	$60.03
HTO	1. pyre	ScoutXtra 3.7 oz $8.21	ScoutXtra 3.7 oz $8.21	Asana 9.6 oz $9.06	Warrior 5 oz $10.35	Warrior 5 oz $10.35	Warrior 5oz $10.35	Dantl/Orth $10.62	$77.15
HTO	2. OP/pyr	ScoutXtra 3.7 oz $8.21	Lockon 4pt $10.00	Asana 9.6 oz $9.06	Lorsban 2 pt $10.00	Lorsban 2 pt $10.00	Warrior 5oz $10.35	Dantl/Orth $10.62	$76.45

Table 4. Yields, boll damage and plant mapping variables for long staple part of the insecticide regimes study of 1999 on the Safford Agricultural Center.

Treatment	Lint Yield	% Damaged Bolls	First Fruiting Br.
Untreated Check	86 c	91.3 a	7.5 a
Pheromone +	171 b	80.5 ab	6.6 a
Pyrethroids	199 ab	73.3 b	6.3 a
OP/Pyre rotation	166 b	76.7 ab	6.5 a
IGR+OP/P rot	254 a	79.2 ab	7.3 a
Average	175.3	80.2	6.8
LSD(05)	74.3	17.3	2.7
CV(%)	27.5	14.0	26.0

Treatment	Plant Height	Total Nodes	Height to Node Ratio	Plant Population
Untreated Check	42.8 a	27.5 a	1.56 a	42653 a
Pheromone +	41.8 a	26.5 a	1.60 a	36754 ab
Pyrethroids	37.1 a	24.3 a	1.55 a	34939 ab
OP/Pyre rotation	37.5 a	25.5 a	1.47 a	26998 b
IGR+OP/P rot	37.3 a	24.9 a	1.49 a	37888 ab
Average	39.3	25.7	1.53	35846.3
LSD(05)	7.3	3.7	0.31	12809.7
CV(%)	12.1	9.4	13.2	23.2

Table 5. Yields, boll damage and plant mapping variables for short staple part of the insecticide regimes study of 1999 on the Safford Agricultural Center.

Treatment	Lint Yield	% Damaged Bolls	First Fruiting Branch
Untreated Check	258 c	74.6 a	6.3 bc
Pheromone +	443 b	62.3 ab	7.4 ab
Pyrethroids	527 ab	40.3 b	7.1 abc
OP/Pyre rotation	624 a	44.1 b	7.9 a
IGR+OP/P rot	548 ab	51.4 ab	6.1 c
Average	480.0	54.4	6.95
LSD(05)	136.8	27.0	1.17
CV(%)	18.5	32.1	11.0

Treatment	Plant Height	Total Nodes	Height to Node Ratio	Plant Population
Untreated Check	36.6 a	29.1 a	1.27 a	66474 a
Pheromone +	39.8 a	27.3 ab	1.46 a	72146 a
Pyrethroids	34.9 a	24.6 b	1.44 a	63298 a
OP/Pyre rotation	39.8 a	26.1 ab	1.52 a	72146 a
IGR+OP/P rot	37.5 a	26.6 ab	1.42 a	68063 a
Average	37.7	26.8	1.42	68425.5
LSD(05)	10.0	3.89	0.37	18168.2
CV(%)	17.2	9.4	17.0	17.2

Table 6. Yields, boll damage and plant mapping variables for the insecticide regimes by Bt study of 1999 on the

Safford Agricultural Center.

Treatment	Lint Yield	% Damaged Bolls	Plant Height	First Fruiting Branch
Bt across Insecticide Treatments				
DP 90 B	1520 a	25.8 b	37.1 b	9.4 a
DP 90	1023 b	68.2 a	43.0 a	9.2 a
Insecticide Treatments across Bt				
Untreated Check	1069 b	54.3 a	42.4 a	9.0 a
Pyrethroids	1232 ab	43.8 a	38.7 b	9.7 a
OP/Pyre Rotn	1489 a	48.4 a	39.8 ab	9.5 a
IGR+ OP/Pyr	1297 ab	41.5 a	39.5 ab	9.0 a
Average	1271.7	47.0	40.1	9.3
$LSD(05)_{BT}$	185.1	11.0	2.1	1.2
$LSD(05)_{INS}$	261.8	15.6	3.0	1.7
CV(%)	19.8	31.8	7.1	17.1

Table 7. Yield, plant mapping and boll damage variables for the insecticide regimes by Bt study of 2000 on the Safford Agricultural Center.

Variety	Treatment	Lint Yield (lbs/ac)	% Damaged Bolls	Bolls per Plant	1st Fruiting Branch
5690RR	1. pyre	1235	28.9	22.5	5.3
	2. OP/pyr	1242	31.5	18.3	5.0
655BRR	1. pyre	1398	12.2	10.3	10.5
	2. OP/pyr	1482	8.0	12.5	8.5
HTO	1. pyre	771	14.5	23.0	8.5
	2. OP/pyr	552	28.4	29.0	10.0
Average		1113.3	20.6	19.3	8.0

Variety	Treatment	Plant Height (in)	#Nodes	Height to Node Ratio
5690RR	1. pyre	37.5	25.0	1.50
	2. OP/pyr	33.0	26.3	1.26
655BRR	1. pyre	32.5	24.3	1.34
	2. OP/pyr	33.3	24.3	1.37
HTO	1. pyre	26.8	22.3	1.20
	2. OP/pyr	29.8	27.0	1.10
Average		32.1	24.8	1.3