Chlorguard Plus: New Insecticide Combination Product Effective Against Cotton Bollworm, *Helicoverpa armigera* (Hb.)

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ABSTRACT

Studies undertaken to manage bollworm, Helicoverpa armigera Hübner in irrigated cotton in Raichur, India over three seasons, indicate some benefits of using certain insecticide mixtures. These benefits included an overall reduction in sucking pests and reduced damage by H. armigera. Resistance of H. armigera was lower to mixtures than to some of the components used alone. Among the mixtures evaluated, Chlorguard Plus (alphamethrin 24 g.a.i/l + chlorpyrifos 480 g. a.i/1) of M/S. Gharda Chemicals Limited, India achieved the highest profit compared to the untreated control plots.

Introduction

Cotton is one of the most important commercial crops of India and is grown over about nine million hectares under diverse agroclimatic conditions. Cotton production has stagnated with low productivity. One of the reasons is yield losses due to insect pests. It is estimated that these range from 25 to 70 percent of the potential crop. Cotton is attacked by large number of polyphagous pests, among which jassid, Amrasca biguttula Ishida, the whitefly Bemisia tabaci Gennadius, the aphid, *Aphis gossypii* Glover and American bollworm, *Helicoverpa armigera* Hübner are the most serious pests in south India (Sundaramurthy, 1996). In order to manage this pest complex, more than 80 percent of cotton farmers apply mixtures of two or more insecticides (Dhawan and Simwat, 1996). This indiscriminate mixing of chemicals can lead to the outbreak of one or more pest species, creating a need to develop combination products involving synthetic pyrethroid and organophosphate insecticides that are chemically compatible, mixed at the dosages required to achieve added benefits against multiple cotton pests in a single application (Dhawan and Simwat, 1997).

This study attempted to evaluate the bio-efficiency of such pre-formulated combinations, to estimate the resistance ratio in H. armigera larvae and to determine their cost efficiency.

Material and Methods

Chlorguard plus - 50.4 EC (alphamethrin + chlorpyrifos at 24 + 480 g. a.i./ha); Polytrin C - 44 EC (cypermethrin + profenophos at 40 + 400 g. a.i./ha); Spark 36 EC (deltamethrin + trizophos at 10 + 350 g. a.i./ha) and Nurelle D 505 (cypermethrin + chlopyrifos at 50 + 500 g. a.i./ha) were tested at various dosages (Table 1) over three seasons (1995-96, 1996-97 and 1997-98) at the Regional Research Station, Raichur, Karnataka, India. Results were compared to two pyrethroids (alphamethrin 10 EC and cypermethrin 10 EC) and one organophosphate (chlorpyrifos 20 EC) applied alone. A hybrid cotton cultivar, DCH-32, was sown during July in a randomized block design with three replications. The crop was grown using recommended agronomic practices (Anon, 1997). Twenty-five and 40 days after sowing, early sucking pests were controlled by the application of systemic insecticides.

The treatments (Table 1) were applied from 55 days after sowing. Application was based on economic threshold levels for bollworm incidence (10 percent damage of fruiting bodies) in each season, using a knapsack sprayer at a volume of 1000 l / ha.

Sucking pests including jassid, aphid and whitefly adults were counted on three leaves from each treatment (3rd, 5th and 7th leaves from the top of the mainstem) with results averaged per leaf for statistical analysis. The number of predators was recorded on the same three leaves. Counts of infested squares and bolls were made before and three days after each spray and the percentage of fruiting bodies damaged was computed. At harvest the number of healthy and damaged bolls per plant was recorded for each treatment. Cotton yield per plot was recorded, expressed as metric tonnes per hectare (mt/ha). Data were pooled for three seasons for analysis, using Duncan's Multiple Range Test.

Studies were undertaken during 1997-98 to monitor insecticide resistance in *H. armigera* larvae collected from cotton fields near Raichur. During boll development, early (2nd and 3rd) instar larvae were collected from the field and treated with single or combination insecticides, using a micro applicator and mortality was recorded, using the method of Armes *et al.* (1992). Data were compared with those for susceptible *H. armigera* larvae obtained from ICRISAT, Hyderabad, India. LD_{50} values were calculated for both field collected and susceptible larvae and resistance ratios were computed.

Cost benefit statistics were computed for the three season's pooled data, using several parameters, including cost of insecticides, cotton yield and the prevailing price of cotton.

Results and Discussion

The efficacy of different combinations and single insecticides on sucking pests and bollworm incidence is summarized in Tables 1 and 2, respectively.

Jassids

Chlorpyrifos + alphamethrin resulted in 0.62 jassids per leaf, a number similar to that with profenophos + cypermethrin and alphamethrin applied alone. Triazaphos + deltamethrin and cypermethrin alone gave a significantly higher jassid density (Table 1). Chlorpirifos alone resulted in the highest jassid density other than in the untreated control plots. Similar results were reported by Dhawan (1998).

Whiteflies

Triazaphos + deltamethrin resulted in 0.30 whiteflies per leaf, a result similar to that obtained with profenophos + cypermethrin. Results with the latter did not differ significantly from those with chlorpyrifos + alphamethrin. Chlorpyrifos + cypermethrin led to higher whitefly populations but these were lower than with the application of synthetic pyrethroid alone. Interestingly, the untreated control resulted in only 0.82 whiteflies per leaf, possibly due to competitive displacement by jassid as hypothesized by Patil (1996).

Aphids

Aphid densities that were significantly lower than those for pyrethroids applied alone, were similar for all pre-formulated mixtures. Chlorpyrifos alone gave a significantly lower aphid density. The untreated control had the lowest population of aphids (4.1·aphids/leaf), again a possible consequence of displacement by jassids.

Bollworm incidence

Chlorpyrifos + alphamethrin led to a 7.5 percent bollworm incidence, similar to that for profenophos + cypermethrin and chlorpyrifos + cypermethrin treatments. The latter was similar to the triazophos + deltamethrin treatment and all four mixtures appeared significantly more effective than pyrethroids or chlorpyrifos applied alone. Control plots had the highest bollworm incidence of 44.0 percent. Dhawan (1998) reported that chlorpyrifos mixed with cypermethrin or alphametrin resulted in less *H. armigera* damage than the other products. Numbers of healthy and damaged bolls should follow similar trends to bollworm incidence (Table 2).

Seed cotton yield

Profenophos + cypermethrin gave the highest yield of 1.63 mt/ha, a result similar to that for the chlorpyrifos + alphamethrin and chlorpyrifos + cypermethrin treatments. The latter did not differ significantly to those with triazophos + deltamethrin (Table 2). All the four mixtures gave significantly higher seed cotton yields than single pyrethroid or chlorpyrifos treatments. The untreated control gave the lowest yield of 392 kg/ha seed cotton yield.

Insecticide Resistance ratio

Insecticide resistance ratios (the ratio between LD_{50} values of susceptible to resistant strains) were lower (4- to 5- fold) for all four mixtures than single products (Table 3). Resistance to cypermethrin was higher than to chlorpyrifos or alphamethrin applied alone. *H. armigera* is resistant to pyrethroids and organophosphates in South India (Armes *et al.*, 1992). These results are in accord with those of Kranthi (1995), suggesting that a profenofos + cypermethrin mixture may delay the development of resistance compared to individual insecticides.

Effect on predator populations

The numbers of predators was low in all insecticide treated plots. However, chlorpyrifos + alphamethrin plots resorded significantly higher spider densities than the other three mixtures (Table 4). Lacewing numbers were significantly lower following treatments with profenfos + cypermethrin and triazophos + deltamethrin than with chlorpyrifos + deltamethrin or chlorpyrifos + cypermethrin.

Cost benefit analysis

Chlorpyrifos + alphamethrin achieved the highest profit per ha compared to the untreated control, followed by chlorpyrifos + cypermethrin, profenophos + cypermethrin and triazophos + deltamethrin. Single products achieved lower profits per ha than the mixtures (Table 5).

All four insecticide mixtures yielded benefits over single compounds in terms of reducing sucking pest densities, bollworm damage and increased seed cotton yield. Resistance of H. armigera larvase to the mixtures was lower than to the commonly used individual insecticides. Overall, the study highlighted that restricted use of products such as "Chlorguard plus" can assist with increasing the productivity of cotton.

References

Anon, (1997): Package of practices for cotton cultivation. UAS Dharwad 11:101-107.

Armes N.J., D.R. Jadhav, G.O. Bond and A.B.S. King. (1992): Insecticide resistance to *Helicoverpa armigera* in south India. Pesticide Science. 34:355-364.

Dhawan, A.K and G.S. Simwat. (1996): Pattern of insecticide use on cotton by farmers in Punjab. Dept. of Ent., PAU, Ludhiana, India.

Dhawan, A.K. and G.S. Simwat. (1997): Status of insecticide mixtures in management of bollworm

complex in Punjab. Dept. of Ent., PAU, Ludhiana, India.

Dhawan, A.K. (1998): Integrated pest management in cotton: Insecticide mixtures for management of changing insect pest complex. Proc. Seminar on Integrated Pest Management. ICPA, Mumbai, April 3-4 1998.

Kranthi, R. (1995): Insecticide resistance monitoring. Podborer management newsletter, 6. Dec. 1995 ICRISAT, Hyderabad, India,

Patil, B.V. (1996): Competitive displacement of *Bemisia* with leafhoppers and aphids in a cotton ecosystem. In: *Bemisia* 1995: Taxonomy Biology, Damage, Control and Management. ® D. Gerling and R.T. Mayer (Ed). Intercept U.K. Pp. 243-246.

Sundarámurthy, V.T. (1996): Eco-friendly insect management system for cotton. J. Indian Society Cotton Improvement. September (special issue) Pp. 135-140.

Table 1. Effect on sucking pests.

Treatments	Dosage l/ha	Sucking pests / leaf		
		Jassids	Whitefly	Aphids
Chlorpyrifos + Alphacypermethrin	1.00	0.62a	0.74b	16.35b
Profenophos + Cypermethrin	1.50	0.47a	0.46ab	11.87b
Triazophos + Deltamethrin	1.25	1.35b	0.30a	14.14b
Chlorpyrifos + Cypermethrin	1.00	0.94ab	1.12c	18.85b
Alphacypermethrin	0.25	0.80a	2.45d	32.80c
Cypermethrin	0.60	1.28b	3.10e	35.15c
Chlorpyrifos	2.50	4.35c	0.90bc	6.93c
Untreated control	--	6.30d	0.82b	4.17a

Means with the same letter in each column not statistically different (P = 0.05). Duncan Multiple Range Test

Table 2. Effect on bollworm incidence, yield parameters and yield of cotton.

Treatments	Bollworm	Healthy	Damaged	Yield
	Incidence %	Bolls/Plant		(Kg/Ha)
Chlorpyrifos + Alphacypermethrin	7.50a	18.20a	9.13a	16.13a
Profenophos + Cypermethrin	6.85a	18.35a	8.85a	16.27a
Triazophos + Deltamethrin	9.25b	16.14b	10.36a	14.79b
Chlorpyrifos + Cypermethrin	7.88ab	17.70 a	9.81a	15.62ab
Alphacypermethrin	13.20c	14.23c	12.60ab	12.06c
Cypermethrin	18.2d	10.12d	14.17b	10.18d
Chlorpyrifos	26.70e	8.55e	17.38c	7.27e
Untreated control	44.35f	3.60f	20.14d	3.92f

Means with the same letter in each column not statistically different (P = 0.05). Duncan Multiple Range Test
Data for bollworm incidence were transformed to angles for statistical analysis

Table 3. LD50 values and resistance ratios for H. armigera strains (Raichur) collected during 1997-98.

Treatments	LD_{50} (ug/larva)		Resistance Ratio
	Susceptible strain	Raichur strain	
Chlorpyrifos + Alphacypermethrin	0.046	0.24	5.3
Profenophos + Cypermethrin	0.051	0.26	5.1
Triazophos + Deltamethrin	0.054	0.22	4.0
Chlorpyrifos + Cypermethrin	0.048	0.27	5.6
Alphacypermethrin	0.053	1.35	25.3
Cypermethrin	0.059	3.56	60.5
Chlorpyrifos	0.055	1.55	28.4

Table 4. Effect on predators.

Treatments	Dosage	Predators per three leaves	
		Spider	Chrysoperla
Chlorpyrifos + Alphacypermethrin	1.00	1.28b	1.02bc

Profenophos + Cypermethrin	1.50	0.80c	0.15d
Triazophos + Deltamethrin	1.25	0.37d	0.22d
Chlorpyrifos + Cypermethrin	1.00	1.23d	1.04bc
Alphacypermethrin	0.25	1.18b	0.84c
Cypermethrin	0.60	0.95bc	0.48d
Chlorpyrifos	2.50	1.10b	0.33d
Untreated control	--	3.90a	3.16a

Means with the same letter in each column not statistically different (P = 0.05). Duncan Multiple Range Test

Table 5. Cost benefit analysis.

Treatments	Dosage (lit/ha)	Price/l $	Cost/ha ($)	CS/yield mt/ha	Income/ha ($)		Profit over control/ha
					Gross	Net	
Chlorpyrifos + Alphacypermethrin	1.00	10.00	10.00	16.13	741.98	731.98	551.68
Profenophos + Cypermethrin	1.50	14.00	21.00	16.27	748.42	661.88	481.56
Triazophos + Deltamethrin	1.25	14.75	18.45	14.79	680.34	661.88	481.56
Chlorpyrifoó + Cypermethrin	1.00	13.75	13.75	15.62	718.52	704.75	524.45
Alphacypermethrin	0.25	12.75	3.20	12.06	554.76	551.00	370.70
Cypermethrin	0.60	8.00	4.80	10.18	468.28	463.48	283.18
Chlorpyrifos	2.50	4.75	11.88	7.27	334.42	322.53	142.23
Untreated control	--	--	--	3.92	180.32	180.30	--

Price of cotton $460/mt