Field Demonstration of Integrated Pest Management in Cotton in India

A.K. Basu
Cotton Corporation of India Ltd., P.O. Box 11682. Mumbai 400 021, India

ABSTRACT

The traditional methods of insect control in India depended heavily on chemicals but results were often disappointing because of various factors, including pesticide resistance. Integrated Pest Management strategies have been devised to manage pests efficiently and economically with minimum environmental pollution. The measures include the use of bioagents such as Trichogramms, Chrysopa and nuclear polyhedral virus with chemical controls only when necessary. The Cotton Corporation of India, the Government of India with the help of federal and state agricultural universities has established field demonstrations of IPM in several cotton growing regions. The 1997-98 results were very encouraging with reduced costs and reduced chemical use, leading to increased profits to the farmers. This programme is being extended to other areas to motivate farmers to take up this cost effective, environmentally friendly management of cotton pests. IPM seems to be the most efficient method of sustainable cotton production but the availability of the bioagents in cotton producing areas is a constraint. Field laboratories for their production are being established.

Introduction

All the four cultivated cotton species, *Gossypium arboreum*, *G. herbaceum*, *G. hirsutum* and *G. barbadense* and the hybrids *G. herbaceum* X *G. arboreum* and *G. hirsutum* X *G. barbadense*, are grown in India on 8.5 to 9 million hectares. Production of cotton in India in 1996-97 was 17.8 million, 170 kg bales with a yield of 330 kg lint/hectare. There has been a decline in production and yield during 1997-98, mainly due to pest damage to the crop. In addition, 70% of cotton is rainfed with erratic rainfall in many cotton growing areas. Insect pests and diseases account for 30-40 for cent loss in yield (Basu, 1993).

Causes of Recent Aggravation of Insect Pest Problems

The main insect pests of cotton in India are listed in Table 1: Pest problem in cotton has recently been aggravated by:

1. Change in species composition with American Upland cotton (*G. hirsutum*) and their hybrids replacing more tolerant indigenous cotton *G. arboreum* and *G. herbaceum*. Prior to the 1940s, less than 2% of the area under cotton was planted to *G.hirsutum*.
2. Change in the cropping system leading to the availability of host crops of polyphagous pests throughout the year. For instance, the Vidharbha region of Maharashtra has more than 1.6 million hectare under cotton, redgram and sorghum are grown during June-December, followed by vegetable crops in the summer wherever irrigation is available. This provides bollworm (*Helicoverpa armigera*) with hosts throughout the year.
3. Indiscriminate use of pesticides, leading to pesticide resistance.
4. Indiscriminate use of pesticides, leading to the destruction of natural enemies (parasites and predators)
5. More irrigation and fertilizer have made the irrigated crop more vulnerable to pests.
6. Lack of adequate surveillance and monitoring of pests.

Pesticide Use

Farmers rely heavily on pesticides for protecting the cotton crop. The cotton crop accounts for 53% of the pesticides used in agriculture in India but it occupies only 5% of the total cultivated area. Excessive use of pesticides has, however, not helped in the management of pests, due to faulty application of pesticide, use of the wrong pesticides, incorrect dosage and more importantly development of pest resistance to the pesticide. Excessive use of pesticide has therefore escalated the cost of cultivation without a commensurate increase in yield.

Integrated Pest Management

An alternative method of pest management, Integrated Pest Management (IPM) has been devised for efficient management of pests. IPM incorporates host plant resistance, cultural, biological and mechanical methods with judicious use of chemical pesticides to keep the pest population below the economic injury

Proceedings of the World Cotton Research Conference-2. Athens, Greece, September 6-12, 1998. pp.797-800.

level. The bioagents commonly used in India are *Trichogramma* (egg parasite), *Chrysopa* (predator) and the insect pathogen nuclear polyhedral virus (NPV), (Sundarmurthy and Basu, 1985). IPM has been developed for different agroecological zones where cotton is grown in India.

The Cotton Corporation of India (CCI), a public sector undertaking under the Ministry of Textiles, which supplements the extension efforts of the Ministry of Agriculture, with the help of Federal Institutions and State Agricultural Universities, established IPM field demonstrations in several cotton growing regions during 1997-98.

Northern India

District Ganganagar in Rajasthan

The IPM demonstration plot consisting of 10 hectares had four rounds of insecticide sprays with one release of *Trichagramma* and two of NPV. The non-IPM plot (control) had eight rounds of insecticide sprays. The cultivar used is RST-9 (*G. hirsutum*). The incidence of bollworms was marginally higher in the IPM plots. Although yields were similar, there was a marginal increase in net return in the IPM plot due to a lower cost of production.

Central India

Hansot sub-division of Bharuch district of Gujarat

The IPM demonstration plots were laid out in six areas, each consisting of two and one hectares respectively with corresponding control plots. Installation of pheromone traps, spray of NPV for *Helicoverpa* and *Spodoptera*, release of bioagents *Trichogramma* and *Chrysopa* four times and once, respectively and five rounds of insecticidal spray made up IPM strategy. There was a moderate incidence of jassids (*Amrasca* sp.) and aphids (*Aphis* sp.) but heavy attacks of *Helicoverpa* and *Spodoptera*. The yield was higher in all the IPM plots than their corresponding checks.

South India

Dharwad in Karnataka

The size of the IPM demonstration plot was 7.2 hectares with a control plot of 1.6 hectare. The salient features of the IPM programme was use of 7 rounds of insecticide, including a spray of Botanical Pesticide, release of *Trichogramma* twice, planting, *Hibiscus esculentus* as a trap crop and installing pheromone traps for monitoring *Helicoverpa* moths. The control plot had nine rounds of insecticide.

Raichur in Karnataka

The IPM field demonstration was 100 hectare and the IPM schedule consisted of resistant hybrid NHH 44 (as against susceptible DCH-32), seed treatment with trichoderma and imidacloprid, sex pheromone traps for monitoring *Helicoverpa*, spraying of *Trichogramma* and NPV and spraying of insecticides including botanicals. Although there was no difference in yield between the IPM and control plots, the net return favoured the IPM plots because of lower cost of production due mainly to reduced number of sprays.

Guntur in Andhra Pradesh

The size of the IPM demonstration was 10 hectare with a 10 hectare of control plot. IPM practices included use of resistant/tolerant hybrids NHH 44 and Savita, recommended fertilizer rates, topping at the 16-18 node stage to reduce egg laying of *Helicoverpa*, two releases of *Trichogramma*, two releases of NPV, spraying of botanical, spraying four rounds of insecticides and hand collection and destruction of fifth instar *Helicoverpa* larvae and *Spodoptera* egg masses. The control plot had 15-23 rounds of insecticide spray. The incidence of pests in the IPM and control plots, production and economics are shown in Table 6. The IPM plots had higher yield and better return than the control plots.

Conclusions

These demonstrations of IPM tend to show the advantages of IPM practice over the traditional farmers practice that rely heavily on pesticides. The farmers have reacted favourably to IPM practice and are willing to adopt the programme in preference to traditional plant protection practices. One of the main constraints, however, is the availability of bio-agents. CCI has provided for the establishment of biological control labs in the IPM projects sanctioned during 1998-99. This will supplement the biological control labs of the Ministry of Agriculture and State Agricultural Universities to augment the supply of bio-agents to the cotton growers. Educating the cotton growers on IPM practices and their advantages, the supply of seeds of resistant varieties and timely availability of bio-agents will go a long way towards the adoption of IPM in cotton in India for sustainable cotton production.

Acknowledgement

The author expresses his sincere gratitude to Shri M.B. Lal, Chairman cum Managing Director, Cotton Corporation of India Ltd., Mumbai for sponsoring his participation in the Conference and expresses thanks to scientists of Agricultural Universities for providing data of experiments on IPM conducted by them.

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Table 1. Insect pests of cotton in India.

Insect Pest	Seasonal Occurence	Crop Age (days)	Growth Phase
Jassids: *Amrasca devastans*	June-Oct.	30-50	Vegetative
Aphids: *Aphis gossypii*	July-Sept.	30-60	Vegetative
Thrips: *Thrips tabaci*	Sept-Oct.	35-60	Square formation
Whitefly: *Bemisia tabaci*	July-Sept/Oct.	35-60	Square formation
Spotted bw: *Earias vittella*	July-Sept.	35-100	Square formation
American bw: *Helicoverpa armigera*	Aug-Feb.	65-100	Boll formation
Pink bw: *Pectinophora gossypiella*	Aug-Dec/Feb.	65-100	Boll formation
Red cotton bug: *Dysdercus spp*.	Sept-Dec.	80-120	Boll bursting and Maturity
Dusky cotton bug: *Oxycarenus lavaterae*	Sept-Dec.	80-120	Boll bursting and Maturity

Species identification: Matthews and Tunstall, 1994

Table 2. Incidence of pest (Bollworms) in IPM and control plots.

Observation Date	Bollworm Incidence			
	Spotted Bollworm (%)		American Bollworm (%)	
	IPM	Control	IPM	Control
26.07.97	21.3	18.2	1.4	1.1
21.08.97	24.8	22.7	2.8	2.6
21.09.97	18.2	15.3	3.2	3.4

(Source: Joshi, 1998)

Table 3. Yield and economics of cotton production of IPM and control.

Strategy	Yield (Kg/Ha)	Prod. Cost (US$./Ha)	Net Return (US$./Ha)
IPM Plot	1,240	236.5	120.9
Control	1,250	251.5	108.8

(Source: Joshi, 1998)

Table 4. Yield of IPM and check plots are as under.

Plot	Yield (Kg/Ha)	
	IPM	Control
1	2,600	2,400
2	2,600	2,500
3	2,620	2,500
4	2,500	2,300
5	26.2	22.0
6	28.0	24.0

(Source, Patel, 1998)

Table 5. Average No. of egg, Larvae of Helicoverpa and damage to fruiting bodies, good opened bolls and yield.

Item	IPM	Control
No. of eggs	1.16	3.25
No. of larvae	0.58	2.30
% damage to fruiting bodies	17.38	29.40
No. of good opened bolls	25.50	14.90
Yield (Kg/Ha)	2,882	1,350

(Source: Panchabhavi and Patil, 1998)

Table 6. Economics of cotton production of IPM and control.

Item	IPM	Control
Average.yield (Kg/Ha)	2,390	2,440
Cost of production (US$./Ha)	320.5	476.8
Gross Income (Rs./Ha)	720.2	656.5
Net Income (Rs./Ha)	399.7	252.2

(Source, Patil, 1998)

Table 7. Incidence of pests, predator, boll damage and yield and economics on IPM and control plots.

ParticularsARTICULARS	IPM	Control
Jassids (no/ 10 leaves)	12.0	32.0
Aphids (no/10 leaves)	36.3	56.0
Square damage (%)	2.7	12.4
Green boll damage (%)	7.5	18.3
Locule damage (%)	6.8	21.3
Predators (No/ 10 plants)	84.0	15.0
Insect infested cotton (%)	15.0	20.0
Yield (Q/Ha)	28.50	22.50
Net Return (Rs./Ha)	29775	10125