# Integrated Pest Management Strategy for Irrigated Cotton

*B.V. Patil and M. Bheemanna*
Department of Agril. Entomology, College of Agriculture, Raichur-584 101, Karnataka, India.

## ABSTRACT

*An adaptable IPM package developed for cotton at the Regional Research Station, Raichur was demonstrated on over 100 ha. in farmers fields. It involves integration of seed treatment for early sucking pests and soil born diseases, raising a trap crop, releases of Trichogramma egg parasitoids, application of Helicoverpa NPV and botanicals (neem) and selective use of pesticides, with proper application technology based on ETL of pests and monitoring with sex pheromone traps. This was compared with farmers' plant protection practices. Assessment of sucking pest and bollworm populations and the natural enemy complex were made both in IPM and non IPM farmer fields. Analysis of the cost effectiveness of the IPM strategy indicated a reduction of 40 per cent in pesticide applications with a 50 per cent reduction in the cost of plant protection, resulting in higher net profit and natural enemy populations in IPM fields. Various constraints in the IPM technology implementation and potential benefits to cotton entomologists, extension officers, policy makers and cotton farmers are discussed.*

## Introduction

Several workers have attempted to develop working IPM modules for cotton (Patil *et al.*, 1992; Sidhu *et al.*, 1992; Sundaramurthy and Chitra, 1992; Anon, 1995). An IPM module based on studies conducted at the Regional Research Station, Raichur on irrigated cotton over the past ten years and based on the results has been suggested (Patil *et al.*, 1996).

## Material and Methods

The cotton IPM module includes appropriate sowing time, seed treatment, and applications of selective insecticide for core pest with effective application technology (Table 1). This IPM strategy was demonstrated during the 1997-98 cotton season in 248 acres in two villages (79 acres in Kasbe Camp and 169 acres in Sitanagar Camp) near Raichur, Karnataka, India. Intraspecific hybrid cotton was sown during the first week of July 1997 in Kasbe camp and the last week of July in Sitanagar Camp following rain. The recommended package of agronomic practices was followed (Anon, 1997). Some distance away from the IPM farmer fields, 15 acres of cotton fields were selected in Kasbe Camp and 25 acres in Sitanagar Camp as non IPM farmer fields for comparison. All the agronomic practices followed by IPM and non-IPM farmers were recorded. Regular monitoring of pest populations was undertaken at weekly interval on 100 plants selected at random in both IPM and non IPM farmer fields in both the villages. The imposition of the IPM treatment was based on ETL for different pests in the IPM fields (Sundaramurthy and Chitra, 1992).

Non IPM farmers practiced 5-7 days interval spraying from 25 days after sowing, often with tank mixtures of two insecticides and/or fungicides. Observations on natural enemy populations were also made thee times in different months in IPM and non-IPM fields in both the villages. At each picking the number of healthy and damaged opened bolls per plant was recorded on 100 randomly tagged plants in both fields and villages and average per plant. The economics of IPM and non IPM farmers fields were computed, taking into consideration the cost of IPM/protection and agronomic practices and returns, based on seed cotton yield and prevailing market prices.

## Results and Discussion

The IPM treatments were applied in a timely manner.

### *Sucking pests*

Jassid populations were slightly more in non-*IPM* fields than IPM fields but remained below the ETL (Table 2). Failure of rain during August resulted in a thrip population increase that surpassed the ETL level in non IPM farmer fields and the levels in IPM fields where timely spraying of systemic insecticide (Oxydemeton methyl) was effective.

Whitefly adult populations were below the ETL in IPM fields in both the villages because of the use of botanicals but above in non IPM fields. The population of aphids was significantly high in non IPM fields because indescriminate spraying with mixtures of insecticides incorporating synthetic pyrethroids gave rise to aphid resurgence.

Red spidermite, *Tetranychus spp*. populations increased late in the season in the trial area. The application of a selective acaricide (Dicofol) in the IPM fields in both villages helped to reduce the mite population compared to the level in non IPM fields (Table 2).

### *Bollworm damage*

Among the bollworm complex, *Helicoverpa armigera (Hb.)* dominates in the trial area. *Earias spp.* were seen

only in the early stage as shoot borers. Pink bollworm incidence was recorded after December (8 per cent). *Helicoverpa* damage was maximal from mid September to December with three peaks during the 3rd week of September, the 2nd week of October and last week of November. The percent damage was more or less below the ETL except during the peak periods in both the IPM and non-IPM fields (Table 3). In general the incidence was more in Sitanagar Camp than Kasbe Camp and it was slightly higher in non-IPM fields than IMP fields. The *Helicoverpa* egg population was at a maximum during the first week of October and last week of November (Table 4), following the peak larval damage on cotton in both the IPM and non-IPM fields in both villages. Application of insecticide on the terminal shoots during this period reduced the incidence in IPM fields compared to non-IPM fields.

***Natural enemies***

Because of indiscriminate use of pesticides over years in trial areas, natural enemy activity has declined considerably. However, there was some difference in the population in both the villages between IPM and non IPM fields (Table 5). Predator populations of *Coccinellid, Chrysoperla* and spiders per plant were significantly higher in IPM field than non IPM field in both the villages. Because of imposition of IPM components viz., release of *Trichogramma* egg parasitoid and spray of *Helicoverpa* NPV in IPM fields recorded 24.75 per cent and 21.17 per cent recovery of parasitization in Kasbe and Sitanagar Camp respectively as compared to no parasitization in non IPM fields. Similarly, NPV infected *Helicoverpa* larvae per plant was recorded only in IPM fields (Table 5).

***Seed cotton yield***

The number of healthy and damaged open bolls per plant was similar in both IPM and non IPM fields in both the villages (Table 6). However, there was a yield reduction of 100 kg per acre in Sitanagar Camp as compared to Kasbe Camp in both IPM and non IPM fields. This may be due to three weeks delayed sowing of cotton in Sitanagar Camp where a higher incidence of cotton pests was recorded throughout the cotton period.

***Cost economics***

The cost of plant protection in IPM fields was US$ 79/acre in Kasbe and US$ 78/acre- in Sitanagar Camp. It was double these figures in non IPM fields, US$ 178 in Kasbe and US$ 148 in Sitanagar Camp. (1 US $ = 43 Indian rupee). This difference results from the number of applications of insecticides by non IPM farmers. In Kasabe Camp, these was a reduction from 6.15 kg a.i. per acre insecticide in non IPM fields to only 2.73 kg a.i. per acre in IPM fields. Similarly, in Sitanagar Camp, IPM reduced insecticides from 6.08 to 2.95 kg a.i. per acre while maintaining the same level of cotton yield. In addition, the environmental cost of higher application of pesticides should be considered. Total cost of cultivation and gross income was calculated (Table 7). The net profit was highest in IPM fields in both the villages and it was US$ 56 and US$ 79 more in IPM farmer fields compared to non IPM farmer fields in Kasbe and Sitanagar Camps, respectively. Earlier workers (Sundaramurthy and Chitra, 1992; Dhawan and Simwat, 1996) also made similar village demonstrations of cotton IPM

It is clear that benefits can be gained from the integration of environmentally compatible IPM tools with chemical insecticides. However, the appropriate timing of measures is even more important than simply the choice of insecticide.

## Constraints faced with IPM implementation

1. The poor availability of biological agents is a major limiting factor in India.

2. The technology for mass production and application of bioagents needs refinement.

3. Some of the inherent problems associated with bioagents like the effect of UV on NPV needs solution under field conditions.

4. Insufficient attention is paid given to quality control in producing biopesticides.

5. Extension gaps between farmers, extension officials, scientists and administrators still exist and restrict IPM implementation.

By overcoming these constraints with regular education of farmers through NGO's, KVK's, Extension agencies, research and development units of pesticide companies and demonstration of integrated crop management which also includes integrated pest management, cotton production and productivity can be increased considerably in India.

## Acknowledgement

The authors are grateful to the Cotton Corporation of India Limited, Mumbai for financial assistance given to this project.

## References

Anon, (1997): Package of practices, Region I: University of Agricultural Sciences, Dharwad, Karnataka. Pp 101-107.

Anon, (1995): Annual report, AICRP on biological control of crop pests. APAU, Rajendranagar, Hyderabad. Pp 8-10.

Patil, B.V., G. Thimmaiah, K.S. Thyagarajan and M.J. Hardcastle. (1992): Conservation of ecosystem with higher profit through integrated pest management in cotton. Entomon, 16:391-498.

Patil, B.V., S. Lingappa, A.G. Srinivasa and M. Bheemanna. (1995): Integrated insect pest management strategies for cotton. Paper presented in XX international Congress of Entomology, Firenze, Italy 25-31 August, 1996.

Sidhu, A.S., M.S. Sandhu, R. Arora, D.S. Brar, C.S. Dhaliwal and R.S. Bal. (1992): Integrated Pest Management increases cotton yield in Punjab. Indian Farming, 42:9-11.

Sudaramurthy, V.T. and K. Chitra. (1992): Integrated pest management in cotton. Indian J.Plant Protection, 20:1-17.

**Table 1. IPM module for irrigated cotton in TBP area.**

1) Seed treatment with *Trichoderma* (4 g/seed) for soil and seed borne diseases and imidacloprid (10g/kg seed) for early sucking pests.
2) Spray botanicals/systemic insecticides for sucking pests if they persist.
3) Release *Trichogramma* egg parasitoid at 50 and 57 days after planting at 100K per acre against eggs of bollworms
4) Fix sex pheromone traps at 2 per acre with a change of lures every 15 days for monitoring of Helicoverpa
5) Spray soft insecticides like phosolone/endosulfan against early bollworm population after parasite release
6) Spray ovicidal insecticides like methomyl/profenofos when peak egg population is noticed.
7) Spray 200 LE/ac *Helicoverpa* NPV only during cloudy days.
8) Spray synthetic pyrethroids to coincide with peak *H. armigera* larval population (Two applications only)
9) Spray botanicals - commercial neem formulations
10) Spray quinalphos/chlorpyrifos/carbaryl in turn against bollworm as an insecticide resistance management strtegy.
11) Spray acephate/monocrotophos against aphids, mites and bollworms at the end of cropping season.

Note :

a) Diseases if any in the later stages should be managed
b) Marigold/pigeon pea should planted all along the bunds
c) Clipping of terminal shoots after 120 days crop growth
d) Use high volume knapsack sprayer up to 50 days crop growth and later low volume power sprayer.
e) Imposition of treatments must be based on the ETL of the pests

**Table 2. Average population per leaf of sucking pests in IPM and non IPM cotton fields.**

| Sl. No. | Insect pest | Month | Kasbe Camp | | Sitanagar Camp | |
|---|---|---|---|---|---|---|
| | | | IPM | Non-IPM | IPM | Non-IPM |
| 1. | Jassids | Aug. | 0.68 | 0.85 | 0.75 | 0.95 |
| | | Sep. | 0.45 | 1.40 | 0.60 | 1.25 |
| 2. | Thrips | Aug. | 7.40 | 12.85 | 7.20 | 10.60 |
| 3. | Whiteflies | Nov | 4.30 | 7.15 | 3.70 | 6.45 |
| | | Dec | 3.70 | 4.35 | 2.75 | 4.10 |
| 4. | Aphids | Dec | 8.80 | 14.65 | 6.30 | 21.25 |
| | | Jan | 7.15 | 12.70 | 8.20 | 16.30 |
| 5. | Mites | Nov. | 5.25 | 18.10 | 8.40 | 13.75 |
| | | Dec. | 4.10 | 15.30 | 6.20 | 8.90 |
| | | Jan. | 5.35 | 9.25 | 3.70 | 7.15 |

**Table 3. Bollworm damage in IPM and non IPM cotton fields.**

| Sl No. | Month | Week | * Per cent bollworm damage to fruiting bodies | | | |
|---|---|---|---|---|---|---|
| | | | Kasbe Camp | | Sitanagar Camp | |
| | | | IPM | Non-IPM | IPM | Non-IPM |
| 1. | September | I | 6.50 | 5.00 | -- | -- |
| | | II | 5.25 | 5.25 | -- | -- |
| | | III | 8.75 | 10.15 | -- | -- |
| | | IV | 8.10 | 7.30 | 9.35 | 6.30 |
| 2. | October | I | 5.60 | 6.35 | 11.10 | 12.35 |
| | | II | 13.15 | 19.80 | 17.50 | 19.30 |
| | | III | 8.70 | 11.30 | 6.85 | 13.75 |
| | | IV | 10.30 | 7.25 | 12.65 | 12.00 |
| 3 | November | I | 6.35 | 8.10 | 7.10 | 9.35 |
| | | II | 10.20 | 9.35 | 9.35 | 10.65 |
| | | III | 5.35 | 6.80 | 10.60 | 8.10 |
| | | IV | 12.60 | 18.20 | 16.25 | 15.35 |
| 4. | December | I | 17.10 | 15.80 | 23.15 | 28.20 |
| | | II | 9.80 | 11.30 | 10.00 | 14.35 |
| | | III | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | IV | 7.75 | 8.35 | 9.25 | 11.10 |
| 5. | January | I | 10.80 | 6.10 | 6.15 | 7.35 |
| | | II | 4.35 | 3.50 | 5.70 | 6.20 |
| | | III | 5.20 | 4.80 | 6.10 | 4.80 |
| | | IV | -- | -- | 4.15 | 5.30 |

* Average of 100 plants observation

**Table 4 . Population of *Helicoverpa armigera* eggs in IPM and non IPM farmers fields.**

| Sl No. | Month . | Week | * No.of eggs on terminal shoots per plant | | | |
|---|---|---|---|---|---|---|
| | | | KasbeCamp | | SitanagarCamp | |
| | | | IPM | Non-IPM | IPM | Non-IPM |
| 1. | Semptember | I | 0.28 | 0.18 | 0.08 | 0.10 |
| | | II | 0.71 | 1.02 | 0.13 | 0.25 |
| | | III | 0.85 | 0.74 | 0.41 | 0.72 |
| | | IV | 1.13 | 1.67 | 0.28 | 0.68 |
| 2. | October | I | 2.80 | 3.25 | 2.13 | 2.72 |
| | | II | 1.45 | 2.90 | 1.87 | 2.05 |
| | | III | 0.70 | 0.82 | 0.73 | 1.25 |
| | | IV | 0.80 | 1.20 | 0.47 | 1.05 |
| 3. | November | I | 1.05 | 1.30 | 1.02 | 0.90 |
| | | II | 0.60 | 1.12 | 1.35 | 0.61 |
| | | III | 3.65 | 4.05 | 0.82 | 1.17 |
| | | IV | 4.10 | 5.20 | 3.87 | 5.64 |
| 4 | December | I | 2.35 | 3.60 | 4.08 | 5.37 |
| | | II | 1.30 | 2.65 | 1.72 | 3.55 |
| | | III | 0.80 | 1.90 | 0.25 | 1.12 |
| | | IV | 0.75 | 0.68 | 0.36 | 0.85 |
| 5. | January | I | 0.35 | 0.96 | 0.52 | 0.73 |
| | | II | 0.27 | 0.36 | 0.68 | 1.06 |
| | | III | 0.05 | 0.25 | 0.17 | 0.34 |
| | | IV | 0.06 | 0.10 | 0.12 | 0.10 |

* Average of observations on 100 plants

**Table 5 . Activity of natural enemies in IPM and non-IPM cotton fields. (Mean of three observations).**

| Sl. No. | Natural enemy | Kasbe Camp | | Sitanagar Camp | |
|---|---|---|---|---|---|
| | | IPM | Non-IPM | IPM | Non-IPM |
| 1. | Coccinellad grubs/ plant | 2.17 | 0.85 | 2.35 | 1.15 |
| 2. | Chrysoperla eggs/ plant | 7.05 | 2.35 | 5.65 | 3.12 |
| 3. | Spiders/plant | 2.23 | 0.70 | 1.68 | 0.34 |
| 4. | Per cent parasitisation by *Trichogramma* on *Helicoverpa* eggs | . 24.75 | 0.00 | 21.17 | 0.00 |
| 5. | NPV infected *Helicoverpa* larvae/plant | 1.75 | 0.00 | 2.20 | 0.00 |

**Table 6 . No. of good opened bolls and bad opened bolls per plant and seed cotton yield in IPM and non IPM cotton fields.**

| Parameter | Kasbe Camp | | Sitanagar Camp | |
|---|---|---|---|---|
| | IPM | Non-IPM | IPM | Non-IPM |
| 1. No. of good opened bolls/ plant | 35.25 | 36.80 | 28.32 | 25.54 |

| | | | | |
|---|---|---|---|---|
| 2. No.of bad opened bolls/plant | 14.62 | 13.18 | 17.85 | 19.87 |
| 3. Seed cotton yield (qt/ac) | 2535 | 2698 | 2254 | 2184 |

Average of 100 plants observation

**Table 7. Cost economics of IPM and non IPM cotton fields.**

| Factor per acre | Kasbe Camp | | Sitanagar Camp | |
|---|---|---|---|---|
| | IPM* | Non-IPM** | IPM+ | Non-IPM++ |
| IPM/plant protection cost (US$) | 78.84 | 157.19 | 77.88 | 145.72 |
| a) No.of insecticide applications | 11 | 24 | 12 | 23 |
| b) A.I./Ha (kg) | 6.75 | 15.20 | 7.29 | 15.02 |
| Agronomic practices cost (US$) | 99.02 | 108.67 | 122.07 | 119.77 |
| Total cost of cultivation (US$) | 177.86 | 265.86 | 199.95 | 265.49 |
| Seed cotton yield (Kg/Ha) | 2535 | 2698 | 2254 | 2184 |
| Gross income (US$) | 496.77 | 528.21 | 441.16 | 427.60 |
| Net Profit (US$)[1] | 318.91 | 262.35 | 241.21 | 162.12 |
| Profit over non IPM field (US$) | 56.56 | 79.09 | | |

* Average of 79 acre field
\+ Average of 169 acre field
** Average of 15 acres field
++ Average of 25 acres field
[1] (Price of seed cotton: 1 qt = Rs.2080)
(1US$ = 43 Indian Rupees)