INTEGRATED PEST MANAGEMENT IN COTTON

Cotton is a key cash crop having direct bearing on socio-economic structure of farmers of Marathwada region of Maharashtra. It continues to suffer heavily from a complex of insect-pests and diseases, which affect the crop from seedling to harvest stage. The losses due to pests amount to 50-60% resulting in substantial yield reduction. Attaining the projected demand of 24 million bales of cotton by the end of 2020 will be a daunting task despite the intensive cropping and pest management systems that are currently available. Calendar based application of chemical insecticides and their injudicious use was the prime strategy to manage the various pests during 1980s. Though the crop occupied only 5% arable land, it consumed 54% of the total chemical pesticides before introduction of transgenic cotton in 2002. The altered cropping systems, multiplicity of non-descript cultivars, imbalanced fertilizer use, and intensive cultivation have aggravated the problems of pests and environmental hazards. IPM strategies had become imperative to sustain productivity of cotton in an eco-friendly manner. A bio-intensive IPM module with much reliance on conservation and promotion of naturally occurring bio-agents, bio-pesticides and botanicals as tools for sustainable production of cotton was validated over 200 hectares under farmers' field conditions at Ashta village located in Nanded district of Maharashtra State (MS), a predominantly rain-fed cotton belt.

Development and validation of IPM Module

Existing literature and the work carried out by various ICAR institutes as well as SAUs on rain-fed cotton pest management formed foundation to formulate IPM modules for their field testing during 1995. It was decided to carry out experimentation at Agricultural College, Nanded in collaboration with Cotton Research Station, MAU, Nanded. Four IPM modules were synthesized viz., bio-intensive, bio-control + insecticides, biocontrol + intercrop and chemical modules. The higher seed cotton yield obtained in bio-intensive module signifying higher population of predators and

parasitoids in 1996 indicated promise for an eco-friendly pest management approach. Consequently, the trial was repeated for the second year (1997) in the same area along with its implementation on pilot scale in 5 ha of a progressive farmer's field at village Barad located in Nanded (MS) district. During 1997 the (bio-control + intercrop) module proved very effective in managing not only aphids but also jassids, thrips and whiteflies.

Components of bio-intensive module

As per feedbacks and observations made during three years (1995-1997) of validation, a number of modifications were made in the module. The successfully tested module comprised use of bio-agents, bio-pesticides and botanicals based on scouting and constant monitoring of pests and their economic threshold levels (ETL) with introduction of suitable crop management practices. The management practices adopted in the bio-intensive module were:

- Mass motivation of farmers for large-scale field sanitation.
- Uniform sowing windows using certified acid delinted seeds of single hybrid (NHH-44) and a variety (Renuka) in the entire village. Synchronized sowing was completed within a week in the entire village, soon after the onset of monsoon rains, which usually coincide with last week of June.
- Seed treatment with imidacloprid @ 7 g a.i./kg of seed.
- Use of recommended spacing of 90 cm x 60 cm and 60 cm x 30 cm, respectively for the hybrid and the variety. Planting of maize as border crop interspersed with cowpea to provide substrate for build-up of *coccinellid* (lady bird beetles) predators and their migration to cotton.
- A row of Setaria was planted between every 9 or 10 rows of cotton to enhance the activity of predatory birds by serving as food source and acting as live perch.
- *Trichogramma chilonis* @ 1, 50,000/ha was released in cotton fields when 2-8 adult moths of *H. armigera* per pheromone trap were captured continuously for 3-4 days in a week.
- Neem seed kernel extract (NSKE) 5% (w/v) was sprayed a week after release of *T. chilonis.*

- Application of *Ha*NPV @ 250 LE/ha was made based on the ETL of *H. armigera*.
- Low incidence of diseases did not warrant management at the whole village level. However, in some pockets, the crop at the first picking in the later stage was found severely affected with grey mildew (*Ramularia areola*). Such a situation in 1999-2000 season was managed with either carbendazim or wettable sulphur.

Impact of Astha IPM

Insect pest and disease scenario

Seed treatment with imidacloprid provided an umbrella of protection in IPM fields. The seed decay as well as seedling mortality caused due to *Alternaria* spp., *Aspergillus* spp., *Colletotrichum gossypii*, *Chaetomium* spp., *Fusarium* spp., *Pythium* spp., *Rhizopus* spp., *Macrophomina phaseolina*, *Rhizoctonia bataticola*, *R. solani*, *Sclerotium rolfsii*, and *Xanthomonas axonopodis* pv. *malvacearum* were noticed in traces at Ashta a and appeared to have been taken care of by the field sanitation measures followed and acid-delinting of seeds. Most of foliar diseases dependent on free water or high humidity could not prevail there due to free air flow provided by wider spacing between the rows and plants. Grey mildew did appear in severe form at boll dehiscence stage which warranted fungicidal (wettable sulphur or carbendazim) application in 1999.

The population of sucking pests in general was low in IPM fields as compared to non-IPM. Seed treatment with imidacloprid kept the sucking pests at bay for more than 50 days of the crop. Apart from this, the higher incidence of coccinellids and chrysopids in IPM fields and planting of maize interspersed with cowpea as border crop provided optimal conditions for multiplication and conservation of these natural enemies which regulated the population of the sucking pests as compared to non-IPM plots. The number of bollworm larvae (*E. insulana*, *P. gossypiella* and *H. armigera*) per plant showed that population of *Helicoverpa* were less by half (0.13 larvae/plant) in comparison to non-IPM. Similarly, marked differences existed in the population of pink bollworm (0.17 and 0.30) and spotted bollworm population (0.09 and 0.14), respectively in IPM and non-IPM fields. Parasitisation of the bollworm larvae by the natural enemies was critical under least chemical interventions (0.3 and 0.1 per plant

of coccinellids and 0.5 and 0.2 eggs of *Chrysoperla*/plant in IPM and non-IPM, respectively). Also the reduction in bollworm population in IPM field can be attributed to the growing of a row of Setaria after every 10th row of cotton. Setaria flowers attracted birds (myna, finches and black jay) and provided perch which in turn predated upon the larvae pest on cotton crop.

Economics of IPM

The IPM module resulted in substantial reduction of chemical insecticide use and avoided overhead expenditures on crop protection, conserved natural fauna and created a congenial atmosphere for the natural force of defence to act. The average seed cotton yield was 962.5 kg/ha as compared to 220 kg/ha during the previous season (1997), which reflected a difference of 742.50 kg/ha or an increase of 77.1% (4.37 times) over the 1997, while in the neighbouring village Murli, the yields of seed cotton under farmers' practice was 577.5 kg/ha.

The yields from cotton were supplemented by yields of Setaria and provided additional net returns and remuneration. The total cost of IPM inputs exclusive of the labour charges amounted to Rs 1545/ha which downsized the expenditure on cost of plant protection by over Rs 1680/ha as compared to the input cost under the farmers' practices (Rs 3225/ha) that reflected a decrease in the cost to the tune of 52.1% over the previous season. The cost benefit ratio of IPM over the farmers' practice (non-IPM) at Ashta was 1: 10.69, while at Murli the ratio was 1: 5.01. The IPM practices resulted higher in monetary gains of Rs 17,705 as compared to Rs 9950 in non-IPM (farmers' practices) with IPM gains to the tune of 56.2% per hectare.

Impact on environment

Regular crop health monitoring revealed that the use of eco-friendly bio-pesticides and conservation of egg parasites and predators had resulted in restoration of clean environment. The population of predatory lady bird beetles was 0.04-0.36 adults/plant under the non-IPM practices compared to the 3.00 to 4.8 adults/plant in IPM fields. The population of green lace wing (Chrysoperla) was negligible in non-IPM plots compared to 1.4 eggs/plant in IPM plots. Planting Setaria as intercrop between 9th and 10th row of cotton and providing bird perches enhanced the activity of the predatory birds (bulbul), and the predation of bollworm larvae was to the extent of

52-54%. Field collected bollworm larvae had shown 100% parasitisation. The conservation of natural enemies and reduced usage of chemical pesticides had made the cotton ecosystem, a habitat congenial for the birds to build their nests, which was hitherto an unusual phenomenon. All the practices under the IPM provided for a safe environment.

The general impacts of the Ashta IPM are as below:

- Conservation and enhancement in the activity of the natural enemies.
- Reduction in the quantity of chemical insecticides used
- Environmental safety, evident by increase in the number of bird population in the crop.
- Compensatory yields and higher net returns

Indian Council of Agricultural Research

ICAR Award for Team Research, 2001-2002

The ICAR Award for Team Research
for the Biennium 2001-2002
is presented to

Prof. Amerika Singh, Dr O.M. Bambawale, Dr O.P. Sharma, Shri R.C. Lavekar, Dr A. Dhandapani, Dr S.N. Puri, Dr C.D. Mayee and Dr S.K. Murthy

for their outstanding research contribution in the field of
Pest Management

New Delhi
19 October 2004

Mangala Rai
Director-General

Sharad Pawar
Union Minister for Agriculture

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

ICAR AWARDS FOR OUTSTANDING MULTI-DISCIPLINARY TEAM RESEARCH IN AGRICULTURE AND ALLIED SCIENCES FOR THE BIENNIUM 2001-2002

CITATION

The ICAR Award for Team Research for the Biennium 2001-2002 is given to Prof. Amerika Singh and his team for their significant contribution in handling different components of pest management in an eco-friendly manner.

Cotton in India occupies around 9 million ha supporting 60 million people. Due to increased pest attack, cultivation of cotton has not only become costly but also very risky. It has become a challenge to plant-protection specialists to develop suitable technology. A landmark in cotton production has been the validation of IPM incorporating ICM practices and Habitat management involving entire village of Ashta, District Nanded (1998-2001), a representative of > 2 million ha rainfed cotton in Central India, in a Farmers' Participatory Mode. The system successfully faced varying pest situations during the four years including the onslaught of *H. armigera* in 2001, mainly through conservation of natural enemies and is sustainable even after withdrawal of direct support from 2002. The cost of plant protection reduced by 31.3%, chemical pesticide consumption reduced by 94.3% and seed cotton yield increased by 56.9%. The successful Ashta experience prompted its adoption as a role model under Technology Mission on Cotton. The Ashta model has also been found indispensable in drawing maximum benefits from Bt transgenic cotton. The massive effort spread across 8 years from its inception to sustainable stature involved continued, harmonious team effort and has shown a way for similar efforts in other crops.

The research work was conducted at the National Centre for Integrated Pest Management, IARI Campus, New Delhi.