BOLLWORM MANAGEMENT IN COTTON PRODUCTION TO MEET THE QUALITY COTTON REQUIREMENTS OF THE INDUSTRY

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Cotton is highly valued commercial crop cultivated for its fibre and oil. India ranks second in production after China with 9.13 million hectares area under cultivation. Among the several constraints for low yields, the losses due to pests and diseases are the foremost, which have led to poor sustainability of farm production. Over ambitious plant protection measures adopted by farmers for this commercial crop resulted in tragic crop failure in spite of heavy expenditure, which was followed by many suicidal instances of the cotton growers. The state has been beset with problems of cultivating cotton hybrids from private seed industry due to poor pest suppression under high crop management levels. The pest pressure, particularly of bollworms, due to which crop loss in cotton becomes very high, drives the growers to all tactics may not be really suited to the given situation and would ensure failure of such efforts.

Though the value of IPM in sustainable agriculture has been well recognized, much intense action is desired at field level. The slow progress in adopting IPM by cotton growers and raising demand for chemical pesticides is the issue of great concern. Hence a suitable technology for the cotton farmers in various agroclimatic regions has to be adapted to all states.

Bollworms of Cotton

American bollworm - *Helicoverpa armigera* Hub. (Noctuidae: Lepidoptera)

Square and bolls show regular, circular bigger bore holes. Larva seen feeding on the boll by thrusting its head inside. Presence of faecal pellets outside the bore hole. Excessive leaf damage during outbreaks.

Pink bollworm *Pectinophora gossypiella* Saund

Rosette flowers and larval feeding on staminal column, pollen and anthers of the flowers. Infested buds and young bolls may drop off. Interlocular burrowing and improper opening of bolls. Lint is discoloured, fibre quality, ginning percentage and oil content are affected.

Spotted Bollworm *Earias vittella* Fab

During early vegetative stage, infested shoots wither, drop and show drying. Flaring up and shedding of infested squares and young bolls. Infested bolls open prematurely and the quality of lint spoiled due to rotting.

Major components of IPM for bollworm management in Cotton

1. Diversified cropping system:

Monocultures and overlapping crop seasons are more prone to severe outbreaks of pests and diseases. Diversity of natural enemy complexes attacking various stages of the pests prevalent in polycrop and intercropping systems also tend to prevent severe pest outbreaks. Hence in available area instead of growing cotton alone other possible crop, less preferred by cotton pest have to be cultivated.

2. Cotton free period:

Cotton should be grown only once in a year. Cotton double cropping, ratooning or extending the crop by applying additional fertilizers and water beyond certain period should be avoided as they provide continuous food supply for pest multiplication and carry over population to the next crop.

3. Crop rotation:

Cotton should be rotated with crops, which are not favourable or less preferred by cotton pests. It is observed that cotton maize/sorghum- cotton has given considerable high cotton yield than cotton alone.

4. Time of sowing:

Sowing cotton cultivar within 10-15 days in a village at a proper time and avoidance of staggered sowing have been found helpful in reducing insect build up. Delayed sowing gets high attack of pink bollworm.

5. Spacing and fertilizer:

Adoption of higher dose of fertilizers particularly nitrogen results in bushy crop growth, which provide favourable microclimate for the pest to multiply and thus the crop becomes vulnerable to pest attack. Further high crop density interferes with pesticide application. Hence, the insecticide will not reach the target leading to improper coverage. Application of neem cake 250 kg /ha reduces infestation of stem weevil, ash weevil, pathogenic nematode and soil borne pathogen. Early earthing up 15-20 days after sowing minimizes the stem weevil incidence.

6. Irrigation water management:

Alternate row or skip row irrigation, drip irrigation, avoiding excessive irrigation etc will minimize the development of microclimate for the development and build-up of pests.

7. Cropping Systems Approach:

The principle behind this system is to create a polycrop ecosystem, which will minimize the pest load on any one host crop and maximize the natural enemy load.

a. Trap crops:

To serve as trap crops for major pests and for in situ conservation and enhancing predator and parasite population and NPV/fungus infection of the key pests.

Maize:

Planting maize or sorghum in the cotton field at fixed rows encourages aphid predators (coccincllids and chrysophids), which migrate to cotton crop to feed on the cotton pest.

Castor:

One plant for 6 meters as a border crop attracts female moths of *Spodoptera litura* Fab. for egg laying and the eggs can be collected and destroyed**.**

Okra:

As a trap crop receives more number of bollworm eggs *(Earias* and *H. armigera)* on its fruits than on cotton. The larvae can be collected and destroyed.

b. Intercropping:

Cowpea, sunflower, bhendi and marigold intercropped with cotton favours colonization of more aphid predators and bollworm (*Earias* spp.) parasitoids.

8. Monitoring:

The occurrence, activity and abundance of bollworm moths can be monitored by erecting pheromones traps.

9. Bird perches:

Certain carnivorous birds like Myna and Drango prey on caterpillars. Erection of bird perches 20—25 /ha observed helpful for the birds to sit and prey on the caterpillars.

10. Host plant resistance (Resistant cultivar):

Insect resistant cotton varieties provide an inherent control, which involves no expenses or environmental pollution problem and helps in suppressing the pest population with least disturbance to ecosystem. Selection of pest -resistant cultivar greatly reduces insect population and dependency on insecticides. Insect resistant cultivars form foundation for IPM in which pest suppression strategies are superimposed. Varieties with characters like less trichomes and yellowish green canopy received less oviposition by insect pests and further those with higher content of total sugars, gossypol and dihydroxy phenols are also reported to be resistant to pests and diseases. Some early maturing varieties viz., Abadhita and LRK 516 escape from bollworm damage. Cotton varieties with high foliage and dense canopy are conducive for proliferation of pests.

11. ETL adopted for major pests:

The foremost factor to be determined for use of insecticide or any other appropriate technology is the arrival of economic threshold level. The field scouting for the pest has to be assessed by counting the insects and natural enemies or affected parts present in 50 randomly selected plants per ha. Based on the economic threshold level appropriate insect suppression techniques are to be adopted.

Spotted bollworm	more than 1O % of attacked fruiting bodies
American bollworm	10 % infested fruiting bodies or one egg or larva per plant
Pink bollworm	More than 10 % attacked bolls or flowers

12. Biological control:

The cotton ecosystem is endowed with rich fauna of natural enemies. Cotton bollworm pest complex alone is attacked by more than 65 natural enemies. Inundative release of parasitoids has been reported to play an important role in suppressing the bollworm particularly the pesticide resistant American bollworm, *H. armigera*. A true IPM system should conserve beneficial insect and utilize them as a basic component in the management of key pests.

a. Parasitoids:

Trials conducted at several locations revealed that release of the egg parasitoids *Trichogramma chilonis* @ I .5 lakh/ ha thrice after observing adult moth catch in pheromone traps or fresh eggs of *H. armigera* has reduced the incidence.

b. Microbial Pesticide:

Application of Nuclear Polyhedrosis Virus HaNPV @450 LE / ha 2-3 times after immediately observing early instars larvae reduced the bollworm damage. Laboratory bioassay studies revealed that NPV infection in late stage larvae of *H. armigera* increases its susceptibility to insecticides.

c. Botanical pesticide:

Among the botanical pesticide neem product such as neem seed kernel extract 3-5 % and neem oil 0.5 % were found effective in suppressing bollworm and whitefly without affecting natural balance of cotton ecosystem.

13. Mechanical control:

Collection of egg masses, larvae, flared up squares, affected and fallen reproductive parts of cotton plant minimise the pest cycle to greater extent. Even after application of insecticide, surviving larvae are to be collected and destroyed as they may be resistant population to insecticide which will form as inoculums of resistant population in the ecosystem. Remove cotton crop and dispose of crop residues as soon as harvest is over.

14. Need based Chemical control:

Selection of right insecticide and applying them at recommended dose is most essential to conserve susceptibility. This is achieved by strategies aimed at preventing the development of resistance to existing new pesticide. Application of synthetic pyrethroid or its combination has to be avoided. The use of ineffective insecticides, insecticides that induce vegetative growth (Acephate, monocrotophos) are to be avoided. Chemicals like phosalone and Endosulfan which are less harmful to beneficial insects are preferred.

15. Transgenic cotton

Transgenic cotton has emerged as a potential biotechnological tool for management of cotton pests, particularly *Helicoverpa armigera*. However being resistant to specific group of insects which do not totally eliminate the need to use pesticides and are also to be accepted with caution against their breakdown under given set of conditions.

16. Other important IPM packages:

- Deep summer plouging to expose soil-borne pests, pathogens and weed seeds and their destruction.
- Early sowing on ridges and furrows, especially in areas with drip facility, could be adopted
- Using only the certified and delinted seeds for good plant stand and preventing seed-borne disease causing organisms as pink bollworm.
- Seed treatment with Imidacloprid 7g / Kg seed helps in delaying the first spray for hybrids in protecting the crop against jassids upto 40-60 days
- Weed free conditions should be maintained in the first 10 weeks.
- Proper pesticide application technique should be followed, avoid the combination of insecticides.
- Grazing the crop by cattle to destroy pest affected plant parts.

17. Insecticide Resistance Management:

- Pyrethroids are effective against moths and younger larvae of *Spodoptera* and *Helicoverpa*. Usage may be once based on pheromone trap counts. Over dose or repeated sprays of pyrethroids lead to excessive whitefly flare up. Pyrethroid should be used only once, after 110 days to control Helicoverpa and Pink bollworm.
- It is necessary to spray against sucking pests only on susceptible crop varieties. Broad-spectrum organophosphate insecticides strongly disrupt natural enemy populations. Natural enemies of pests occur abundantly during the first three months of the crop.

- Avoidance of organophosphate insecticides such as monocrotophos, metasystox, dimethoate, acephate, and phosphomidon for the first three months helps in build-up of entomophage populations such as *Chrysoperla*, *Campoletis chloridae*, *Microchilonis curvimaculatus* and Tachinids which contribute to the management of *Helicoverpa*.
- Resistance levels against certain organophosphate group of insecticides (Quinalphos, Chlorpyriphos & Profenophos) and carbamates (Thiodicarb) have been found to be low in most populations tested. These can be used as effective larvicides during 90-110 DAS based on ETLs 100% affected plants
- Do not spray insecticides against minor pests such as the semiloopers, leaf folders and the hairy caterpillars. Semilooper and leaf folder larvae were found to cause minimal crop damage while serving as a breeding ground of generalist parasitoids that keep Helicoverpa populations in check.
- The farmer should be trained in the methodology for bioassay of chemicals and biomonitoring the pesticide content in the larvae through farmer participatory IRM trials to manage insecticide resistance in bollworms and sucking pests of cotton for selecting the right insecticide.
- Although the components of 1PM have been broadly spelt out time and again, specific protocols are necessary at regional and local levels in order to get the effects of IPM practically felt by farmers. A conscientious effort to practice the steps IPM is necessary.