



IPM PACKAGE NO. 25



# **INTEGRATED PEST MANAGEMENT PACKAGE**

FOR

# **COTTON**



Government of India  
Ministry of Agriculture  
Department of Agriculture & Cooperation  
**Directorate of Plant Protection, Quarantine & Storage**  
N. H. IV, Faridabad - 121 001.

# IPM PACKAGE FOR COTTON

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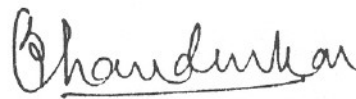
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**FOREWARD**

Integrated Pest Management (IPM) approach has been globally accepted for achieving sustainability in agriculture. It has become more relevant due to a number of advantages like safety to environment, pesticide-free food commodities; low input cost based Crop Production Programme etc. Though IPM approach has been taken up since 1981, its impact has not been felt until 1994. Human Resource Development has helped to sensitize extension functionaries and farmers about the usefulness of IPM.

For successful implementation of IPM, gathering of the scattered information on various components of this eco-friendly approach in the form of package is basic necessity. In this direction, initial attempts were made in 1992 to harmonize the IPM Package of Practices of various crops. Subsequently, concerted efforts were made in 1998, 2001, 2002 and 2003 to update and develop IPM Package of Practices for agricultural and horticultural crops. Keeping in view, the development of resistance and attainment of pest status by certain insects, updating of IPM modules in five crops (Cotton, Rice, Sugarcane, Groundnut & Coconut) was done in 9<sup>th</sup> National Workshop held at CIL, Faridabad during 22<sup>nd</sup>-23<sup>rd</sup> December, 2003.

  
(P. S. Chandurkar)

31<sup>st</sup> December, 2003

## P R E F A C E

In order to minimize the indiscriminate and injudicious use of chemical pesticides, INTEGRATED PEST MANAGEMENT (IPM) has been enshrined as cardinal principle of Plant Protection in the overall Crop Protection Programme under the National Agricultural Policy of the Govt. of India. IPM is an eco-friendly approach for managing pest and disease problems encompassing available methods and techniques of pest control such as cultural, mechanical, biological and chemical in a compatible and scientific manner. The greater emphasis has been given on biological control including use of biopesticides.

With a view to provide technical knowledge to the extension functionaries and farmers in the States, first National Workshop on IPM for harmonization of Package of Practices was organized at National Plant Protection Training Institute (NPPTI), Hyderabad during June 29-30, 1992. Subsequently workshops were organized on April 15-17, 1998 and Nov. 5-6, 1998 at the Directorate of Plant Protection, Quarantine & Storage, Faridabad and IPM Package of Practices for 20 crops were finalized on rice, cotton, vegetables, pulses and oilseeds. In this series, two National Workshops on IPM have been conducted at NPPTI, Hyderabad and Dte. of PPQ&S, Faridabad during May 14-17, 2001 and February 20-22, 2002 respectively to update 20 available IPM Packages and developed 31 new IPM Packages especially for horticultural crops. Sixth and Seventh National Workshops held at Central Insecticides Laboratory, Faridabad on 4<sup>th</sup>-5<sup>th</sup> July, 2002 and 9<sup>th</sup>-10<sup>th</sup> January, 2003 respectively for 18 IPM Packages and Eighth National Workshop was held at NPPTI, Hyderabad on 28<sup>th</sup>-29<sup>th</sup> May, 2003 for 8 IPM Packages. In these Workshops, 77 IPM Package of Practices for cereal crops (Rice, Wheat, Maize, Sorghum, Millets), commercial crops (Cotton, Sugarcane, Tobacco, Tea, Betelvine, Saffron), pulse crops (Pigeonpea, Gram, Black gram/Green gram, Peas, Rajma), oilseeds (Groundnut, Soybean, Rapeseed/Mustard, Sesame, Olive, Safflower, Castor, Sunflower, Oilpalm), vegetables (Potato, Onion, Tomato, Brinjal, Okra, Chillies, Cruciferous vegetables, Leguminous vegetables, Cucurbitaceous vegetables, Broccoli, Spinach, Lablab bean, Garlic), fruits (Citrus, Banana, Apple, Mango, Guava, Grapes, Jackfruit, Pineapple, Sapota, Pomegranate, Litchi, Papaya, Apricot, Peach, Pear, Cherry, Walnut, Ber, Amla, Loquat, Strawberry, Watermelon, Fig, Phalsa, Persimmon, Custard apple, Raspberry, Kiwi, Passion fruit), spice and plantation crops (Small Cardamom, Large Cardamom, Black Pepper, Ginger, Coriander, Cumin, Fennel, Coconut, Cashew and Arecanut) have been finalized. Moreover, 9<sup>th</sup> National Workshop for Review/Upgradation of IPM Package of Rice, Cotton, Sugarcane, Coconut and Groundnut crops was held during 22<sup>nd</sup> -23<sup>rd</sup> Decembe, 2003 at CIL, Faridabad. Latest research developments, pest problems and their management practices have been incorporated in these IPM packages.

IPM technology manages the pest population in such a manner that economic loss is avoided and adverse side effects of chemical pesticides are minimized. The IPM packages encompass various management strategies for containing the pest and disease problems. Pest monitoring is one of the important components of IPM to take proper decision to manage any pest problem. It can be done through Agro-Ecosystem Analysis (AESA), field scouting, light, pheromone, sticky/yellow pan traps. The economic threshold levels (ETL) of important pests and diseases are also given in the packages to take appropriate control measures when pest population crosses ETL.

These IPM packages developed with the technical inputs from experts from the various Institutes of Indian Council of Agricultural Research, State Agricultural Universities, Central Directorate of Plant Protection, Pesticide Industries and State Departments of Agriculture/Horticulture will provide technical backup in the management of pests, diseases, weeds, nematodes and rodents in the agriculture and horticulture. These will also be useful in reducing the pesticide residues in agricultural commodities and would also help in the management of pests/diseases/weeds/nematodes which may get inadvertently introduced in the country.

IPM Package of Practices for agricultural and horticultural crops will be helpful to minimize the ill-effects of chemical pesticides to promote the IPM for sustainable production. These IPM packages will be useful for the researchers, extension workers and farmers alike who are engaged in the agricultural practices.

31<sup>st</sup> December, 2003



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## IPM PACKAGE FOR COTTON

### I. MAJOR PESTS

#### A. Pests of National Significance

##### 1. Insect Pests

1.1 American bollworm (*Helicoverpa armigera*)

1.2 Whitefly (*Bemisia tabaci*)-Vector for CLCV

1.3 Jassid (*Amrasca bigutella bigutella*)

1.4 Tobacco caterpillar (*Spodoptera litura*)

1.5 Spotted bollworm (*Earias vittella*)

1.6 Thrips (*Thrips tabaci*)

1.7 Pink bollworm (*Pectinophora gossypiella*)

##### 2. Diseases

2.1 Cotton Leaf Curl Virus (CLCV)

2.2 Blackarm/Angular leaf spot (*Xanthomonas campestris* p.v. *malvacearum*)

2.3 Fusarium wilt (*Fusarium oxysporum* f.sp. *vasinfectum*)

2.4 Root rot (*Rhizoctonia* spp)

##### 3. Weeds

###### Monocots

3.1 Burmuda grass (*Cynodon dactylon*)

3.2 Barnyard grass (*Echinochloa* spp).

3.3 Cowfoot grass (*Dactyloctenium aegyptium*)

3.4 Signal grass (*Brachiaria* spp)

3.5 Torpedo grass (*Panicum* spp.)

3.6 Purple nut sedge (*Cyperus rotundus*)

**Dicots**

- 3.6 Coclebur (*Xanthium strumarium*)
- 3.7 Wild jute (*Corchorus* spp.)
- 3.8 Cox comb (*Celosia argentea*)
- 3.9 Carpet weed (*Trianthema* spp.)
- 3.10 Purselane (*Portulaca oleracea*)
- 3.11 Netamundia (*Tridax procumbens*)
- 3.12 Field bind weed (*Convolvulus arvensis*)
- 3.13 Velvet leaf (*Abutilon* sp.)
- 3.14 Sida (*Sida* sp.)
- 3.15 Spurge (*Euphorbia* spp.)

**B. Pests of Regional Significance****1. Insect Pests**

- 1.1 Termites (*Odentotermes obesus*) - Haryana, Punjab, M.P.,  
Gujarat and Rajasthan
- 1.2 Aphid (*Aphis gossypii*) A.P., Karnataka, Tamil Nadu,  
Maharashtra, M.P., Gujarat
- 1.3 Spinny Bollworm (*Earias insulana*) - Punjab, Haryana, Rajasthan,  
Maharashtra
- 1.4 Shoot weevil (*Alcidodea affaber*) - Tamil Nadu, Karnataka, Gujarat
- 1.5 Stem Weevil (*Pemphras stimis*) - Tamil Nadu

**2. Diseases**

- 2.1 Grey mildew - T.N., Maharashtra, M.P., Gujarat
- 2.2 Alternaria leaf spot - Punjab, Haryana, A.P., Karnataka
- 2.3 Verticillium wilt (*Verticillium dahliae*)- A.P., Karnataka and Tamil Nadu.

### 3. Nematodes

- 3.1 Reniform Nematode (*Rotylenchulus reniformis*) - Haryana, Punjab, Rajasthan, Gujarat, M.P. & Maharashtra.

## II. PEST MONITORING

### A. **Agro Eco system Analysis (AESAs)**

AESA is an approach, which can be gainfully employed by extension functionaries and farmers to analyse field situations with regard to pests, defenders, soil conditions, plant health, the influence of climatic factors and their interrelationship for growing healthy crop. Such a critical analysis of the field situations will help in taking appropriate decision on management practices. The basic components of AESA are:-

1. Plant health at different stages.
2. Built -in - compensation abilities of the plants.
3. Pest and defender population dynamics
4. Soil conditions.
5. Climatic factors.

The details of the AESA are given in Annexure -I.

### B. **Survey / Field Scouting**

The objective of surveys through roving surveys is to monitor the initial development of pests and diseases in endemic areas. Therefore, in the beginning of crop season survey routes based upon the endemic areas are required to be identified to undertake roving surveys. Based upon the results of the roving surveys, the State extension functionaries have to concentrate for greater efforts at Block and village levels as well as through farmers to initiate field scouting. Therefore, for field scouting farmers should be mobilised to observe the pest and disease occurrence at the intervals as stipulated hereunder. The plant protection



measures are required to be taken only when pests and diseases cross ETL as per result of field scouting.

1. **Roving survey**:- Undertake roving survey at every 10 km distance initially at weekly intervals and thereafter at 10 days intervals (depending upon pest population). Record incidence of bollworms on all host crops of the locality. Observe at each spot diagonally criss cross 20 plants/acre at random. Record the population potential of different biocontrol fauna. Record the major disease and their intensity.
2. **Field scouting**:- Field scouting for pests and biocontrol fauna by extension agencies and farmers once in 3-5 days should be undertaken to workout ETL. For sucking pests, population should be counted on three leaves (top & middle portion) per plant. For whitefly, third and seventh leaves from the top of the plant should be observed for nymphs and adults. For bollworm eggs terminal leaves should be observed. Observe larvae on fruiting bodies and leaves per plant. For percent bollworm incidence count total and affected fruiting bodies on the plant and also in the shed material and work out the percent infestation.

The State Departments of Agriculture should make all possible efforts by using different media, mode and publicity to inform the farmers for field scouting in the specific crop areas having indication of pest or disease build up.

### C. **Pest Monitoring through Pheromones / Yellow Pan/Sticky Traps etc.**

Certain pests require positioning of various kinds of traps like pheromones, yellow pan, sticky traps to monitor the initial pest build up. Therefore, the State Department of Agriculture is to initiate action for positioning of different kinds of traps based upon the results of roving surveys at the strategic locations at village level. While the concept needs to be popularised amongst farming community, the State Department of Agriculture is to take greater initiatives for pest monitoring through specific pheromone trapping methods as per following details.

1. **Pheromone trap - monitoring** :- Use pheromone traps for monitoring of Amercian bollworm, spotted bollworms, pink bollworm and *Spodoptera*.

Install pheromone traps at a distance of 50 m @ five traps per ha. for each insect pest . Use specific lures for each insect pest species and change it after every 15-20 days. Trapped moths should be removed daily. ETL for pink bollworm is 8 moths per days per trap consecutively for 3 days. ETL for American bollworm is 4-5 moth per day per trap.

2. **Yellow pan / sticky traps** :- Set up yellow pan / sticky traps for monitoring whitefly @ 25 yellow pans / sticky traps per ha. Locally available empty yellow palmoline tins coated with grease/vasline/castor oil on outer surface may also be used.

#### **D. Economic Threshold Levels (ETLs)**

Based upon the result of survey /field scouting etc., the extension functionaries are to determine the ETLs for different pests to advise farmers to initiate pest management practices accordingly. The ETLs for major pests are as under:-

<b>Insect pest</b>	<b>ETL</b>
1. American & Spotted bollworm	5% damaged fruiting bodies or 1 larva per plant or total 3 damaged square/plant taken from 20 plants selected at random for counting.
2. Pink bollworm	8 moths/trap per day for 3 consecutive days or 10% infested flowers or bolls with live larvae.
3. <i>Spodoptera</i>	1 egg mass or skeletized leaf/10 plant.
4. Jassids *	2 jassids or nymphs per leaf or appearance of second grade jassid injury.(yellowing in the margins of the leaves)
5. Whitefly *	5-10 nymphs or adults per leaf before 9 AM.
6. Aphids	10% affected plants counted randomly
7. Thrips *	5-10 thrips/leaf
8. Nematode	1-2 larvae per gm of soil

\* 3 leaves (top, middle, bottom) per plants from 10 plants

## E. Insecticide Resistance Management (IRM) of *Helicoverpa*

For the last few years, incidence of insecticide resistance in *Helicoverpa* have been reported on important crops like cotton and pigeonpea in some parts of the country. Extension functionaries should get in touch with the experts of respective State Agricultural Universities for mapping such areas. Wherever the scientific input is available about occurrence of insecticide resistance in *Helicoverpa* the areas should be very clearly demarcated. During the course of surveys and also in advising farmers about *Helicoverpa* management strategies, utmost care need to be taken “NOT TO ADVOCATE” the pesticide for which resistance has been reported in specific areas. Most of the cases of such resistance have been recorded from Andhra Pradesh, Tamil Nadu, Haryana and Punjab against synthetic pyrethroids, especially Cypermethrin. The best-bet Insecticide Resistance Management (IRM) window strategy for cotton pests including *Helicoverpa* is given in Annexure-IV.

## II. INTEGRATED PEST MANAGEMENT STRATEGIES

### A. Cultural practices

1. Summer deep ploughing to expose soil inhabiting / resting stages of insects, pathogen and nematode population.
2. Growing cotton after cotton should be avoided. Adopt proper crop rotation.
3. Select healthy seeds of resistant / tolerant varieties (Annexure -II)
4. Only certified seeds should be used.
5. Acid delinting treatment should be followed before sowing @ one litre commercial sulphuric acid for 10 kg. seeds.
6. Seed treatment to control soil and seed borne diseases should be followed. *Trichoderma* spp. @.4 g/kg. or Captan 3 g/kg of seed or carbendazim 2 g/kg seed. In North Zone dipping of seeds in streptomycin 0.01% in black arm endemic areas is recommended.
7. Seed treatment with imidachloprid 70 WS \* @ 5 g/kg of seed in case of non-hybrid variety and 10 g/kg in case of hybrid or Thiomethoxam 5 g/kg seed or carbosulfan 25 DS @ 50 gms/kg of seeds for early sucking pests. After insecticide seed treatment *Trichoderma* or fungicide treatment can be undertaken.
8. Sowing should be done timely within 10 to 15 days in a village or block in the season. Early sowing in Northern region sowing should be completed by first week of May.
9. Adopt proper spacing, irrigation and fertilizer management. Avoid application of high nitrogenous fertilizers to boost the crop. Use neem cake with least oil content @ 5 quintal/ha in termite/nematode infested fields.
10. The crop should be maintained weed free for at least 8-9 weeks after sowing till canopy starts closing in by timely inter-culture. A hoeing in between crop rows is to be given 18-20 days after emergence of cotton seedlings to control primary perennial weeds.

11. Remove and destroy weeds as alternate hosts viz. *Sida* sp., *Abutilon* sp., *Logascae mollis* and other malvaceous plants in the cultivated area.
12. The following inter-cropping system is recommended for Central and South Zone to colonize the bioagents fauna such as lady bird beetles, chrysopa and syrphid flies :
  - i) Cotton + Cowpea,
  - II) Cotton + Soybean
  - III) Cotton + Groundnut
  - IV) Cotton + Pulses (Green gram / Black gram)
13. Use of trap crops like okra, Canabinus, castor, marigold (Tagets), early Pigeon pea, coriander, jowar, maize crops is recommended. Insects feeding on these crops must be removed and destroyed.  
 However, in North Zone okra should not be used as trap crop and cotton should not be grown in or around citrus orchards to avoid spread of CLCV disease.
14. Do not extend the normal crop period and avoid ratooning.
15. Grazing by animals after last picking is recommended for checking the carry over population of bollworms.
16. Remove and make use of crop residues after last picking as FYM or in Paper Industry.
17. Staking the cotton stalks near the field should be avoided. Destroy opened bolls on the plant.
18. Crushing of cotton seeds should be completed by early April in North Zone. Otherwise fumigate the seeds by the end of May under expert supervision.
19. Clean the gin thrashers for checking of carry over population of pink bolloworm. Install pink bollworm pheromone traps in the premises of ginning factories to trap emerging pink bollworm moths.

## B. Mechanical practices

1. Hand picking and destruction of various insect stages, affected plant parts and rosetted flowers.
2. Clipping of terminal shoots on 90-110 days of crop growth depending upon cultivars.

## C. Biocontrol practices

### 1. Seed treatment:

- 1.1 Seed treatment with *Trichoderma* spp. @ 4 gm per kg. of seed after acid delinting for soil and seed borne diseases.

### 2. Conservation:

- 2.1. Conservation of predators (lacewings, lady bird beetles, staphylinids, predatory wasps, surface bugs like *Geocoris*, *Anthocorid*, Nabids, Reduviids, Spiders, parasitoids like *Apanteles*, *Bracon*, *Rogas*, *Agathis*, *Campoletis*, *Eriborus*, *Trichogramma*, *Telenomu* by growing two rows of maize / sorghum or cowpea along the border
- 2.2. Collection of *Spodoptera* egg masses and putting them in perforated cage.
- 2.3. Install 8-10 bird perchers per ha. for the benefit of predatory birds after 90 days of crop growth like black drango, king crow, orange Myna and Blue jay.

### 3. Augmentation:

- 3.1. Monitor the incidence of sucking pests and release eggs or first instar larvae of *Chrysoperla* @ 10,000 eggs/grubs/ha. Observe the incidence of bollworms either by visual observation or by using pheromone @ 5 traps/ha. specific for each bollworm species. Release *Trichogramma chilonis* (cotton strain) immediately after the appearance of bollworms eggs (when moth activity is observed) @ 1,50,000/-ha/week (2-3 releases) 40-50 days after sowing. Avoid spraying with insecticides for at least one week before and after the release of biocontrol agents.

- 3.2. Apply *Spodoptera* NPV 250-500 LE/ha (1LE=  $2 \times 10^9$  POBs) (1LE /lit. of water) on observing 1st Instar larvae. HNPV @ 250 LE can be applied in the early infestation of *Helicoverpa*. However, HNPV is found to be more effective in Ravi hosts and its application on ravi crop is advisable to minimize the carry over population.
- 3.3 Entomopathogenic fungi such as *Metarhizium anisopliae*, *Beauveria bassiana* and *Nomurea rileyi* can be used against *Helicoverpa*.

#### D. Chemical Control Measures

1. Need based, judicious and safe application of pesticides are the most vital tripartite segments of chemical control measures under the ambit of IPM. It involves developing IPM skills to play safe with environment by proper crop health monitoring, observing ETL and conserving natural biocontrol potential before deciding in favour of use of chemical pesticides as last resort. Therefore, it is necessary to rely upon pesticides as per the list in Annexure-III.
2. Following suggestions have important bearings for the success of control measures in the context of IPM strategy :
  - 2.1 Avoid mixing of two or more insecticides / tank mixing.
  - 2.2 Repeated application of same insecticide should be avoided.
  - 2.3 Avoid using insecticides such as pyrethroids which result in resurgence of sucking pests.
  - 2.4 Use neem based formulations.
  - 2.5 Use selective insecticides (Endosulfan) during early fruiting phase of crop growth.
  - 2.6 Alternate with various chemical groups (Cyclodine, Organophosphates, Carbamates, Pyrethroids and insect growth regulator).
  - 2.7 Pyrethroids usage should be restricted to twice (1-2) in the cropping period depending on the incidence of spotted and pink bollworms.

## 2.8 Proper spray equipments should be used :

- a) Knapsack sprayer in the early stage of crop growth. Tractor mounted sprayers are recommended in the North Zone in early vegetative and fruiting phase of crop.
- b. Power sprayer in the later stages of crop growth.
- c) Discourage using undescriptive and inefficient sprayers and also CDA sprayers.

## 2.9 Use proper spray volume for unit area :

### E. Cotton Leaf Curl Virus Disease Management

1. Cultivation of susceptible varieties in the established endemic areas should be immediately discouraged.
2. Quarantine measures must be implemented to restrict movement of diseased plants and its parts.
3. Removal of weeds, which are alternate host of *B. tabaci* from the fields.
4. Avoid growing bhindi, cucurbitaceous, solanaceous and other alternate host crops in cotton growing tracts.
5. Avoid growing cotton crop near citrus orchards. Grow resistant varieties near orchards.
6. Select any of the following resistant varieties such as RS-875, LHH-144, RS-810, RS 2013, F-1861, H-1098, Ankur-651 and whitegold. All desi cotton varieties are resistant to leaf curl. virus. Grow desi cotton varieties in the hot spot /endemic areas.
7. Excessive use of nitrogenous fertilizers should be avoided.
8. Use yellow traps for mass trapping of whitefly populations.



9. Following insecticides may be used to manage the whitefly populations.

i. Seed treatment as given in the Annexure-III

ii. Acetamiprid 30-40 gram a.i./ha; Thiomethoxam 25 gram a.i./ha

iii. Imidachloprid 25 gram ai/ha.

iv) NHKE 5% or Neem formulations (1500 ppm) 2.5 lit/ha.

v) Triazophos 40 EC 1.5 litre/ha.

10. Avoid use of synthetic pyrethroids when whitefly population exists.

11. While spraying, ensure thorough coverage of the lower surface of cotton leaves for effective control of whitefly.

#### F. Weed Management practices :

##### I. Preventive Measures

1. Summer deep ploughing during May/June to expose and destroy the underground vegetative parts of the deep rooted perennial weeds. The field should be kept exposed to sun at least for 2-3 weeks.

2. Follow recommended agronomic practices for land preparation, stubble management, seed rate, sowing time, fertilizer and irrigation management etc. so as to have a desirable crop stand.

3. The crop should be maintained weed free initially for 8-9 weeks after sowing by resorting timely inter-culture and hand weeding.

##### II. Control Measures

1. Smothering of weeds by mulching with straw/plastic sheets etc.

2. Use power of hand operated implements for maintaining crop weed free for initial 8-9 weeks DAS.

3. Pre-emergence application of pendimethalin (0.75 to 1.25 kg a.i./ha) or alachlor ( 2.0-2.5 kg. a.i. /ha.) or diuron (0.75 to 1.5 kg. a.i./ha) or trifluralin (0.96 to 1.2 kg a.i./ha) or pre-plant incorporation of fluchloralin (0.9 to 1.2 kg a.i./ha) control both types of weeds effectively.

4. At post emergence stage (15 to 30 DAS) Paraquate @ 0.3-0.5 lit. a.i./ha may be applied as direct spray.

G. **Nematode management practices for endemic areas:**

1. Deep summer ploughing to expose inhabiting nematodes.
2. Remove and destroy crop residues.
3. Application of neem cake.

H. **Other Precautions:**

1. **Seed Treatment**

- 1.1 For seed dressing, use either metal seed dresser /earthen pots or polythene bags.
- 1.2 After seed treatment, do not open lid / cover of the polybag / earthen pot immediately to avoid inhalation of pesticide / fungicide.
- 1.3 Do not use left over treated seeds either for human consumption or as animal feed.

2. **Cautions during spraying**

- 2.1 If operator feels giddiness, uneasy, he must discontinue spraying /dusting at once.
- 2.2 Operator should not spray / dust more than 4 hours at a stretch in a day.
- 2.3 Operator should not take up spray/dusting work with empty stomach.

**IPM for Bt. Cotton**

1. For sucking pest control seed treatment with insecticides already identified may be given
2. If the hybrids are susceptible to sucking pests spray should be given on ETL.
3. Spray against *Spodoptera* should be given as and when ETL crossed with the identified insecticides . Egg masses and gregarious larvae should be picked and destroyed.

## IV. STAGE-WISE IPM PRACTICES TO BE ADOPTED AGAINST COTTON PESTS & DISEASES

S.No.	Crop stage/pest		Stage-wise IPM Practices
1.	<b>Pre-sowing</b>		
			<ol style="list-style-type: none"> <li>1. Deep ploughing in summer.</li> <li>2. Removal of alternate hosts.</li> <li>3. Avoid cotton after cotton.</li> <li>4. Adopt crop rotation.</li> </ol>
2.	<b>At sowing</b>		
	Soil & seed borne diseases	Cultural practice	<ol style="list-style-type: none"> <li>1. Select tolerant/resistant cultivars.</li> <li>2. Use certified seeds.</li> </ol>
		Chemical practices	<ol style="list-style-type: none"> <li>3. Acid delinting treatment for seeds.</li> <li>4. Seed treatment with fungicides.</li> <li>5. Seed dipping in antibiotic in black arm endemic areas.</li> </ol>
	Sucking pests	Cultural practice	<ol style="list-style-type: none"> <li>1. Early sowing.</li> <li>2. Adopt recommended spacing &amp; fertilization.</li> </ol>
		Chemical practice	<ol style="list-style-type: none"> <li>1. Seed treatment with insecticides.</li> </ol>
	Weeds	Chemical practice	<ol style="list-style-type: none"> <li>1. Use pre-emergence/post emergence herbicides.</li> </ol>
3.	<b>Vegetative growth stage (20-50 days)</b>		
	Weeds	Cultural practice	<ol style="list-style-type: none"> <li>1. Gap filling and thinning.</li> <li>2. Inter culture &amp; hand weeding.</li> </ol>
	Sucking pest	Cultural practice	<ol style="list-style-type: none"> <li>1. Check population on trap crops &amp; inter crops.</li> </ol>
		Biological control	<ol style="list-style-type: none"> <li>1. Release of <i>Chrysoperla</i> grubs @ 10,000/ha.</li> <li>2. Spray neem products for whitefly.</li> </ol>
		Chemical control	<ol style="list-style-type: none"> <li>3. If pest persists spray recommended insecticides.</li> </ol>
	Shoot borer ( <i>Earias</i> sp.)	Mechanical control	<ol style="list-style-type: none"> <li>1. Crushing of larvae in the shoots mechanically.</li> </ol>
	Bollworms	Monitoring	<ol style="list-style-type: none"> <li>1. Set pheromone traps.</li> </ol>
	Whitefly	Monitoring	<ol style="list-style-type: none"> <li>1. Fix yellow sticky traps.</li> </ol>
	Diseases	Cultural practices	<ol style="list-style-type: none"> <li>1. Remove &amp; destroy root rot affected plants.</li> </ol>
4.	<b>Early fruiting stage (50-80 days)</b>		
	Weeds	Mechanical practice	<ol style="list-style-type: none"> <li>1. Inter culturing &amp; hand weeding.</li> </ol>
	Sucking pest	Cultural practice	<ol style="list-style-type: none"> <li>1. Management of trap crops &amp; inter crops.</li> </ol>
		Biological practice	<ol style="list-style-type: none"> <li>2. Release <i>Chrysoperla</i> @ 10,000 /ha</li> </ol>
	Bollworms	Monitoring	<ol style="list-style-type: none"> <li>1. Use pheromone traps and change lures.</li> </ol>
		Cultural practice	<ol style="list-style-type: none"> <li>2. Management of population in trap crops.</li> </ol>
		Biological practice	<ol style="list-style-type: none"> <li>3. Release of <i>Trichogramma</i> @ 1.5 lac/ha.</li> </ol>
		Mechanical practice	<ol style="list-style-type: none"> <li>4. Set up bird perchers.</li> </ol>
		Chemical practice	<ol style="list-style-type: none"> <li>5. Window strategy of IRM should be followed.</li> </ol>
	Whitefly	Monitoring	<ol style="list-style-type: none"> <li>1. Use yellow sticky traps</li> </ol>
		Biological practice	<ol style="list-style-type: none"> <li>2. Use neem products</li> </ol>
	CLCV Disease	Mechanical practice	<ol style="list-style-type: none"> <li>1. Destroy affected plants.</li> </ol>
		Chemical practice	<ol style="list-style-type: none"> <li>2. Spray recommended chemical for vector control.</li> </ol>
5.	<b>Peak flowering &amp; fruiting stage (80-120 days)</b>		
	Whitefly	Monitoring	<ol style="list-style-type: none"> <li>1. Use yellow sticky traps.</li> </ol>
		Biological practice	<ol style="list-style-type: none"> <li>2. Spray neem products.</li> </ol>
		Chemical practice	<ol style="list-style-type: none"> <li>3. Spray triazophos/acephate/acetamidrid.</li> </ol>
	Bollworms	Monitoring	<ol style="list-style-type: none"> <li>1. Use pheromone traps</li> </ol>

		Mechanical practice	2. Collection & destruction of damaged floral bodies. 3. Collection of grown up larvae under destruction.
		Biological control	4. Use Ha. NPV @ 250-500 LE/ha. 5. Use neem products.
		Cultural practice	6. Removal of terminals (topping) is to be done.
		Chemical practice	7. Recommended window strategy of IRM should be followed.
	<i>Spodoptera</i>	Monitoring	1. Use pheromone traps.
		Mechanical practices	2. Hand collection & destruction of egg masses & early instar larvae.
		Biological practice	3. Spray Spodoptera NPV in evening hours.
		Chemical practice	4. Spray recommended insecticides. 5. Adopt poison baiting technique.
	Whitefly	Monitoring	1. Yellow sticky traps.
		Biological practice	2. Spray neem products.
		Chemical practice	3. Spray recommended insecticides.
	CLCV disease	Mechanical practice	1. Destruction of CLCV affected plants.
		Chemical practice	2. Spray recommended insecticides for vector control.
	Black arm disease	Chemical practice	1. Spray recommended chemical (antibiotics)
6.	<b><u>Boll opening stage (120-150 days)</u></b>		
	Whitefly	Monitoring	1. Use yellow sticky traps.
		Biological practice	2. Spray neem products.
	Bollworms	Chemical practice	3. Need based application of recommended insecticides.
		Cultural practice	1. Don't extend the crop period. 2. Use monitoring device.
		Mechanical practice	3. Collection and destruction of damaged parts & grown up larvae.
		Chemical practice	4. Spray recommended insecticide alternatively using different groups with power sprayers.
	Mites	Chemical practice	1. Use recommended <i>acaricides</i> .
	CLCV disease	Mechanical practice	1. Destruction of CLCV infected plants.
	Black arm	Chemical practice	1. Spray recommended chemicals.
	Wilt	Chemical practice	1. Spot application of chemicals.
7.	<b><u>After last picking of cotton</u></b>		
			1. Allow grazing by animals. 2. Remove and destroy crop residue. 3. Avoid staking of the cotton stalks near the fields. Destroy the opened bolls if any on the plant before staking. 4. Crushing of cotton seeds to be completed by April end. 5. Fumigation of seeds may be undertaken with expert supervision. 6. Clean the Gins thrashers to check PBW population. Instal PBW traps in ginneries.

## V. DO'S AND DON'TS IN COTTON PEST MANAGEMENT

S.No.	Do's	Don'ts
1.	Grow only recommended variety / hybrid	Do not grow the under script material which vary greatly in fruiting pattern and pest susceptibility.
2.	<p><b>Agronomic Practices</b></p> <p>a) Sowing time:</p> <p>Prefer to sow the crop from mid April to mid May for North Zone and upto 30th June for South and Central Zone.</p> <p>b) Judicious use of fertilizers :</p> <p>Always use recommended NPK fertilizers in balanced proportion based on soil testing report.</p> <p>Uproot and destroy the weeds like <i>Sida</i> sp., <i>Abution indicum</i> and <i>Xenthium</i> sp. before sowing of the cotton crop to reduce the initial build up of bollworm, whitefly and CLCV disease.</p> <p>c) Rouge the plants infested with CLCV regularly during vegetative phase.</p>	<p>Avoid late sowing of the crop because yields are considerably reduced in late sowings.</p> <p>Avoid overuse of Nitrogenous fertilizers as crop becomes more susceptible to pest and diseases.</p> <p>Do not use under, over or imbalanced fertilizer applications which might result in poor plant health and reduced resistance to various insect pests and diseases.</p>
3.	<p><b>PEST MANAGEMENT</b></p> <p>a) Regular Surveillance : Ensure regular scouting /monitoring for timely detection of economic threshold values which are required for need based application of control measures against different insect</p>	Do not keep the CLCV infested plants in the field to check the further spread of the disease.

	<p>pests.</p> <p>b) Selection of effective pesticides and its dosages at right stage :</p> <p>i) Use only recommended pesticides at the recommended dosages for the control of various pests.</p> <p>c) Spray technology: Always follow the recommended spray technology using adequate spray of material.</p> <p>d) Use recommended pesticides</p>	<p>Do not go for blanket sprays without field roving.</p> <p>Do not use unrecommended mixtures of various insecticides in any case.</p> <p>Do not use the insecticide at lesser/over dosages than the recommendation.</p> <p>All these can lead to :</p> <p>a) Chemical control failure</p> <p>b) Quick development of resistance among insect pests to various insecticides</p> <p>c) resurgence of pests like whitefly.</p> <p>d) induction of secondary pest problems like leaf spots.</p> <p>e) economical waste and contamination of the environment.</p> <p>Do not use substandard nozzles with high discharge rate which lead to poor coverage of the target site.</p> <p>Do not use those pesticides which are not recommended. The date expired pesticides should not be used.</p> <p>Do not purchase insecticides without bills and the information on batch number.</p>
4.	<p><b>WEED MANAGEMENT</b></p> <p>a) A deep ploughing is to be done on bright sunny days during the months of May or June. The field should be kept exposed to sun light at least for 2-3 weeks.</p> <p>b) Maintain optimum and healthy crop stand which would be capable of competing with weeds at a critical</p>	<p>Do not plank or irrigate the field after ploughing, at least for 2.3 weeks to allow desiccation of weed's bulbs /or rhizomes of perennial weeds.</p> <p>Less seed rate of crops should not be used.</p> <p>Crops should not be exposed to moisture</p>

<p>stage of crop - weed competition.</p> <p>c) Pre-emergence herbicides should be applied immediately after sowing before emergence of weeds and crop.</p> <p>d) Herbicides like fluchloralin should be incorporated in to soil immediately after spraying to avoid its photodegradation.</p> <p>e) Apply only recommended herbicides at recommended dose, proper time, appropriate spray solution with standard equipment along with flat fan or flat jet nozzles.</p>	<p>stress at their critical growth stages.</p> <p>Pre emergence herbicides should not be applied after emergence of crop and /or weeds as they will not control the germinated weeds as well as may cause phytotoxicity to the crop.</p> <p>Soil incorporation of fluchloralin should not be delayed or avoided for achieving effective weed control.</p> <p>Pre-emergence as well soil incorporated herbicides should not be applied in dry soils.</p> <p>Herbicides should not be applied along with irrigation water or by mixing with soil, sand or urea.</p> <p>The spray equipment including nozzles used for herbicides application should not be used for insecticides or fungicides application to avoid possible phytotoxicity to crop.</p>
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## **VI SAFETY PARAMETERS**

Safety parameters deals with the classification of toxicity as per Insecticides Rules, 1971, WHO Classification of hazards, colour of toxicity triangle, first aid measures, symptoms of poisoning and treatment of poisoning, the extension functionaries of the State Department of Agriculture have to make use of this information as under :-

- i) Basic precautions which are required to be taken as per classification of toxicity as well as hazard criteria by WHO may be seen as per Annexure-V.
- ii) The extension functionaries are to educate the farmers on safety use of pesticides with the help of colour toxicity triangle as the farming community can follow the colour and corresponding safety precautions.
- iii) The symptom of poisoning must be known to the extension functionaries to enable them to extend first aid measures to affected persons to the extent possible.
- iv) Basically, the information on first aid measures and treatment of poisoning is required to be passed on by the extension functionaries to the doctors at Primary Health Centres as well as to the Private Doctors in the vicinity of spraying of pesticides.
- v) Extension functionaries must ensure that names of common pesticides during plant protection measures along with a copy of the leaflet which is an integral part of a pesticide container must be made available to the doctors in the vicinity of plant protection operations.
- vi) Extension functionaries are to request the doctors to intervene in procurement of antidotes for different pesticides as cited under "Treatment of poisoning.



## SAFETY PARAMETERS IN PESTICIDES USAGE

S. No	Name of pesticide	Classification as per Insecticides Rules, 1971	Colour of Toxicity Triangle	WHO classification by hazard	First aid measures	Symptoms of poisoning	Treatment of poisoning	Waiting period (No. of days)
<b>INSECTICIDES</b>								
<b>ORGANOCHLORINE PESTICIDES</b>								
1.	Endosulfan	Highly toxic	Yellow	Class II – Moderately Hazardous	<p>Remove the person from the contaminated environment.</p> <p>In case of (a) Skin contact – Remove all contaminated clothings and immediately wash with lot of water and soap; (b) Eye contamination – Wash the eyes with plenty of cool and clean water; (c) Inhalation – Carry the person to the open fresh air. loosen the clothings around neck and chest, and (d) Ingestion – If the victim is fully conscious, induce vomiting by tickling back of the throat. Do not administer milk, alcohol and fatty substances. In case the person is unconscious make sure the breathing passage is kept clear without any obstruction. Victim's head should be little lowered and face should be turned to one side in the lying down position. In case of breathing difficulty, give mouth to mouth or mouth to nose breathing.</p> <p>Medical aid: Take the patient to the docotr/Primary Health Centre immediately along with the original container, leaflet and label.</p>	<p>Nausea, vomiting, restlessness, tremor, apprehension, convulsions, coma, respiratory failure and death</p>	<ul style="list-style-type: none"> <li>- Gastric lavage with 2-4 L. tap water – Catharsis with 30 gm. (10 oz.) sodium sulphate in one cup of water</li> <li>- Barbiturates in appropriate dosages repeated as necessary for restlessness or convulsions</li> <li>- Watch breathing closely, aspirate, oxygen and/or artificial respiration, if needed.</li> <li>- Avoid oils, oil laxatives and epinephrine (Adrenalin) – do not give stimulants.</li> <li>- Give calcium gluconate (10% in 10 ml. Ampules) intravenously every four hours.</li> </ul>	
<b>ORGANOPHOSPHATE PESTICIDES</b>								
2.	Quinalphos	Highly toxic	Yellow	Class II – Moderately Hazardous		Mild – anorexia, headache, dizziness, weakness, anxiety.	For extreme symptoms of O.P poisoning, injection of atropine (2-4 mg., for	

3.	Monocrotophos	Extremely toxic	Bright red	Class I b - Highly hazardous	tremors of tongue and eyelids, miosis, impairment of visual acuity.	adults, 0.5-1.0 mg for children) is recommended, repeated at 5-10 minute intervals until signs of atropinization occur.
4.	Profenophos	Highly toxic	Yellow	Class II - Moderately hazardous	Moderate- nausea, salivation, lacrimation, abdominal cramp, vomiting, sweating, slow pulse, muscular tremors, miosis.	Speed is imperative
5.	Phosphamidon	Extremely toxic	Red	Class I a - Extremely Hazardous	Severe - diarrhoea, pinpoint and non-reactive pupils, respiratory difficulty, pulmonary edema, cyanosis, loss of sphincter control, convulsions, coma and heart block.	- Atropine injection - 1 to 4 mg. Repeat 2 mg. when toxic symptoms begin to recur (15-16 minute intervals), Excessive salivation - good sign, more atropine needed;
6.	Acephate	Moderately toxic	Blue	Class III - Slightly hazardous		- Keep airways open, Aspirate, use oxygen, insert endotracheal tube. Do tracheotomy and give artificial respiration as needed.
7.	Phosalone	Highly toxic	Yellow	Class II - Moderately Hazardous		- For ingestion lavage stomach with 5% sodium bicarbonate, if not vomiting. For skin contact, wash with soap and water (eyes- wash with isotonic saline). Wear rubber gloves while washing contact areas.
8.	Triazophos	Highly toxic	Yellow	Class I b - Highly Hazardous		In addition to atropine give 2-PAM (2-pyridine aldoxime methiodide). 1 g and 0.25 g for infants intravenously at a slow rate over a period of 5 minutes and administer again periodically as indicated. More than one injection may be required.
9.	Chlorpyrifos	-do-	-do-	Class II - Moderately hazardous		Avoid morphine.

							theophyllin, aminophyllin, barbiturates of phenothiazines.
							Do not give atropine to a cyanotic patient. Give artificial respiration first then administer atropine.

**CARBAMATES**

10.	Carbosulfan	Highly toxic	Yellow	Class II - Moderately hazardous		Constriction of pupils, salivation, profuse sweating, lassitude, muscle incoordination, nausea, vomiting, diarrhoea, epigastric pain, tightness in chest.	- Atropine injection 1 to 4 mg. Repeat 2 mg when toxic symptoms begin to recur (15-60 minute intervals). Excessive salivation - good sign, more atropine needed.
11.	Thiocarb	Highly toxic	Yellow	-do-			- Keep airway open. Aspirate, use oxygen, insert endotracheal tube. Do tracheotomy and give artificial respiration as needed.
							- For ingestion, lavage stomach with 5% sodium bicarbonate, if not vomiting. For skin contact was with soap and water (eyes - wash with isotonic saline). Wear rubber gloves while washing contact area.
							- Oxygen - Morphine, if needed.
							Avoid theophyllin and aminophyllin or barbiturates. 2-PAM and other oximes are not harmful and in fact contra indicated for routine usatge.

Do not give atropine to a cyanotic patient. Give artificial respiration first then administer atropine.

HERBICIDES

12.	Alachlor	Moderately toxic	Blue	Class III - Slightly hazardous		Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat eyes and skin etc.,	No specific antidote. Treatment is essentially symptomatic.
13.	Pendimethalin	Moderately toxic	-do-	-do-			
14.	Diuron	-do-	-do-	Table 5 - Unlikely to present acute hazard in normal use			
15.	Trifluralin	-do-	-do-	-do-			
16.	Fluchloralin	-do-	-do-	Class III - Slightly hazardous			
17.	Paraquat	Highly toxic	Yellow	Class II - Moderately hazardous			
18.	Diflufenzuran	Moderately toxic	Blue	Table 5 - Unlikely to present acute hazard in normal use			

SYNTHETIC PYRETHROIDS

19.	Fenvalerate	Highly Toxic	Yellow	Class II - Moderately Hazardous		Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat eyes and skin, allergic manifestations etc.,	No specific antidote. Treatment is essentially symptomatic.
20.	Deltamethrin	-do-	-do-	-do-			
21.	Alphamethrin	Moderately toxic	Blue	-do-			
22.	Cypermethrin	Highly toxic	Yellow	-do-			

23.	Lamdacyhal othrin	-do-	-do-	-do-				
OTHERS								
24.	Imidacloprid	Highly toxic	Yellow	Class II - Moderately hazardious		Headache, palpitation, nausea, vomiting, flushed face, irritation of nose, throat eyes and skin etc.,	No specific antidote. Treatment is essentially symptomatic.	

AGRO ECO SYSTEM ANALYSIS (AESA)

AESA is an approach, which can be gainfully employed by extension functionaries and farmers to analyse field situations with regard to pests, defenders, soil conditions, plant health, the influence of climatic factors and their inter-relationship for growing healthy crop. Such a critical analysis of the field situations will help in taking appropriate decision on management practices. The basic components of AESA are :

1. Plants health at different stages.
2. Built-in-compensation abilities of the plants.
3. Pest and defender population dynamic.
4. Soil conditions.
5. Climatic factors.
6. Farmers past experience.

The methodology of AESA is as under :-

**A. Field Observation:-**

- a) Enter the field at least 5ft. away from the bund. Select a site with a dimension of 1 sq. mt. randomly.
- b) Record the visual observations in following sequence :-
  - i) Flying insects (both pests & defenders)
  - ii) Close observation on pests and defenders which remain on the plants.
  - iii) Observe pests like *S. litrura* and defenders like ground beetle /rove beetle /earwigs by scrapping the soil surface around the plants.
  - iv) Record disease and its intensity.
  - v) Record insect damage in percentage.
- c) Record parameters like number of leaves, branches plant height and reproductive parts of the selected plants which should be flagged for making observation in the following weeks.

- d) Record the types of weeds, their size and population density in relation to crop plant.
- e) Record soil conditions viz. flooded, wet or dry.
- f) Observe rodent live burrows
- g) Repeat the step (a) to (f) in four sites randomly selected.
- h) Record the climatic factors viz. sunny, partially sunny, cloudy, rainy etc. for the preceding week.

**B. Drawing :**

First draw the plant with actual number of branches/leaves etc. at the centre on a chart. Then draw pests on left side and defender on the right side. Indicate the soil condition, weed population, rodent damage etc. Give natural colours to all the drawing for instance, draw healthy plant with green colour, diseased plant/leaves with yellow colour, White drawing the pests and the defenders on the chart care should be taken to draw them at appropriate part of the plant, where they are seen at the time of observation. the common name of pest and defenders and their population count should also be given alongwith diagram. The weather factor should be reflected in the chart by drawing the diagram of sun just above the plant if the attribute is sunny. If cloudy , the clouds may be drawn in place of sun. In the case of partially sunny, the diagram of sun may be half masked with clouds.

**C. Group discussion and decision making :**

The observations recorded in the previous and current charts should be discussed among the farmers by raising questions relating to change in pest and defender population in relation to crop stages, soil condition, whether factors such as rainy, cloudy or sunny, etc. The group may evolve a strategy based upon weekly AESA, ETL and corresponding change in P : D ratio and take judicious decision for specific pest management practices.

**D. Strategy for decision making : (Examples)**

- i) When large number of egg masses and early instar larvae of *Spodoptera / Helicoverpa* are observed, the group may conclude application of

*Trichogramma*/ NPV.

- ii) Some of the defenders like lady beetles, groundnut beetles, rove beetles and wasps play an important role in arriving at Pand D ration.

### **AESA BY EXTENSION FUNCTIONARIES :**

The extension functionaries during their regular visit to the village mobilise the farmers, conduct AESA and critically analyse the various factors such as the pest population vis-à-vis defender population and their role in natural suppression of the pest, the influence of prevailing weather condition / soil conditions on the likely build up of defender / pest population. They may also take the decision based on the AESA, which IPM components like release of defenders, application of neem formulations / safe pesticides are to be used for specific pest situation. Such an exercise may be repeated by the extension functionaries during every visit to the village and motivate the farmers to adopt AESA in their fields.

### **AESA BY FARMERS :-**

After a brief exposure during IPM demonstrations/field trainings, farmers can practice AESA in their own fields. Wherever trained farmers are available their experiences could be utilised in training their fellow farmers in their own villages. Thus a large group of farmers could be made proficiently competent in undertaking weekly AESA thereby empowering themselves in decision making on any specific pest situations. Farmers -to-farmers training approach will go a long way in practicing IPM on a large area on sustainable basis.



**RESISTANT /TOLERANT VARIETIES OF COTTON****A. Zone-wise**

1. North Zone : Bikaneri Nerma, LH 900, F 414, F 505, H 777, RST-9, LD-327, RG-8, LH-1134, LH-886, F-846, F-1054, RS-875, LRA-5166, LRK-516, LHH-144. RS-875, RS-810, RS-2013
2. Central Zone : Eknath, Purnima, Y-1, Malgari, Khandwa-2, Badnawar-1, G-cot-12, Jaydhar, NHH-1, NHH-44, AKO-81, LRK 516
3. South Zone : MCU -5VT, Supriya, Abhadita, LK-861

**B. Pest /Disease -wise**

<b><u>Pest / Disease</u></b>	<b><u>Resistant /Tolerant</u></b>
1. Jassids	Bikaneri Nerma, ABH-466, H-777, G.cot-12, G-cot-10, RS-875, RST-9, F-5-5, Fatch, RS 2063
2. White fly	Supriya, Kanchana, LK-861, RS-875, RS - 2013
3. Nematode	Bikaneri Nerma, Khandwa 2
4. Verticillium wilt	MCU-5VT, Surabhi
5. Fusarium wilt	DB-3-12, AK-145, Sanjay, Digvijaya, G. cot - 11, G.cot-13, LD-327, PA-32
6. Bollworms	LH-900, F-414, Abadita, RS - 2013
7. Root rot	LH-900
8. Leaf curl virus	All desi cottons, RS -875, RS 810, RS 2013 LHH-144, LRA-5166, LRK-516, GK-515

**RECOMMENDED PESTICIDES IN COTTON PEST MANAGEMENT**

<u>Jassids /Aphids /Thrips</u>	<u>Dosage</u> (g a.i./ha)	<u>Stage of crop</u>
Neem products (1500 ppm)	2.5 lit/ha	Early phase of crop growth
Oxydemeton methyl 25 EC	300	-do-
Phoshamidon 85 WSC	200	-do-
Acephate 75 SP	290	Above 60 days
Monocrotophos 36 SL	350-600	-do-
Acetamiprid	15	
Imidacloprid	25	
Thiomethoxam	25	
<b><u>Whitefly</u></b>		
Neem products (1500 ppm)	2.5 lit	
Triazophos 40 EC	600-800	
Acetamiprid	30-40	
Imidacloprid	25	
Thiomethoxam	25	
<b><u>Bollworms</u></b>		
Neem products (1500 ppm)	2.5 lit	40-60 day
Endosulfan 65 EC 35 EC	875 -1050	-do-
Phosalone 65 EC 35 EC	700-900	-do-
Quinalphos 20 A F	500-700	During fruiting stages
Chlorpyrifos 20 EC	500-700	-do-
Profenofos 50 EC	1000-1250	-do-
Thiodicarb 75 SP	500	-do-
<b><u>Pyrethroids</u></b>		
Deltamethrin 2.8 EC	10-12.5	
Alphamethrin 10 EC	15-25	Above 75 days only
Cypermethrin 10 EC	40-60	once or twice in the
Fenvalerate 20 EC	75-100	cropping period
Indoxacarb	75	
Deltamethrin tablet 0.5	25 tablet/ha (12.5 g a.i./ha)	
Lambdacyhalothrin 5 EC	15 g a.i./ha	
Spinosad 48 SC	50-75	
Trizophos 40 EC	600-800	
Novaluron	609 g/ha	

**Spodoptera & Others**

Chlorpyrifos 20 EC	500	
Quinalphos 20 AF	500	
Diflubenzuron 50 WP	75	For early instars only
Poison bait using Monocrotophos 36 SL	250-500	Early & grown up larvae

**Seed dresser**

Imidacloprid 70WS	5-10 g/kg of seed	Early sucking pests
Carbosulfan 20 SP	20 gm/kg of seed	-do-
Thiomethoxam 70 WS	5 g/kg	
Acetamiprid 20 SP	20 g/kg	

**Soil insecticides**

Carbofuron 3 G	750	Early sucking pests
Phorate 10 G	1000	-do-

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(+) as and when registered.

**IRM STRATEGIES**

Insect Pests	Jassids Aphids	Jassids, Aphids, Thrips	Helicoverpa, Whiteflies, Jassids	Helicoverpa, Whiteflies	Pink Bollworm	Pink bollworm Red cottonbug
Economic threshold		Jassids- 2/leaf Thrips- 50/leaf	Helicoverpa 10 larvae/20 plants.	Helicoverpa 20 larvae/20 plants.	10% damaged bolls.	
Management Options	<ol style="list-style-type: none"> <li>1. Imidacloprid as seed treatment for hybrids.</li> <li>2. Grow jassid resistant genotypes.</li> </ol>		Endosulfan or HNPV or neem seed extract.	Quinalphos or profenofos or chlorpyriphos	Methomyl or Thiodicarb	Pyrethroid +sesamum oil
Crop stage	Vegetative	Vegetative	Squares & flowers	Squares, flowers & bolls	Squares, flowers & bolls	Bolls
Crop stage	0-30 days	30-60 days	60-90 days	90-120 days	120-150 days	150-180 days

**BASIC PRECAUTIONS IN PESTICIDE USAGE****A. Purchase:**

1. Purchase only JUST required quantity e.g. 100,250,500 or 1000 g/ml for single application in specified area.
2. Do not purchase leaking containers, loose, unsealed or torn bags.
3. Do not purchase pesticides without proper/ approved LABELS.

**B. Storage:**

1. Avoid storage of pesticides in the house premises.
2. Keep only in original container with intact seal.
3. Do not transfer pesticides to other container.
4. Never keep them together with food or feed/ fodder.
5. Keep away from the reach of children and livestock.
6. Do not expose to sun-light or rain water.
7. Do not store weedicides along with other pesticides.

**C. Handling:**

1. Never carry/ transport pesticides along with food materials.
2. Avoid carrying bulk - pesticides (dusts / granules ) on head, shoulders or on the back.

**D. Precautions for Preparing Spray Solution :**

1. Use clean water.
2. Always protect your NOSE, EYES, MOUTH, EARS and HANDS.
3. Use hand gloves, face mask and cover your head with cap.

4. Use polyethylene bags as hand gloves, handkerchiefs or piece of clean cloth as mask and a cap or towel to cover the head (Do not use polyethylene bag contaminated with pesticides).
5. Read the label on the container before preparing spray solution.
6. Prepare spray solution as per requirement.
7. Do not mix granules with water.
8. Concentrated pesticides must not fall on hands etc. while opening sealed containers. Do not smell the sprayer tank.
9. Avoid spilling of pesticide solution while filling the sprayer tank.
10. Do not eat, drink, smoke or chew while preparing solution.
11. The operator should protect his bare feet and hands with polyethylene bags.

E. **Equipment:**

1. Select right kind of equipment.
2. Do not use leaky, defective equipment.
3. Select right kind of nozzle.
4. Don't blow/clean clogged- nozzle with mouth. Use old tooth- brush tied with the sprayer and clean with water.
5. Do not use same sprayer for weedicide and insecticide.

F. **Precautions for applying pesticides:**

1. Apply only at recommended dose and dilution.
2. Do not apply on hot sunny day or strong windy condition.
3. Do not apply just before the rains and also after the rains.
4. Do not apply against the wind direction.
5. Emulsifiable concentrate formulations should not be used for spraying with battery operated ULV sprayer.
6. Wash the sprayer and bucket etc with soap water after spraying.
7. Containers, buckets etc. used for mixing pesticides should not be used for domestic purposes.

8. Avoid entry of animals and workers in the fields immediately after the spraying.

G. **Disposal:**

1. Left over spray solution should not be drained in ponds or water lines etc. Throw it in barren isolated area, if possible.
2. The used/ empty containers should be crushed with a stone / stick and buried deep into soil away from water source.
3. Never re-use empty pesticide container for any purpose.

