



## Cotton Crop Protection Strategies 2018

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### GENERAL PRACTICES

- ✚ **Apply Farm Yard Manure** or compost 5 to 10 t/ha.
- ✚ **Timely sowing** immediately after receiving at least 80-100 mm rainfall.
- ✚ **Grow short duration and sucking pest tolerant varieties or Bt hybrids:** Short duration varieties/hybrids receive adequate soil moisture during the critical flowering and fruiting phase and are able to escape bollworm attacks during squaring-flowering stage. In the absence of any form of protective irrigation, avoid long duration varieties/hybrids in rain-fed conditions. Sucking pest tolerant genotypes reduce initial sprays required for the sucking pests and allow conservation and proliferation of natural enemies that take care of these insect pests in the initial phase. Compact statured short duration varieties under high density give high yields in a short period of 140-160 days.
- ✚ **Sowing on ridges in rain-fed regions** under high density planting systems (HDPS) should be preferred to cope up with excessive rain and drought conditions.
- ✚ **Bt-cotton hybrids** may be sown at 90 x 30 cm in rain-fed regions and at wider spacing under irrigation depending upon the soil depth.
- ✚ **To escape from drought stress and bollworms attack** grows early maturing non-Bt varieties close to 15th June under HDPS at 60x10 cm (45x10cm for Phule Dhanwantari). Varieties such as Suraj (CICR); NH 615 (VNMAU Parbhani); AKH 081 (Dr PDKV Akola); Phule Dhanwantari (MPKV Rahuri) and Anjali (LRK 516) are early maturing and amenable for HDPS.
- ✚ **Intercropping in non-Bt cotton varieties in HDPS** sown at 90x10 cm or Bt hybrids, can be taken up with soybean, clusterbean, cowpea or blackgram in 4:2 or 6:2 (Cotton:intercrop) which can help to enrich soil by way of nitrogen fixation.
- ✚ **Sowing border rows** (2-3) of pigeonpea or bajra or maize or sorghum around cotton fields found to reduce infestation of sap sucking insects such as whitefly, mealybugs etc. These crops also serve as refuge for *Helicoverpa armigera*.
- ✚ **For nutrients fixation** *Azotobacter* and PSB (phosphate solubilizing bacteria) @ 25 g / kg seed can be used.
- ✚ **Apply NPK** as recommended by respective SAU of the region.



- ✚ To enhance Cry1Ac expression and also to reduce problems of leaf reddening foliar sprays of macro and micronutrients 1% MgSO<sub>4</sub>, 2% Urea, 0.5% Zinc Sulphate and 0.2 % Boron, twice at 15 days interval on 90 days old crop followed by 2% DAP.
- ✚ Sprays and soil drenching with Carbendazim 50WP 1% in the early stage of wilt, could help to recover the affected plants.
- ✚ **To cope up with squares and flowers drop** spray Planofix 4.5 SL (NAA) 5 ml per 10 litres (L) of water.

## DISEASE MANAGEMENT



Alternaria leaf spot



Bacterial leaf blight



Root rot



Grey mildew

**Root rot** (Seedling to vegetative stage): Apply ZnSO<sub>4</sub>@24kg/ha as soil application. Seed treatment with Trichoderma @ 4g/kg seed **Or** bio- agent *Pseudomonas fluorescens* @ 10g/ kg seed **Or** Thiram 75% WS 3g/kg seed **Or** Soil drenching with Trichoderma @ 10kg/ha mixed with 200kg moist FYM. Spot drenching with Carbendazim 50WP 2g/L water at the base of affected plants as well as surrounding healthy plants.

**Fusarium wilt** (Any stage of crop growth): Seed treatment with Thiram 75% WS 2g/kg seed **Or** Spot drenching with Carbendazim 50% WP 2 g/ L water.

**Alternaria leaf spot** (Vegetative and flowering stage): Spray Pyraclostrobin 20%WG 2g **Or** Metiram 55%+Pyraclostrobin 5% WG 12g /10 L water.

**Bacterial leaf blight:** Seed treatment with Carboxin 75% WP 1.5 g/kg seed or Carboxin 37.5%+Thiram 37.5%DS 2.5g/kg seed. Foliar spray with streptomycin 1g + copper oxychloride 25g/ 10 L water.

**Boll rot:** Spray Carbendazim 50%WP 2 g/L water.

**Grey Mildew:** Foliar spray of Carbendazim 50 WP 20g **Or** Pyraclostrobin 20%WG 2g **Or** Metiram 55%+Pyraclostrobin 5% WG 12g per 10 L water when symptoms seen.

**Para wilt or Sudden drying (New wilt):** Symptoms are noticed in some fields after drought followed by rains or irrigation. Spray cobalt chloride @10mg/litre (10ppm) on affected plants within few hours of onset of symptoms and/or Drench plants with a mixture of Copper-Oxy-Chloride 25g and 200g Urea in 10 liter of water or Carbendazim 50WP 1g/l.

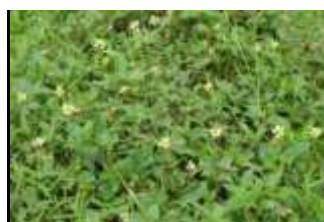
## WEED MANAGEMENT



Lavi/ Motha  
(*Cyperus rotundus*)



Spurge  
(*Euphorbia geniculata*)



Kabarmodi  
(*Tridax procumbance*)



Congress grass  
(*Parthenium hysterophorus*)

**Pre-emergence weedicides:** Spray Pendimethalin 30% EC or Fluchloralin 45% EC 1 liter per acre on soil and harrow immediately to prevent degradation. Herbicides are most effective on younger weeds.

**Post emergence weedicides:** **Grasses:** Spray Quizalofop Ethyl 5% EC or Fenoxaprop-p-ethyl 9.3% EC 25-30ml per 10 L water

**Broadleaf weeds:** Spray Pyrithiobac Sodium 10% EC 25-30ml/10 L water. This would provide effective and timely control especially when intercultural operations or manual weeding becomes difficult in wet soils.

Farmers may consult the technical experts from ICAR-CICR, KVK or SAUs for further details.

## WATER LOGGING MANAGEMENT

- ✚ Provide adequate drainage channels or water ways (especially in heavy soils) along the slope of the land for draining excess water under heavy rainfall situations.
- ✚ Open ridges and furrows with the help of a ridge plough or a bund maker for better soil moisture conservation, preferably in areas where rainfall is 700-900mm. Heavy rains will not affect the crop because the furrows will drain away excess water.
- ✚ Sowing cotton on ridges would conserve rainwater and the furrows acts drainage channels whenever heavy rains are received particularly in heavy clays.
- ✚ Apply fertilizers foliar spray with 0.5 to 1.0% DAP or 19:19:19 (soluble complex of Nitrogen) at weekly intervals to assist plant recoup from the effect of water logging if the crop becomes pale due to water logging.
- ✚ If heavy rains are forecast, fertilizer application should be avoided so as to prevent losses due to surface run-off.



## INSECT PEST MANAGEMENT

### General recommendations

#### DO's

1. **Grow sucking pest resistant varieties/Bt hybrids:** Growing sucking pest resistant varieties/hybrids enable to reduce chemical insecticide sprays during the initial phase of growth (first 2-3 months) of the crop when natural enemies (predators and parasitoids) of pests remain abundant that prevent builds up of pest population in the cotton fields. Chemical insecticides sprayed early in the season disrupt the ecosystem beyond revival, which makes crop dependent on continuous insecticide sprays for the control of insects throughout the season.
2. **Intercropping** with any of the compatible crop such as cowpea, sorghum, soybean, blackgram, green gram and clusterbean to encourage natural enemies of cotton pests.
3. **Seed treatment with Imidacloprid or Thiamethoxam** (8 g/kg seed) to protect crop against sucking pests such as aphids, whitefly, jassid and thrips.
4. **Optimum use of nitrogenous fertilizers** to minimise susceptibility of cotton crop to sucking pests.
5. **Intercultural operations and weeding** as and when required.
6. **Use biopesticides and/ or biological control agents** for eco-friendly pest management.
7. **Install pheromone traps** 5 /ha for monitoring and 20/ha for mass trapping of Pink bollworm.
8. **Leaf reddening:** Apply spray of MgSO<sub>4</sub> 1 %, Urea 2%, followed by DAP 2%.

#### DONT'S

1. **Late and pre-season sowing of crop.** Avoid late sowing (beyond 15th May) in North India to prevent CICuD. Avoid pre-season sowing in central and south India for pink bollworm management. In central and south India sowing should be done in June.
2. **Avoid chemical insecticides during the first two months of the crop.** During initial phase of crop growth, natural enemies such as ladybird beetles, *Chrysoperla*, Syrphid fly, *Geocoris* bugs, *Aenasius arizonensis*, *onensis*, *Acerophagus papaya*, *Aphelinus* wasps and spiders prey on sucking pests (aphid, jassid, thrips, mirids, whitefly and mealybugs) as well as eggs of lepidopteran pests. Avoiding chemical sprays during this period helps to conserve naturally occurring biological control agents that help to keep pest population under check.
3. **Not to spray against minor lepidopteran insects** such as the cotton leaf folder, *Sylepta derogata* and cotton semilooper, *Anomis flava*. These insect larvae cause negligible damage to cotton but serve as hosts for parasitoids such as *Trichogramma* spp., *Apanteles* spp and *Sysiropa formosa*, that attack *H. Armigera* and other bollworms.
4. **Minimum foliar sprays of neonicotinoid insecticides** such as Acetamiprid, Imidacloprid, Clothianidin and Thiomethoxam which are likely to aggravate insect resistance, since Bt cotton hybrid cotton seeds are treated with neonicotinoids.
5. **Do not use WHO Class 1a and Class 1b insecticides (Extremely and Highly hazardous category).**

6. **Avoid Pyrethroids** during the first 4 months after sowing. Pyrethroids may be used only late in the season as one or at the most two sprays for the control of pink bollworm.
7. **Avoid insecticide/fungicide/ urea/ growth regulators mixtures** all through the crop phase to prevent outbreaks of pest such as whitefly and unwanted vegetative growth which hinders chemical spraying operations.

### Economic Threshold Levels (ETLs)

Farmers are advised to initiate pest management practices as soon as the pest crosses ETL.

The ETLs for major pests are as under.

Insect	ETL : Pest count in a sample of 20 plants per acre
Jassid	≥5 plants showing (25% plants infested) damage grade II/ III/ IV
Thrips	≥5 plants showing silvery patches on underside of leaves above mid canopy (25% plants infested)
Whitefly	6 Whitefly/plant
Aphids	≥2 affected plants counted randomly showing symptoms cupping / crumpling of few leaves on the upper portion of plant (10% plants infested)
Mealybugs	≥20 plants/acre showing damage grade II/ III/ IV
Mirid bugs	≥5 mirid nymphs or adults per plant ( from top canopy squares) (25% plants infested)
Spodoptera	≥2 Egg mass / cluster of gregarious larvae
Spodoptera	≥10 infested plants (50%) having ≥5 solitary full grown larvae/plant
<b>Bollworms</b>	
Bollworms (American & Spotted)	20% plants having one or more 'flared up' square.
Pink bollworm	More than 8 moths / trap per night for 3 consecutive nights or more than 10 % infested flowers or bolls with live larvae.

### PESTS MANAGEMENT ADVISORY

#### *Crop growth stage: 0-60 days after sowing (DAS)*

**Tobacco caterpillar:** Collect and destroy egg masses/ gregarious larvae/ solitary larvae by hand picking. Spray crop with Neem oil 5ml/l +5% NSKE+ 1gm detergent powder per litre water to kill residual larvae if infestation seen.

**Tobacco caterpillar, American and spotted bollworm:** Under emergency situation spray Cloranthraniliprole 18.5 SC 3ml/10 L water.

**Mealybugs:** Destroy congress grass and other weeds from field and field boundaries prior to the onset of season. Do not disturb young cotton plants that have slight infestation of the mealybugs in early stages of the crop because mealybug crawlers spread through human interventions.

**Other sucking pests:** Avoid spraying of any chemical insecticides during initial crop growth stage as Bt-cotton seeds are treated with insecticides. However, if 25 % plants are infested by sucking pest, spray Flonicamid 50 WG 4 g/ 10L water.

**Pink bollworm:** Install pheromone traps 5/ha at 45 DAS for monitoring of pink bollworm. Spray crop with Neem oil 5ml/L +5% NSKE+ 1 gm detergent powder per litre water at 50-60DAS, mandatorily.



Jassid



Whitefly



Aphid



Thrips

### **Crop Growth Stage: 60-90 DAS**

**Bollworms (American and Spotted):** If 20% plants are having one or more ‘flared up’ squares spray Cloranthraniliprole 18.5 SC 3ml/10 L water.

**Pink bollworm:** Initiate pink bollworm monitoring starting from flowering stage. Assess ETL by picking 20 green bolls from randomly selected plants across one acre. ETL of pink bollworm -10% infested flowers or 10% infested bolls or 8 male moths catches/trap/night for 3 consecutive nights. If ETL crosses spray Thiodicarb 75 WP 20g or Quinalphos 20AF 20ml per 10 L of water in the month of September.

**Mealybugs:** Destroy congress grass. Remove infested plants in plastic bag and destroy. Conserve parasitoid, *Aenasius arizonensis* and *Acerophagus papayae* by avoiding harmful chemicals.

**Jassid, Aphid:** If 25% plants shows infestation grade II/III/IV by jassid or 10% plants infested by aphid, spray Flonicamid 50 WG 4g/10 L water.

**Whitefly:** Install yellow sticky traps for monitoring and management of whitefly. If whitefly cross ETL, spray Buprofezin 25 % SC 10ml **Or** Diafenthiuron 50 % WP 12g **Or** Spiromesifen 22.9% EC 12ml **Or** Pyreproxifen 10%EC 20 ml per 10 L water.



American bollworm



Spotted bollworm



Pink bollworm



Tobacco caterpillar

### **Crop Growth Stage: 90-120 DAS**

**American and spotted bollworms:** If 20% plants having one or more ‘flared up square’ by bollworms, spray Flubendiamide 39.35% SC 3ml **Or** Indoxacarb 14.5 SC 5ml **Or** Spinosad 45% SC 2.5ml per 10 L water.

**Jassids, thrips:** If 25% plants shows Grade II/III/IV symptoms by jassids or 50% plants show silvery patches on underside of leaves by Thrips or 10% plants are infested by aphid, spray Thiomethoxam 25%WG 2g per 10 L water.

**Whitefly:** Spray Diafenthiuron 50%SC 12g per 10 L water.

**Pink bollworm:** Release parasitoid *Trichogramma bactrae* @60000/acre where ever available. Spray Chlorpyriphos 20%EC 25ml **Or** Thiodicarb 75 WP 20g per 10 L water after 10 days of release of *Trichogramma*.

**Pink bollworm and/ or Mealybugs:** If 20 plants/ acre having infestation Grade II/III/IV of Mealybugs and or pink bollworm infestation observed spray Thiodicarb 75 WP 20g **Or** Quinalphos 20AF 25ml **Or** Chlorpyriphos 20 % EC 25ml per 10 L water.

### **Crop Growth Stage: >120 DAS**

**Pink bollworm:** If 10% infested flowers or bolls with live larvae of Pink bollworm observed, spray Fenevelerate 20% EC 10 ml **Or** Cypermetherin 10% EC 10 ml per 10 L water.

## STRATEGIES FOR PINK BOLLWORM MANAGEMENT IN CENTRAL AND SOUTH INDIA

- **Avoid sowing of cotton crop in the month of April-May** as it would be susceptible to pink bollworm (PBW).
- **Take up sowing in the month of June** with early maturing short duration Bt-cotton hybrids/ varieties recommended for the region. Timely sown short duration crop escapes PBW.
- **Procure authentic Bt-cotton or variety seeds**, retain bills of seeds that have been purchased.
- **Refuge (20% non Bt seeds)** should be planted along with Bt cotton, if provided in separate packet.
- **Install pheromone traps @ 5/ha 45 days after sowing** for monitoring moth activity of PBW.
- **One spray of neem seed kernel Extract 5%+ neem oil 5ml/l** may be taken up at 50-60 days after sowing.
- Inspect the crop at squaring and flowering stage for presence of PBW larvae within flowers.
- **At boll formation stage, farmers are advised to inspect for presence and damage of PBW** by plucking 20 green bolls per acre from randomly selected plants.



Pink bollworm



Rosette flower



Exit hole on green boll



PBW infestation in green boll



PBW infestation in opened boll

- **Release parasitoid *Trichogramma bactrae* @60000/acre**, where ever available, 90DAS.
- Chemical control measures should be initiated when pink bollworm crossed Economic Threshold Level (ETL) ETL of pink bollworm- 10% damaged flowers (rosette flowers) or 10% damaged green bolls (at least two bolls out of 20 having white or pink larvae or exit holes) or 8 moth catches per pheromone trap per night for consecutive 3 days.  
*September-* Quinolphos 20% AF 20 ml **Or** Thiodicarb 75% WP  
*October-* Chlorpyriphos 20% EC **Or** Thiodicarb 75% WP  
*November-*Fenevelerate 20% EC *or* Cypermetherin 10% EC
- **Destroy residual stalks** and partially opened bolls.
- **Collect and destroy fallen squares**, flowers and bolls in the field.
- **Do not store infested or stained cotton** in house/ godowns.
- **Picking of clean and infested** cotton may be carried out separately. Clean cotton may be stored or marketed. Infested cotton should be destroyed.
- **Install light traps and pheromone traps** near ginneries, market yards for mass trapping of adults. Trapped adults should be destroyed/ killed. This should be done during season as well as off season.
- **Terminate cotton crop timely** by December-January.
- **Crop rotation** should be followed to break the life cycle of PBW.

## ADVISORY FOR WHITEFLY MANAGEMENT IN NORTH INDIA

### General recommendations

1. **Timely sowing (before 15th May):** Timely sown crop resists whitefly and CLCuD, whereas late sown cotton exhibits susceptibility.
2. **Select ‘CLCuD-tolerant Bt hybrids’:** CLCuD-tolerant-Bt-hybrids for north India shortlisted by AICCIP (All India Coordinated Cotton Improvement Project of the ICAR-CICR) which may be taken up in consultation with SAU of the region. Avoid cultivating Bt-hybrids that are susceptible to CLCuD and whitefly.
3. **Promote Desi cotton varieties:** Varieties of desi cotton *Gossypium arboreum* are resistant to the whiteflies and are immune to the cotton leaf curl virus (CLCuV). Desi cotton varieties may be promoted in the regions which are highly prone to CLCuD.
4. **Grow medium duration (160-180 days) Bt-hybrids:** Medium duration Bt-hybrids timely sown escape whitefly infestation. This also facilitates timely sowing of wheat and cotton in the cotton-wheat rotation system.
5. **Weeding:** Keep fields and bunds free of weeds especially during July.
6. **Barrier crops:** Grow two rows of sorghum or pearl-millet or maize as border around cotton fields.
7. **Avoid excessive urea during vegetative phase** of the crop. Excessive urea especially before square initiation makes the crop vulnerable to sap-sucking insects especially whiteflies and leaf hoppers. Balanced nutrients of N with adequate P and K assist plants to combat whiteflies and the CLCuD. Basal application of fertilizers at the time of sowing and split dose at flower initiation is ideal for yield and pest management.
8. **Avoid indiscriminate use of insecticides** to conserve naturally occurring enemy fauna. Indiscriminate and frequent use of insecticides disrupts cotton ecosystem and adversely affect the population of natural enemies. Whitefly predators, such as *Cheilomenes sexmaculata* (Fabricius), *Serangium parcesetosum* (Sicard) and *Brumoides suturalis* (Fabricius), *Coccinella septempunctata* L., *Chrysoperla zastrowi sillemi* (Esbensen-Petersen) are present in cotton ecosystems in north India. Parasitoid like *Encarsia lutea* (Masi), *Eretmocerus* spp., are important parasitoid of whiteflies in north India. Naturally occurring biological control in the field is reported to have been effective for keeping whitefly population under check.



### INTERVENTIONS AT ETLs

1. **Install yellow sticky traps during the initial phase of whitefly infestation.** Yellow sticky traps may be standardized (based on size and density of traps) and used to correlate / determine economic thresholds of 6 adults per leaf.
2. Vacuum suction traps may be encouraged during the early phase of infestation.
3. **Botanicals and biopesticides:** Sprays based on Neem oil should be preferred to avoid disruption of naturally occurring biological control. Biopesticides from *Lecanicillium lecanii* may be used. Target nymphal stages and make sure that the sprays reach lower leaf surface of leaves.
4. **Apply sprays of insecticides when whitefly cross ETL:** Ensure that the sprays reach lower leaf surface to target nymphal stages  
Buprofezin 25% SC: Chitin biosynthesis inhibitor  
Pyriproxyfen 10% EC: Juvenile hormone mimic;  
Diafenthiuron 50% SC: Oxidative phosphorylation inhibitor  
Spiromesifen 22.9% EC: Lipid synthesis inhibitor.
5. **Avoid indiscriminate use of insecticides** especially synthetic pyrethroids, acephate and all kinds of insecticide mixtures during the initial phase of whitefly infestation. These insecticides are known to aggravate resurgence of whiteflies when used indiscriminately.

The strategies are developed based on the research output from various experiments conducted by ICAR-CICR, guidelines issued by national (CIB&RC) and international agencies (WHO, IOBC).

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