Cotton Health Management Strategies for 2016

(Authored by K. R. Kranthi - No part of this advisory may be used in any form in any publication electronic or print or any other means without the permission of the author)

General Crop Health Management Practices

1. **Avoid long duration varieties/hybrids in rain-fed farms** especially in the absence of any form of protective irrigation. Short duration varieties get adequate soil moisture during the critical flowering and fruiting phase and escape bollworm attacks during squaring-flowering stage. Compact statured short duration varieties under high density give high yields in a short period of 140-160 days cropping season.
2. **Early or timely sowing** is preferred in rain-fed regions immediately after receiving the first showers of at least 80-100 mm rainfall.
3. **Sowing on ridges in rain-fed regions** especially in high density planting systems is most preferred.
4. **Bt-cotton hybrids** may be sown at 90 x 30 cm in rain-fed regions and at wider spacing under irrigation
5. **Non-Bt varieties** such as Suraj (CICR); NH 615 (VN-MAU Parbhani); AKH 081 (Dr PDKV Akola); Phule Dhanwantari (MPKV Rahuri) and Anjali (LRK 516) are early maturing. If these varieties are sown before 15th June in high density planting at 60x10 cm (45x10cm for Phule Dhanwantari), the crop will escape drought stress and bollworms.
6. **Intercropping in high density non-Bt cotton varieties** sown at 90x10 cm or Bt-hybrids, can be taken up with soybean, clusterbean, cowpea or blackgram (seeds treated with *Rhizobium* and *Bradyrhizobium japonicum* for soybean), as one row between two cotton rows.
7. **Border rows (2-3 rows) of pigeonpea or bajra or maize or sorghum** around cotton fields was found to reduce infestation of sap sucking insects such as whiteflies, mealy bugs etc. These crops also serve as refugia for *Helicoverpa armigera*.
8. **Farm Yard Manure** @ 5 to 10 t/ha or compost should be applied just after the first rain.
9. ***Azotobacter* and PSB** (phosphate solubilizing bateria) @ 25 g each / kg seed should be used for nutrients fixation.
10. **NPK** should be recommended as per the respective SAU recommendations.
11. **Foliar sprays of nutrients** for macro and micronutrients. Foliar spray of 1% MgSO4, 2%, Urea 0.5%, Zinc Sulphate and 0.2 % Boron, twice at 15 days interval on 90 days old crop followed by 2% DAP, was found to enhance Cry1Ac expression and also to reduce problems of leaf reddening.
12. **Early stage of wilt:** Sprays and soil drenching with Bavistin 1% in the initial stage of wilt was found to help in the recovery of plants.
13. **Retention of squares and flowers:** Spray Planofix 4.5 SL (NAA) hormone @ 21 ppm (7 ml per 15 litres of water).

Disease Management

Para wilt or Sudden drying (New wilt) or **Wilt / Root rot:** 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 ltr of water or Carbendazim 1g/L.

Boll Rot: Generally early formed lower bolls rot due to cloudy and drizzling conditions.
Spray Mancozeb 75 WP + Chlorothalonil 70 WP each @ 2 g/lit of water. For better results, mix 10g Selvet 99 or 50 ml Triton in 100 litres of fungicide solution.

Alternaria blight: spray Mancozeb@2.5 g per one litre of water.

Myrothecium leaf spot disease and/or Bacterial blight: Spray Streptomycin sulphate (15-20 g/ha) plus Copper oxychloride (1500-2000 g/ha) in 200-250 L of water.

Weed Management

Application of Pre-emergence weedicide Stomp 30EC or Basalin @ 45EC 2.5 lt/ha and harrow immediately to prevent degradation.

Herbicides are most effective on younger weeds.

Post emergence herbicides (application rate 50 to 75 g ai /ha)

Grasses: Spray Quizalofop-ethyl or Fenoxaprop ethyl or Fluazifop butyl
Sedges and grasses: Spray Propaquizafop ethyl
Broadleaf weeds: Spray Pyrithiobac sodium

Post-emergence weedicides would provide effective and timely control especially when interculture operations or manual weeding becomes difficult in wet soils. Weedicides are effective against younger (less than 10-15 days old) weeds, especially grasses. For grassy weeds, Quizalofop ethyl, Fenoxaprop ethyl, fluazifop butyl, can be used. For sedges and grasses, Propaquizafop ethyl is effective. Pyrithiobac sodium is effective on broad leaf weeds. Farmers may consult the technical experts of the Agricultural Universities for further details.

Water Logging Management

Cotton is very sensitive to excess water. In many parts of Central and South India, water logging can be problematic due to excess rains. Cotton grown on deep black soils and ill drained conditions is worst affected due to water logging. Provide adequate drainage channels or water ways (particularly in heavy soils) along the slope of the land for draining excess water under heavy rainfall situations. For better soil moisture conservation, preferably in areas where rainfall is 700-900mm, the land can be reshaped into ridges and furrows with the help of a ridge plough or a bund former. This technique and sowing cotton on ridges would conserve rainwater and the furrows acts drainage channels whenever heavy rains are received particularly in heavy clays.

Drainage channels must be opened up along the field borders so that excess water is removed from the fields. If sowing hasn't yet been completed, it is strongly recommended that to take up sowing immediately on ridges and furrows by planting on top of ridges.
Heavy rains will not affect the crop because the furrows will drain away excess water. Apply fertilizers if the crop becomes pale due to water logging. If heavy rains are forecast, fertilizer application may be postponed so as to prevent losses due to surface run-off.

Foliar spray with 0.5 to 1.0% DAP or 19:19:19 (soluble complex of Nitrogen) at weekly intervals will help the plants to recover from the effect of water logging.

Insect Pest Management

General recommendations

Do's	Don't's
1. **'SUCKING PEST VARIETIES HOLD THE KEY FOR IPM'** Sucking pest resistant varieties/hybrids make it possible to avoid chemical insecticide sprays during the first 2-3 months of the crop when natural pest control builds up in cotton fields. Chemical insecticide sprays early in the season kill naturally occurring parasitoids and predators of insect pests thereby disrupting ecosystems generally beyond revival, which in-turn renders the crop dependent on continuous insecticide sprays for the control of insects all through the season.	1. **Avoid late sowing beyond 15th May in North India** to prevent aggravation of cotton leaf curl virus. 2. **As far as possible, avoid chemical insecticides during the first two months of the crop** to conserve naturally occurring biological control that can get established in cotton fields in the absence of chemical interventions. Natural control comprising of ladybird grubs and beetles, *Chrysoperla* grubs and adults, Syrphid flies, *Geocoris* grubs and bugs, *Aenasius* spp., *Aphilinus* grubs and wasps, mirid bugs and Spiders can effectively control aphids, jassids (leaf hoppers), thrips, mirids, whiteflies and mealybugs.

2. **Inter-crop with clusterbean, cowpea or sorghum or soybean or blackgram** to encourage predators of sucking pests.
3. **Imidacloprid** (8 g), **Vitavax** or **Thiram** (3 g) per kg seed will protect varieties against sucking pests and diseases.
4. **Use nitrogenous fertilizers to the minimum** especially for sucking pest susceptible varieties.
5. **Maintain field sanitation** (weed free)
6. **Remove and destroy mealy bug infested plants.**
7. **Use Neem preparations and biological control options** for least disruptive pest management.
8. **Pheromone traps** are efficient for pest monitoring of Pink bollworm.

3. **Do not spray against minor lepidopteran insects** such as the cotton leaf folder, *Sylepta derogata* and cotton semilooper, *Anomis flava*. The 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. **Do not spray Bt-formulations on Bt cotton** to avoid further selection pressure.
5. **Avoid foliar application of neonicotinoid insecticides** such as Acetamiprid, Imidacloprid, Clothianidin and Thiomethoxam which are likely to aggravate insect resistance, since hybrid cotton seeds are treated with imidacloprid.
6. **Do not use WHO Class-I (Extremely Harzardous category) insecticides** such as Phosphamidon, Methyl parathion, Phorate, Monocrotophos, Dichlorvos, Carbofuran, Methomyl, Triazophos and Metasystox.
7. **Avoid Pyrethroids** during the first 4-5 months after sowing and **avoid insecticide mixtures** all through the crop phase to prevent whitefly and other pest outbreaks.
8. **Pyrethroids** may be used only late in the season as one or at the most two sprays for the control of pink bollworm.

Sucking Pest Management

Economic Threshold Level (ETL): If whitefly and/or leafhopper damage reaches economic threshold levels of grade-II damage of curling and crinkling of lower leaves and yellowing of margins in 25% plants or more, any one of the following pest control measures as suggested below can be used.

a. Neem oil 1.0% + Neem Seed Kernel Extract 5.0% + 0.05-0.1% detergent
b. *Verticillium lecanii* 10gms/lit of water, wherever good formulations are available from reliable manufacturers
c. Diafenthiuron 50WP 300g a.i/ha,
d. Flonicamid 50 WG 75g a.i/ha or
e. Buprofezin 25% SC 250g a.i/ha

Insecticides such as Dimethoate or Acephate or Ethion can also be used but may be considered as alternatives only, in view of factors that relate to ecological and environmental safety, efficacy and resistance. If mirid bugs are observed to cause economic damage to squares, it is advised to spray Acephate 75 SP @ 1 g/lit or Dimethoate.

Bollworm Management

Bt-cotton is still effective in controlling American bollworm *Helicoverpa armigera* and spotted bollworm *Earias* spp. The pink bollworm *Pectinophora gossypiella* has developed resistance to Cry1Ac+Cry2Ab in Bollgard-II and needs to be managed through other strategies.

The following strategies are being recommended for non-Bt cotton

At Economic Threshold Levels (ETLs) of 50% infested plants (plants having flared squares with entry hole) **for *Helicoverpa armigera*.**

1. **Use *Ha*NPV** (*Helicoverpa armigera* Nuclear Polyhedrosis Virus) on *Bt*-cotton followed by the application of **5% Neem Seed Kernel Extract (NSKE)** a week later**.**
2. ***Trichogramma spp.***, if available, can be used on non-Bt genotypes at 70-80 DAS.
3. Use ***Trichogramma bactriae*** egg parasitoid releases at ETL for the control of pink bollworm
4. **Insecticides effective on Bollworms,** especially *Helicoverpa armigera*.

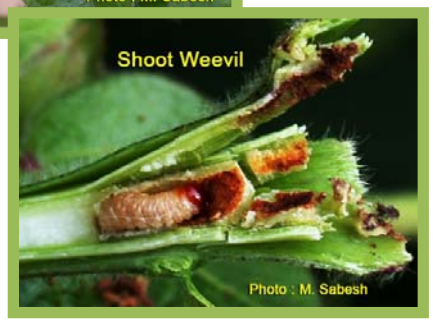
a. Chlorantraniliprole,
b. Flubendiamide,
c. Spinosad,
d. Emamectin benzoate and
e. Indoxacarb

These insecticides have good selective toxicity towards the target pests while being less toxic to many beneficial insects in the cotton ecosystem. These insecticides are suited in eco-sustainable insecticide resistance management programmes.

5. **Pink bollworm:** ETL level of one live larva in 10 green bolls or 8 moths per night for three consecutive nights. Spray Quinalphos 25 EC / Profenophos 50 EC @ 2 ml/lit of water / Spray of Thiodicarb 75 WP @ 20 g or any pyrethroid.

Other Minor Pest Management

1. ***Spodoptera litura*:** Collection of egg masses or application of *S*lNPV (*Spodoptera litura* Nuclear Polyhedrosis Virus) @ 500 LE/ha or Spray 200 ml Novaluron 10 EC or 250g Thiodicarb 75WP in 250 litres of water per acre
2. To minimize **shoot weevil** damage, spray Profenofos @ 2 ml/lit
3. **Snail incidence in heavy rainfall areas**: baiting with 2% Metaldehyde (Snail kill) @ 12.5 kg/ha has to be taken up and it is to be applied at the hideouts of the snails, on the bunds and to the soil around the crop where the damage is seen



DOs

IPM/IRM STRATEGIES FOR WHITEFLY-2016

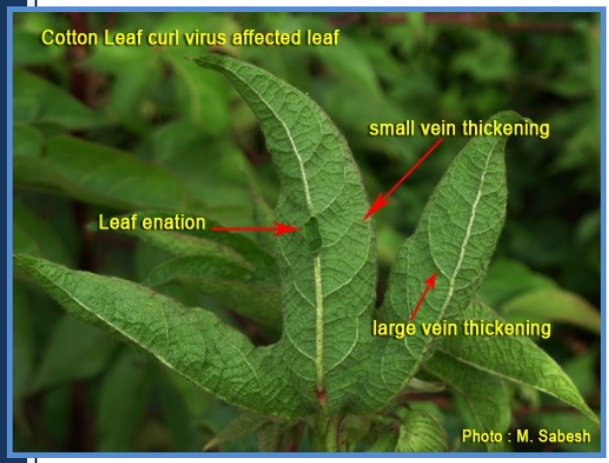
FOUR MAIN STEPS TO FOLLOW

- TIMELY SOWING
- CHOOSE 'CLCuD-TOLERANT BT-HYBRIDS' OR *DESI* VARIETIES
- JUDICIOUS USE OF UREA & RECOMMENDED P&K
- FOLLOW IPM/IRM

1. **Promote Desi cotton varieties:** Majority of Desi cotton varieties, species *Gossypium arboreum* are resistant to the whiteflies and immune to the cotton leaf curl virus (CLCuV). Desi cotton may be preferred in regions which are highly prone to cotton leaf curl virus disease (CLCuD) disease.
2. **Choose 'CLCuD-tolerant-Bt-hybrids':** A list of CLCuD-tolerant-Bt-hybrids Bt-hybrids for 2016 is prepared by the AICCIP (All India coordinated cotton improvement project of the ICAR-CICR) and recommended by respective state agricultural universities in north India. The Universities and State Agricultural Department may be consulted. Bt-hybrids that are susceptible to the CLCuD and whiteflies must not be permitted to be cultivated.
3. **Cultivate medium duration (160-180 days) Bt-hybrids for north India:** Choose medium duration varieties. These escape whiteflies especially when sown in time. Additionally they facilitate timely sowing of wheat and cotton in the cotton-wheat rotation system.
4. **Timely sowing (before 15th May):** Timely sown crop tolerates whitefly and CLCuD, whereas late sown cotton exhibits susceptibility.
5. **Weeding:** Keep fields and the vicinity 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. **Judicious use of urea:** 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 and later is ideal for yields and pest management.
8. **Conserve naturally occurring natural enemy fauna:** CARE MUST BE EXERCISED TO ENSURE THAT THE NATURAL ECOSYSTEMS ARE NOT DISRUPTED WITH INDISCRIMINATE CHOICE AND INDISCRIMINATE USE OF INSECTICIDES. Reports show that at least three whitefly predators, *Serangium parcesetosum* (Sicard), *Cheilomenes sexmaculata* (Fabricius) and *Brumoides suturalis* (Fabricius) were most commonly present in cotton ecosystems in north India. Two other predators *Coccinella septempunctata* L., *Chrysoperla zastrowi sillemi* (Esben-Petersen) were found to occur albeit at lesser population densities. The parasiotid *Encarsia lutea* (Masi) was also reported. Reports also indicate that *Eretmocerus* spp., is an important parasitoid of whiteflies in north India. Naturally occurring biological control in the field is reported to have been effective to the extent of 65.0%.

INTERVENTIONS AT ECONOMIC THRESHOLD LEVELS

- **STEP-1: During the initial phase of whitefly infestation use 'yellow sticky traps' to determine economic threshold levels and 'vacuum suction traps' for control.** Yellow sticky traps may be standardized (based on size and density of traps) and used to correlate / determine economic thresholds of 8 adults per leaf. Vacuum suction traps must be encouraged during the early phase of infestation.
- **STEP-2: Botanicals and biopesticides:** Sprays based on Neem oil, castor oil, cotton seed oil, fish oil rosin soap etc., must be preferred to avoid disruption of naturally occurring biological control. If available, *Lecanicillium lecanii* may be used. Ensure that the sprays reach lower leaf surface to target nymphal stages.
- **STEP-3: Insecticides:** For effective management of whitefly, insect growth regulating (IGR) chemicals should be preferred, because they are less toxic to natural enemies of whiteflies. For effective IRM, the preferred insecticides for whitefly control are **Pyriproxyfen:** Juvenile hormone mimic; **Buprofezin:** Chitin biosynthesis inhibitor; **Diafenthiuron:** Oxidative phosphorylation inhibitor and **Spiromesifen:** Lipid synthesis inhibitor. Ensure that the sprays reach lower leaf surface to target nymphal stages.



DON'Ts

FOUR MAIN STEPS TO AVOID

1. **AVOID LATE SOWING**
2. **AVOID Bt-HYBRIDS THAT ARE SUSCEPTIBLE TO CLCuD**
3. **AVOID EXCESSIVE UREA**
4. **AVOID INDISCRIMINATE USE 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.

Pink Bollworm Management

PURCHASE GENUINE SEEDS WITH BILL

SHORT DURATION (150-160 days), JASSID TOLERANT BT-HYBRIDS: For light and marginal soils under rain-fed tracts to be planted at 90x30 cm.

MEDIUM DURATION (less than 180 days), JASSID TOLERANT BT-HYBRIDS: For black-cotton soils, medium-deep soils and/or irrigated conditions to be sown at 120x30 cm or 120x60 cm.

REFUGE PLANTING: Seed companies to ensure that the 120g refugia seed hybrid provided with Bt-hybrid seeds is near-isogenic with the corresponding Bt cotton hybrid, with similar flowering and fruit forming window. Bhendi (ladies finger) may be planted in a manner that the crop would bear fruits by October-November to trap pink bollworms.

TIMELY SOWING: Pink bollworm occurs in central and south India after October. Timely sown short duration crop escapes pink bollworm.

PHEROMONE TRAPS: Starting from mid-October, install pink bollworm pheromone traps at 4-5 traps per hectare for monitoring. Monitor for pink bollworm moths once every three days. If the number of moths exceeds 24 per trap after 3 days in at least 2 traps per field, release *Trichogramma bactriae* or *Bracon hebator.*

AVOID EXCESSIVE UREA before 45 days: Nitrogen and potash should be applied in three equal splits at planting and 60, 90 days after sowing, or 30,60 and 90 days after sowing at 8-10 cms away from plants. Phosphorus fertilizer must be applied as basal dose at sowing time

AVOID INSECTICIDES EARLY IN THE SEASON: Follow IPM / IRM strategies using neem based products, botanicals, biopesticides and biological-control especially during the first three months to conserve naturally occurring biological control and to avoid chemical insecticides as much as possible.

AVOID INSECTICIDES THAT PROLONG THE CROP DURATION: During the first three months of the crop, avoid insecticides that prolong vegetative phase, stagger flowering phase and delay crop maturity. Select hybrids / varieties that are tolerant to sucking pests. Cultivation of 'Jassid-tolerant hybrids' will help in avoidance of insecticides in the early crop growth stages. Spray application of insecticides from the neonicotinoid group and organophosphates such as monocrotophos and acephate, especially at the early stage of the crop results in growth of fresh green leaves, switching back from squaring-flowering to vegetative phase and delays maturity of the crop apart from disrupting natural enemies of insect pests. Avoidance of these insecticides helps in synchronous early maturity of bolls which helps in the escape of pink bollworm infestation

STRICTLY AVOID INSECTICIDE MIXTURES: Insecticide mixtures severely disrupt the ecosystem beyond repair. Naturally occurring biological control of bollworms can function efficiently if the ecosystems are least disrupted, especially during early season.

INSECTICIDES AS LAST RESORT: Short or medium duration varieties if sown timely are likely to be harvested before the onset of winter generally before December. Such crops escape the pink bollworm. For long duration varieties and or extended crop take up one spray of chlorpyriphos or quinalphos or thiodicarb during mid-October to November and fenvalerate or cypermethrin in December at Economic threshold levels (ETL). About 20 green bolls from 20 random plants may be dissected once a week from mid-October to mid-December. At economic threshold level of 10% damage with live pink bollworm larvae and / or 8 pink bollworm moths per pheromone trap per 3 consecutive nights in at least 2 traps per field, the above insecticide sprays may be recommended. Insecticide sprays in December may be taken up only in fields having at-least 8-10 green bolls per plant, generally in irrigated cotton. Insecticide spray must be done to protect green bolls only after picking the fully open bolls. Repeated application of pyrethroids or acephate or fipronil was found to have triggered whitefly outbreaks.

TERMINATE THE CROP BY DECEMBER and strictly avoiding ratoon or extending the crop.

CROP RESIDUE MANAGEMENT: Pink bollworm goes into diapause at the last larval instar (4th instar) stage. Such larvae spin a loose silky cocoon and are present sometimes in the soil but mostly in crop residues such as in seeds, bolls and stalks. Therefore crop residual management is important to prevent infestation in the subsequent season. Infested bolls and seeds must be destroyed. Cotton stalk composting may be taken up on the farm using microbial consortia provided by KVK or State Agricultural Universities or the State Agricultural Department.

CROP ROTATION is strongly recommended to break the pest cycle.

MASS TRAPPING: Mass trapping and / or mating disruption using pheromone traps can effectively reduce infestation. Installation of light traps in fields during the season and also near go-downs, ginning mills, market yards etc., during October-December can effectively trap late season moths, thereby reducing infestation.

Publication Note: The strategies recommended in this brief note are based on results of experiments conducted by ICAR-CICR and developed in consonance with various ecologically compatible guidelines issued by various National and Global agencies.

Written by Dr K R Kranthi, Director, CICR, Nagpur, May 2016

Images and designed by M. Sabesh, Scientist, CICR, Regional Station, Coimbatore