Package of Practices for Cotton Cultivation in Andhra Pradesh

Package of Practices for 2023-2024 (*Kharif*)

Cotton Varieties (*G. arboreum*.L)	:	Yaganti
American Cotton Varieties *(G. hirsutum L.)*	:	LK-861, L-389, L -604, Narasimha (NA-1325), NDLH-1938 and LHDP Cotton 1, NDLH 2051-1, LHDP Cotton 5 and NDLH 2035-5.
Intra-specific Cotton Hybrids	:	LAHH-5, Lam Cotton Hybrid-7 and NDLHH-240.
Egyption Cotton Varieties / Inter-specific Cotton Hybrids	:	Suvin / Jayalakshmi (DCH-32) and LAHB cotton 1
Bt. Cotton Hybrids	:	Officially identified private Bt cotton hybrids being cultivated and found suitable for the past 4-5 years.
Soils	:	Deep black Cotton and red fertile soils with irrigated or assured rainfall conditions.

Land Preparation

For rainfed cotton, deep ploughing once in 3 years with mould board plough or disc harrow facilitates deep infiltration of water and charging of soil profile with large quantities of water. The land has to be ploughed 2 to 3 times and work with harrow to bring the soil to good tilth. Seeds can be dibbled by maintaining spacing in between plants after running a marker in one or two direction(s). For irrigated crop, ridges and furrows are to be formed at recommended spacings after deep ploughing.

Seed Rate

American Cotton Varieties *(G. hirsutum* L.*)*	2.5-3.5 kg / acre
Desi Cotton Varieties (*G. arboreum* L. and *G. herbaceum* L.)	4-5 kg / acre
Intra-/Inter-specific Cotton Hybrids /Bt. hybrids	0.9-1 kg / acre (Black soils of coastal and Rayalaseema areas)
	1.5 - 1.75 kg/ha (Red soils with irrigation facilites)

Seed Treatment :

For acid delinting, seed should be treated with 80-l00 ml H_2 SO_4 per kg of seed for 2-3 minutes followed by lime solution and thorough washing with water 2-3 times to make the seed acid free. Seed treatment with appropriate insecticide, imidacloprid 70 WS @ 5 g/kg or thiomethoxam 70 WS @ 4 g / kg + *Pseudomonas fluorescens* or *Trichoderma viride* or *T. harzianum* @ 10 g / kg or carboxin+thiram 3.5g/kg of the seed.

Spacing

Desi Cotton Varieties (cm) : 60 x 30

American Cotton Varieties (cm) : 90 – 105 and 45-60 for black soils of coastal and Rayalaseema areas
75-90 and 30-45 for red soils with irrigation

Bt. Cotton Hybrids (cm) : 105-120 and 45-60 for black soils
90 – 105 and 30-45 for red soils

Sowing with Cut-off dates :

Red soils : June – 1st Fortnight of July
Black soils : July – 1st Fortnight of August

Inter Cropping in Cotton :

Inter cropping with mungbean / urdbean / soybean / cluster bean in 1:2 or 1:3 ratio and pigeonpea 4:1 or 6:1 or 8:1 ratio.

Gap filling and Thinning:

Gap filling should be done preferably within 10 DAS. Thinning should be done within three weeks after sowing retaining two plants per hill in case of varieties, one plant per hill in case of hybrids.

Nutrient Management: Use of organic manures and growing of green manure crops including *in situ* green manuring of sunhemp etc. for improving of soil organic matter content of the soil.

Zone wise Nutrient recommendation for cotton for A.P. are as follows

Region	Season	Variety/ hybrid	Total-N (kg/ha)	Split applications at days (N)			P_2O_5 Entire Basal	K_2O	Split application at days (K)		
				30	60	90			30	60	90
Coastal											
	Kharif	Varieties (Hir)	90	30	30	30	45	45	15	15	15
		Hybrids (HxH))	120	40	40	40	60	60	20	20	20
		Bt	150	50	50	50	60	60	20	20	20

		Hybrids									
Rayalaseema											
	Mungari	Varieties (*Desi*)	20				20				
		Varieties (Hir) (Rainfed)	40	20	20		20				
		Varieties (Hir) (Irrigated)	90	30	30	30	45	45	15	15	15
		Hybrids (HxH))	120	40	40	40	60	60	20	20	20
		Bt Hybrids	150	50	50	50	60	60	20	20	20

Band placement of fertilizers at 5 cm depth and 5cm away from the plant for efficient utilization is suggested.

Micro-Nutrient disorders and their correction:

Mg: deficiency in cotton is common in highly calcareous soils and soils having high K or soils fertilized with high K fertilizers. In Mg deficiency the older leaves become yellow from the margins, while the veins remain green. The leaves finally dry and fall.

Correction: Spray 1% Mg SO_4 (10 g/l) twice at 45 and 75 DAS

Zn: Zn deficiency is seen on middle leaves. Veins remain green. Interveinal area becomes yellow. Terminal leaves become small and clustered and inter nodal distance decrease. This is usually observed in calcareous, low organic matter, high P soils.

Correction: Apply 50 kg $ZnSO_4$/kg in the last plough. If the deficiency is seen on the crop, spray 0.2% $ZnSO_4$ 2-3 times or 0.1% chelated Zn 2-3 times till the plants become normal.

Boron: Boron deficiency is predominant in all places of cotton cultivation in A.P. Boron is very important to cotton crop throughout its growth. Deficiency occurs in drought season/due to floods or in calcareous soils.

Deficiency: Change in the size of flowers and petioles, formation of small squares. Petioles irregular, thick and thin with pink coloration, and cracks, flowers and bolls drop.

Correction: Spray borax or boric acid @ 1-1.5 g/l) of at 60 and 90 DAS twice. If the problem is recurring in the same field, broadcast 1 kg/ha of borax mixed with 50 kg sand or soil in lines for uniform distribution at sowing for next crop.

Flooded /water logged condition: When the crops are waterlogged for about a week, spray 1% urea or 1% KNO_3 solution for rejuvenation has to be done.

Weed Management:

The first 60 days after sowing is very critical for weed competition. For effective weed control spray pendimethalin @ 1.5 to 2.0 l/acre immediately or within 48 hours of sowing. Inter cultivation with tyned harrow and blade harrow 2-4 times up to 90 DAS. For control of the grasses and broad leaved weeds post emergence spray of quizalofopethyl @ 400 ml/acre (2 ml/l) and pyrithiobac sodium @ 250 ml / acre (1.25 ml/l) is recommended at 25-30 DAS. Post emergence directed spray of paraquat @ 5.0 ml/l of water is recommended for control of the weeds in the cotton crop, where inter-cultivation or manual weeding is not possible due to unfavourable weather conditions.

Irrigation: Generally cotton crop requires 2-4 irrigations depending upon the soil type. Square formation, flowering and boll development stages are critical for moisture stress. For moisture conservation and effective weed control furrows for every row or alternate rows should be opened during the last inter cultivation operation.

Pest Management in Cotton

Management of Sucking Pests in cotton:

1. Grow sucking pest tolerant / resistant varieties or hybrids.
2. Seed treatment with imidacloprid 70 WS @ 5 g/kg or thiomethoxam 70 WS @ 4 g / kg + *Pseudomonas fluorescens* or *Trichoderma viride* or *T. harzianum* @ 10 g / kg or carboxin 75 WP @ 2g/kg of the seed.
3. Growing of intercrops like mungbean or urdbean or soybean or cluster bean in 1:2 or 1:3 ratio will facilitate the buildup of native natural enemy populations and in turn keep sucking pests under check
4. Growing of cowpea as bund crop is advantageous to encourage predatory insects like coccinellids, syrphids and chrysopids
5. Maize or sorghum or pearlmillet grown as barrier crops on the border prevents spread of insect pests from neighbouring fields.
6. Stem application at 60 DAS with imidacloprid (1:20) for protecting the crop from early season sucking pests is highly effective.
7. Setting up of yellow sticky traps @ 10 per acre for monitoring whitefly incidence and blue sticky traps @ 10 per acre for monitoring thrips incidence.
8. Economic Threshold Level (ETL) for sucking pests on cotton is presented hereunder :

Name of the Pest	ETL
Jassids	Two adults or nymphs per leaf or appearance of second grade injury (yellowing in the margins of the leaves)
Thrips	10 adults per leaf
Aphids	15% affected plants
Whiteflies	6-8 adults per leaf
Mealy bugs	5% affected plants
Mites	10 per cm^{-1}

9. **ETL based application of insecticides**

Leafhoppers / aphids / thrips -
Acephate 75 SP @1.5g/l or
Imidacloprid 17.8 SL @ 0.4 ml/l or
Acetamiprid 20 SP @ 0.2 g/l or
Thiamethoxam 25 WG @ 0.2 g/l or
Fipronil 5 SC @ 2.0 ml/l
Diafenthiuran 50 WP @ 1.25 g/l
Flonicamid 50 WG @ 0.3 g/l

Whitefly - Acephate @ 1.5 gl/l or
Profenophos 50 EC @ 2.0 ml/l or
Acetamiprid 20 SP @ 0.2 g/l or
Diafenthiuron 50% WP @ 1.25 g/l or
NSKE @ 5% (extract from 10.0 kg of Neem Powder/acre)

Red mite - Wettable sulphur 80 WP @ 3.0 g/l or
Dicofol 18.5 SC @ 5.0 ml/l

Integrated Pest Management in Cotton:

1. Avoid monocroping of cotton.
2. Application of chemical fertilizers as supplement to organic or biological fertilizers as per the recommended doses.
3. Growing intercrops/strip crops/barrier crops with greengram, blackgram, soybean cowpea, clusterbean, groundnut, foxtail millet and coriander were found better intercrops in increasing the effectiveness of natural enemies like coccinellids, syrphids, chrysopids, spiders, *Trichogrammids*, *Apantelids* etc. Growing fodder sorghum or maize as barrier crops and castor as ovipositional trap crop with in the cotton was also found to be more advantageous to manage the pests of cotton.
4. Seed treatment with recommended insecticides and fungicides.
5. Stem application of imidacloprid at 60 DAS.
6. Monitoring pests by using light, sticky and pheromone traps. The adults monitoring should be supported by egg and larval monitoring following sequential sampling technique at frequent intervals in case of boll worms.
7. Bird perches should be arranged @ 10 per acre for encouraging bird predation on bollworm larvae.
8. The buildup of broad spectrum predators *viz.*, spiders, coccinellids and chrysopids should be synchronised in other cultural operations. Release of *Trichogramma* egg parasite @ 60,000/acre should be done as soon as the first brood of bollworms are noticed.
9. Topping of cotton plants when maximum egg laying of *Helicoverpa armigera* is noticed (October-November months).
10. Application of HNPV @ 500 LE/ha or neem seed kernel extract (5%) in synchrony with early larvae of *Helicoverpa*. Neem oil formulation to manage initial whitefly.

11. ETLs for Bollworms

Name of the Pest	ETL
American bollworm (*H. armigera*) and Spotted Boll worm (*E. vitella*)	Five per cent damaged fruiting bodies or one larva per plant or total three damaged square per plant taken from 20 plants selected at random for counting.
Pink bollworm (*P. gossypiella*)	Eight moths per trap per day for three consecutive days or 10 % infested flowers or bolls with live larvae.
Tobacco caterpillar (*S. litura*)	One egg mass or skeletonized leaf / ten plants

12. Poison bait (10 kg of rice bran + 2 kg jaggery + 500-750 ml of chlorpyriphos or 250-300 g of thiodicarb) for the control of grown up larvae of *Spodoptera*.

13. Resorting to chemical insecticides for the control of leafhoppers spray acephate 75 SP @ 1.5 g/l or fipronil 5% SC @ 2.0 ml/l or imidacloprid 17.8 SL @ 0.4 ml/l or acetamiprid 20 SP @ 0.2 g/l or thiamethoxam 25 WG @ 0.2 g/l or flonicamid 50 WG @ 0.3 g/l. For the management of whitefly spray or profenophos 50 EC @ 2.0 ml/l or diafenthiuron 50 WP @ 1.25 g/l or neem seed kernel extract @ 5% or neem oil @ 5.0 ml/l; for the control of *Helicoverpa armigera* spray quinalphos 25 EC @ 2.5 ml/l or chlorpyriphos 20 EC @ 3.0 ml/l or acephate 75 SP @ 1.5 g/l or indoxacarb 14.5 SC @ 1.0 ml/l or thiodicarb 75 WP @ 1.5 g/l or spinosad 45 SC @ 0.3 ml/l or flubendiamide 48 SC @ 0.3 ml/l or chlorantraniliprole 18.5 SC @ 0.3 ml/l. For managing red spider mites, application of wettable sulphur 80 WP @ 3.0 g/l or dicofol 18.5 SC @ 5.0 ml/l.
14. Removal of cotton stubbles after last picking without opting for ratoon crop or prolonging the crop growth with irrigations and fertilizer applications. This is essential to break the cycles of problematic pests in the system as a whole

Mealy bug management in Cotton

- Adopt crop rotation
- Removal and burning of alternate weed hosts like *Parthenium, Abutilon* etc.in the vicinity of cotton crop
- Control mealy bug population on the alternate crop hosts during and off season
- Monitoring the initial infestation of mealy bug, particularly on border plants and shaded areas for timely control measures.
- Need based spraying of insecticides, profenophos 50 EC @ 3.0 ml/l or acephate 75 WP 2.0 g/l mixed with stickers like triton or sandovit or teapot etc @ 1ml/l of spray fluid
- Spot application of insecticides is desirable when the infestation is confined to isolated pockets in the field.
- Removal and destruction by burning of heavily infested dried / dead cotton plants may be taken up to arrest further spread of the pest incidence.
- Removal and burning of left over cotton stubbles after harvesting.

Management strategies for pink bollworm:

ETL for Pink bollworm:

- Eight moths per pheromone trap per day for three consecutive days.
- One rosette flower/ 10 flowers (10 % infested flowers).
- One live larvae / 10 bolls (10 % infested bolls).

Sampling technique:

Scout cotton crop for PBW incidence and determine ETL through

- Examination of 50 flowers across the whole field randomly for rosette flowers
- Collect 20 bolls/acre randomly, not more than one boll per plant and cut open them for damage and larval presence at 10 days interval.

Integrated Management of Pink bollworm in Bt Cotton:

Off Season Practices:

Certain off-season cultural practices which aim to maintain a host-free period play a key role in minimizing carry-over of pink bollworm to the succeeding season

- Gin sanitation: Destroy damaged seed trash by burying them in pits or through burning. Install four pheromone traps around the pile of waste lint from the gins to trap the emerging male moths
- Field sanitation. Pink bollworm larvae remain hidden in dried or improperly opened bolls. So, destroy leftover cotton stalks with dried/unopened green bolls by burying them in pits or through burning.
- Allow cattle, sheep and goats to graze upon immature green bolls and attacked bolls after final picking to prevent carry-over of the pest to the next season.
- Prompt removal and destruction of cotton stubbles to prevent carryover of pest to next season without stacking in the fields.
- Spread awareness on the importance of destroying pink bollworm damaged cotton seeds after ginning. These seeds could contain diapausing pink bollworm larvae hidden within the half-eaten seed.
- Destroy trashed and stained cotton with damaged seeds whether lying in the farmer's house or in the Gins. This is a rich and concentrated source of resting pink bollworm larvae.
- Avoid ratooning and summer cotton.
- Restrict the movement of cotton seed from other areas/states
- Crop rotation to break the life cycle of the pest

Pre-season Practices:

This is the key period to create awareness amongst growers on the good agricultural practices which need to follow.

- Deep summer ploughing should be done to destroy the dipausing larvae of pink bollwrom in soil and plant debris.

- Grow early maturing varieties so that the cotton bolls mature before the heavy population of pink bollworm builds up.
- Avoid staggered sowing in an area and take up timely sowings.

In season *(June-January)* Practices:

- Monitoring for pest build up with pheromone traps @ 10 /ha and random destructive sampling of green bolls.
- Mass trapping and mating disruption technique on wide area through integrated approach
- Destroy rosette flowers and remove the dropped squares, dried flowers and pre-matured bolls to suppress pest population periodically at the initial stage.
- Adopt efficient and timely agronomic practices such as use of organic manures and recommended doses of 'N' fertilizers only.
- Release of *Trichogramma* @ 60,000/acre at the time of peak flowering stage to facilitate the egg parasitism
- Need based use of insecticides: Spraying of insecticides like thiodicarb 75 WP @ 1.5 g/l or profenophos @ 2 ml/l or quinalphos 25 EC @ 2.5 ml/l or chlorpyriphos 20 EC @ 2.5 ml/l at 15 days interval.
- If the crop is at final stage, spray synthetic pyrethriods such as cypermethrin 10 EC @ 1.25 ml/l or lambda cyhalothrin 5 EC @ 1.0 ml/l (caution- Use of synthetic pyrethroids will increase the incidence of sucking pests).

  Timely crop termination without extending the crop through irrigation and fertilizers as late formed bolls may severely attract pink boll worm incidence and taking up the sequential crop depending up on the resources available.

Management of Cotton Diseases:

Bacterial blight: Angular leaf spots develop and spread through veins causing vein blight. Under severe conditions disease spreads to branches causing black arm. Dark green spots develop on bolls which turn black and bolls rot.
Control: Seed treatment with *Pseudomonas fluorescens* @ 10 g/kg seed; spraying copper oxy chloride 3.0 g/l starting from 50 days after sowing, 2-3 times, at fortnightly intervals.

Alternaria leaf spot: Brown spots with concentric rings develop on leaves, join together and dry; defoliation occurs. Lesions on stem extend and break.

Corynespora leaf spot: Round to irregular, reddish brown spots white depression in the centre and target board appearance and sometimes surrounded by yellowish green halo.

Helminthosporium leaf spot: Light brown spots with ashy centres and red margins

Cercospora leaf spot: Dark brown circular spots with white centres and purple margins develop on leaves.
Control: For the control of leaf spots seed treatment with *P. fluorescens* @ 10 g /kg of seed; spraying copper oxy chloride 3 g/l or propiconazole 1ml/l or captan + hexaconazole 2ml/l or starting from 50 DAS, 2-3 times, at fortnightly intervals.

Grey mildew: Angular, white, powdery spots develop on leaves, spread and defoliation occurs. **Control:** Spraying water soluble sulphur 3 g/l or kresoxim methyl @ 1ml/l 2-3 times, at 10-15 days interval.

Rust: Yellowish brown to reddish brown pustules develop on both sides of the leaves.
Control: Spraying water soluble sulphur 3.0 g/l or propiconazole 1.0 ml/l, starting from 75 DAS, 2-3 times, at fortnightly intervals.

Boll Rots: Dark spots or lesions develop on bolls.
Control: Spray copper oxy chloride 3.0 g/l, 2-3 times at 7-10 days interval.

Root rot: Sudden death of young plants in patches, roots become sticky and bark shreds in grown up plants.

Fusarium wilt: Damping off symptoms at seedling stage, lower leaves wilt early and drop. Brown streaks are visible in split open branches or stems, sometimes with black spores.
Verticillium wilt: Interveinal chorosis and dark lesions develop on leaves with appearance of tiger stripes, brown discolouration is visible in split open stems, branches and also inside the bark, plants die in the centre of infected patch.
Control: Seed treatment with *Trichoderma viride* @ 10 g or *P. fluorescens* @ 10 g or soil application of *T. viride* or *P. fluorescens* @ 1 kg/acre developed in 90 kg FYM or vermicompost along with 10 kg of neem cake; balanced Nitrogen application and correcting micronutrient deficiencies; soil drenching at the base of infected plants with copper oxy chloride @ 3.0 g/l.
Tobacco Streak Virus Disease: The symptoms includes large yellow or brown necrotic lesions on the leaves, squares and bolls. Stunting of the plants with fewer bolls, boll shredding and reduced canopy.

Management:

- Clean cultivation: Removal of *Parthenium* before flowering
- Stem application with imidacloprid in 1:20 ratio at 60 DAS
- Correction of micronutrient deficiencies
- Erection of blue sticky traps @ 15-20 per acre
- Avoid indiscriminate use of nitrogen fertilizers and do not use urea after 80-90DAS
- Sowing of 2-4 thick rows of Maize or Sorghum as border crop
- Vector Management: Spraying of botanicals like 5% NSKE or neem oil 1500 PPM @ 1 l/acre
- Spraying of chemicals like fipronil 5 SC @ 400ml or acephate 75 SP @ 300g or imidacloprid 17.8 SL @ 80ml or acetamiprid 20 SP @ 40g or thiamethoxam 25 WG @ 40g per acre in rotation.

Harvesting :

1. *Kapas* from fully opened bolls should be collected during cooler times of the day.
2. *Kapas* picked should be free from debris like dried leaves, dried bracts etc.
3. *Kapas* from the first and last pickings should not be mixed with middle pickings, which are of better quality.

4. *Kapas* damaged by bollworms should be picked separately.
5. The cleaned *kapas* is to be graded and stored in heaps or in gunny boras in dry and well ventilated godowns.

Post-harvest handling of cotton:

1. It is essential that proper care is taken at various stages of handling and processing to ensure that the quality of cotton is not adversely affected so as to realize maximum price.
2. Watering the *kapas* before weighment should be avoided.
3. Admixtures of different varieties should be avoided. The admixture of the inferior type lowers the quality of the superior type, due to differences in the fiber quality traits.
4. Only one variety of cotton should be heaped and packed to maintain the purity and quality of the cotton.
5. For supply of high quality of cotton, proper packing should be done to protect from contamination and dampness.
6. Storing in open yards at the market should be avoided.
7. The seeds from infested and immature bolls being more fragile get crushed during ginning resulting in staining of lint by the oil oozing out of the cut-seeds. This oil acts as a medium for growth of the micro-organisms which will destroy the lint. So, the infested *kapas* should be separated.

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