

## Approved Package of Practices for Cotton: Punjab State

Cotton is an important *kharif* crop of the Punjab State. It was grown on 509 thousand hectares in 2004 – 2005. The total production was 2087 thousand bales. The average lint yield for the state as a whole was 697 kg per hectare.

### Hints for high yield of cotton

1. Grow only recommended and early maturing varieties resistant to cotton leaf curl viral disease.
2. Eradicate alternate hosts of cotton leaf curl virus / volunteer cotton plants before sowing, to avoid the multiplication and spread of diseases.
3. Must soak delinted seed in water for 2 – 4 hours.
4. Heavy pre – sowing irrigation is must to obtain good germination and early establishment of plants.
5. Complete the sowing during April. It will help to escape the attack of American bollworm to great extent.
6. Avoid growing *bhindi*, *moong*, *arhar*, *castor*, *dhancha* in and around the cotton fields to avoid simultaneous build up and spread of pests and diseases to cotton.
7. Maintain the plant to plant spacings of 60 cm for American cotton varieties and 45 cm for *desi* cotton varieties through manual thinning after first irrigation.
8. Avoid sowing American cotton in / or near the orchards.
9. The incidence of insect pests increases with excessive use of nitrogenous fertilizers, hence use only recommended dose.
10. Spray to control jassid only when it reaches economic threshold level of second injury grade i.e. marginal cupping of leaves.
11. Give 3 – 4 sprays of 2% potassium nitrate starting at flower initiation.
12. Avoid using synthetic pyrethroids after September 15 to minimize resurgence of whitefly. Prefer to use triazophos and ethion to control whitefly.
13. Avoid tank mixing and use of readymade insecticidal mixtures.
14. Control American bollworm at the initial stages. Use chlorpyrifos / spinosad / acephate / indoxacarb for the control of larvae when their length is more than 1.25 cm.
15. The incidence of insect pests increases with excessive use of nitrogenous fertilizers, hence use only recommended dose.
16. Use chlorpyrifos / thiodicarb / acephate / quinalphos / endosulfan against tobacco caterpillar taking into consideration the pest complex.
17. Follow Insecticide Resistance Management (IRM) strategy for effective management of insect pests.
18. Use fixed type hollowcone nozzle which discharges 600 ml of spray material per minute for efficient pest control.

## Important hints for Bt Cotton

1. Grow only recommended hybrids (RCH 134, RCH 317, MRC 6301, MRC 6304) of Bt Cotton.
2. Avoid sowing Bt Cotton in light sandy soils.
3. Give first irrigation 4 – 6 weeks after sowing depending on soil type.
4. Control sucking pests and tobacco caterpillar as and when situation arises.
5. Grow non Bt – cotton as refuge on the periphery of Bt cotton to prevent development of resistance against Bt in bollworms. If 20 percent area is under refuge then it should be protected against bollworms by using recommended insecticides but if refuge occupies only 5 percent area then it should not be protected.

## Climatic Requirements:

A daily minimum temperature of 16 degree C is required for germination and 21 degree C to 27 degree C for proper crop growth. During the fruiting phase, the day temperature ranging from 27 degree C to 32 degree C and cool nights are needed. The cotton – picking period from mid – September to November must have bright sunny days to ensure a good quality of the produce.

**Soil Type:** Cotton can be successfully grown on all soils except sandy, saline or waterlogged types. Proper drainage of excess water during rains is essential.

## Rotations

Cotton – Fallow  
Cotton – Wheat / Barley  
Cotton – Sunflower  
Cotton – Senji / Barseem / Oats  
Cotton – Sunflower – Paddy – Wheat

## Agronomic Practices

**Land Preparation :** A fine seed – bed is essential for securing good plant stand.

<i>Varieties/hybrids</i>	<i>Seed rate (kg/acre)</i>
<b>American Cotton</b>	
Hybrids :	LHH 144, Ankur 651 and Whitegold 1.5
Varieties :	F 1861, F 1378, F 846 and LH 1556 3.5
<b>Desi Cotton</b>	
Hybrids :	Moti 1.25
Varieties :	LD 694 and LD 327 3.0

**Acid Delinting of Cotton Seed:** Mix 400 g commercial grade concentrated sulphuric acid with 4 kg cotton seed for American cotton and mix 300 g commercial grade of sulphuric acid with 3 kg seed of *desi* cotton in either / plastic container by stirring it vigorously for two to three minutes with a thick wooden or glass rod. As soon as the fuzz gets dissolved, add 10 litres of water, stir well and drain out water through the perforated plastic basket. Repeat these washings three times to make the seed free from sulphuric acid residue. Dip the washed seed for about one minute in sodium bicarbonate solution (50g sodium bicarbonate in 10 litres of water) to neutralize the acid residue on the cotton – seed. Give one more washing with water and remove light, damaged and rotten inviable seeds floating on the surface. Dry the healthy fuzz free seed in the shade by spreading in a thin layer. Treat the dry seed with recommended fungicides.

### **Precautions**

1. Metal or wood container should not be used.
2. The operator should wear the plastic gloves
3. The water containing acid and alkali residue should be properly disposed off in the waste land.
4. Inadequate washing and delayed washing of the seed after acid treatment and residual acid on the seed if not neutralized may impair the germination of seed.

**Seed Treatment:** Add half gram (0.5 g) Emisan – 6 and one fourth gram (0.25 g) of Streptocycline for one kg cotton seed in one litre of water. In case of acid delinted seed soak the seed for 2 – 4 hours and for non – delinted seed 6 – 8 hours. Also add half g succinic acid in 5 litres of water to promote good establishment of plant stand, better early growth and more yield. After this treatment, the cotton seed should be smeared with Gaucho 70 WS (Imidacloprid) @ 5 g/kg seed for preventing damage by cotton jassid.

In case undelinted seed is used, rub it with fine earth, cowdung or ash to remove its fuzz and ensure its uniform distribution.

**Time of Sowing:** Whole of April

**Note :** Sowing during this period ensures better yield and escapes the attack of insect pests and diseases.

**Sowing and Spacing :** Sow in lines 67.5 cm apart with a cotton sowing drill. The plants within rows be kept 60 cm apart at thinning in case of narma and 45 cm in case of desi cotton. However, for hybrid LHH 144, Ankur 651 and Whitegold plant to plant distance should be kept at 75 cm. It may be done after first irrigation or heavy showers. For Moti Hybrid the plant to plant spacing should be kept at 60 cm.

**Ridge Sowing :** Sowing of cotton on ridges prepared with cotton planter and irrigating the crop planter and irrigating the crop in furrows saves considerable amount of irrigation water without reduction in seed cotton yield.

**Weed Control :** Hoe two or three times. The first hoeing should be done before first irrigation. For hand weeding, use of a weel hoe is recommended. A tractor drawn cultivator or bullock driven Triphali can also be used in the early stages of the crop growth but their use after fruit initiation should be avoided. Chemical weed control in cotton is cheap and efficient. For control of weeds particularly its it (*Trianthema portulacastrum*), Madhana / Makra (*Eleusine spp*), apply Treflan 48 EC, Shaktiman Triflurex 48 EC (trifluralin) @ 1.0 litre / acre on a well prepared seed bed and incorporate these herbicides thoroughly in 3 – 4 cm soil or stomp 30 EC @ 1.0 litre / acre as pre – emergence within 24 hours of sowing. Weeds start emerging at about 5 – 6 weeks after application of herbicide. Give one hoeing / interculture around 45 days after sowing to control these weeds.

Alternatively, in place of hoeing / interculture apply Gramoxone 24 percent WSC (paraquat) 500 ml / acre or Roundup 41% SL / Glycel 41% SL (Glyphosate) 1.0 litre / acre in 100 litres of water (6 – 8 weeks ) after sowing when the crop is about 40 – 45 cm in height as a directed spray to control weeds in – between the crop rows. To avoid drift, spray these herbicides on non – windy days. The directed spray can be done using knap – sack sprayer fitted with flat fan nozzle and keeping the boom height low ( 15 – 20 cm above the ground level ) or using a protective hood so that herbicide does not fall on crop leaves. Both paraquat and glyphosate are non – selective herbicides and can cause injury to the crop if it falls on the crop leaves. However, falling of herbicides on stem of the plant is not harmful. In situations where perennial weeds are a problem, glyphosate is more effective and provides long duration control.

In situations where *its it* emerges after 'first irrigation or with the rain shower Stomp @ 1.0 litre/acre can also be applied as post- emergence after first irrigation to cotton. If the weeds emerge before the application of the herbicide, a light hoeing/interculture may be done as the Stomp does not control the emerged weeds. Dissolve the herbicide thoroughly in 200-250 litres of water/acre and spray it uniformly with a knap sack sprayer fitted with flat fan or flood jet nozzle. The herbicide can also be sprayed with tractor mounted sprayer fitted with flat fan nozzle. For getting good results with the herbicide, following precautions should be taken:

- Prepare a fine seed bed free from plant residues and clods ensure adequate moisture in the field at the time of spray of herbicide.
- Spray of the herbicide should be done either in the morning or evening hours

**Fertilizer Application:** Cotton responds well to the application of nitrogen. In certain areas, the crop shows some response to the application of phosphatic fertilizers.

Drill all phosphorus with the last ploughing. Apply half N at thinning and the remaining half at the appearance of the first flower for all varieties except LH 1556.

For LH 1556 the first half dose of N may be applied alongwith phosphorus at sowing and remaining half of N around mid-July. If the soil is low in fertility, the first half dose of N may be applied at sowing instead of at thinning. Apply 20 kg muriate of potash and 10 kg zinc sulphate per acre to cotton on light soils. To get higher yields, give four sprays of 2% potassium nitrate at weekly interval starting at flower initiation in addition to soil applied fertilizers.

The following fertilizer recommendations are made:

		<i>*Nutrients (kg/acre)</i>		<i>Fertilizers (kg/acre)</i>		
		<i>N</i>	<i>P<sub>2</sub>O<sub>5</sub></i>	<i>Urea (46% N)</i>	<i>DAP or (18% N 46% P<sub>2</sub>O<sub>5</sub>)</i>	<i>Super- Phosphate (16% P<sub>2</sub>O<sub>5</sub>)</i>
(A)	Varieties	30	12	65	27	75
(B)	Hybrids	60	12	130	27	75

\* These nutrients can also be supplied from other fertilizers available in the market

\*\* Where 27 kg DAP is used, reduce the urea dose 10 kg.

**Note:** Omit application of phosphorus to cotton when it follows wheat which received recommended dose of phosphorus.

**Irrigation and Drainage:** Cotton requires four to six irrigations, depending upon the seasonal rainfall. The first irrigation should be given 4 to 6 weeks after sowing and the subsequent ones at interval of two or three weeks sowing cotton on ridges and irrigation in furrows save considerable amount of water. The crop must not be allowed to suffer for want of water during the flowering and fruiting stages, otherwise a lot of shedding of flowers and bolls will take place resulting in low yield cotton during its early growth is very sensitive to water stagnation. Therefore, drain out the stagnant water, if such a situation arises. To hasten boll opening give the last irrigation by the end of September.

**Caution:** On light soils and in crop sown on ridges, the first irrigation may be advanced if necessary.

### Hybrid Seed Production

**LHH 144:** This is a cross between PIL 43 (Female parent) having okra lobed leaves and PIL 8 Miah (male parent). The hybrid seed is produced by hand emasculation of flower buds of female parent and pollination by flowers of male parent. The seed of parental lines should be purchased from Punjab Agricultural University every year to maintain genetic purity. The emasculated female bud is covered with soda straw

pipe and the male flower is tied with a 3” piece of a thread in the evening. The tied male flowers are used for pollinating the emasculated female buds in the morning. A piece of thread is tied to the stalk of the bud after pollination which serves as a marker for crossed boll.

### Characteristics of Parents

**PIL 43:** The female parent of LHH 144 has bushy plant habit with 3.4 monopods, okra type narrow lobed green leaves, creamy white flower and pollen. It has bold seeds. It matures in about 185 days.

**PIL 48:** The male parent of LHH 144 has compact plant type with 0 – 1 monopod and about 130 cm plant height. It has medium lobed green leaves, creamy white flowers and matures in about 165 days.

**Isolation of hybrid seed plot:** The hybrid seed production field should have an isolation of 50 meters from other American cotton varieties and 5 meters between male and female plots to ensure the genetic purity of the seed.

**Seed Rate and Spacing in Hybrid Seed Plot:** One acre hybrid seed production plot requires 6 kanal area under female parent and 2 kanal area under male parent with the following seed rate and spacing

<i>Parental lines</i>	<i>Seed rate (kg/acre)</i>	<i>Spacing (cm) LHH 144</i>
Female	3.0	67.5 × 90
Male	1.5	67.5 × 60

The skipping of one row after every two rows in female plot gives better setting of crossed bolls. In LHH 144 hybrid seed production 50 percent of the male parent should be sown along with female parent and the remaining 50 percent 10 – 15 days later to get sufficient number of male flowers for crossing.

**Rougeing:** Off – type plants based on plant colour, leaf shape, flower colour etc., if any, should be rogued to maintain purity of parental lines.

**Seed Production Technique:** The F1 hybrid seed is produced by the placement of functional pollen of the desired male parent on to the receptive stigma of the emasculated female at right time. Emasculation of flowers is done from 3 PM to 6 PM by removing the anthers with thumb nail before maturity (anthesis) and pollinate the next morning from 8 AM to 10 AM when stigma is receptive. Avoid too young or too old buds. The male flowers to be taken for pollination should be selfed the previous evening to avoid contamination by insects. For identification of crossed bolls at maturity the crossed flower buds should be tagged in order to enhance the setting percentage unattempted flowers and naturally formed bolls should be removed . Hybrid seed plot should be kept free from weeds and special care should be taken to prevent damage due to insect pests and diseases.

**Picking, Storing and Ginning:** The kapas from crossed healthy and marked bolls should be picked, stored and ginned separately. The cleaned seed should be labeled and stored in a clean dry place. Its genetic purity and germination should be tested before use.

## **Hybrid Seed Production**

### **Moti: Desi Cotton Hybrid:**

This hybrid is produced by crossing DS – 5 (female parent) with LD 210 (male parent). DS – 5 is a genetic male sterile line and, thus there is no need of emasculating the female flowers. Crossing is accomplished by applying pollen from freshly opened flowers of the male parent on the stigma of the freshly opened flowers of the female parent.

### **Maintenance of Parental lines**

**Female Parent (DS – 5):** The male sterile line is maintained by pollinating the male sterile plants with pollen from male fertile plants of the same line. Since male sterility DS – 5 is controlled by a single recessive nuclear gene, so we always get a mixture of male sterile and male fertile plants in 1: 1 ratio.

The male sterile plants are identified on the basis of their small, whitish and shriveled anthers. The male fertile plants have well developed anthers and after flower opening the anthers are covered with bright yellow pollen grains. Freshly opened flowers on male sterile plants are pollinated with pollen from male fertile plants in the morning (9.00 – 11.00 AM). Pollination is done by rubbing the anthers of fertile flowers in the stigma of male sterile flowers. For identification of cross these artificially pollinated flowers, a thread is tied to the pedicel of the flowers immediately after pollination.

**Male Parent (LD 210):** This is a normal male fertile genotype. It is maintained just like other varieties by following normal seed production and certification norms. Care should be taken to maintain maximum genetic purity.

### **Characteristics of Parents**

**DS – 5** It is generic male – sterile line. The male – sterile plants are identified on the basis of their small, shriveled and whitish anthers. It has green plant body with narrow deep cut leaves, creamy white flowers and monopodial plant habit.

**LD 210** Green plant body with narrow lobbed deep cut leaves, white flowers, plant habit semi sympodial.

## Production of hybrid seed

**Isolation of hybrid seed plot:** The hybrid seed production plot should have an isolation of 50 meters from other desi cotton varieties and 5 meters between male and female plots to ensure genetic purity of the seed.

**Seed rate and Spacing in hybrid seed plot:** One acre hybrid seed production plot requires 6 kanal area under female parent and 2 kanal area under male parent with the following seed rate and spacing.

<i>Parental lines</i>	<i>Seed rate (kg/acre)</i>	<i>Spacing (cm)</i>
DS-5 (Female Parent)	2.0	67.5 × 45
LD 210 (Male Parent)	1.0	67.5 × 45

The skipping of one row after every two rows in female plot gives better setting of crossed bolls.

**Roughing:** In the female parent, 50% plants are expected to be male – fertile. These plants are identified by examining the first opened flower and roughed out. This is necessary to obtain a pure stand of the male – sterile plants.

**Crossing Procedure:** For production of hybrid seed, freshly opened flowers of the male parent (LD 210) are used as source of pollen. Pollen is applied in the morning (9.00 – 11.00 AM) by rubbing anthers of the male flower on the stigma of freshly opened flowers of female parent (DS – 5). For identification of crossed bolls, threads are tied to the pedicel of cross pollinated flowers. In order to enhance the setting percentage, unpollinated flowers and naturally pollinated bolls should be removed. Hybrid seed plot should be kept free from weeds and special care should be taken to control insects and diseases. The crop should not suffer from moisture stress flowering stage as it will lead to shedding of flowers / bolls.

**Picking, Storing and Ginning:** The Kapas from crossed healthy and marked bolls should be picked, stored and ginned separately. The cleaned seed should be labeled and stored in a clean dry place. Its genetic purity and germination should be tested before use.

## Plant – Protection Measures

### Insect Pests Management (Bt cotton)

BT cotton does not provide effective control of sucking pests and tobacco caterpillar. Among sucking pests, jassid, aphid and whitefly are most serious on Bt cotton and they cause maximum damage during July – September. Nymphs and adults of jassid suck sap from leaves and cause shedding in case of severe



infestation. Whitefly adults and nymphs suck sap from leaves and excrete honey dew on leaves which become sticky. Affected leaves and seed cotton turn black due to development of sooty mould. Aphids appear sporadically. The nymphs and adults of aphid suck sap and excrete honey dew on leaves on which black fungus develops.

Tobacco caterpillar is a polyphagous pest. The larvae cause serious damage to crop from August to October. The small larvae are black whereas grown up larvae are dark green with black triangular spots on body. Its moths lay eggs in masses covered with brown hairs on the lower side of mature leaves. After hatching, first and second instar larvae feed gregariously and skeletonize the foliage. Later on grown up larvae disperse and feed singly. Besides leaves, they also damage the buds, flowers and green bolls.

Spotted, pink and American bollworms may also attack Bt cotton late in the season. Due to attack of these bollworms shedding of flowers and bolls may occur.

For effective protection of Bt cotton, it is necessary to adopt the following Integrated Pest Management strategies.

#### **A. Cultural and Mechanical Control**

- i. Grow only recommended Bt cotton hybrids.
- ii. Complete sowing in the April.
- iii. Avoid growing castor, moong, dhaincha and bhindi in and around the Bt cotton. These are the most preferred hosts of tobacco caterpillar, helping the pest to multiply and shift to cotton.
- iv. Keep the fields free from the weed, itsit as acts as an alternate host of tobacco caterpillar.
- v. Egg masses and young larvae of tobacco caterpillar feeding gregariously should be collected along with leaves and destroyed.

#### **B. Monitoring of bollworms and tobacco caterpillar with sex pheromones**

The monitoring of bollworms and tobacco caterpillar should be done with the initiation of flowering stage of crop. Observations on moth catch should be recorded on every alternate day. This monitoring strategy will help in making decision for effective management of bollworms and tobacco caterpillar.

**Pink bollworm** Using Sticka / Delta traps with at least 10 micro litre of gossypure and place it at 15 cm above crop canopy. Replace the lure after 15 days and use 1 trap / ha.

**Spotted / Spiny bollworms:** Use Sleeve / Moth catch traps for spotted bollworms and replace the lure at 15 days interval. Place the trap at 15 cm above the crop canopy and use 2 traps / ha.

**American bollworm:** Use Sleeve / Moth catch trap with at least 2 mg of pheromone and place it at 15 cm above crop canopy. Replace the lure after 15 days and use 2 traps / ha.

**Tobacco Caterpillar:** Use sleeve / moth catch trap for tobacco caterpillar. Replace the lure after every 15 days. Place the trap 15 cm above crop canopy and use 2 traps / ha.

### C. Chemical Control

- a) **Sucking insect pests:** The decision regarding spray of insecticides should be taken based on economic threshold (ETH). Initiate spray against jassid whenever some of the fully formed leaves in the upper canopy show curling and yellowing at the margins on 50 percent of the plants. Sprays against whitefly should be done when population reaches six adults per leaf in the upper canopy of plants before 10 Am or when honey dew appears on 50% of the plants. Spray against aphid should also be done on the appearance of honey dew on 50% plants (Table 1).
- b) **Tobacco Caterpillar :** Bt Cotton does not provide protection against tobacco caterpillar. Tobacco caterpillar can cause severe damage to the Bt crop if not controlled in time. For effective control of this pest, insecticides mentioned in table 2 should be sprayed when the need arises.
- c) **Bollworms :** Bt cotton provides effective protection against all cotton bollworms. However, regular monitoring should be done at weekly interval during reproductive phase. Farmers should examine their fields twice a week in order to ensure that bollworms damage does not exceed 5 percent in shed flowers and bolls. For this purpose divide the field into four quarters and collect 25 freshly shed flowers and bolls at random in each quarter. The bolls damaged by bollworms will have feeding holes or their larvae. In case the damage exceeds 5 percent, the crop should be sprayed immediately and thereafter spray as when need arises. If at all American bollworms cross ETH level during late crop season, use insecticides as mentioned in table 2. Prefer spinosad and indoxacarb for the control of American bollworm during September.

**Resistance management:** To avoid the development of resistance in Bt cotton to bollworms, 20 percent area should be sown under non – Bt cotton hybrids around Bt cotton. The non - Bt hybrids should be protected against damage by insect pests as mentioned in case of non – Bt cotton hybrids. Alternatively 5 percent area of non – Bt hybrids can be sown around Bt cotton and this should be kept unsprayed.

## **Insect Pests Management (Non – Bt Cotton)**

Bollworms are the most harmful insects which attack cotton in the Punjab. Spotted bollworms damage growing points during May – June and cause heavy shedding of squares, buds, flowers and bolls during July to October. The American bollworms causes severe shedding of fruiting bodies during September – October especially on American cotton. The colour of its larvae greatly varies. They have one line on upper side and two wavy lines on lateral side of body. Their body also has sparse hairs. Pink bollworm does maximum damage from mid – July to mid – October. Due to severe attack of bollworms, the plants continue to grow without having adequate number of bolls.

Tobacco caterpillar is a polyphagous pest. The larvae cause serious damage to crop from August to October. The small larvae are black whereas grown up larvae are dark green with black triangular spots on body. Its moths lay eggs in masses covered with brown hairs on the lower side of mature leaves. After hatching, first and second instar larvae feed gregariously and skeletonize the foliage. Later on grown up larvae disperse and feed singly. Besides leaves, they also damage the buds, flowers and green bolls.

Amongst sucking pests, jassid and whitefly are most serious on American cotton and they cause maximum damage during July – September. Nymphs and adults of jassid suck sap from leaves and cause shedding in case of severe infestation. Whitefly adults and nymphs suck sap from leaves and excrete honey dew on leaves which become sticky. Affected leaves and seed – cotton turn black due to development of sooty mould. Whitefly also transmits cotton leaf curl virus in American cotton. Aphids appear sporadically. The nymphs and adults of aphid suck sap & excrete honey dew on leaves on which black fungus develops.

The larvae of leaf – roller, semi – loopers, hairy – caterpillars and bud moth may also appear sporadically and damage the crop during July – October.

For effective protection of cotton, it is necessary to adopt the following Integrated Pest Management approach based on cultural, mechanical and chemical control measures.

### **(A) Cultural and Mechanical Control**

- i. Burn all trash collected during the ginning process. Remove all seed from the ginneries by the end of April. Fumigate the seed left uncrushed in the mills before end of May with Celphos / Phostoxin / Delicia @ one 3 – g tablet per cubic metre space, giving an exposure of 48 hours or use two tables with an exposure of 24 hours. No un – fumigated seed should be retained are slod by the ginner is only cotton – seed cake (khal) should be fed to the cattle and no seed should be kept for this purpose.

- ii. The seed meant for sowing should be acid – delinted in the ginneries before it is sold. The acid – treatment kills the larvae of the pink bollworm and the bacterial pathogen of bacterial blight. It also removes fuzz and thereby facilitates mechanical sowing.
- iii. Even the apparently healthy seed – cotton (kapas) may be harbouring larvae of pink bollworm. Hence, kapas retained by the farmers should be ginned by the end of March and seed fed to cattle. If this seed is to be retained for sowing. It should be acid – delinted / fumigated or thoroughly dried in the sun in a thin layer for 3 – 4 consecutive days in April.
- iv. Sow only recommended varieties / hybrids because they are moderately resistant to jassid and due to their early maturity they also escape the late – season attack of bollworms.
- v. Terminate the crop as early as economically feasible. For this purpose give last irrigation by end of September. It would reduce bollworms damage and their carryover.
- vi. After the last picking, allow sheep, goats and other farm animals into cotton fields to feed on plant debris and un – opened bolls.
- vii. Stacking of cotton sticks in a shaded place and in horizontal position favours the survival of the over wintering larvae of pink bollworm. Stacking in the field helps in easier spread of the first brood. Therefore, bundles of sticks should be stacked vertically in the open within the village premises. Before stacking the sticks, dislodge the burs and unopened bolls by beating them against the ground or just pluck them. The burs and bolls so collected should be burnt immediately.
- viii. Uproot and destroy the alternate host plants of spotted bollworms like kanghi buti and peeli buti, growing on field bunds, water channels and waste land in the area during the off – season of cotton. Repeat these operations at monthly interval upto the end of May.
- ix. Avoid growing bhindi, moong and arhar in the cotton crop and as border rows in order to reduce the incidence of Helicoverpa, spotted bollworms, jassid and whitefly. Bhindi, moong, dhaincha and castor are also the most preferred hosts of tobacco caterpillar, helping the pest to multiply and shift to cotton. The above pests on these crops grown in the vicinity of cotton fields, should be properly controlled in order to check their migration to the cotton crop.
- x. Egg masses and young larvae of tobacco caterpillar feeding gregariously should be collected along with leaves and destroyed.

### **(B) Monitoring of bollworms with sex pheromones:**

The monitoring of bollworms should be done with the initiation of flowering stage of crop. Observations on moth catch should be recorded on every alternate day. This monitoring strategy will help in making decision for effective management of bollworms.

**Pink bollworm:** Use Sticka / Delta trap with at least 10 micro litre of gossyplure and place it at 15 cm above crop canopy. Replace the lure after 15 days and use 1 trap / ha.

**Spotted / Spiny bollworms:** Use Sleeve / Moth catch traps for spotted bollworms and replace the lure at 2 weeks interval. Place the trap at 15 cm above the crop canopy and use 2 traps / ha.

**American bollworm:** Use Sleeve / Moth catch trap with at least 2 mg of pheromone and place it at 15 cm above crop canopy. Replace the lure after 15 days and use 2 traps / ha.

### (c) Chemical Control

**(a) Sucking pests:** The decisions regarding spray of insecticides are taken based on economic threshold (ETH). Initiate spray against jassid whenever some of the fully formed leaves in the upper canopy show curling and yellowing at the margins on 50 percent of the plants. Sprays against whitefly should be done when population reaches six adults per leaf in the upper canopy of plants before 10 AM or when honeydew appears on 50% of the plants. Spray against aphid should also be done on the appearance of honeydew on 50% plants.

#### **Insecticides for the control of sucking insect pests**

<b>Insecticides</b>	<b>Dose</b>	<b>Brand (s)</b>
<b>Jassid</b>		
<b>(a) Seed treatment:</b> At the time of sowing smear the seed with any of the following insecticides.		
i. Imidacloprid 70 WS	5 g/kg seed	Gaucho
ii. Thiomethoxam 70WS	3 g/kg seed	Cruiser
<b>(b) Spray:</b> Spray any of the following insecticides, if incidence is noticed in standing crop.		
i. (a) Imidacloprid 200 SL	40 ml/acre	Confidor
(b) Imidacloprid 555/	40 ml/acre	Confidence
(c) Imidacloprid 17.8 SL	40 ml/acre	Imidacel
ii. Acetamiprid 20 SP	20 g/acre	Pride/Rapid
iii. Thiomethoxam 25 WG	40 g/acre	Actara/Extra super
<b>Whitefly</b>		
i. Triazophos 40 EC	600 ml/acre	Hostathion
ii. Ethion 50 EC	800 ml/acre	Fosmite/E-mite/ Volthion

Note: Insecticide for jassid control is also effective against aphid

**(b) Bollworms** : In order to control bollworms, conduct sprays on different varieties during their effective boll formation period based on economic threshold (ETH). Farmers should examine their fields twice a week in order to ensure that bollworms damage does not exceed 5 percent among the freshly shed fruiting bodies (squares, buds and young bolls). For this purpose divide the field into four quarters and collect 25 freshly shed fruiting bodies at random in each quarter. The fruiting bodies damaged by bollworms will have feeding holes or their larvae. In case the damage exceeds 5 percent, the crop should be sprayed immediately and thereafter spray as when need arises. The effective boll formation period of different varieties / hybrids of American cotton during which spray of insecticides should be done is as follow:

**Effective boll formation period in different varieties / hybrids of American Cotton**

Variety / hybrid	Effective boll formation period
LH 1556, Ankur 651 and White gold F 1378, F 846, F 1861 and LHH 144	4 <sup>th</sup> week of July to mid September 2 <sup>nd</sup> week of August to 1 <sup>st</sup> week of October
Long duration under script varieties	3 <sup>rd</sup> week of August to October

**Desi Cotton:** In case of desi cotton, the first spray against bollworms should be done when 25 percent plants start producing squares. Subsequent spray should be need based.

**Detopping:** Desi cotton grown on medium to high fertility soils generally attain unmanageable height for effective spraying against bollworms. The top portion of plants with excessive height usually remains unsprayed. Fruiting bodies of these uncovered plant portions contribute very little towards yield but greatly help in bollworms build up. Plants attaining height more than 1.5m should be detopped as and when required by using pruning scateur / sickle / green mulberry stick.

**Insecticide Resistance Management (IRM) Strategy:** IRM is component of Integrated Pest Management (IPM) programme. The adoption of this strategy helps in reducing / delaying the insecticide resistance to insects. It also increases function life of the insecticides.

**1. Sucking pests management (Sowing – first week of July)**

- Sow recommended varieties which are resistant to sucking pests and cotton leaf curl virus to avoid early sprays.
- Destroy alternate hosts of cotton leaf curl virus and whitefly.
- Timely sowing, judicious use of fertilizers, irrigation, proper spacing and clean cultivation will prevent the early build up of pests and help conserve natural enemies.

- Treat seed with Gaucho / Cruiser to control the cotton jassid in susceptible cultivars.
- Do not use any insecticide during this period to conserve natural enemies.
- Do not spray against thrips and black semilooper, as they do not cause any economic damage to the crop.

## 2. Sucking pests and bollworms management (Second week July – first week of August)

- Use endosulfan for bollworms infestation as it is less toxic to natural enemies. It gives moderate control of cotton jassid also.
- Avoid the use of synthetic pyrethroids for the control of spotted bollworms (SBW). Use them only if endosulfan fails to give satisfactory control.
- Avoid the use of nitogvadine compounds against jassid as these are toxic to natural enemies.
- Do not use organophosphates / carbamates against bollworms.

## 3. Bollworms and tobacco caterpillar management (Mid to end August)

- Use profenophos / quinalphos / carbaryl in alternation with synthetic pyrethroids for the control of bollworms.
- Prefer the use of acephate for the control of grown up larvae of American bollworm. It will also provide effective control of tobacco caterpillar.
- Use spinosad only in case of severe infestation of American bollworm.

## 4. Bollworms and tobacco caterpillar management (September – October)

- Use profenophos / triazophos / quinalphos / thiodicarb for younger larvae of American bollworm. Prefer chlorpyrifos for grown up larvae. Chlorpyrifos, thiodicarb and quinalphos will also provide effective control of tobacco caterpillar.
- Use indoxacarb / spinosad in case the American bollworm is serious.
- Use triazophos / ethion for the management of whitefly. It will also provide effective control of pink bollworm and spotted bollworms.

### Insecticide for the control of bollworm in cotton

Insecticides	Dose per acre	Brand (s)
<b>Pink and spotted bollworms</b>		
<b>A. Synthetic Pyrethroids</b>		
i. Alphamethrin 10 EC	100 ml	Fastac/Alphagaurd/Merit Alpha
ii. $\beta$ -cyfluthrin 0.25 SC	300 ml	Bulldock
iii. (a) Cypermethrin 10 EC	200 ml	Ripcord/Bilcyp/Bullet/Ustad/Cypergaurd
(b) Cypermethrin 25 EC	80 ml	Cymbush/Cyperkill/Hillcyper/Colt/Basathrin/Agrocyper/Cypergaurd

iv. Deltamethrin 2.8 EC	160 ml	Decis/Rukrain/Decicare
v. Fenvalerate 20 EC	100 ml	Sumicidin/Fenval/Agrofen/Fenlik/Triumphcard/ SB Fenvalerate/Milfen/Markfenval
vi. Fenpropathrin 10EC	300 ml	Mesthrin

**Pink, spotted and younger larvae of American bollworm**

<b>A. Carbamates</b>		
i. Carbaryl 50 WP	1 kg	Sevin/Hexavin
ii. Thiodicarb 75 WP	250 g	Larvin
<b>B. Organochlorinate</b>		
iii. Endosulfan 35 EC	1 litre	Thiodan/Endocel
<b>C. Organophosphates</b>		
iv. Profenophos 50 EC	500 ml	Curacron/Carina/Profex/Celcron
v. Monocrotophos 36 SL	500 ml	Corophos/Milphos/Markphos/Nuvacron/Phoskill/Monocil/ Monolik/Kadett/SB Monocrotophos/ Lumphos/Azophos
vi. Quinalphos 25 EC	800 ml	Ekalux/GAIC Quinalphos/Quingaurd
vii. Triazophos 40 EC	600 ml	Hostathion
viii. Ethion 50 EC	800 ml	Fosmite/E-mite/Volthion

**Grown up larvae of American bollworm**

<b>A. Organophosphates</b>		
i. Acephate 75 SP	800 g	Orthene/Asataf/Starthene
ii. Chlorpyrifos 20 EC	2 litres	Coroban/Dursban/Durmet/Chlorgaurd/Radar/ Lethal/Force
<b>B. Naturalyte</b>		
iii. Spinosad 48 SC	60 ml	Tracer
<b>C. Oxadiazine</b>		
iv. (a) Indoxacarb 15 SC	200 ml	Avaunt
(b) Indoxacarb 15 EC	200 ml	Avaunt

**Tobacco caterpillar**

<b>A. Carbamate</b>		
i. Thiodicarb 75 WP	250 g	Larvin
<b>B. Organochlorinate</b>		
ii. Endosulfan 35 EC	1 litre	Thiodan/Endocel
<b>C. Organophosphates</b>		
iii. Acephate 75 SP	800 g	Orthene/Asataf/Starthene
iv. Chlorpyrifos 20 EC	2 litres	Coroban/Dursban/Durmet/Chlorgaurd/Radar/ Lethal/Force
v. Quinalphos 25 EC	1 litre	Ekalux/GAIC Quinalphos/Quingaurd

**Note :**

- a) Regularly monitor the pest population
- b) For effective insecticide resistance management do not repeat the insecticide of same group in subsequent sprays.
- c) Do not use mixtures of insecticides as they will result in faster development of resistance and resurgence of pests.
- d) Do not use synthetic pyrethroids on cotton for the control of bollworm complex after mid September.
- e) Repeat the spray immediately if it rains within 24 hours after spray.
- f) If hairy caterpillars damage cotton crop during June – July use 500 ml endosulfan 35 EC / quinalphos 25 EC or 200 ml of Nuvan / DDVP 100 in 100 litres of water per acre.
- g) Never follow the wrong advice of the pesticide dealers.
- h) Cotton is highly sensitive to the 2, 4 – D weedicide. Some farmers spray the ester form of 2, 4 – D for controlling weeds in maize grown near the cotton fields. Owing to the volatile nature of 2, 4 – D ester, its vapours cause serious injury to the cotton crop. Hence avoid the application of this herbicide in maize, if cotton is grown in the adjoining fields. The other precautions are:



- 1) After using 2, 4 – D on any crop, fill all spraying equipment as well as tubs, buckets, etc. with 0.5 percent washing soda solution (500 g of washing soda in 100 litres of water) in the evening. Next morning, flush all equipment thoroughly with fresh water.
- 2) To avoid the use of contaminated insecticides on cotton. It is advisable to test two weeks in advance on a few plants. If the insecticide is contaminated with 2, 4 – D the tender leaves and shoots could become distorted and lancolated within 10 days. Reject such an insecticide.

### Performance of various insecticides against insect pests and safety to natural enemies of cotton

Insecticides	Insect Pests						Natural enemies	Remarks
	J	W	PBW/ SBW	ABW		TC		
				Young	Grown up			
<b>A. Organochlorinate</b>								
Endosulfan	Good	Good	Good	Good	Poor	Very good	Safe	Safer to the natural enemies, low resistance in American bollworm early in the season
<b>B. Organophosphates</b>								
Monocrotophos	Good	Poor	Good	Poor	Poor	Poor	Highly toxic	Excessive use can cause resurgence of whitefly and American bollworm
Profenophos	Poor	Poor	Good	Good	Poor	Poor	Toxic	-
Quinalphos	Poor	Poor	Good	Good	Poor	Very good	Toxic	Excessive use can cause resurgence of jassid
Chlorpyriphos	Poor	Poor	Good	Very good	Very good	Very good	Highly toxic	Excessive use can cause resurgence of jassid
Acephate	Good	Poor	Good	Very good	Very good	Very good	Toxic	Excessive use can cause resurgence of whitefly and American bollworm
Triazophos	Poor	Very good	Good	Good	Poor	Poor	Toxic	-
Ethion	Poor	Very good	Good	Good	Poor	Poor	Toxic	-
<b>C. Synthetic pyrethroids</b>								
Alphamethrin, $\beta$ -cyfluthrin, cypermethrin, deltamethrin, fenvalerate	Poor	Poor	Very good	Poor	Poor	Poor	Toxic	Excessive use can cause resurgence of whitefly and American bollworm, high level of resistance in American bollworm
<b>D. Carbamates</b>								
Carbaryl	Poor	Poor	Good	Good	Poor	Poor	Toxic	Excessive use can cause resurgence of mite
Thiodicarb	Poor	Poor	Good	Good	Poor	Very good	Toxic	Excessive use can cause resurgence of

								mite
<b>E. Naturalyte</b>								
Spinosad	Poor	Poor	Good	Very good	Very good	Poor	Safe	Safer to the natural enemies
<b>F. Oxadiazine</b>								
Indoxacarb	Poor	Poor	Poor	Very good	Very good	Poor	Toxic	-

J= Jassid, W = Whitefly; SBW = Spotted bollworm; PBW = Pink bollworm; ABW = American bollworm  
TC = Tobacco caterpillar

## Spray Technology

The insecticides recommended for control of sucking pests bollworms and tobacco caterpillar should be sprayed using 125 – 150 litres spray material per acre with the manually operated knapsack sprayer of 75 litres with the shoulder mounted power sprayer and tractor mounted sprayer. Quantity of spray material may vary with different types of sprayer and nozzles. However, actual amount of insecticide recommended should be reduced.

Making pathways by pressing the branches on both sides helps in efficient spraying. Make such pathways at 2 metres distance for the manually operated knapsack sprayer and at 4 metres for the shoulder – mounted power sprayer.

Tractor mounted sprayer should have 13 triple action nozzles fixed on the boom at 75 cm distance from each other. Each zone should discharge 500 – 600 ml spray material per minute. The tractor should be operated at 4.0 and 2.5 km per hour speed for spraying against sucking pests and bollworms, respectively. Use the same tyre tracks and run the tractor in the same direction for all sprays. Keep the spray boom about 50 cm above the crop canopy. Each run of the tractor should cover about 10 meters width of the crop.

## Diseases

### Leaf Curl:

Disease is caused by whitefly transmitted virus. The diseased plants become stunted and have twisted internodes. Leaves remain small, show cupping and curling. Veins on the lower side of the leaves become thickened with netted appearance. Small leaflets (enations) also develop on the under side of the leaves on the main as well as lateral veins. Numbers of fruiting bodies are reduced in the diseased plants.

The disease can be reduced by adopting the following measures:

- i. LHH 144 and desi cotton varieties are resistant to leaf curl virus. LH 1556, Ankur 651, Whitegold and F 1861 are tolerant to this disease.

- ii. Avoid growing American cotton in and around citrus orchards and adjoining bhindi crop.
- iii. In American cotton use 4 kg seed per acre and go on uprooting and destroying the infected plants upto initiation of fruiting phase.
- iv. Protect the crop against whitefly vector at 4 – 5 leaf stage by using recommended insecticides.
- v. Follow clean cultivation and destroy Kanghi buti (*Sida* sp.) and Peeli buti (*Abutilon* sp.) which act as collateral hosts.
- vi. Destroy volunteer / ratoon cotton plants during the off season.

**Root rot :** This disease is caused by *Rhizoctonia solani* and *R.bataticola*. The main symptom is sudden and complete wilting of plant. The disease spreads in field in round patches. The affected plants can be pulled out very easily. The disease starts much early but wilting takes place quite late. The bark of the roots is broken into shreds and gives foul smell.

**Bacterial blight:** It is caused by *Xanthomonas axonopodis* pv *malvacearum* which survives in seed and plant debris. Lesions on the leaves appear as minute, water – soaked, angular spots, which subsequently turn brown and then are transformed into black angular dead lesions on both sides of the leaf. The bacterium also infects the young developing bolls and causes small, round, water soaked spots depressed in the centre. Spray will Blitox 50 (500g) + Agrimycin (20g) / Streptocycline (3 g) per acre at 15 – 20 days interval starting just after the first shower of rain. Three sprays will be enough. These chemicals can be mixed with the pesticides recommended for the control of insect pests after consulting compatibility chart. The quantity of water will depend upon the crop growth and the spray pump to be used.

**Anthracnose:** It is caused by *Glomerella gossypii* which survives on crop debris in the soil. It produces small, round reddish spots on leaves, bracts and bolls. The disease is severe at the seedling stage.

**Leaf blight:** The disease is caused by *Helminthosporium speciferum*. The fungus generally attacks the seedling causing pre and post emergence deaths. Light brown spots occur on the leaves. During severe infection, there is shedding of leaves, flowers and bolls.

The fungus *Alternaria gossypina* also causes blighting of the leaves. In the early – stages, the spots have a pale green area with irregular margins. As the spots enlarge, irregular concentric zones are formed. Sometimes severe shedding of leaves occur due to this disease. The plants with low vigour because of drought or deficiency of potash favour the development of this disease.

**Leaf spots:** The disease is caused by *Myrothecium roridum* and the symptoms appear on leaves, bracts as well as on bolls. The disease is characterized by circular to semicircular brown coloured spots with broad violet margins. At later stages, shield shaped, small size fruiting bodies appear in the central necrotic portion of the

spot. The pathogen is a seed borne and also survives on the dead leaves. High humidity and intermittent rains are congenial for the development of the disease.

Another type of leaf spot disease which is caused by *Cercospora* sp. generally appears towards the end of the season. It produces small, circular spot having white purple margin. In advance stages, necrotic central portion may fall out giving shot hole appearance.

To control anthracnose, leaf blights and leaf spots, the crop should be sprayed alternately with Blitox 50 or Captan 83 (500 g in 200 litres of water) at interval of 15 to 20 days starting just after the first shower of rain. Two to three sprays will be enough.

**Wilt:** It is a fungal disease caused by *Fusarium oxysporum* f.sp. *vasinfectum*. The pathogen of disease is both soil and seed – borne. In the diseased seedlings and plants, the leaves lose their turgidity, first turn yellow, then brown, start wilting and finally drop off. Discoloration of the leaves start from the margins and spreads towards the mid – ribs. The older leaves are affected first, followed by the younger ones towards the top. Wilting may be complete or partial. In the later case only one side of the plant is affected while the other remains apparently healthy. In complete wilting, the plant remains stunted, wilt rapidly and dies. The most prominent diagnostic symptom of the disease is browning and blackening of the vascular tissues. Five to six year rotation with non – host crops may help in controlling the disease. In the infested field, sow LD 694 variety of desi cotton since the same is tolerant to wilt. In the highly infested fields grow American cotton because it remains free from this disease. For the chemical control of wilt soak 3 kg seed in 6 litres of water containing 6 g of Bavistin / Derosal for 6 – 8 hrs. (non delinted seed) or 2 – 3 hrs (acid delinted seed).

**Grey mildew:** Grey mildew or dahiya disease caused by *Ramularia areola* occurs sporadically during humid weather. It appears on leaves as dull white, irregular, translucent spots bordered by veinlets with frosty growth on the lower surface of the leaves. It may cause defoliation and premature boll opening.

**Tirak:** It is a physiological disorder. It is characterized by the yellowing and reddening of leaves, followed by the bad opening of the bolls. The disease appears now and then the attack is more pronounced in the dry belt adjoining Rajasthan and Haryana. It is particularly serious in pockets where cotton suffers from persistent drought, inadequate water supply, nutrient deficiency on light sandy drought, inadequate water supply, nutrient deficiency on light sandy soils, too early sowing or lack of plant protection measures. These factors may operate singly or in different combinations. Spells of high temperature prevailing during the flowering and fruiting further aggravate the intensity of this malady. Judicious fertilization and timely watering particularly during flowering and fruiting stages and the adoption of recommended plant protection schedule help to mitigate the intensity of this disease.

**Picking:** Cotton should be picked clean and dry to get a good price in the market. Desi cotton is ready for picking in the third week of September. Picking should be done after every 8 – 10 days to avoid loss because of the Kapas falling to the ground. Do not keep the picked cotton in wet water channels in the field, as this practice impairs the quality of cotton. Store kapas in a dry godown. Keep produce of different varieties separately.

**Removal of cotton sticks:** Soon after the last picking, remove the cotton sticks along with the roots from the field and bury the remaining plant debris with furrow turning plough as sanitary measure against pests and diseases. Use or burn cotton sticks by the end of February at the latest.

Use two – row tractor operated Cotton Stalk Uprooter for uprooting of Cotton stalks. The Cotton Stalk Uprooter should be operated at a speed of 7 to 9 km/hr and at a depth of 12 to 15 cm with 45hp tractor for efficient field operation. This equipment will provide 10 to 15% more cotton sticks by weight than conventional manual stalk chopping method with a field capacity of 1.25 to 1.50 acre/hr.

### Marketing Hints

- 1) Kapas should be picked dry, with covered head free from trash, with no dew on it.
- 2) The first and the last picking are usually of low quality and should not be mixed with rest of the produce. High – grade kapas mixed with low grade kapas sells at a relatively low price.
- 3) Store kapas in damp proof and rat – free room.
- 4) Store different varieties separately.

### Improved Varieties

#### American Cotton

**RCH 134 Bt:** It is high yielding, intra – *hirsutum* Bt Cotton hybrid resistant to spotted bollworm and American bollworm. It has broad lobed green leaves, 2 – 3 monopods and 25 – 26 sympods. It matures in 160 – 165 days. Its boll size is 3.8 g with good fluffy opening. It gave average yield of 11.5 q/acre seed cotton. It has very good fibre properties with 27.7 mm 2.5% span length, 25.0 g/tex fibre strength and 34.4% ginning outturn.

**RCH 317 Bt:** It is high yielding, intra – *hirsutum* Bt cotton hybrid resistant to spotted bollworm and American bollworm. It has broad lobed green leaves with 2 – 3 monopods and 26 – 27 sympods. It matures in 160 – 165 days. It has boll size of 3.7 g with good fluffy opening. It recorded average yield of 10.5 q/acre. It has 28.6 mm 2.5% span length and 33.9% ginning outturn.

**MRC 6301 Bt:** It is high yielding, intra – *hirsutum* Bt Cotton hybrid resistant to spotted bollworm and American bollworm. It has green broad leaves, 3 – 4 monopods and 24 – 25 sympods. It gave average yield of 10.0 q/acres seed cotton and matures in 160 – 165 days. It has good boll size (4.3g) with good fluffy opening. It has 28.3 mm 2.5% span length and 34.7% ginning outturn.

**MRC 6304 Bt:** It is high yielding, intra – *hirsutum* Bt cotton hybrid resistant to spotted bollworm and American bollworm. It has green broad lobed leaves, 2 – 3 monopods and 26 – 27 gypods. It matures in 160 – 165 days. It has boll size of 3.9g and has good fluffy opening. It gave an average yield of 10.1 q/acre seed cotton. It has good fibre properties with 2.5% span length of 29.0 mm and 35.2 percent ginning outturn.

**Ankur 651** - This is an intra – *hirsutum* leaf curl virus resistant and jassid tolerant hybrid having small leaves with broad lobes. It is short, compact, early and sympodial. It has one monopod and 23 – 25 sympods and of about 97 cm plant height. It matures in about 170 days and is suitable for cotton – wheat rotation. It recorded an average seed cotton yield of 7 q/acre. It has 28 mm medium staple fibre and 32.5% ginning outturn.

**Whitegold** – It is an intra – *hirsutum* hybrid tolerant to leaf curl virus disease with dark green broad lobed leaves. It has 1 – 2 monopods and 20 – 22 sympods with 125 cm plant height. Its maturity period is 180 days. Average seed cotton yield is 6.5 q/acre. It has 29.4 mm staple length and ginning outturn is 30%.

**LHH 144 :** This is an intra – *hirsutum*, leaf curl virus resistant hybrid, with semi – okra lobed leaves. It has 3 – 4 monopods, 20 – 25 sympods and about 151 cm plant height. The average boll weight is 5.5 g. Besides its resistance to leaf curl it is also tolerant to jassid and bacterial blight. It matures in about 180 days and is suitable for cotton – wheat rotation. It recorded an average seed cotton yield of 7.6 q/acre. It has 28.8 mm 2.5% span length and 33.0% ginning outturn. LHH 144 has superior medium staple fiber which is suitable for spinning at 40s counts.

**F 1861:** It is a cotton leaf curl virus resistant variety recommended for cultivation throughout the Punjab State. The plant of this variety bears 1 – 2 monopods with 13 – 16 sympods and has an average plant height of 135 cm. It has dark green broad lobed leaves with narrow tips slightly curved upwards. Its maturity period is 180 days. It recorded an average seed cotton yield of 6.5 q/acre. It has medium staple with 2.5% span length of 26.3 mm. Its ginning outturn is 33.5% and is spinnable at 30s counts.

**F 1378:** It is a high yielding, semi – sympodial variety, the plant bears 0 – 2 monopods with 19 – 20 fruiting branches and has an average plant height of 150 cm. It has light green broad lobed flat leaves and big round bolls with good fluffy opening. Its maturity period is 180 days. It recorded an average seed – cotton yield

of 10 q/acre. It has medium staple with 2.5% span length of 26.2 mm. Its ginning outturn is 35.5 percent.

**F 846:** This is semi – spreading, high yielding variety. The average plant height of the variety is about 134 cm with strong main stem. The plants bear 2 – 3 monopods with 18 – 20 fruiting branches. It has green broad lobed leaves and big round bolls with good fluffy opening. Its maturity period is about 180 days. The average yield is about 11 quintal kapas/acre. The ginning outturn is 35.3 percent with 2.5% span length of 25.8 mm. It is suitable for spinning at 30s counts.

**LH 1556 :** It is short duration, early maturing variety of cotton. It is semi – sympodial in growth habit with 1 – 2 monopods and plant height of 140 cm. It has light green medium sized leaves and round bolls with good fluffy opening. Its 2.5 percent span length is 27.7 mm and is suitable for spinning at 40 counts and gins 34.0 percent. It matures in about 165 days. Its seed cotton yield is 8.5 quintal/acre.

### **Desi Cotton**

**Moti:** It is a new Fusarium wilt tolerant male sterility based desi cotton hybrid. It has green plant body, semi sympodial, bushy habit of growth, average plant height of 164 cm, narrow leaves with white flowers, large boll size with 4 – locules and good fluffy opening and easy to pick. It matures in 165 days. Its average yield is 8.45 quintal per acre. Its ginning outturn is 38.6% and fibre length is 20.5 mm.

**LD 694:** It is a desi cotton variety with dark – red pigmented plant body, narrow lobed leaves, pink flowers and red spot inside the petal. It possesses big bolls with fluffy opening. LD 694 matures in about 170 days and is more synchronous in maturity than other released varieties of desi cotton. It is short staple, coarse fibre variety with ginning outturn of 40.9%. It gave an average seed – cotton yield of 7 q/acre. It is resistant to jassid and more tolerant to Fusarium wilt and bacterial blight.

**LD 327:** It is a high yielding and high ginning semi – sympodial variety. The plants are reddish brown with narrow – lobed deep cut leaves and pink flowers. It possesses big bolls usually with 4 loculi, better opening and easy picking. It vacates the field in about 175 days for the timely sowing of wheat. It is relatively tolerant to Fusarium wilt. Its fibre is short, coarse and suitable for export. Its average yield is 11.5 q/acre. Its 2.5% span length is 19.0 mm and ginning percentage is 41.9.

## Varieties/hybrids of American and arboreum cotton released by Punjab Agricultural University, Ludhiana

Sr. No.	Variety/hybrid	Parentage	*Year of release	Yield potential (q/ha)	Fibre length (mm)	Ginning outturn (%)	Micronaire value	Fibre strength (g/tex)	Spinnability (s Counts)	Resistance to diseases/ insect-pests	Duration (days)
<b>AMERICAN COTTON</b>											
1.	LSS	Selection	1931	15.00	22.4	33.4	4.5	45.0	30		270
2.	320F	Selection	1951	13.70	23.1	34.6	3.2	45.6	30		270
3.	J 34	45F × L 55	1966	14.00	24.3	34.8	4.1	46.6	32	Resistant to Jassid	190
4.	J 205	J 2 × UL 48	1973	15.00	25.1	34.3	3.6	46.1	35	Resistant to Jassid	185
5.	F 414	Selection from B.N.	1977	19.00	23.4	34.2	4.4	49.8	30	Resistant to Jassid	180
6.	LH 372	G 67 × Am. Nectriless	1980	16.87	24.2	33.3	4.5	47.7	30	Resistant to Jassid	180
7.	F 286	F 414 × Empire 61	1983	21.00	23.9	33.8	4.6	47.2	30		180
8.	LH 900	LH 223-480 × LH 223-343	1985	27.50	23.1	33.9	4.8	47.7	30	Resistant to bacterial blight	165
9.	F 505	F 414 × A 231	1986	24.00	24.3	34.6	4.6	48.2	30	Tolerant to jassid	180
10.	LH 886	LH 62 × EC 34859	1988	26.10	23.0	35.0	4.5	47.7	30		180
11.	LH 1134	IAN 6074 × LH 96-4	1990	27.00	27.6	35.5	4.5	47.7	40	Tolerant to jassid	175
12.	F 846	F 452 × LH 223-481	1992	27.50	25.8	35.3	4.4	45.6	30		180
13.	F 1054	F 470 × A 258	1992	28.60	26.8	34.6	4.7	48.2	30		160
14.	Fateh	LHH 660 × Suman	1994	29.00	26.0	34.2	4.8	22.6	30		180
15.	LH 1556	(LH 886 × LH 900) × LH 952	1995	24.00	27.7	34.0	4.8	49.8	40	Tolerant to CLCuV	165
16.	F 1378	(SRT 1 × F 413) × CP 32	1997	24.00	26.2	35.5	4.2	45.6	30		180
17.	LHH 144	PIL 43 × PIL 8	1997	19.10	28.8	33.0	4.6	23.1	40	Resistant to CLCuV	180
18.	F 1861	F 505 × F 380	2002	20.10	26.3	33.5	4.6	20.6	30	Resistant to CLCuV	180
<b>ARBOREUM COTTON</b>											
1.	231R	Selection	1959	12.80	15.5	42.0		39.1	6		180
2.	G 27	Selection	1969	15.00	16.0	38.0	7.2	42.9	8-10		180
3.	LD 133	Selection	1978	16.87	16.7	38.9	7.7	37.5	8-10		180
4.	LD 230	G 27 × 231R	1981	26.25	18.0	37.8	7.8	40.7	8-10	Tolerant to fusarium wilt	160
5.	LD 327	G 57 × (G 27 × L 124)	1987	28.50	17.0	41.9	7.4	41.8	10-12	Tolerant to fusarium wilt	175
6.	LDH 11	G 327 × IC 30839	1994	31.30	21.8	40.1	8.5	40.7	8-10	Tolerant to fusarium wilt	175
7.	LD 491	LD 251 × Gao 20	1995	23.15	19.9	38.9	7.5				
8.	LD 694	LD 260 × LD 360									
9.	Moti	DS 5 × LD 210	2004	21.13	20.5	38.6					

\*Punjab Agricultural University, Ludhiana was established during 1962