Centurion
UNIVERSITY

INSECT PESTS OF COTTON

Common name	Scientific name	Family	Order
1. Spotted boll worm	*Earias vitella, E. insulana*	Noctuidae	Lepidoptera
2. American boll worm	*Helicoverpa armigera*	Noctuidae	Lepidoptera
3. Pink boll worm	*Pectinophora gossypiella*	Gelechiidae	Lepidoptera
4. Tobacco caterpillar	*Spodoptera litura*	Noctuidae	Lepidoptera
5. Leaf hoppers	*Amrasca biguttula biguttula*	Cicadellidae	Hemiptera
6. White fly	*Bemicia tabaci*	Aleurodidae	Hemiptera

Common name	Scientific name	Family	Order
7. Cotton aphid	*Aphis gossypi*	Aphididae	Hemiptera
8. Mites	*Tetranychus telarius*	Tetranychidae	Acarina
9. Cotton thrips	*Thrips tabaci* *Scirtothrips dorsalis*	Thripidae	Thysanoptera
10. Red cotton bug	*Dysdercus cingulatus*	Pyrrhocoridae	Hemiptera
11. Dusky cotton bug	*Oxycarenus hyalinipennis*	Lygaeida	Hemiptera
12. Cotton leaf roller	*Sylepta derogata*	Pyralidae	Lepidoptera

Common name	Scientific name	Family	Order
13. Cotton stem weevil	*Pempherulus affinis*	Curculionidae	Coleoptera
14. Grasshoppers	*Cyrtacanthacris ranacea*	Acrididae	Hemiptera
15. Cotton mealy bug	*Phenacoccus solenopsis*	Pseudococcidae	Hemiptera

The cotton crop in its early stage of crop growth is generally subjected to the attack of sucking pests. From flowering till harvest, the bollworms cause appreciable damage. The losses in cotton from insect attack affect both yield and quality of the lint.

SPOTTED BOLLWORM *Earias vitella Earias insulana*
Noctuidae: Lepidoptera

DISTRIBUTION:

- *Earias vitella* and *E. insulana* are serious pests of cotton.
- These insects are very widely distributed.
- These pests attack a no of other plants of the family malvacea

APPEARANCE:

- Adult of *E. vitella* has pale whitish fore wings with a broad greenish band in the middle
- while *E. insulana* has completely green forewings.
- The adult body length is about 1 cm while the wing span is about 2.5 cm.
- ETL 10% damaged shoot (or) 5% damaged bolls

Spotted bollworm (*Earias vitella*)

Farias insulana adult

LIFE HISTORY:

- The female moth lays spherical, sculptured bluish eggs singly or in groups on tender parts of the plant *viz.,* fresh leaves, fresh squares (flower buds), and flowers.
- On an average each female moth lays 60-80 eggs. Egg stage is about 2-10 days.
- The caterpillars of both the species have a number of black and brown spots on the body and hence the name spotted boll worm.
- Full grown larva measures 14 mm in length. The larval stage lasts for about 9-25 days.

***Earias* Larva**

- Pupation takes place generally in fallen material, outside the boll, on plant surfaces and in cracks and crevices of the soil.
- Before pupation however, the larva spins a dirty, white silken cocoon of **boat** shaped one. Pupal period is about 6-25 days.

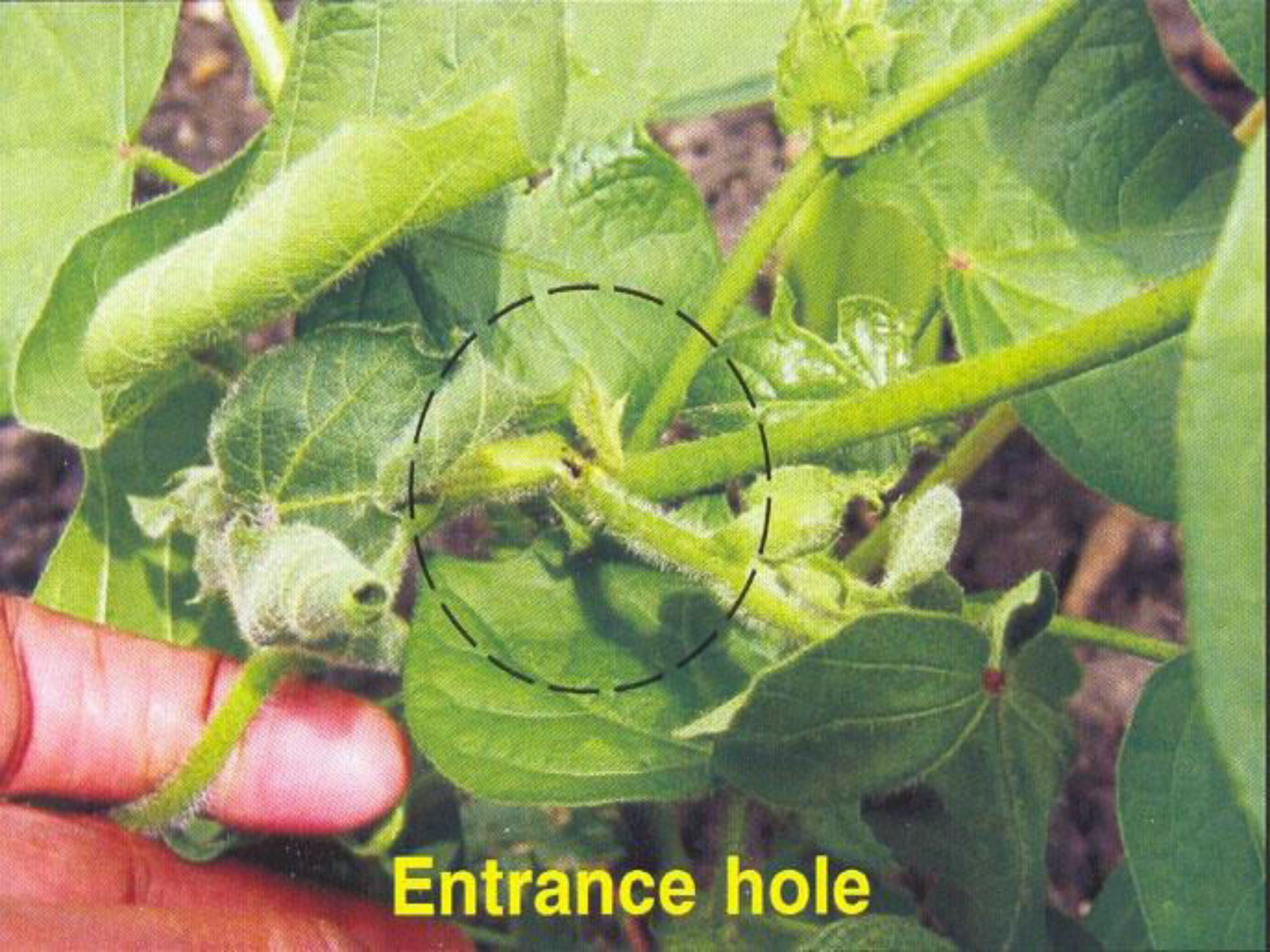
SYMPTOMS OF DAMAGE:

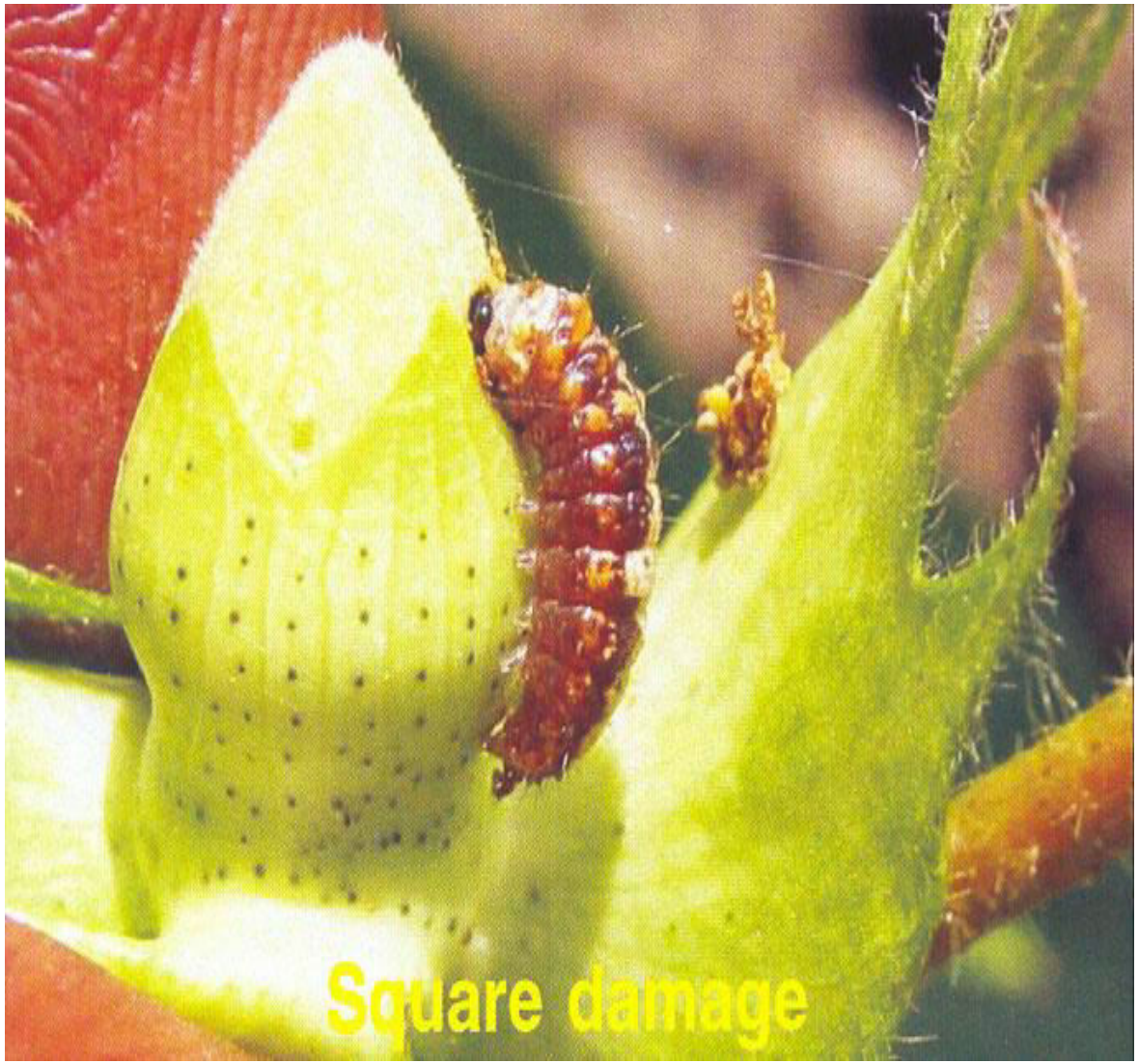
- The spotted bollworm appears about 6 weeks after sowing and initially damages the tender shoot by boring into it resulting in "drying of central shoots" which withers and drops down.
- The larvae later bore into the flower buds, squares and bolls.
- The larva inserts its head inside the boll and feeds by filling the boll with excreta.
- A larva may move out and feed on another bud or boll.
- The feeding causes severe shedding of early formed flower buds and bolls.

The damage results in

- Presence of wilting, withering and drooping or drying of tender shoots in early stage of crop growth.
- Presence of bored flower buds (squares), bored bolls with larval frass at the entrance holes
- Premature dropping of affected bolls
- Premature opening of damaged bolls, which remain on plants.
- Presence of badly damaged tissues including lint and seed in damaged bolls.


Infested shoot


Entrance hole


Square damage

Earias Larva feeding on boll

MANAGEMENT:

- Destruction of plants, crop residues and alternative weed hosts which harbour pests in off season
- Collection and destruction of infested shoots, squares and bolls and the fallen material.
- Adopting crop rotation
- Deep ploughing in summer
- Intercultivation with sorghum, greengram, cluster bean, jowar
- Setting of pheromone traps @ 12/ha
- Conservation and use of natural enemies like *Trichogramma evanescens* which parasitises the eggs and *Bracon lefroyi, B. greeni, B. hebetor, B. brevicornis, Apanteles* sp and *Elasmus* sp which parasitise the larval stage and *Chelonus* and *Chalcis* species that parasitise pupal stages.

- Release of first instar larvae of *Chrysoperla* sp.@ 1,00,000/ha
- Foliar spray with *Bacillus thuringiensis* @2g/l of water
- The parasitoid activity in the field should be carefully assessed before the insecticidal application
- Foliar spray with quinalphos 2.5 ml; chlorpyriphos 2.5 ml; acephate 1.5 g; triazophos 2 ml; thiodicarb 1.5 g and profenphos 2 ml/l
- The insecticidal application should coincide with the peak of hatching of eggs, so that the just hatched larvae may get the fatal dose before entering the plant tissue

AMERICAN BOLLWORM : *Helicoverpa armigera,* Noctuidae: Lepidoptera

DISTRIBUTION:

- American bollworm has a world wide distribution in all the cotton growing regions of the world.
- It is a polyphagous, infesting gram, lablab, safflower, chillies, groundnut, tobacco, tomato *etc*.

APPEARANCE:

- Moth is stout, medium sized with brownish/greyish forewings with a dark cross band near outer margin and dark spots near costal margins, with a wing expanse of 3.7 cm.
- Caterpillars are of varying colour, initially brown and later turn greenish with darker broken lines along the side of the body.


(*Helicoverpa armigera*)

ETL 10% of damaged buds (or) 5% of damage bolls or one egg / plant or one larva / 10 plants

Polymorphism in Gram caterpillar

LIFE HIESTORY:

- The spherical, yellowish eggs are laid singly on tender parts and buds of plants.
- The egg period lasts for 2-4 days.
- The larval period lasts for 18-25 days. Body covered with radiating hairs.
- When full grown, they measure 3.7 to 5 cm in length.
- The full grown caterpillar pupates in the soil in an earthen cell and emerges in 16-21 days.

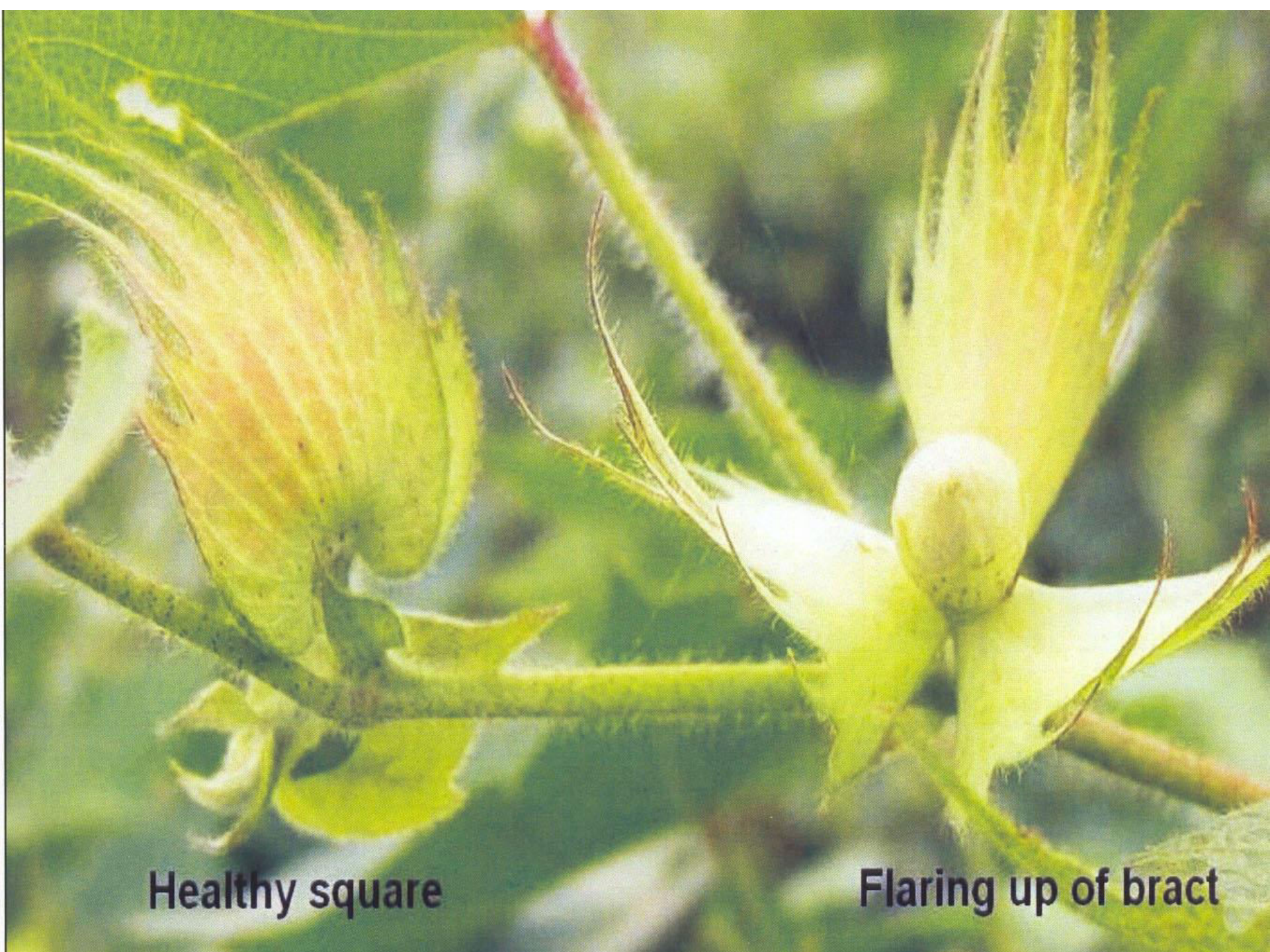
SYMPTOMS OF DAMAGE:

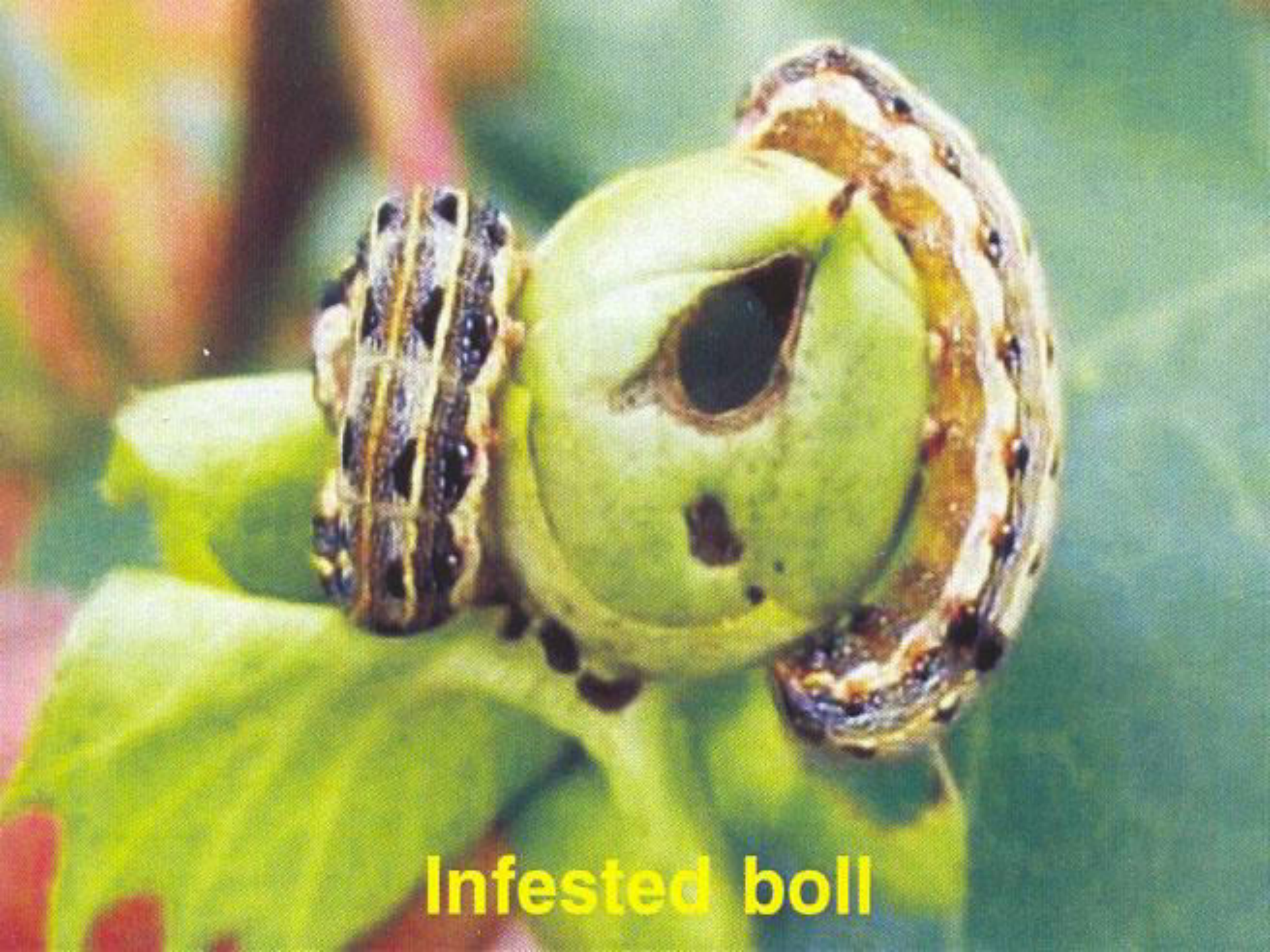
- Young larva feeds on the leaves for sometime and then attacks squares and bolls.
- Internal tissues are eaten severely and completely hollowed out.
- While feeding, the caterpillar thrust its head inside leaving the rest of the body out side.

- Bolls are bored at the base of flower buds which are hollowed out, bracts of damaged flower buds spread out and curl down wards.
- Premature boll opening and shedding

Helicoverpa Larva feeding on Flower bud

Helicoverpa Larva feeding on Flower bud


Healthy square
Flaring up of bract


Infested boll

MANAGEMENT:

- Destruction of crop residues
- Hand picking up of the grown up larvae ·
- Encouraging new crop rotation
- Nipping terminal buds when 16 to 18 sympodias are present in the plant within 80 – 100 days to reduce the egg load
- Growing intercrops such as cowpea, onion, maize, coriander, urdbean in 1:2 ratio for conservation of natural enemy population.
- Growing sorghum or maize in 4 rows all around cotton crop as guard crop.

- Use of ovipositional trap crops such as marigold @ 100 plants / acre and collection of larvae from flowers.
- Erecting of bird perches for encouraging predatory birds such as king crow, mynah, *etc*.
- Growing early maturing and tolerant varieties such as Abadita, LK 861, LPS 141, NA 1280 and G 27.
- Installing pheromone traps @ 4 / ac (ETL 10 moths/trap/day)
- Releasing of egg parasitoid *Tricogramma chilonis* at weekly interval @ 1.5 lakhs/ ha or release of 2nd instar larvae of *Chrysoperla carnea* @ one lakh/ha at 75 and 90 days after sowing

- Application of HaNPV @ 200 LE/ac
- Larval parasitoid such as *Campoletis chloridae* (Ichneumonidae)*; Eriborus angenteopilorus; Diadegma fenestalis; Bracon brevicornis; Peribaca orbata etc*.
- In severe incidence, sprays with indoxacarb 1 ml/l or spinosad 0.3 ml/l or emamectin benzoate 0.5 g/l after collecting late instars.

- Dose of virus is generally expressed as (LE) Larval equivalent
- One LE = 6*109 POB
- One LE is obtained from three mature virus infected larvae.
- The dose commonly recommended in the field for NPV is 250-500 LE/ha

PINK BOLLWORM *Pectinophora gossypiella*
Gelechiidae: Lepidoptera

DISTRIBUTION:

- The pink bollworm is a very widely distributed and probably the most serious cotton pest on a world basis.
- The American cottons in India are damaged much more by the pink bollworm than the indigenous varieties.
- It is distributed in parts of India, Pakistan, America, Africa, Australia and Asia.

APPEARANCE:

- Moth is small about 5-6 mm in length and has wing span of 12.5 mm.
- Body is dark brown in colour with numerous small black spots on the wings.
- The first segment of the antenna bears 5-6 long stiff hairs and the palpi are pointed and curved upwards. The moths are active during night.
- The freshly hatched larvae are white and turn pink as they grow older

Pink bollworm

Pink bollworm larva

LIFE CYCLE:

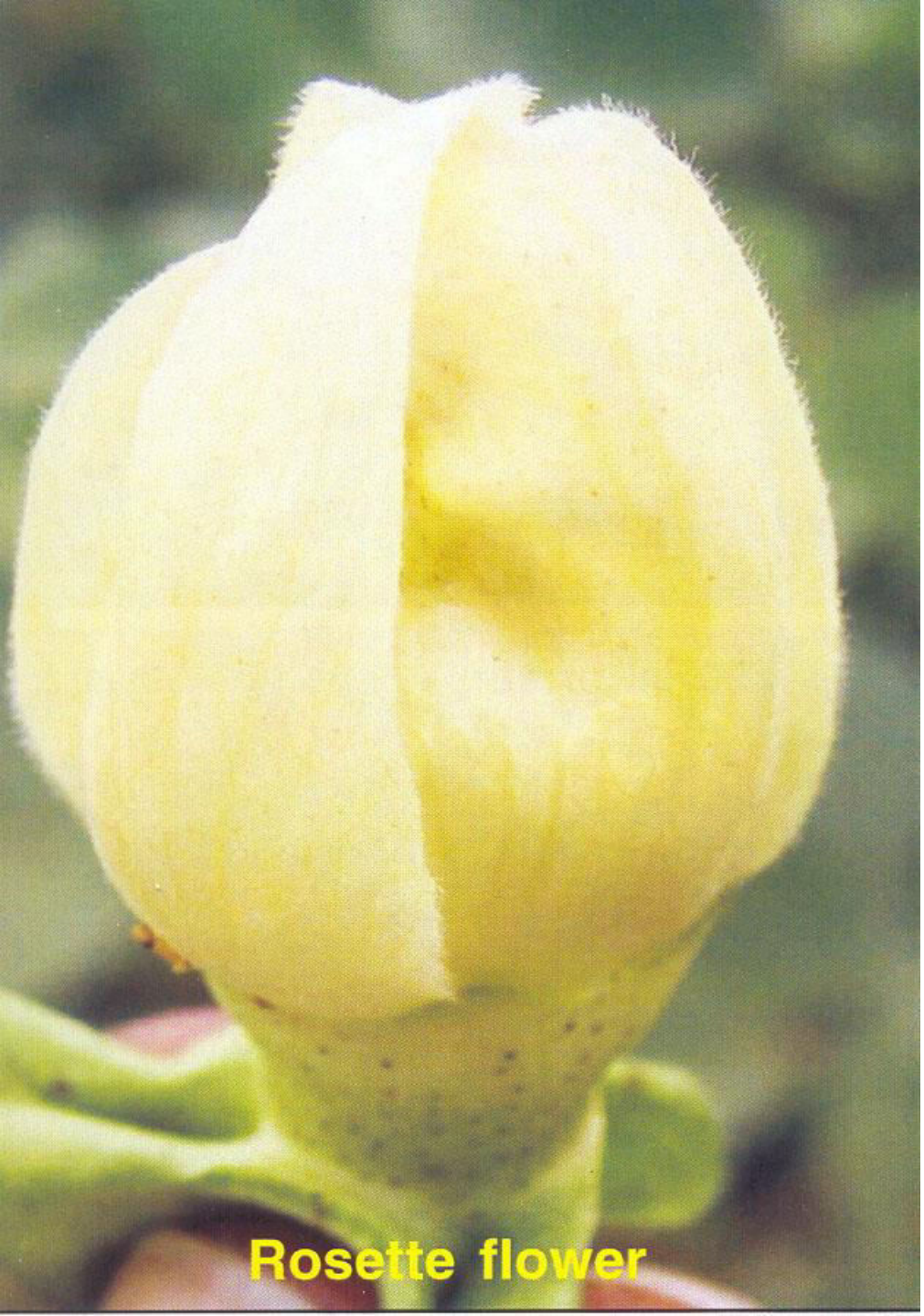
- Female lays flattish scale like whitish eggs singly on various parts of young shoots.
- However, half developed bolls are preferred when available.
- Egg period ranges from 4-25 days.
- Larva is full grown in 25 – 30 days. The full grown, uniformly pinkish larvae measures about 8-16 mm with dark brown head and prothoracic shield.
- The larva undergoes generally only 3 moults.
- Pupation occurs in flimsy cocoon in boll, often in seed hollowed out by larva.
- The pupation period lasts for about 6-20 days depending on the season.

SYMPTOMS OF DAMAGE:

- The larvae do most spectacular damage to practically mature cotton bolls which they enter mostly at such a tiny stage of just hatched larvae that their entry holes get healed and in which they remain, devouring both seed and fiber forming tissues.
- The infestation at times is so severe that up to 10 larvae are found in each boll and 75-100 per cent bolls are found infested.

***The damage results in

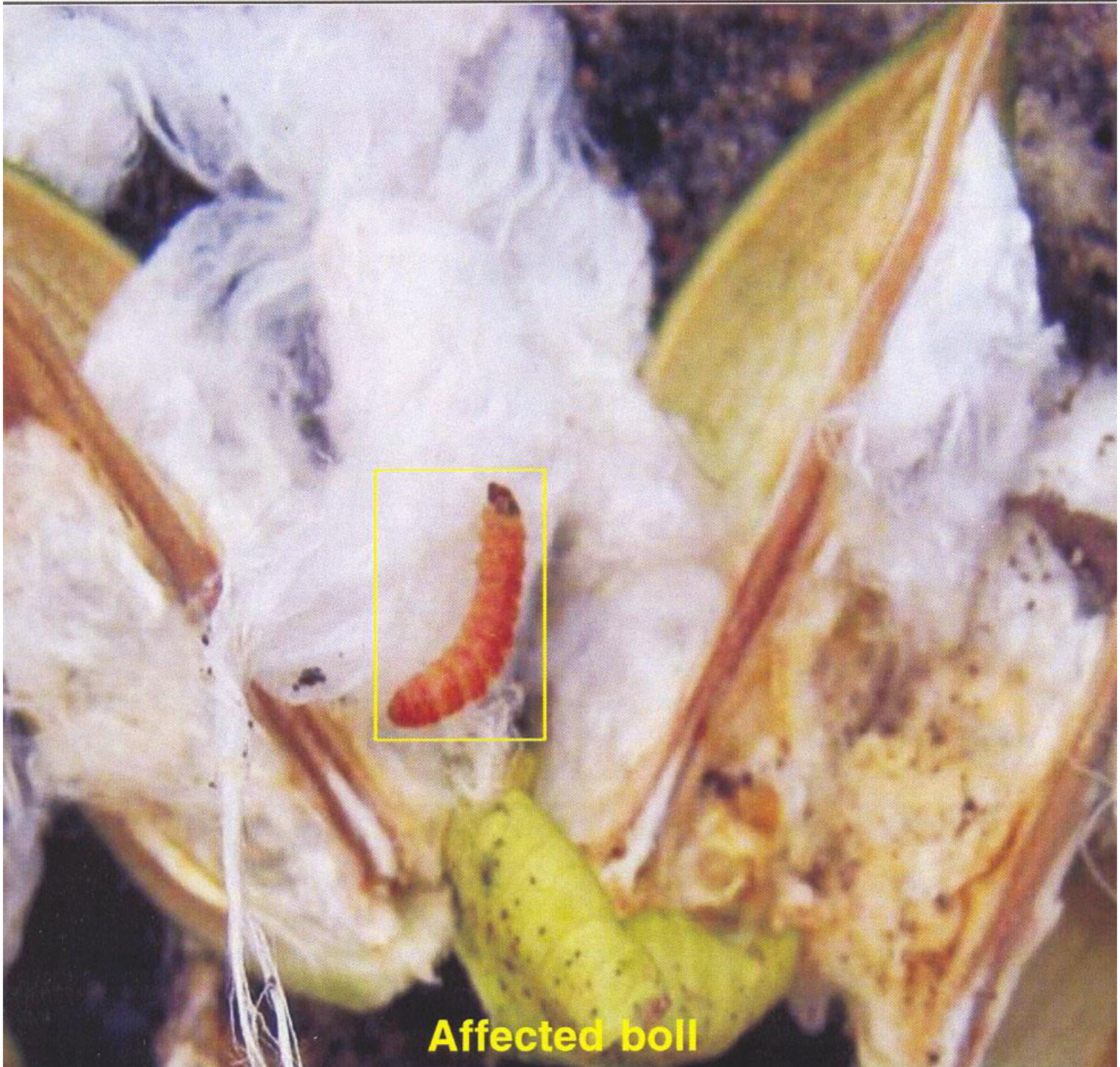
- "**Rosette**" flowers
- Attacked flowers drop prematurely and the seeds are destroyed in advanced stage
- The lint development is retarded and is weakened.
- It causes premature opening of the boll leading to invasion of saprophytic fungus.
- Stain the lint both in the gin and in the boll, thus the ginning percentage and quality of lint is greatly reduced.
- Poor germination capacity of seeds in the attacked boll.



Rosette flower

Rosette Flower

Pink bollworm Larvae feeding on boll


Affected boll

MANAGEMENT:

Since eggs are mostly protected by calyx and the newly hatched larva bore into the bolls immediately, it is difficult to manage this pest with insecticides alone. Therefore the following methods are suggested.

- Growing early maturing varieties: bolls mature before heavy population builds up
- Taking up timely sowings. Avoid staggered sowings
- Use acid delinted seeds: soak seed in concentrated sulphuric acid (80 – 100 ml / kg seed) for 2 – 3 minutes, wash with water 2 – 3 times followed by washing with lime supernatant, shade dry.

- Use of organic manures, recommended doses of N ·
- Keeping the crop free of weeds
- Monitoring through field scouting and pheromone traps (Gossyplure)
- Destroying PBW in rosette flowers and periodically remove and destroy dropped squares dried flowers and premature bolls.
- Avoiding ratooning and summer cotton.
- After final picking, allowing cattle, sheep and goats to graze upon immature green bolls to prevent carry over of pest to next season.
- Destroying cotton stubbles to prevent carryover.

- Seed fumigation with methyl bromide @ 0.4 kg / 1000 cu ft. or aluminium phosphide (Quickphos, Phosfume, Phostoxin) @ 50 tablets (each 3 g)/ 1000 cu ft.
- Need based use of insecticides. ETL: 10 % PBW infested rosette flowers. In particular, persistent insecticides like quinalphos 2.5 ml/l; chlorpyriphos 2 ml/l; at 15 days interval.
- In severe incidence cypermethrin 2 ml/l or lamda cyhalothrin 1.5 ml/l or thiodicarb 1.5 g/l on need basis towards the end of crop season.
- Even at ginning mills, burning the stained kapas is suggested.

TOBACCO CATERPILLAR *Spodoptera litura* Noctuidae: Lepidoptera

DISTRIBUTION:

- It is found through out the tropical and sub tropical parts of the world, wide spread in India
- Besides tobacco, it feeds on cotton, castor, groundnut, tomato, cabbage and various other cruciferous crops.

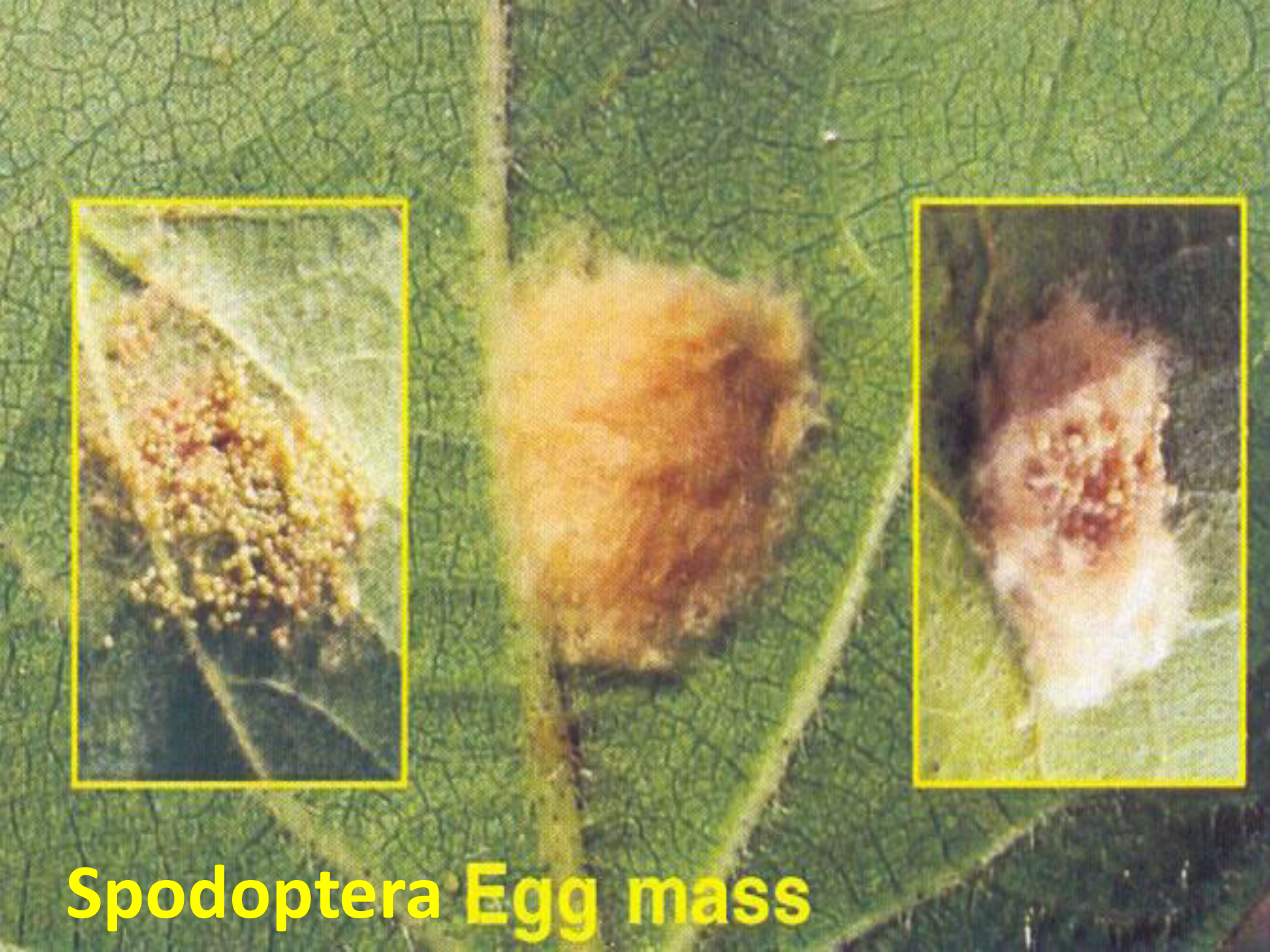
APPEARANCE:

- Moth is medium sized and stout bodied with forewings pale grey to dark brown in colour having wavy white crisscross markings.
- Hind wings are whitish with brown patches along the margin of wing. Pest breeds throughout the year.
- Moths are active at night.

Tobacco Caterpillar (*Spodoptera litura*)

LIFE HISTORY:

- Female lays about 300 eggs in clusters.
- The eggs are covered over by brown hairs and they hatch in about 3-5 days.
- Caterpillar measures 35-40 mm in length, when full grown.
- It passes through 6 instars. Larval stage lasts 15-30 days
- Pupation takes place inside the soil, pupal stage lasts 7-15 days.
- Adults live for 7-10 days. Total life cycle takes 32-60 days. There are eight generations in a year.


Spodoptera Egg mass

Larva


Larva entering into soil

Pupa

SYMPTOMS OF DAMAGE:

- In early stages, the caterpillars are gregarious and scrape the chlorophyll content of leaf lamina giving it a papery white appearance.
- Later they become voracious feeders making irregular holes on the leaves and finally leaving only veins and petioles.
- During flowering and boll formation stage, the caterpillars also feed on the internal contents of bolls causing irregular holes.

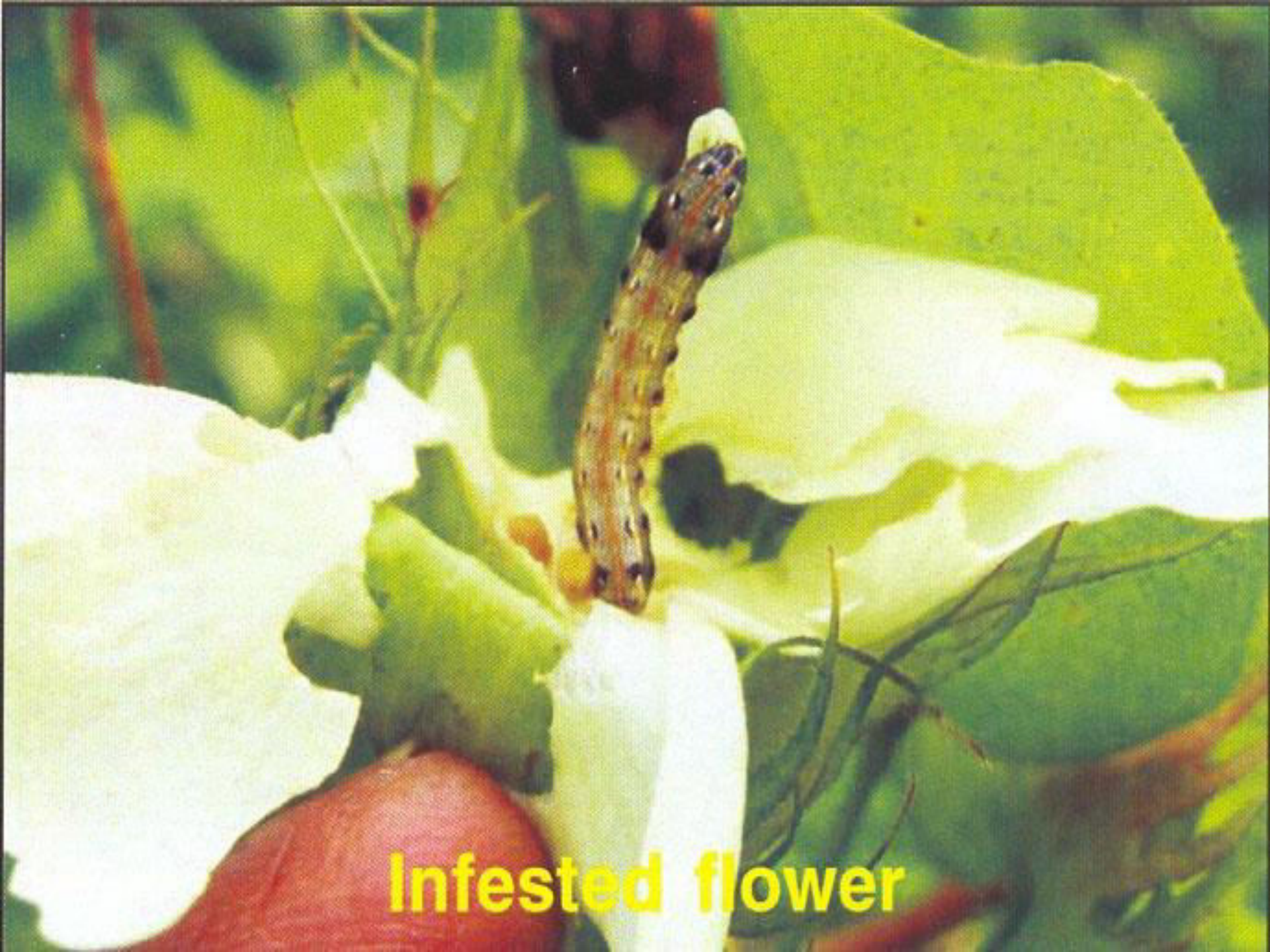
ETL: 1 egg mass/10 plants.

- Irregular holes on leaves initially and later skeletonisation leaving only veins and petioles
- Heavy defoliation.
- Presence of bored bolls.

First instar Spodoptera larvae feeding gregariously


Infested leaf


Infested square


Infested flower

MANAGEMENT:

- Collection and destruction of the infested material from the field.
- Plucking of leaves harboring egg masses / gregarious larvae and destroying.
- Setting up light traps for adults.
- Setting up of pheromone traps @ 12/ha
- Spraying NSKE 5 % against eggs and first instar larva.
- Spraying NPV @ 200LE/ac
- Release of egg parasitoid *Trichogramma* @ 50,000/ha/week four times

- Foliar spraying with endosulfan 2ml/l or thiodicarb 1.5 g/l or quinalphos 2.5ml/l. in severe incidence novaluran 1 ml/l or lufenuron 1 ml/l.
- Baiting with rice bran 10kg + jaggery 2 kg+ chlorpyriphos 750 ml or thiodicarb 300g in sufficient quantity of water in form of small balls and broadcasting in evening hours in one acre.

LEAFHOPPERS *Amrasca biguttula biguttula*
Cicadellidae: Hemiptera

DISTRIBUTION:

- They are distributed in all cotton growing regions of India.
- They are mostly confined to leaf surface infesting okra, potato, brinjal, castor, tomato, hollyhock, *Abutilon indicum* besides cotton.

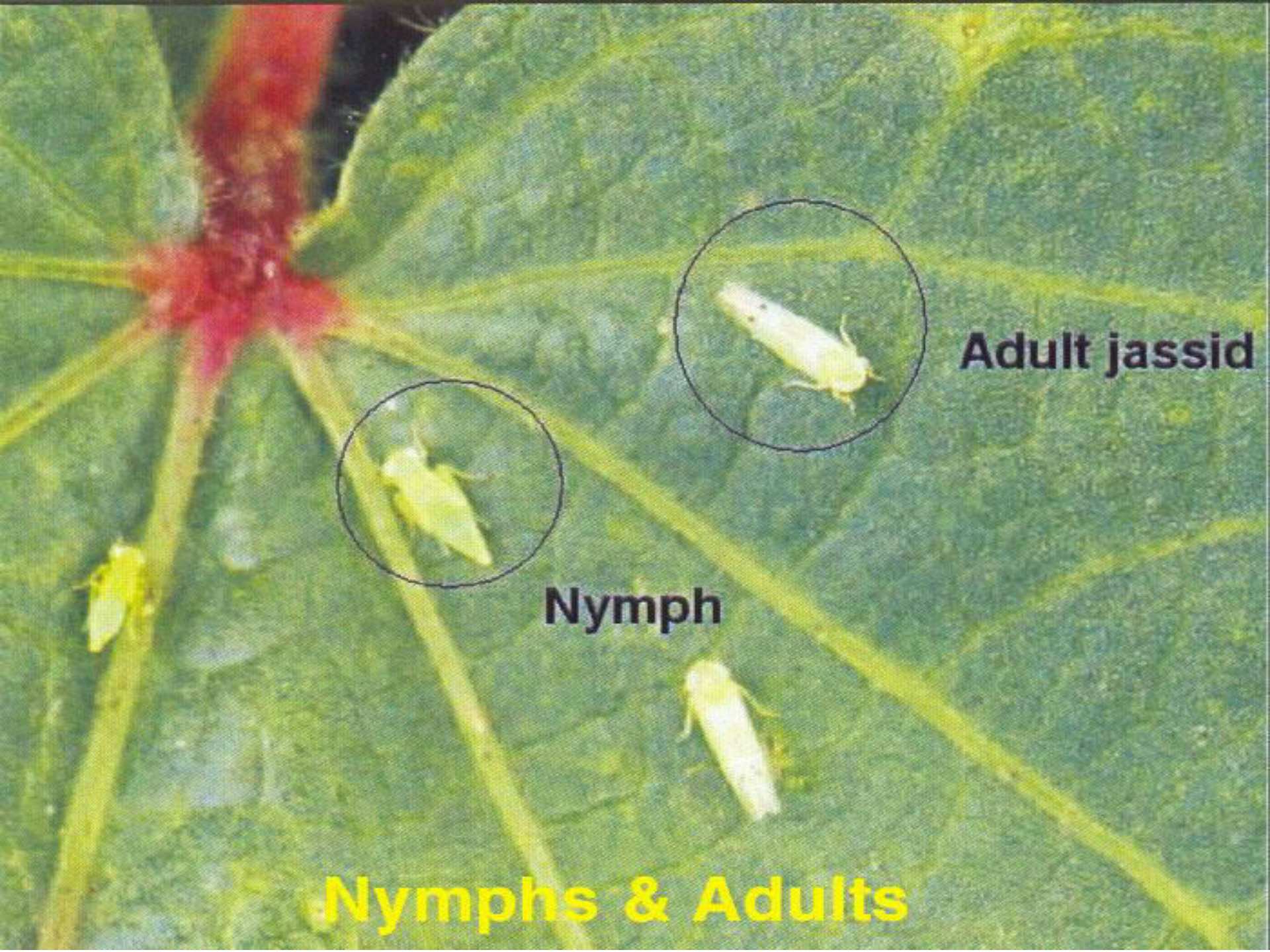
APPEARANCE:

- It is a small insect, varying from less than 1 mm to about 3 mm.
- Its adult stage is subjected to seasonal changes in colour.
- It is reddish in winter and greenish yellow in summer.

- The adult is a wedge shaped insect about 3.5 mm in length.
- There is a black spot on each forewing and two small black spots on the vertex.
- Both nymphs and adults move diagonally, when disturbed.
- Nymphs are also pale greenish in colour like the adults but are wingless and are found in large numbers on lower surface of leaves.

ETL: 2-3 nymphs/leaf


Cotton Jassid
(*Amrasca biguttula bigittula*)
Adult



Nymphs & Adults

LIFE HISTORY:

- Female lays about 30 eggs.
- The eggs are usually inserted full length into the spongy parenchymatous tissue between the vascular bundles and the epidermis.
- The eggs hatch in 4-11 days.
- The nymph moults five times and the nymphal period last for 7-21 days.
- The whole life cycle is completed in about two weeks to more than a month and a half, depending on environmental conditions. There are 8-10 overlapping generations.

SYMPTOMS OF DAMAGE:

- Nymphal stages as well as the adult, they inflict the same type of damage.
- They suck the cell sap from the plant tissue.
- During desapping the plant, they also inject a toxin through saliva into the plant tissue, resulting in hopper burn.
- In susceptible varieties, the attack results in mottling accompanied by the curling of the entire lamina with brown necrotic patches.

- The entire photosynthetic activity of the plant is very seriously interfered with.
  - Hopper burn *i.e.,* the leaf margins turning yellowish initially and subsequently turning reddish and curling up.
  - Stunted growth of the plant.
  - Brown necrotic patches on the leaves.
  - Irrigated conditions in the north and humid conditions in the south; high humidity and high temperature are favourable.


Infested field


Symptoms of initial infestation


Symptoms of initial infestation


Symptoms of severe infestation


Symptoms of severe infestation

MANAGEMENT:

- Growing resistant / tolerant varieties against leafhoppers.
  - **L603, L604, Lam hybrid-4, narasimha**
- For sap feeders in general Seed treatment (after acid delinting) with
  - Carbosulfan - 40 g/kg
  - Imidacloprid 70 WS - 5 g/kg
  - Thiamethoxam 70 WS - 4 g/kg gives protection for 30 days against sap feeders

- Soil application carbofuran 3G 33 kg/ha (1 kg a.i./ha) at sowing
- Stem application (if seed is not treated) with insecticides using brush

  -Monocrotophos or methyl demeton 1:4 with water

  -Imidacloprid 200 SL 1: 20 with water

Three times at 20 – 25, 30 – 35, 40 – 45 Days after sowing.

WHITEFLY *Bemisia tabaci*
Aleurodidae: Hemiptera

DISTRIBUTION:

- It is known to infest about 50 different species of plants but it becomes quite a serious pest of cotton in certain regions of the country.
- The infestation by this pest adversely affects the physiology of the cotton plant at all its stages of growth.
- It is distributed in all cotton growing regions of the world. It also infests radish, water melon, cucumber, chillies, brinjal, tomato, potato, tobacco etc

APPEARANCE:

- Adult is minute insect measuring about 0.5 mm in length having white or greyish wings, a yellowish body and red medially constricted eyes.
- Nymphs are oval shaped, scale like, greenish yellow with marginal bristle like fringes. The nymphs remain stationary once they settle down.

White flies (*Bemisia tabaci*)

LIFE HISTORY:

- A single female of this species lays about 70 stalked eggs singly on the undersurface of leaves, mostly on the top and middle leaves of plant.
- The insect can often breed parthenogenetically.
- The eggs are light yellow in the beginning but turn brown later on.
- Egg period ranges from 3-33 days.
- Nymphs are oval shaped, scale like, greenish yellow with marginal bristle like fringes. The nymphs remain stationary once they settle down.

- Nymphs moult thrice.
- Nymphal period lasts for 9-18 days.
- There are about a dozen overlapping generations in a year.

ETL 5-10 nymphs/leaf

Eggs of Whiteflies


White flies on under surface of leaf


Nymphs and eggs


Adult


Nymph IV


Colony on leaf


Pest Symptoms

SYMPTOMS OF DAMAGE:

- Both nymphs and adults suck sap from lower side of leaves resulting in
- Chlorotic spots which later coalesce forming irregular yellowing of leaves which extends from veins to outer edges.
- The vegetative growth retarded and boll formation seriously hampered.
- Shedding of the bolls and proper opening of the bolls interfered with Low quality lint and low oil content.

- Sooty mould development due to honey dew excretion on infested parts.
- It is vector of cotton leaf curl virus.

MANAGEMENT:

- Growing of tolerant varieties such as Kanchana
- A chalcid parasite attacks the older nymphs and the parasitisation is at times more than 30 per cent. Also, there are a few predators like some species of *Chrysopa* and coccinellids, which feed on the whitefly stages.
- Chemical control same as under cotton leaf hopper.

COTTON APHID *Aphis gossypii* Aphididae: Hemiptera

DISTRIBUTION:

- It is of worldwide distribution. It is a polyphagous species. However on cotton often it causes appreciable damage during severe drought conditions. It also infests brinjal, chilies, amaranthus *etc.*

APPEARANCE:

- Adult is small, soft, yellowish, green or greenish brown in colour.
- It is found in colonies of hundreds on the tender shoot and the undersurface of tender leaves.
- They are characterized by the presence of two tubes like structures called cornicles, on the abdomen.


Cotton Aphid
(*Aphis gossypii*)

- They are wingless normally but winged forms are often found mostly in the beginning and towards the end of season.
- Wings are thin, transparent and are held like a roof over the body.
- Nymphs are light yellowish green or brownish or greenish black in colour.
- They colonise growing points, lower surface of leaves and tender shoots.

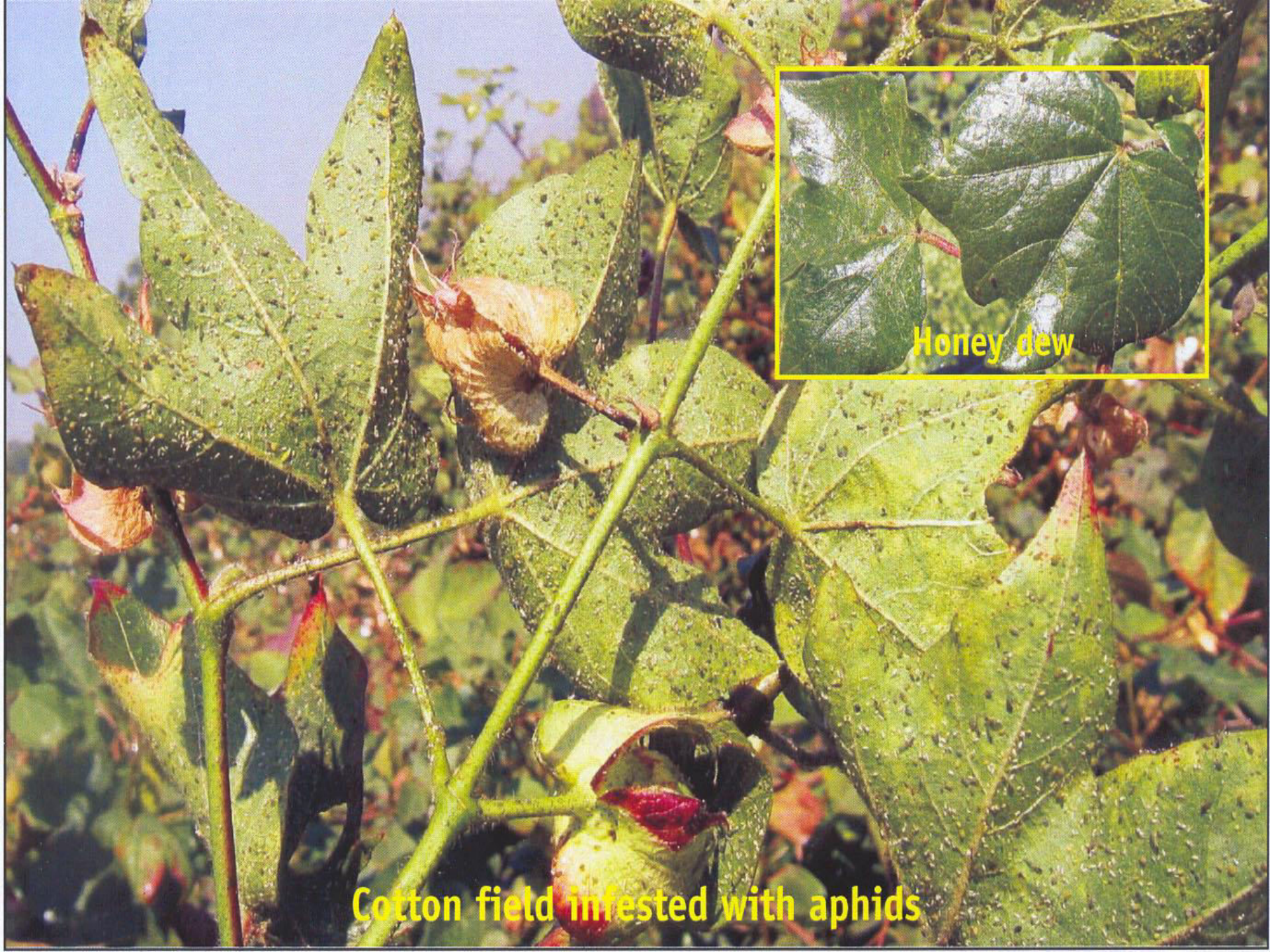
LIFE HISTORY:

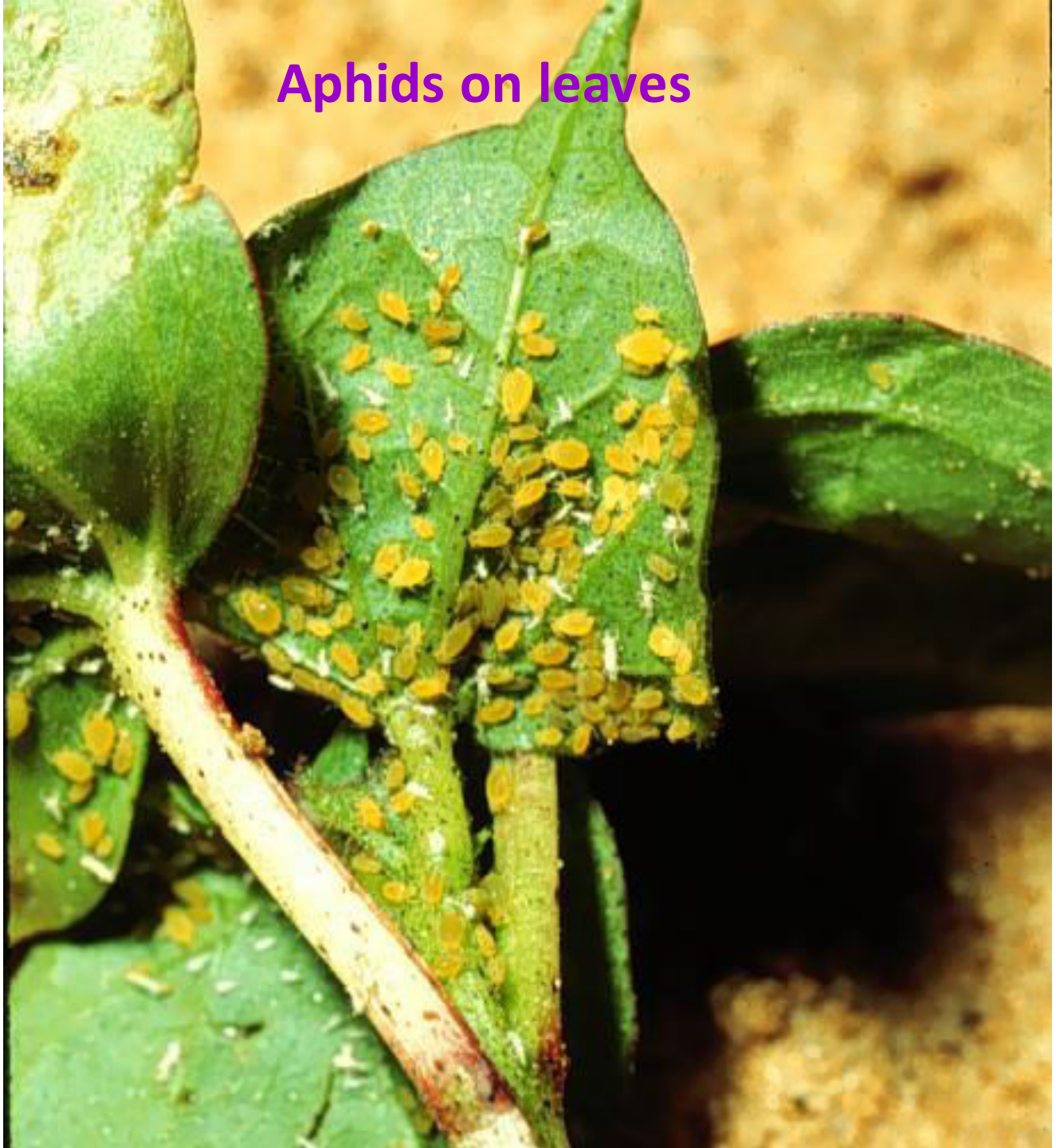
- They reproduce both sexually and parthenogenetically
- There are four nymphal instars.
- Nymphal period is about 7-9 days

SYMPTOMS OF DAMAGE:

Both nymphs and adults suck the sap by remaining on the lower surface of the leaves.

- Curled, faded and dried leaves.
- Development of black sooty mould due to honeydew excretion on infested parts.
- **MANAGEMENT:** Same as in cotton leafhopper.


Honey dew
Cotton field infested with aphids


Aphids on leaves

Cotton field infested with aphids


Shiny appearance due to honey dew secretion


Infested square


Infested flower

MITES

Tetranychus telarius, T. bioculatus (Tetranychidae)

Hemitarsonemus latus, (Tarsonemidae)

DISTRIBUTION:

- The mite is a polyphagous and is known to infest on 183 species of plant including cucurbits, brinjal and bhendi on which it is sometimes very serious.

APPEARANCE:

- Adult female body is oval and is variable in colour *i.e.,* red, green, amber or rusty green and with two large pigmented spots on the body.
- Nymph is light brown in colour and has two eye spots and four pairs of legs and quite active.

The large scale use of chlorinated hydrocarbon insecticides for the control of other pests led to the multiplication of the mites as they are less toxic to mites but more toxic to natural enemies.

LIFE HISTORY:

- It is active from March – October and passes winter as gravid female. It lays 60-80 eggs. Egg period lasts 2-6 days.
- Nymphs grow to maturity in 2 stages within 4-9 days and adults live for 9-11 days. Total life cycle in active period takes 9-19 days.

SYMPTOMS OF DAMAGE:

Mite infestation begins in the seedling stage and extends to harvest

- Both nymphs and adults cause damage by feeding on the lower surface of the leaf underneath a web.
- On close examination of the lower leaf surface, mites smaller than a pinpoint may be seen.
- The infested leaves rapidly curl up, become hard and crisp and ultimately shed
- Bolls ripen prematurely and in serious infestation shed.

Mite (*Tetranychus spp.*)


Mite damage

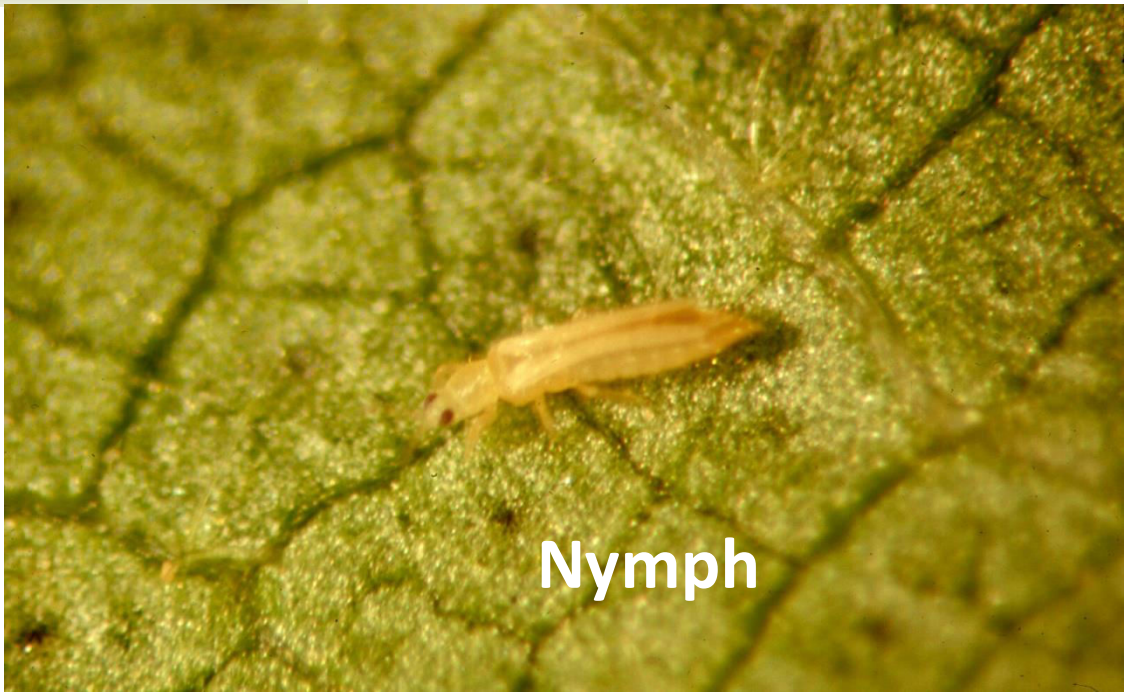
Mites on leaf

COTTON THRIPS

Thrips tabaci, Scirtothrips dorsalis Thripidae: Thysanoptera

- Cotton thrips is a highly cosmopolitan form and is found on all kinds of vegetation. Onion and garlic, amaranthus, guava, solanaceous and cucurbitaceous plants, groundnut, chilies, mango, cabbage, bhendi *etc.*
- Nymphs and adults suck sap from leaves and flower buds. Margins of affected leaves get slightly curled up and the leaf blades show uneven surface, when attack occurs in flowering stage, the affected flowers may wither away.
- It is a vector of yellow spot virus and spotted wilt virus

Thrips
(*Thrips tabaci*)



Thrips feeding on leaf

Adult


Thrips damage

Thrips damage at seedling stage

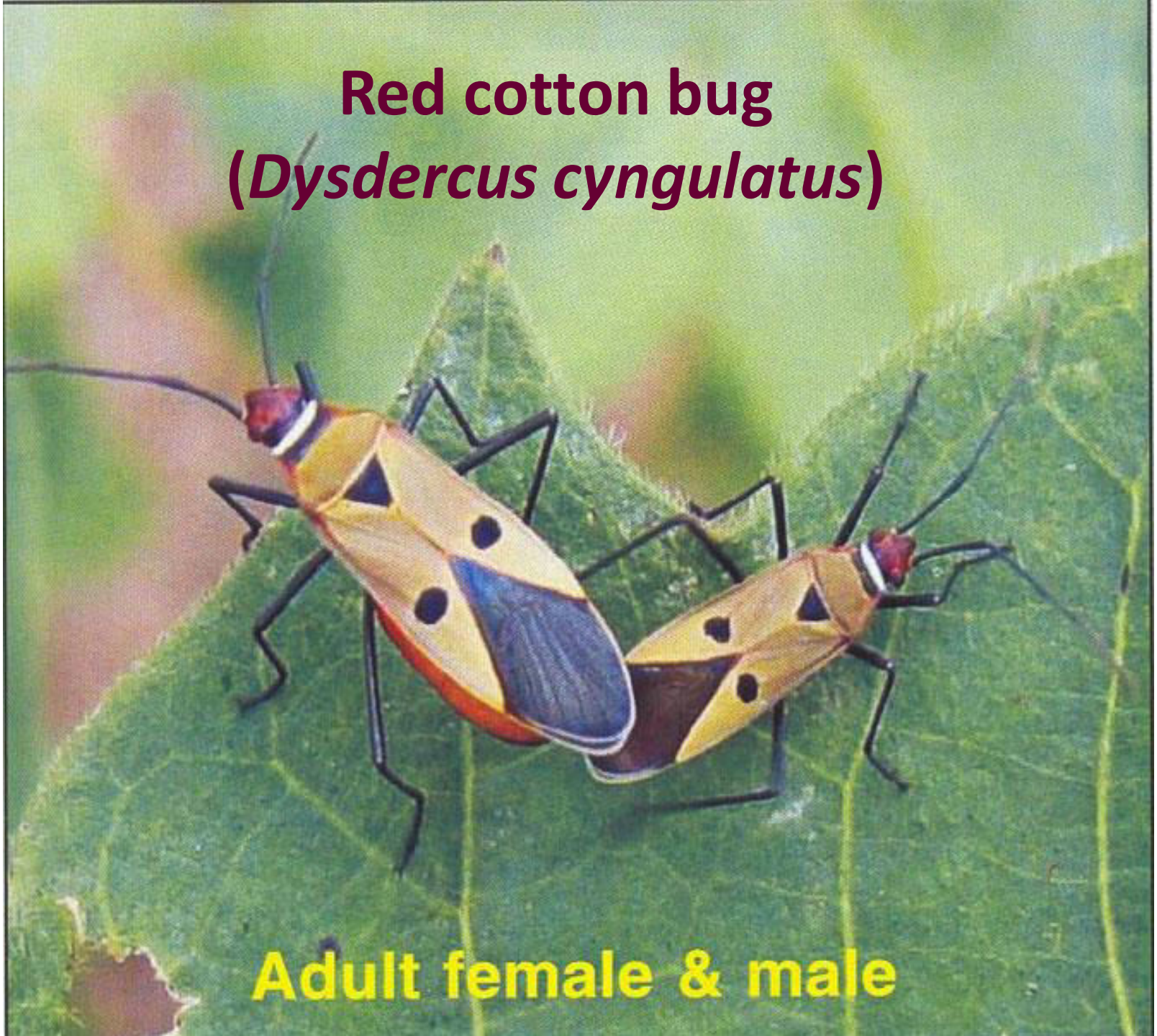
Thrips Infested plant and leaf

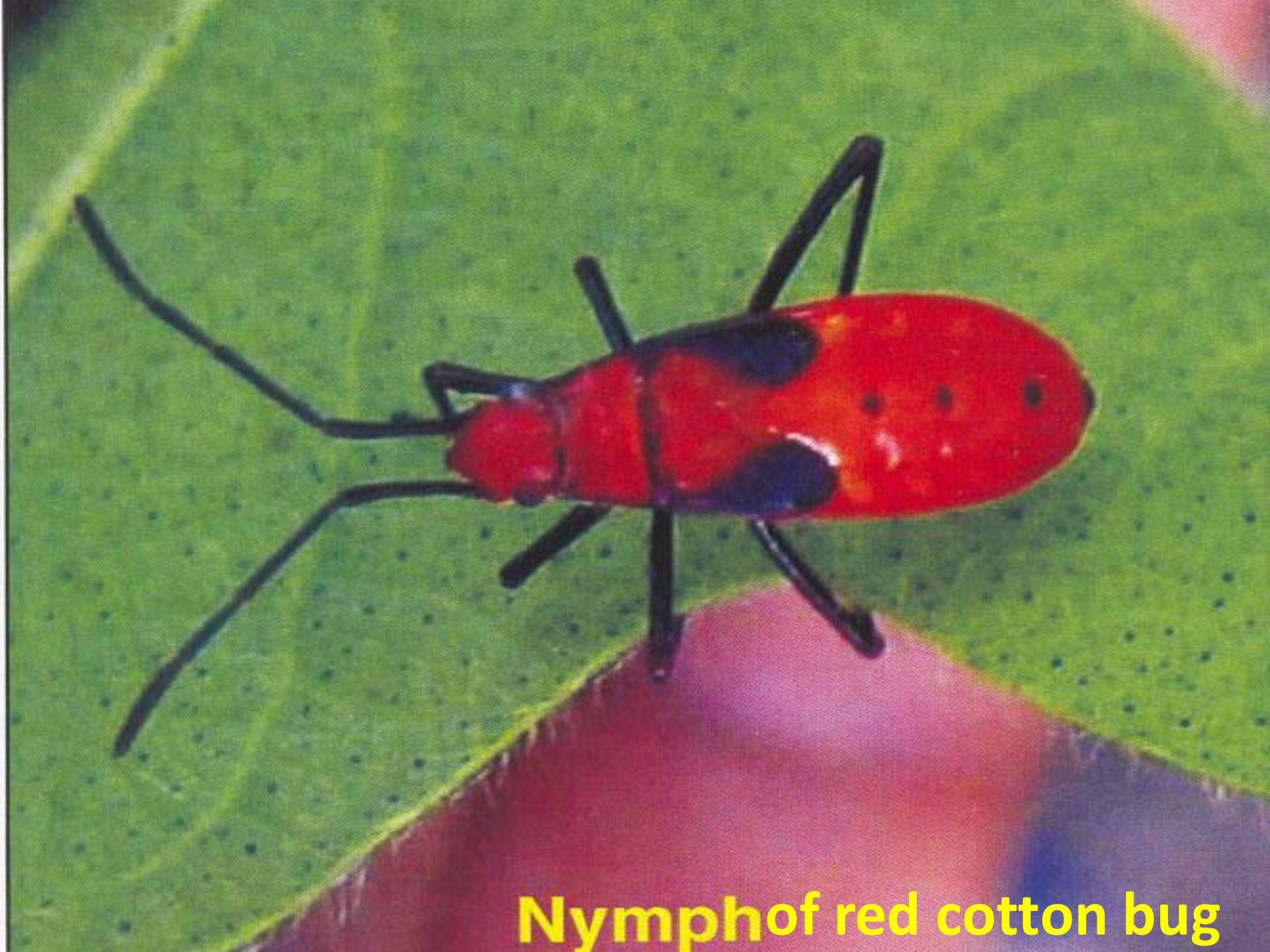
RED COTTON BUG *Dysdercus cingulatus* Pyrrhocoridae: Hemiptera

- In India, the bug infests cotton in all cotton growing regions. Also infests bhendi, maize, mesta *etc.,* are other host plants.
- The nymphs and adults suck sap from tender leaves, petioles and shoots in early stages and then infest flower buds and immature bolls and bolls that have just opened.
- Resulting plants loose their vigour and bolls open prematurely with stained lint.
- Infested seeds get shriveled, underdeveloped, become unfit for sowing and oil content gets reduced.

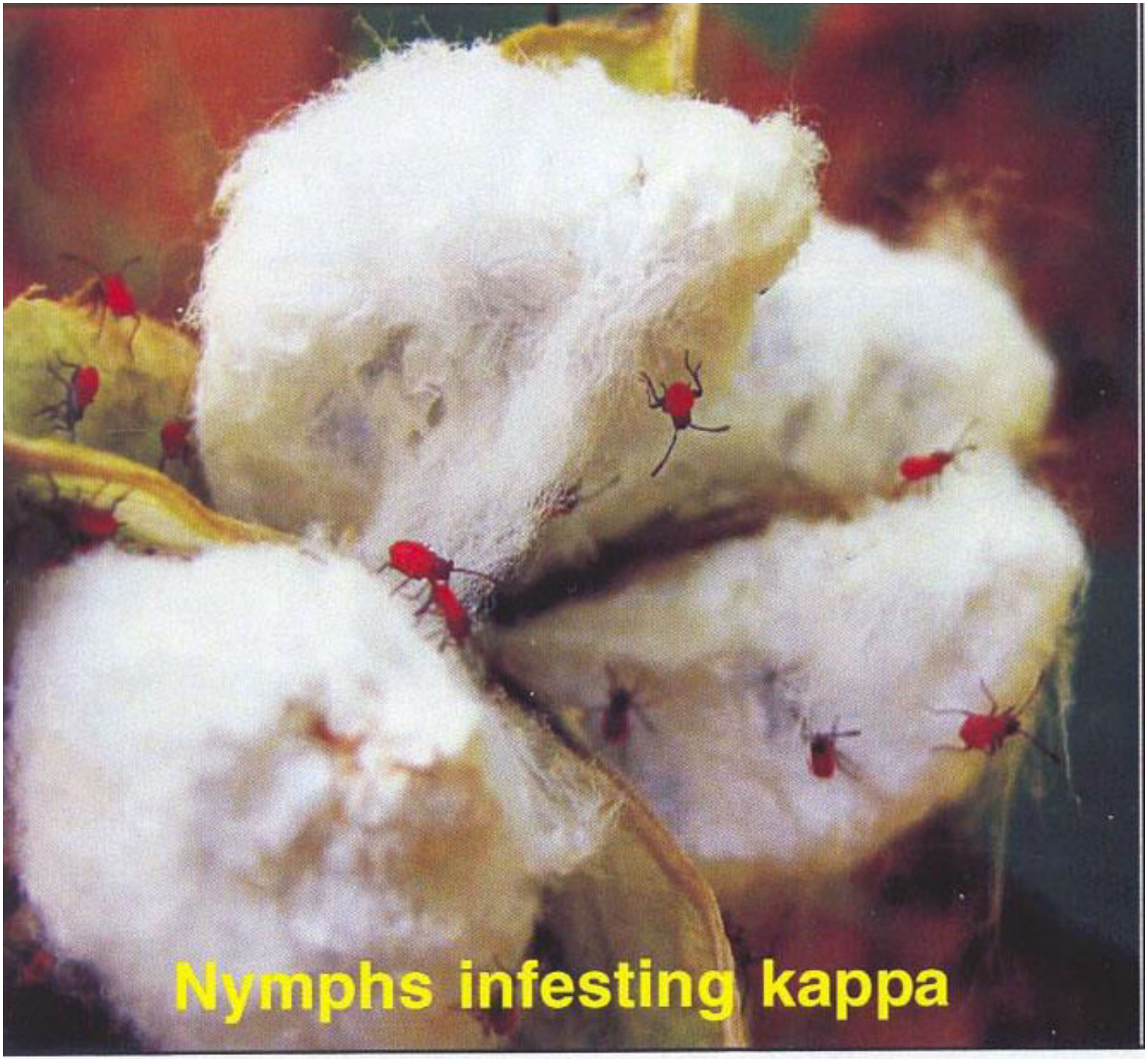
- From the spot of injury on the bolls, a bacterium – *Nematospora gossypii* gains entry and spoils the lint. Some times cannibalism exists in this insect.
- The reduvid bug *Harpactor costalis* is predacious on red cotton bugs, dusting of methyl parathion 2D or carbaryl 10D @ 10 – 12 kg/ac are effective against this pest.

Red cotton bug (*Dysdercus cyngulatus*)




Nymphof red cotton bug


Nymphs infesting boll


Nymphs infesting kappa


Nymphs infesting damaged kappa

******INTEGRTED PEST MANAGEMENT IN COTTON

1. **MONTORING**

- Use pheromone traps for monitoring of boll worms such as american, spotted, spodoptera and pink boll worms, at a distance of 50 m @ 5 traps/ha.
- Set up yellow sticky traps for monitoring whitefly and aphids @ 25/ha

2. PRE SOWING STAGE

- Deep ploughing in summer
- Removal of alternate hosts
- Avoid cotton after cotton
- Adopt crop rotation

- Remove and destroy crop residues by burning
- Trap crop with okra, castor, marigold and insect feeding on them should be periodically removed or killed
- Intercropping with mung bean, soybean, groundnut, ragi, maize, cowpea and onion reduces the infestation of boll worms
- Intercropping with cowpea help to colonize the bio control fauna such as lady bird beetles
- Acid delinting of seeds should be done before sowing with commercial sulphuric acid

3. SOWING STAGE

- Grow tolerant/resistant varieties
- In case of severe leaf hoppers infestation areas select varieties such as L604, Savitha, Narsimha
- Incase of white fly endemic areas select varieties such as Kanchana
- Use of certified seeds
- Early sowing
- Seed treatment with imidacloprid for the management of sucking insect pest

- Adopt proper spacing and maintain plant population
- Adopt judicious fertilisers and water management
- Avoid excessive use of nitrogenous fertilisers
- Maintain weed free crops atleast 8-9 weeks after sowing till canopy starts closing by timely intercultivation
- Use Bt cotton varieties against *Helicoverpa armigera*

4. VEGETATIVE STAGE

- Gap filling and thinning
- Inter culture and hand weeding of weeds
- Check population on trap and intercrops

- Release of *Trichogramma* egg parasite @ 50,000/ha and *Chrysopa* egg larval predator @ 100,000/ha, should be done as soon as the first brood of the boll worms is noticed
- Application of *Ha* NPV @ 250 LE/ha
- Spray neem oil formulation to manage white fly

5. FLOWERING STAGE

- Continue inter culturing and hand weeding of weeds
- Management of trap and inter crops
- Use of pheromone traps and change lures for boll worms
- Use of light traps and bird perches

- Destroy plants effected by cotton leaf curly virus (CLCV)
- Spraying of recommended chemicals for boll worms and for vector control

6. FRUITING STAGE

- Collection destruction of damaged floral bodies
- Collection of grown up larvae and destroy them
- Use neem products
- Spray *Ha* NPV @ 250 LE/ha
- Removal of terminal is to be done
- Spray recommended insecticides against boll worms

7. BOLL OPENING STAGE

- Apply need based insecticides
- Do not extend the crop period
- Use monitoring device
- Use sulphur and dicofol for controlling mites
- Destruction of CLCV infected plants
- Spot application of chemicals and need based application of monocrotophos/ triazophos/ acephate/ fenvelarate