TRAINING MANUAL ON PLANT PROTECTION: INSECT PEST AND DISEASES ON COTTON

BY

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INTRODUCTION

• Cotton is the most important vegetable fibre,
• It is a widely-grown cash crop in the world,
• It plays a very significant role in the political and socio-economic life of any country.
COTTON STAGES OF GROWTH

Cotton: Indeterminate Plant

- Exhibiting overlapping vegetative and reproductive growth phases.
- Duration of various phases depend upon variety, latitude, climate and management practices.

Germination Phase:

- Germination/Emergence completed in 4 days

Early Vegetative Stage:

- Rapid Root Growth
- Slow growth of main shoot
- Emergence of first true leaves
**Squares:**

- First squares (flower buds) appear in 35 – 90 days,
- Continuous to maturity.

**Flowering:**

- Appear 20 – 30 days after appearance of first squares,
- Peak period of flowering is from 70 – 100 days after germination.

**Boll Development:**

- Commence from flowering and continues till maturity.
MAJOR INSECT PESTS ASSOCIATED WITH DIFFERENT GROWTH STAGES

• The insect fauna found with the cotton plant are numerous.
• Not all the insects found are causing any damage.
• Presence of some insect type on cotton is beneficial,
• Insect whose activities on the plant is inimical to the well-being of the crop are referred to as “pest”.
• Insect pest could be categorized as:

  ✓ Sap suckers
  ✓ Leaf feeders and,
  ✓ Bollworms.
Insect pest cause economic damage to cotton during the following growth stages:

- Seedling
- Vegetative
- Reproductive
- Boll maturation
DESCRIPTION AND NATURE OF INSECT DAMAGE TO COTTON:

SAPSUCKERS

- Damage cotton plants by piercing and sucking sap from plant tissues,
- Portions of the plant exposed to this type of damage are the leaves, green bolls and the young developing seeds,
- Sap removed by insect pest leads to loss in vigour and in some viral diseases are transmitted,
- Damage directed at the developing seeds are liable to lose of viability.
- Lint from cotton bolls infested with sap-sucking insects are discoloured.
**LEAF-FEEDERS**

- Insect pest in this group chew leaf portions,
- This may lead to complete leaf defoliation,
- Plant would suffer premature shedding of fruiting bodies *(squares, flowers, green bolls)*,
- Weight and quality of the fibre are low on plants exposed to leaf feeding insects.

**BOLL-WORMS**

- Insects in this group feed on the reproductive parts of cotton plants – *squares, flowers, green-bolls*,
- Insects are the immature stages *(larvae)* of certain insects’
- Contents of fruiting bodies are consumed,
- Infected fruiting bodies are shed prematurely.
BENEFICIAL INSECTS IN COTTON FIELDS

- Insects and insect-like species frequent fields are beneficial,
- They prey on the plant feeding species,
- Helpful to the farmer in suppressing insects and mites that attack cotton,
- Pest species are preyed upon by predators and parasites,
- Predators catch and eat small insect pests,
- One predator can destroy many prey,
- Parasite live on or in the bodies of cotton insect pest during at least one stage of their life cycle,
- Most parasites are either flies or wasps.
DIAGNOSTIC FEATURES, PHYSICAL DESCRIPTION OF THE MAJOR INSECT PESTS OF COTTON

- Diagnostic features and characteristic habit of an insect pest is a tool used in the proper identification of the insect on the field,
- Scientist farm manager could make management decisions to effect the control of the insect,
- Diagnostic features and description of the major insect pest of cotton based on the mode of feeding, habit/behaviour and physical appearance of the insect.
MODE OF FEEDING:

Sap-suckers

- Feed by withdrawing juice from the plant,
- Mouth part is the piercing and sucking type,
- Piercing and sucking mouthpart formed into a pointed hollow tube with a sharp end for the ease of puncturing plant tissues
- Examples are:
  - *Aphis gossypii* (cotton aphids)
  - *Bemisia tabaci* (white fly)
  - *Empoasca* spp. (leaf hoppers)
  - *Dysdercus volkeri* (cotton stainers)
Leaf-feeders

- Pest feeds on cotton leaf by chewing the leaf lamina,
- Leaf consumption scarifying the epidermal layer followed by removal of chlorophyll,
- Insect pest have biting and chewing mouthparts.
- Examples are:
  - Adult and nymphs (immature stages) of grasshoppers, *Sylepta derogata* (cotton leaf rollers).
  - *Spodoptera littoralis* (cotton leafworm),
  - *Cosmophila flava* (cotton semi-looper)
Boll-feeders

- Insect pest feed on the contents of squares, flowers and green bolls having biting and chewing mouth parts,
- Fruiting bodies attacked by these insects shows signs of the feeding insect,
- Include entry or exit holes on the outer wall of the fruiting bodies,
- Presence of frass (excrements) on infested fruiting bodies,
- Hollowed fruiting bodies with colour turning yellowish on the plant
- Infested fruiting bodies are shed prematurely
- Presence of shed fruting bodies showing the feeding sign is an evidence of bollworm infestation.
HABIT AND BEHAVIOUR:

Sap-suckers

- Insect pest that sucks sap from cotton are found on the leaves and other green portions of the plant,
- If aim is to determine the presence or absence of any in this category on a cotton, the place to search is the leaves.

- *Aphis gossypii* have the habit of aggregation,
- Adults and nymphs occur in clusters containing many hundreds of individual insects,
- *Aphis gossypii* have a very high reproductive rate,
- Younger cotton leaves and growing shoot are most attractive to the insect
- *Empoasca* spp. predominantly found on the lower surfaces of cotton leaves,
- Characteristic manner of sideways movement,
- When disturbed make a quick hop to the side, hence the common name "leaf hoppers".

- *Dysdercus volkeri*. Congregates on the cotton plant when drop to the ground below the plant,
- Insect maintain a tandem posture while mating,
- Female insect being heavier than the male, pulls the latter along.
Leaf-feeders

- *Sylepta derogata*: larvae (caterpillars) congregate on the leaf on which they were hatched,
- Larvae migrates individual leaf are rolled around themselves’
- Larvae feed under protective covering of the rolled leaf.

- *Spodoptera littoral*: larvae congregate and moves en masse towards food plant.

- **Boll-worms**: immature stages of six insect types feed on fruiting bodies.
- **Important habit of bollworms oviposition (egg laying) site and the behaviour of larva while feeding.**
Behaviour of larva while feeding:

- **Helicoverpa armigera** feed leaving part of its body outside,
- Larva feed on 8 to 10 cotton squares full maturity,
- Presence of several fruiting bodies with internal contents consumed is indication of *Helicoverpa* on the cotton field.

- **Earias insulana** and **Earias biplaga**: Larvae boring down terminal shoot of cotton plant vegetative stage of growth.

- **Cryptophlebia leucotreta**: Larva produces strands of silk prefer older bolls for egg deposition,
- Larva enters the boll wall immediately after hatching,
- Larva has habit of minning the bollwall, attacks accompanied by severe secondary bacterial and fungal attacks.
PHYSICAL APPEARANCE

• Physical appearance important diagnostic tool identification,
• Discussed under three broad categories: Sapsuckers, leaf feeders and boll-feeders.

Sapsuckers:

Aphis gossypii
• Insect is oval shaped with two projections on its hind quarters,
• Very gregarious and many individuals found in one colony,
• Dark to grey in colour and has soft body,
• Fully matured individuals are winged.

Empoasca spp.
• Insect is green in colour and has a wedge-shape appearance,
• Young ones are wingless and resemble frog.
**Bemisia tabaci**
- Common name is white fly.

**Dysdercus volkeri**
- Is fairly large bug with bright colouration,
- Abdomen is reddish while wings are light-brown,
- Nymph is wingless and has reddish coloured body.

**Sapsuckers:**

**Sylepta derogata**
- Larva is translucent when young,
- Leaf tissues seen in the gut from outside,
- Matured larva has dark thoracic and head plate entire body is cream yellowish colour,
- Pupa is reddish brown and sensitive to touch with hooks at the last abdominal segment,
- Parasitized larva has cocoons of the parasite attached to the body.
Boll feeders

*Heliothis armigera*

**Egg:**
- Nearly spherical with flattened base, dome-shaped,
- Surface is sculptured,
- Egg is yellowish-whit, glistening when fresh,
- Dark brown before hatching.

**Larva:**
- Larva is yellow-white to reddish brown when young,
- Grown larva is 40 cm long,
- Has colour pattern of a narrow, dark, median dorsal band in each side,
- Underside is pale.

*Earias insulana and E. biplaga*
- Spherical and light blue-green.
- Egg is ridged longitudinally, alternate ones project upwards to form a crown.
**Larva:**
- Grown larva is 18 mm long, stout and spindle shaped,
- Segments have sharp spines on them.

*Diparopsis watersi* (Red bollworm)

**Egg:**
- Sky-blue and changing to grey before hatching,
- Has slightly flattened base.

**Larva:**
- Larva has red marks on the sides,

*Pectinophora gossypiella* (Pink Bollworm)

**Egg:**
- Small, oval, irregular sculpturing,
- Reddish orange before hatching.

**Larva:**
- Yellowish when fully matured,
- Has double red band on the upper part of each segment.
Cryptophlebia leucotreta (False-coding moth)

**Egg:**
- Oval, flat, translucent-white, usually singly,
- Sometimes a few together overlapping like tiles.

**Larva:**
- Smoky-grey turning to rose-pink and yellowish below.

ASSESSMENT OF DAMAGE TO COTTON CAUSED BY MAJOR INSECT PESTS

- Necessary to carry out damage assessment on cotton plant,
- Some basic reasons are:
  - Know if activities of pest lead to reduction in yield,
  - Serves as a diagnostic tool to enable farmer/manager decide when control measure be applied.
SAP-SUCKERS

- Assessment of damage due to sap-sucking insects,
- Following insects shall be used as test cases:

Dysdercus volkeri

- When a cotton crop is at fruiting:
  1. Make a random sample of about 100 plants,
  2. Collect two green bolls at random from each plant,
  3. Maintain bolls from each plant separately,
  4. Split open each green boll,
  5. Examine the boll wall and classify whether damaged or undamaged,
  6. Count the total number with Dysdercus damage (P),
  7. Count total number of plants with no damage (q)
  8. Incidence of Dysdercus infestation could be expressed as

\[
P \times \frac{100}{100}
\]
STEP II

- Bulk all the green bolls obtained from 100 plants,
  - Repeat steps 4 - 7, change number of plants to number of green bolls.
  - Percentage green bolls damaged by Dysdercus expressed as:
    \[
    \frac{P \times 100}{200}
    \]

BOLLWORMS

- Assess damage to cotton plant due to bollworm
- Method used is similar to that described above:
  - Make a random sample of squares, flowers, green bolls and a total of 100 of each category is made.
  - Examine external appearance of individuals in each group,
  - Classify each into whether damaged or undamaged,
  - Proceed to split open individuals in each category,
  - Classify each into whether damaged or undamaged,
  - Count the total number of damaged and undamaged individuals,
  - Express our findings in percentage terms.
METHOD USED IN SAMPLING FOR VARIOUS INSECT TYPES

- To sample for different insect groups be familiar with biology and habit of the insect,
- Sap-sucking insects found in close association with leaf and shoot,
- Dysdercus sp. Found sucking sap from green bolls, found in association with cotton plant at fruit formation and boll maturation,
- Former groups found sucking sap from leaf and shoot, populations are usually high at the vegetative stage,
- Sap-sucking insects as Bemisa, Empoasca fly very actively approach the “chosen” plant with care,
- Bend the plant to the side and then examine underside of the leaves,
- Sample insect early in the morning and evening between the hours of 0800 – 1100 am and 1600 – 18.30 pm respectively
Aphis gossypii

- Agreed/chosen number of plants be examined,
- Leaves from the bottom, middle and top portion,
- Record the degree of infestation using the following scale:
  - None:  0
  - Light:  1 – 10
  - Medium: 11 – 25
  - Heavy:  26 and above.
- Aphids be sampled in colonies of 5 both adults and nymph.

Dysdercus volkeri

- Sampling when cotton plants are fruiting,
- Plant be bent carefully as insects quickly falls to the ground.
**BOLLWORMS**

- Commence sampling at the onset of square formation,
- Watch for the presence of bollworm eggs and larvae,
- Signs of bollworm damage as bored squares, young green bolls should be detected,
- Systematic observation be done at 3 – 5 days intervals,
- Examine top 10 or 15 cm of main stem including squares, flowers, green bolls, growing points, peduncles,
- Examine the entire plant,
- Sometimes, damaged squares remain on plant but later shed,
- Pick shed squares from the furrow and examine them.

**SYLEPTA DEROGATA (Cotton leafrollers)**

- Sampling for Sylepta derogata at an advanced stage of vegetative growth,
- Correspond to between 6 – 8 weeks after sowing,
- Inspect at random, specified number of cotton parts,
- Plants be bent sideways,
• Count number of plants infested by Sylepta derogata, number of rolled leaves, number of Sylepta larvae per plant.

TECHNIQUES USED IN MONITORING FOR INSECTS ON COTTON

• Different techniques available for insect pests monitoring,
• Choice of a technique employed is dependent on the wish of the pest monitor.

WHY MONITOR FOR INSECT PESTS ON COTTON

• Developing countries, farmers embark on insect pest control without synchronizing pest control with pest threshold levels,
• Economical to apply control measures when population target pest is high to justify the control;
1. Cost of insect control measure is high;
2. Labour cost is high;
3. Yield from cotton reduced if control is not applied promptly.

- Embark on regular pest monitoring to determine the presence of insect pests on a regular basis, farm manager could predict a head when insect pest is likely to cause economic damage;

TECHNIQUES/METHODS

1. Diagonal;
2. Zig-Zag path;
3. Loop or stepped transverse
4. Quadrat.
KITS FOR EFFECTIVE INSECT PESTS MONITORING ON COTTON

Tool/kit for insect pests scounting:

(a) Essential
(b) Non-essential

ESSENTIAL KITS

1. Hand lenses;
2. Insect sweep;
3. Specimen bottles;
4. Insect killing solution;
5. Note books, pencils.
NON-ESSENTIAL KITS

1. Rain coat;
2. Rain boots;
3. Hand bags.

OTHER NON-ARTHROPOD PEST OF COTTON

• Nematodes (meloidogyne spp.)
• Root-Knots nematodes

Symptoms:
• Plant wilt
• Leaves turn yellow
• Presence of galls or knots on roots
• Nematode infestation serious on cotton growing in light soils;
• Nematodes predisposes cotton plants to Fusarium wilt infection.

Management practices:
• Crop rotation;
• Deep ploughing.

Integrated Pest Managements/Option:
• Integrated pest management (IPM) is the utilization of right tool/appropriate pest management techniques at the correct time for reduction of pest problem;
IPM requires a system approach with:

- Adequate soil/land preparation;
- Good varietal selection;
- Planting date;
- Balanced fertility and water/crop management programme;
- Careful planning for use of chemical/pesticide only when needed;
- Choice would not induce or intensify secondary pest and resistance;
- Basic concept be economically and environmentally sound;
- IPM reduce cost of production and risks of pesticide poisoning.
• IMP cotton programme focuses on production of early high quality and high yielding crop;
• Keeping pest damage to a minimum;
• Achieved through using natural predators, biological, mechanical and chemical management options;
• IPM does not encourage reliance on single or two methods only to achieve management of the pest problem;
• IPM depends upon the knowledge of the crop, biology of the pest, other potential pests, analysis of the pest population and the surrounding environmental conditions.
COTTON DISEASES AND MANAGEMENT

Seedling Diseases

- Seedling diseases are a worldwide problem, causing serious stand loss;
- Soil and seed-borne micro-organisms infect cotton seedlings individually or in association as a disease complex;
- These pathogens are fungi with wide host ranges, bacteria and viruses are sometimes involved;
- Disease syndrome encompassed by the term seedling disease includes any host-pathogen interaction which debilitates or kills the plant between planting and about four weeks after emergence.
Seed Decay

- First stage of attack, due to deterioration of seed as a result of exposure to adverse weather conditions before harvest (especially moisture) and poor storage conditions, lead to contamination of the seed by micro-organisms;
- **Causal organisms:** *Fusarium* ssp., *Colletotrichum gossyii*, *Rhizopus* spp. and *Pythium* spp.;
- **Symptoms:** Poor seedling emergence due to rotting/decay of planted seed;

Damping Off

- Second stage of attack, sub-optimal conditions for plant growth, seedlings failing to emerge, dying shortly after emergence;
Causal organisms: *Pythium* ssp. and *Rhizoctonia solani* are the most common.

Symptoms: Plant producing a sunken lesion due to cortical decay girdles the hypocotyls, causing the seedling to collapse.

**SEEDLING BLIGHT**

- Spotting of the cotyledons or lesions on the hypocotyls is capable of causing serious mortality;

Causal organisms: *Colletotrichum* ssp. and *Cercospora gossypina, Alternaria* spp. and *Ascochyta gossypii*. 
Symptoms:

- Spots caused by *Alternaria* spp. are light brown spots in colour, purple marging, and 2 – 8 mm in diameter;
- Cotyledons are more susceptible than the leaves;
- Bacterial blight of cotton (most damaging disease of cotton) caused by *Xanthomonas campestris pv. Malvacearum* begins as seedling blight.
- Characterized by rounded dark green water soaked lesions on cotyledons and stems.
- Symptoms first appear on the margins ventral side of the cotyledons.
- Severe infection results to deaths.
Prevention and Control of Seedling Diseases:

- Ensure that seed cotton does not remain on the plants for long periods after the boll has split, especially in wet weather;
- Adjust planting date so as to lessen the risk of bolls opening during wet weather;
- Adopt correct and proper seed storage procedure;
- Acid-delinting of seed prior to storage;
- Rotation with crops that are poor hosts to the pathogens;
- Any measure which encourages rapid emergence and growth of seedling;
- Use of seed-dressing chemicals: Captan, Apron plus, Apron star, Bronopol;
• Furrow application of suitable fungicide, e.g. metalaxyl;
• Use of resistant varieties;

**Diseases of the Vegetative Phase**

• Diseases found associated with cotton on the field about four weeks old;

**Cotton Bacterial Blight**

• CBB manifests in the latter life of the crop as angular leaf spots;

**Causal organisms:** Already mentioned under seedling diseases.
Symptoms:
• Angular leaf spots, because the lesions are delimited by the veinlets, giving them angular outline;
• Spots water-soaked, more obvious on the underside of the leaf;
• Lesions later coalesce to form larger lesions.
• Leaf shredded and are shed.

Control:
• Acid delinting of cotton seed;
• Seed dressing with bronopol, carboxin, etc.;
• Foliar spray with antibiotics, carboxin, or oxycarboxin;
• Use of resistant varieties.
Verticillium Wilt

- Vascular wilts affecting cotton;

**Causal organisms:** *Verticillium dahliae*

**Symptoms:**
- Infection and symptoms generally develop only when mean temperature are below 30°C.

Fusarium Wilt

- Fusarium wilt is rarely a problem in areas with mean daily temperatures below 24°C.

**Causal organisms:** *Fusarium oxysporium f.sp. Vasinjectum.*
**Symptoms:**

- Appear on the field between 4 – 8 weeks after planting, around flowering due to changes in host physiology;
- First symptoms appear on cotyledons as vein darkening, peripheral chlorosis, cotyledons progressively more chlorotic;
- In older plants, first external symptom is yellowing at the margin of one or more of the lower leaves.

**Control:**

- Rotation: Once established, it is almost impossible to eradicate. Graminacious spp. Have been considered as non-susceptible;
• Soil solarization;
• Chemical control: Use of a mixture of chloropicrin and methyl bromide;
• Use of resistant varieties.

Other Diseases

Phymatotrichum Root Rot:
• Symptom is bronzing or slight yellowing of the leaves;
• Leaves become flaccid, develop visible wilt and three days permanently wilt die;
• Leaves desiccate, root decay is usually confined to the lower tap root;
• Discoloration of xylem;
• Discoloured sunken lesions;

Control:
• Chemical treatment with 1,3-dichloropropane applied at 700l/ha in shallow treatment, and 45, 90 and 140l/ha;
• Growing resistant cultivars.

Fungal Diseases of the Boll

Colletotrichum boll rot (*Colletotrichum gloesporioides*):
• Thick grey mycelium produced on the surface of the rotted boll;
• Grey mycelium has a pink tinge.
Diplodia boll rot (Diplodia gossypina):
- Decayed boll becomes covered in a sooty black;
- Initial infection manifest as small, brown spots, becoming black in colour.

Fusarium boll rot (F. moniliforme):
- Usually begins with necrotic lesions on the margins;
- Enlarge in wet condition.

Aspergillas boll rot (A. flavus):
- Wound pathogen, invading the boll through insect holes;

Internal infection by Nematospora spp.:
- Bolls infected become completely rotted and are shed;
Control of boll rot pathogens

- Agronomic practices aimed at maintaining low humidity within the crop canopy;
- Seeds treated with fungicides;
- Foliar application of fungicides;
- Control of insect pest which serve as vectors;
- Use of resistance, e.g. cotton varieties with okra leaf shape allows greater air flow through the canopy.
THE END