

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 fruiting bodies showing the feeding sign is an evidence of bollworm infestation.**

HABIT AND BEHAVIOUR:

Sap-suckers

- **Insect pest that sucksap 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**”.
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- ***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) congregates 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 congregates and moves enmasse 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-codding 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**

$$\frac{P * 100}{100}$$

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:**
$$\frac{P*100}{200}$$

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 scouting:

- (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. *Vasinfectum*.

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. Graminaceous 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.

Aspergillus 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