

**Lecture Notes**  
**for**  
**Pests of Field Crops and Stored**  
**Grain and their Management**  
**ASEN 3103 (2+1)**

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*Shaping Lives...*  
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### **Reference book**

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# Introduction

Human beings presume that we are supremacy in the world because of discoveries and advancement in the field of science. But it is not true, insects and taken complete possession of land with > 80% of the species existing on earth and mastered the world long before man appeared on the earth on his evolution.

Insects appeared on the earth 350-500 million years ago, where as, man appeared on the earth just 2 million years ago, which indicates that man had been the intruder and invader into the domain of insects. Therefore insects should call us as pest but we are calling them as pests of ours. Human beings started the cultivation of crops just 10,000 years ago but on which insects are surviving for millions of years for food. This is snatching of food of insects. Insects, to get their requirement damage plants and animals in a variety of ways. Many of them feed on all kinds of plants including crop plants, forest trees, medicinal plants and weeds. They also infest the food and other stored food and also deterioration of food quality.

In this context, dependence of man and insects on the same food for their survival started the struggle between man and insects. So, man cannot over rule or exterminate insect species. At the best he can succeed is bringing down the insect population to a level at which he can co-exist without affecting each other. "Live and let live".

Therefore, here comes the Economic Entomology, the study of insects which are variously related to the welfare of mankind referred as Economic Entomology. Based on economic classification, insects may be harmful or helpful to human beings

- |                       |                       |
|-----------------------|-----------------------|
| 1) Harmful insects    | } Economic importance |
| 2) Beneficial insects |                       |
| 3) Helpful insects    |                       |

## Harmful insects

1. Pests of crop and plant (Agril. Entomology)
2. Pests of forest trees (Forest Entomology)
3. Pests of store grain (Storage Entomology)
4. Disease carrying insects (Medical Entomology)
5. Animal pests and disease carriers (Veterinary Entomology)
6. Household pests etc.

## Beneficial insects

### I. Productive insects

1. Silk
2. Honey bees
3. Lac insects

### II. Body of insects useful or contain substance like

1. Dye (Cochineal insects)
2. Contharidin (Blister beetle)
3. Fish bait (Stonefly nymphs)

### III. Product from insects

1. Tannic acid
2. Ink
3. Dyes

### IV. Insect as food: Food for fishes, birds, certain animals and human beings.

## Helpful Insects

1. Aid in pollination
2. Natural enemies
3. Weed killers
4. Improve soil fertility
5. Scavengers
6. As medicinal purpose
7. As aesthetic value

All these classifications are learnt in previous course. In this course we learn about pests of crops and store grain and their management.

## Types of damage caused by insects pests and damage symptoms

The nature of injury/damage to plant is related to the feeding habits of insect. The peculiarity of mouth parts and mechanism of feeding/type of feeding determine to a larger extent the pest management strategies including the type of pesticide to be used. In process of securing food, the insects cause injury through various means.

1. Direct effects through feeding: Direct damage
2. Indirect – effects through feeding: Indirect damage
3. Injury by other method: other means

### 1. Direct effects through feeding (Direct damage/Injury)

#### A) Injury by chewing insects

Insect with biting type of mouth parts will cause damage by chewing and feeding on plants and resulting damage like.

1. Feeding on growing points of plants and retard the growth.  
Eg: Grape vine flea beetle, Brinjal shoot borer.
2. Feed on leaves and defoliate the plant causing reduction in assimilation area.  
Eg: Semiloopers, hairy caterpillars etc.
2. Nibbling and notching of leaf edge.  
Eg: As weevil, Grass hopper
3. Making small holes on leaves  
Eg: Flea beetle on radish
4. Feed on layer of surface tissue.  
Eg: Grubs and adults of *Epilachna* beetle on brinjal
5. Feed and make large holes of irregular shape.  
Eg: Cabbage semilooper
6. Rollup the leaves and feed within  
Eg: Paddy leaf roller and cotton leaf roller
7. Larvae feed on bark of plants or trees and live inside protective cover of frass and excreta  
Eg: *Indrabella tetraonis*
8. Cut the tender part of shoot at the time of germination.  
Eg: Cutworm; cotton and chilli seedling
9. Feed on flower buds and flowers.  
Eg: Adults of blister beetles, cotton bollworm.
10. Nibble and cut off earhead.  
Eg: Rice grass hopper
11. Eat partially on grains and give chalky appearance.  
Eg: *Helicoverpa* damage on jowar grains and ragi

#### B) Injury by piercing and sucking pests

Insects with piercing and sucking type of mouthparts do damage the plant directly by sucking the sap from plant. Besides feeding on plant juice the saliva sometimes acts as toxic to plant tissues. Following symptoms are exhibited during process of sucking.

1. **Chlorosis:** Aphids, plant hoppers and bugs, jassids – suck the sap from leaves (Stem causes chlorosis resulting drying and withering).
2. Faint yellow speckling of leaves due to feeding by whitefly and scales in coconut.
3. Silvering or whitening of leaf surface due to removal of cell content below epidermis. Eg: Thrips in groundnut, onion, cotton etc.
4. Hopper burn or necrotic brown lesion: Jassids in cotton, plant hoppers in paddy.
5. Crinkling or curling of leaves: Thrips in chilli, cotton.
6. Distortion of foliage and clustering of terminal shoots in mealy bugs/psyllids infesting tender shoots. Eg: Subabul psyllids.
7. Premature shedding of developing fruits or drying of shoots. Eg: Scales and mealy bugs, kajji bug in Guava.

#### C) Injury by internal feeders

These cause damage to plants by remaining within the plants tissue in one or all stages of their development. These feeders may be grouped.

- i. **Borers:** Larvae bore into the plant stem, plant shoot etc. Eg: Rice stem borer, Sorghum stem borer, Cotton stem borer.

- ii. **Worms and weevils:** Larvae bore into bolls, nuts, fruits, flower buds or seeds. Eg: Cotton boll worms, (All 3 types) Mango nut weevil.
- iii. **Leaf miners:** Small maggot/larvae mine between two epidermal layers of leaf. Eg: Citrus leaf miner, Ground leaf miner, Serpentine leaf miner in cotton.
- iv. **Galls:** Immature insects/adults of some insect cause. Special deformity galls for shelter and food. These galls impair the growth and development of plant resulting reduction in yield. Cecidomyiidae, Psyllidae, thysanopter etc. are common groups to cause gall. Eg: Jowar midge, paddy gall midge, Sesamum pod gall. etc.
- v. **Injury by subterranean insect:** Insects which are found in soil and cause the damage by feeding on roots, boring or sucking the sap or forming the galls. Eg: Wireworms, root grubs, root aphids, termites etc.
- vi. **Injury to stored product:** Store grain pest bore to seeds and cause damage both in quantitatively and qualitatively. Eg: Pulse beetle, Rice moth etc.

## 2. Indirect effects of feeding:

- 1. **Making harvest difficult:** Eg: Cotton pink bollworm, Mealy bugs on mango, pomegranate, Grapes. These insects secrete honey dew which makes harvest difficult.
- 2. **Quality loss:** Reduction in market value, or nutritional value. Eg: Cardamum thrips, on berries, Scab formation by thrips on Pomegranate and Grape. Fruit sucking moth.
- 3. **Dissimination of plant diseases:** Vector of plant diseases. Eg: Paddy grassy stunt by Bihar Plant Hopper (BPH), Kattee of Cardamum by aphids, Rice tungro by Green leaf hopper.
- 4. **Injury by other methods**
  - a) **Injury by egg laying:** Damage cause by laying eggs in tissues by piercing ovipositor. Eg: Cicada – Splits the plant at place of ovipositor.
  - b) **Use of plant parts for making nests:**
    - 1) Plants parts are used for construction of nests. Eg: *Megachiola anthracina* – remove circular leaf of rose.
    - 2) **Ants:** Construct nest on trees by webbing
  - c) **Injurious insects carried out from one plant to another**  
Ants carry mealy bug, aphids and hoppers.

## Pests

Pest is an organism that cause significant and economic damage or loss to crops, stored produce and animals which may include insects, nematodes, mites, snails, slugs, bacteria, fungi, birds, weeds, rats, etc.

## Insect pests are classified in several ways

### I. Based on association

- 1) **Regular pest:** Insect pest occur more frequently and close association with particular host. Eg: Chilli thrips, Aphids on cotton, castor shoot and capsule borer.
- 2) **Occasional pest:** Pest occur infrequently and no close association with particular host. Occasionally. Occasionally reaches significant level. Eg: Sugarcane Pyrilla, Castor slug caterpillar.
- 3) **Seasonal pest:** Occur particular part of the year. Climate and weather factors largely influence on these pests. Eg: *Spodopetera litura* on groundnut in Kharif at DWR and Rabi in Raichur.

- 4) **Persistent pest:** Insect pest occur throughout the years. Eg: Chilli thrips, Hopper on cotton, Scales and Mealy bugs.
- 5) **Sporadic pest:** Pest occur in a few isolated localities are known as sporadic pests. Eg: Rice Earhead bug, Slug caterpillar on castor.
- 6) **Cyclic pest:** Pest occur once in 6-8 years as major pest. Eg: Decan wingless grass hopper, earhead bug on sorghum.

## II. Classification based on intensity of infestation

- a) **Epidemic pest:** Infestation occur suddenly in a severe form in a region or locality at a particular season or time is called as epidemic pest. Eg: Bottom paddy.
- b) **Endemic pest:** Pest is confined to particular locality or region lss as regular and causes potential economic. Eg: Gall midge on paddy in coastal, Sorghum ear head midge in DWR.

## III. Classification based on ETL

1. Negligible pest - < 5% loss
2. Minor pest – 5-10% loss
3. Major pest - > 10% loss

## Parameters of insect pest populations

### 1. Economic Threshold Level (ETL)

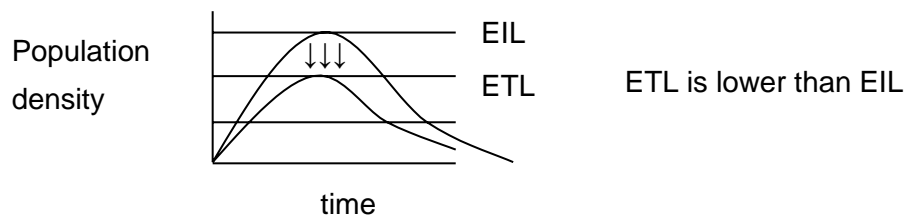
It is decision making factor for application of pest management strategies to bring down pest population to reaching economic injury level.

ETL can also defined as the “Maximum pest population that could be tolerated without a resultant crop loss”

At this level **cost benefit ratio is 1:1**

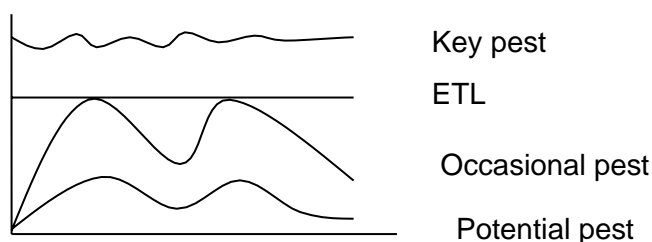
### 2. Economic injury level (EIL)

“It is the lowest pest population density that will cause economic damage”. IT is the level at which damage can no longer be tolerated. Therefore at that point or before reaching that level it is desirable to initiate deliberate control operation.



## Classification of pests based on ETL

- a) **Key pests:** Pests whose populations are always above the damage threshold or ETL are called as key pests.
  - Severe and damaging pests
  - These are persistent and perennial threat to crop
  - Eg: Cotton bollworm, DBM, Pod borer
- b) **Occasional or Sporadic pest:**
  - Are those whose population remain low and insignificant for long period of time, occasionally population is increasing to a damaging level due to favourable biotic and abiotic factors.
  - Eg: White grub, Cutworms, Hairy caterpillar
- c) **Potential pest**
  - Population of these pests lies below threshold and does not cross EIL. These may cause economical damage to the crop if not kept under control by biotic factors.
  - Eg: *Spodoptera litura* on Sunflower – In India.
  - Army worm on wheat



# 1. Pests of Paddy

Rice is important staple food crop for more than two third of population of India and more than 65% of world population. Many biotic and abiotic constraints have to be addressed to meet the productivity gap. Among the various biotic stress constraints damage due to insect pest is substantial and regular attention. The annual yield loss due to insect various from 21-51 percent in India and 26-34% across the world.

About 1400 insects covering 100 species are reported all over the world of which 20 species are of national economical significance and 12 are of state significance.

## National significance pest

1. Yellow stem borer
2. Plant hopper (BPH and WBPH)
3. Paddy leaf roller
4. Paddy ear head bug
5. Paddy gall fly

## Pests of regional significance

1. Yellow stem borer
2. Plant hopper (BPH and WBPH)
3. Paddy leaf roller
4. Climbing cut worm
5. Caseworm
6. Panicle mite

## Borers

1. **Stem borers:** Among the biotic stress, Insect pests are occupying prime position. Of which stem borers are key pests causing 25-30% of loss. Stem borers are major group belonging to the crambidae and noctuidae. These stem borers are more prominent as a national significance pest because of the damage they cause to the major yield components like tillers, panicles and grain filling and they infest the crop from nursery to reproductive phase.

## There are 5 species of stem borer

1. Yellow stem borer – *Scirphophaga incertulas* (crambidae)
2. White stem borer (WSB) – *S. spp.*
3. Dark headed borer (DSB) – *Chilo polychrysus*
4. Pink stem borer (PSB) – *Sesamia inferens*
5. Striped stem borer (SSB) – *Chilo suppressalis*

## Yellow stem borer – *S. incertulas* (Crambidae : Lepidoptera)

**Distribution:** Yellow stem borer is widely spread across the country and is for more abundant than any other species. It is distributed in all paddy growing areas of world especially in Asian countries, Philippines, Thailand, Malaysia.

## Host plant: Rice, Monophagous pest

**Appearance:** Moths are yellowish, female with a predominant back spot on forewings which is not conspicuous on the forewings of males. Usually males are smaller than female. Female possess a tuft of hairs on the tip of the abdomen.

**Life cycle:** A female lays 3-4 egg masses in it life time while each egg mass may contain 100-150 eggs and covers it with bult hairs Neonate larvae move up the plant to the tip of the tallest leaf and drop down suspend with a salivary thread to be swung out by wind in all direction. Later they crawl down the plant and enter leaf sheath and borrow into the tissue grown up second instar larvae bore into stem and feed on the tissue lining. Some of second third instar larvae come out the stem if the larval population in the plant is high and move to adjacent tillers or plant. Fully grown larva move internally to the base of the plant, makes an exit hole covering it with frass and enters into pupal stage.

**Biology:** Egg hatch in 8-10 days, larvae is creamy white colour with orange head, become pale yellow LP-33-41 days. Larvae bore down words at the base portion of the stem for pupation. Before pupation it covers the exit hole with webbing and pupate in side the stem PP 6-10 days.

Pest is observed both in kharif and rabi/summer crop, however severity is observed in summer. The peak incidence is noticed during October-November in Kharif and March-April in Summer.

**Nature of damage:** Larva borer into central shoot and feed inside resulting death of growing point. This is a characteristic damage of “dead heart” where in central leaf whorl does not unfold, turns brownish and dries out although the lower leaves remain green and healthy. The dead portion when pulled out it comes out easily.

If larvae infest the plant at booting stage, the damage manifest as “White ear” Due to feeding at the base, the whole panicle is detached and appears as white ear.

## Management for stem borer

1. Summer ploughing
2. Selection of resistant variety viz., Vikas Sasyashree, Rama, Aket, Deepthi, Ratna.

3. Synchronous planting and harvesting. The peak adult emergence at a location should not coincide with the booting stage of crop.
4. Plant at right time.
5. Trap crop: In Yellow stem borer endemic areas, planting of one row of pusa basmati – 1 as trap crop for every 2.5-3 m of main crop in east-west direction can be adopted to minimise the damage in main crop. Clipping of leaf tips white transplanting is advocated to minimise the egg laying by stem borer.
6. Early planting
7. Judicious use of N-fertilizer is recommended. LCC (Leaf colour chart) may be followed at 21 DAT for application of N. to assess the real time need of crop.
8. Application of K-fertilizer.
9. Destruction of stables.
10. Destruction of egg masses.
11. Sex pheromone: Use of sex pheromone trap @ 3 traps/ac for monitoring and 8 traps/ac for mass trapping. 303-35 male moths/trap/week – ideal for control measure
12. Natural enemies: Egg parasitoids:
 

<i>Trichogramma japonicum</i>	}	30-50%
<i>Telenomus beneficiens</i>		
<i>Tetrastichus schoenobii</i>		

Larvae: *Isotima javensis*

*Amauromorpha accepta*

- Collection of egg masses and placing them in bamboo cages cum perches.
  - Inundative release of *T. japonicum* @ 1,00,000/ac (5-6 release) at 15 days interval
13. Application of Carbofuran 3G @ 33kg/ha or cartap 4G @ 25kg/ha or Fipronil granules @ 15kg/ha at 20 DAT.
    - Chlorpyrifas 20 EC @ 2ml/l.
    - Profenofas 50 EC @ 2ml/l
    - Chlorantraniliprole 18.5 SC @ 0.3 ml/l
    - Flubendiamide 48 SC @ 0.07 ml/l

## 2. Plant hoppers

- a) Brown plant hopper – *Nilaparvata lugens*
- b) White backed plant hopper – *Sogatella furcifera*
- c) Smaller brown plant hopper – *Laodelphax striatellus*

a) Brown plant hopper: *Nilaparvata lugens* (Stal.) (Diptera : Homoptera)

**Distribution:** Brown plant hopper first assumed a major pest status during 1972. It was confined mainly to Southern states of Kerala, Andhra Pradesh, Tamil Nadu, later spread to Tungabhadra region of Karnataka. Now it is regular pest of Goa, Maharashtra, Gujarat, Chattisgarh, Bihar, Uttar Pradesh, Assam and Tripura. Haryana, Punjab and Delhi

### Life cycle:

**Egg:** Eggs laid in group in a straight line at midrib of leaf sheath. Egg laying sites appear as brownish streaks. Eggs are banana shaped. Newly laid eggs are whitish and turn darker when about to hatch. EP : 7-11 days

**Nymph:** The nymph has triangular head with narrow vertex. Body is creamy white with pale brown tinge. NP – 12-20 days

**Adult:** Adult is brownish black with yellowish brown body. Colour variation is there from light brown to dark brown. It has a distinct white band on its mesonotum and dark brown outer sides. Two distinct wing forms are seen in adult stage. Large winged or macropterous form – have wings expanded beyond the tip of abdomen while short winged or brachypterous forms – have smaller wings that do not extend beyond the tip of body. Macropterous forms are adapted for long distance flights and are known to migrate thousands of km distance across land and sea. These forms are first to appear in newly planted field and begin colonization. Eggs laid by these immigrants hatch into tiny nymphs. During course of their development turned into brachypterous adults. Such adults are not capable of flying but more fecund. They lay 300-500 eggs/female. Second generation nymphs and adults crowd at base of plant and their feeding results in “hopper burn”, when the plants start drying up, many of 3<sup>rd</sup> or 4<sup>th</sup> generation nymphs develop into macropterous adults and fly out of the field to neighbouring or distant healthy fields. Thus wing polymorphism is an adaptive strategy of this pest for long distance immigration, colonization, rapid utilization of available resources and outward emigration.

Adult period – 10-25 days

### Mature of damage

If infests rice crop at all stages of plant growth. The nymphs and adult stay at base of rice plant and suck the plant sap and as a result of feeding plants turn yellow and dry up rapidly. At early infestation, round yellow patches appear which soon turn brownish due to drying up of the plants. This condition is called as “hopper burn” the patches of infestation may then spread out and cover the entire field. It also excretes honey dew on which sooty mould develops which interferes with plant functions. It also vector of Grassy stunt, ragged stunt and yellow syndrome.



**Causes of out break**

**1. Indiscriminate use of insecticides**

- a) Indiscriminate use of insecticides disrupt the actions of BPH's natural enemies either by direct killing action or disrupting food chains.
- b) It also causes "pest resurgence"
- c) Secondary pest outbreak: Usually farmers are applying insecticides to control leaf folders or other pest not to BPH but at the same time BPH density is low. However, this non-target secondary pest increases from its normal sub-injurious level to pest status following insecticidal control of target pest. Normally secondary pest is under effective control with natural enemies or other regulatory factors but it erupts only when insecticides or other factors cause ecological disruption.
- d) **Insecticides induces the hormone:** Sub lethal dose of some insecticides increases fecundity of BPH females by stimulating changes in plant nutrient.
- e) Wide scale use of neonicotinoids compounds/other insecticides magnified the resistant problem in both tropical and temperate area.
- f) Insecticide resistance aggravate the problem of resurgence and secondary outbreak of BPH.

**2. Use of heavy dose of 'N' fertilizer**

- (Increased plant nitrogen accerates BPH feeding and honey dew excretion, sunival, fecundity and population growth).
- Vigorous vegetative growth attracts the BPH population.

**3. Continuous cropping of paddy or staggered cropping**

- 4) Use of susceptible varieties
- 5) Ruling of pseudo bio-product in the market
- 6) close planting resulting in preventing aeration and light
- 7) Extensive cultivation of rice (Double cropping, triple cropping, multiple cropping (5 crops in two years) are important factors.

**b) White backed plant hopper:**

The yield reduction due to WBPH ranges from 11 to 90% depending on the degree of infestation.

**Distribution:** The First report of heavy damage of this pest is noticed in Kapurthala, Ludiana, Karnal, Gurgaon

**Life cycle**

**Adult:** Yellow – Yellowish brown body. It has very distinct white band between the junctions of wings and apex of its front – wing has an unbranched band. There is a conspicuous black dot at the middle of the posterior margin of each forewing which meets when the forewings come together. FW are hyaline.

The hoppers especially adult prefer to stay at upper portions of rice stems. Adults are positively phototrophic and are attracted to light.

Moropterous male and females and brachypterous females are where as brachypterous males are rear. AP 10-12 days.

WBPH	BPH
Prefers young stage of crop and more number in early tillering stage.	Reproductive phase of crop
Feeds at base of upper leaves	Prefers base of plant
Oviposition mark is distinct with 8 lit and open window	Less distinct

**Egg:** Eggs are thrust in midrib of leaf sheath and leaves. The plant tissue is slit and the eggs are laid inside. Oviposition site is brownish streak with light yellow hallow.

Eggs are straight, white and turn darker when about to hatch. Before egg hatching two distinct spot appear representing the eyes of developing nymph. IP – 7-11 days.

**Nature of damage:**

Both adult and nymph feed at the base of plant and suck the sap resulting orange colour leaves which turns to yellow and dry up. The plant drying is more random to begin with and rapidly spread to entire field, when WBPH alone occur.

**c) Smaller brown plant hopper (SBPH): *Laodelphax striatellus***

It is most abundant in temperate and sub-trophic part of Asia. It is vector of black streaked dwarf virus and stripped virus. Biology, nature of damage similar to BPH.

## Management:

### 1. Use of resistant varieties:

IR-26 – First high yielding cultivar from IRRI. Manasarovar, Suraksha, Deepti, Jagtial Sannalu (JGL 1798), Krishnaveni, Vajram, IET 7575, IR-64, Jyothi, Bhadra, Bharathi Chaitanya, Aruna, Sonasali, Vijetha (MJU, 1001), Cotton dorasannalu (MTV – 1010).

**PtB-33** – important resistant variety

WBPH: HKR 120, Udaya, Surya, HKR-126, Haryana Basmati.

2. Growing of early mature varieties to have rice free period at for 1 month subsequent crop breakdown pest cycle.
3. Early planting.
4. Avoid close/dense planting. Adopt the recommended wider spacing.
5. Formation of alley ways – Provide 30 cm alleyway at every 2m to allow sufficient – aeration and sunlight to the basal portion of crop canopy and reduce the multiplication rate of plant hopper.
6. Synchronous planting.
7. Crop rotation with non-rice crop to avoid continuous supply of food to the insect.
8. Alternate dry and wetting method will reduce the infestation. Mid season draining of the field to reduce relative humidity.
9. Maintenance of irrigation.
10. Judicious use of 'N' fertilizer and insecticides.
11. Avoid the pyrethroids application.
12. Application of insecticide based on ETL and rotation of insecticides to avoid the resistance.
13. Monitoring and surveillance of pest and natural enemies.
14. Setup of light trap.

## Biological control

### Egg parasitoids

*Oligosita yasumatsui*

*Anagrus* spp, *Gonatocerus* spp.

Major egg parasitoids

### Nymph – adult parasitoids – Dryinid and strepsiteran wasp

*Pseudogonatopus* sp. – Nymph, adult

*Haplogonatopus* sp. – Nymph, adult

*Echthorodelphax fairchildi* – Nymph, adult

*Elenchus yasumatsuii* – Nymph, adult

### Predators

Green mirid bug – *Cyrtorhinus lividipennis* (Egg and nymph)

*Microvelia douglasi* (Hemiptera), *Menochillus sexmaculatus*

### Spiders

*Lycosa* (= *Pardosa*) *Pseudoannulatum* (Nymph and A)

*Oxyopes javanus*, *Tetragnatha maxillosa*

### Fungus:

- *Metarhizium anisopliae*, *M. flavoviridae*
- *Beauveria bassiana*

### Nematode

*Hexameris* sp. (Mermithidae)

### Chemical control

Buprofezin 25 SC @ 1ml/l, Dinotefuran 20 SG @ 0.4 g/l, Thiamethoxam @ 0.25 g/l, Pymetrozine 50 WG @ 0.6 g/l.

### Note:

1. Application of insecticide should be based on ETL
2. Spray 200-250 solution per ac.
3. Before application of insecticide, drain out the water from field.

### 3. Rice Green leaf hopper: *Nephotettix nigropictus*, *N. virescens*

**Adult:** There are small, wedge shaped, distributed all rice tracts in India

- *N. nigropictus* – In case of male, two black spots on forewings extend upto the black distal portion of the forewing. Black tinge along the anterior margin of pronotum and black submarginal band on head. Female – Entirely green without any black tinge on pronotum.
- *N. virescens*. – Black spot in males not extending upto black distal portion of forewing and absence of black tinge on the pronotum and black band on crown.
- It causes more damage than *N. nigropictus*.

**Egg:** Eggs are yellowish laid under epidermis of leaf sheath, 53 eggs/♀.

IP – 6-7 days

Nymphal – NP – 18 days, TLC – 24 days.

**Nature of damage:** Both nymph and adult suck the sap from leaves causing yellowing, stunting and withering of plants. Leaves turning brown with small scratch like marks on leaf in severe infestation.

Transmits rice dwarf, rice yellow dwarf, rice transitory yellowing and rice tungro.

Rice green leaf hoppers are abundant during rainy season. Optimum temperature and high humidity favour the pest.

**Management:**

- Early clipping of infested leaf tips to prevent – virus transmission.
- Removal of alternate host like panicum spp. Echinochloa, Cyperus, and other grasses.
- Seedling root dip with chlorpyrifos @ 0.02%.
- Resistant varieties : IR-20, Vani, Vikramarya.
- Egg parasitoid – *Oligosita nephotetticum*

ETL – 1-2 hoppers/m<sup>2</sup> - In Nursery

10/hills – Tillering

20/hills – Heading

1/hill – Tungro endemic area

Chemical control: Similar to BPH

**4. Rice leaf folder:** In Asia 10 species 4 genera are reported but in India 4 species are reported.

*Cnaphalocrocis medinalis*, *Marasmia patnalis*, *M. exigua*, *Bradina arotraea*

Among these, *C. medinalis* is the most predominant and wide spread in all rice ecosystem across the country.

**Distribution:** It is widely distributed in India. It is assuming major status in recent years in both upland and low land rice ecosystem due to

- a) Use of high yielding varieties accompanied by heavy use of fertilizer and cloudy weather.
- b) Continuous cropping system favours overlapping generations of the pest.

Leaf folder damage can be ascertained more conspicuous during active tiller ear to booting stage.

**Biology**

**Adult:** Moth is small with a wing span of 15mm, brownish distinct two dark wavy lines on forewings and one line on hind wing. Both wings have a dark brown to grey band on their outer margin.

Adult longevity 3-4 days

**Eggs:** Female deposit eggs singly or semi clusters of 3-8 on the upper surface of the leaf.

**Fecundity:** 135-175 with average of 155 eggs/♀

IP – 3-4 days. Eggs are flat oval and yellowish colour.

Neonate larvae move to unopened leaf and feed gregariously by scraping the green matter. From 2<sup>nd</sup> instar larvae, folds the leaves by stitching with silken threads keeping open both ends of the fold. Larval feeding by scraping the green matter staying within the fold resulted in the development of longitudinal white streak.

**Larvae:** The pale yellowish green larvae. LP-15-27 days.

**Pupation:** Pupates inside the white silken webbing in leaf fold at the base of plant and single leaf was folded for pupation. PP-6-8 days. TLC – 26-42 days

**Nature of damage**

Larva folds the leaf and feeds by scraping the green mesophyll tissue from within fold. This feeding result in longitudinal white stripes and under severe infestation whole field appears scorched. The folding and feeding of leaf folders affects the Photosynthetic ability of the leaf resulting in yield reduction. Damage to flag leaf was more serious concern as will be direct impact on grain yield.

**Management for leaf folder**

- Removal of grass from the bund and removal of alternative hosts.
- Avoid close planting.
- Avoid excess use of 'N' fertilizer as it attract the leaf folder adults.
- Sufficient quantity of 'K' fertilizers to be applied.

- Pass thorny bush or rope across the crop in vegetative phase to unfold the leaves and expose the larvae to natural mortality factors.
- Chemical measures: Profenophos 50 EC @ 2ml/l. Chlorpyrifos 20 EC @ 2ml/l, Cartap hydrochloride 4 G @ 8 kg/ac.
- Release of *Trichogramma chilonis* @ 1,00,000/ha, (5-6 times) starting from 15 days after transplanting.
- Larval parasitoids: Xanthopimpla, Ichenumonid

#### 5. Rice Gall midge: *Orseolia oryzae* (Cecidomyiidae : Diptera)

Two species: 1) Asian gall midge : *Orseolia oryzae*  
2) Agrican gall midge : *Orseolia oryzivora*

**Distribution:** Distributed across the country except Punjab, Himachal Pradesh, Haryana, Uttakhand, Western Uttar Pradesh and J & K. It is restricted to localised pockets likes North coastal Andra Pradesh, Southern Telangana, Kuttanad in Kerala, Coastal Karnataka, Vidarbha in Maharashtra, Sambalpur region of Orissa.

#### **Biology:**

**Adult:** Adult is small mosquito like with pink telescopic body. Adult longevity is 1-2 days. Male is small and darker.

**Egg:** Eggs are laid singly or group on leaf blade and sheath. Fecundity – 100-150 eggs/♀. Eggs are IP – 4 days reddish and elongate.

**Maggot:** Maggots are creamy white with pink tinge later turn to reddish, apodus. Period: 8-18 days.

**Pupa:** Pupation at base of gall, but pupa wriggles up to tip projecting half way out. PP-2-8 days. TLC-20-25 days.

**Nature damage:** Maggot after hatching crawls down the space between leaf sheath to reach apical meristem and start feeding on this tissue by lacerating and sucking. Due to feeding the meristem forms a gall chamber surrounding maggot. The gall formed is the modified part of leaf sheath and is due to chemical called “Cecidogon”. Maggot completes its development inside the gall this gall is hallow whitish to pale green cylindrical tube in tillers known as gall/silver shoot/onion shoot, bearing at it tip green. Due to formation of gall, tillers become sterile and does not bear any panicle and grain thus causing yield loss pest attack is generally restricted to vegetative stage of crop. Initial damage leads active tillering to compensate damage. If conditions are favourable these tillers also turns into galls by next generation maggots and plant bears a bushy appearance with gall. Occasionally, if pest damage occur during reproductive stage turning spikelets in the panicle into tiny galls.

#### **Factors for proliferation**

1. Egg stage is sensitive to humidity, cloudy weather with continuous rains favour pest build up.
2. Early onset of monsoon followed by dry spell leading to delayed transplanting of crop leads to severe damage.

#### **Management:**

- Avoid late transplanting in endemic area, early planted kharif crop escapes the pest.
- Selection of varieties is very important. Since ‘6’ biotype is already established.

Biotype (Kogan) 1994 – the term biotype is generally used to describe a population capable of damaging and surviving on plants previously known to be resistant to other populations of same species. These are morphologically indistinguishable from its other members but physiologically distinguishable.

- Seedling dip in Chlorpyrifos @ 0.02%.
- 18 natural enemies. Egg parasitoid – *Platygaster oryzae* plays an important role (80-90%).

ETL – 1 gall/m<sup>2</sup> (Nursery)

- 5% of affected tillers, 1 gall/hill (Main field)

- Application of granules in nursery – Carbofuran 3G (Nursery). Carbofuran 3 G @ 10 kg/ac at 10-15 DAT

#### 6. Rice earhead bug/Gandhi bug

Three species: 1. *Leptocorisa oratorius* – South, east region of country.  
2. *L. acuta* – North  
3. *L. pseudolepida*

**Distribution:** Present in all rice growing tracts of country and regular pest of central part of Telangana and Rayalseema and Malnadu and coastal Karnataka.

The bug emits characteristic unpleasant odour (Buggodour) indicative of their presence in field, hence name is gundhi bug. Pest appears on rice just before flowering stage and continue until panicle ripen.

**Biology:**

**Adult:** Adult is olive brown and ventrally green with long leg and elongated body.

**Nymph:** Pale yellowish green and possess odouriferous glands on fifth abdomen segment. NP – 15-21 days.

**Eggs:** Eggs are reddish brown with boat shaped and laid singly or double rows close to midrib on upper surface of leaves.

**Nature of damage:** Both nymph and adult suck sap from grains in milky stage, peduncle, leaves and stem and causing shrivelled and chaffy grain. Brown spot is observed at feeding site where sooty mould develops and reduction in quality.

**Management:** Clean cultivation, Dusting with Malathion 5D @ 25 kg/ha, Carbaryl 10 D 10 kg/ac. Malathion 2 ml/l.

**7. Rice Hispa: *Dicladispa armigera* (Chrysomeliidae : Coleoptera)**

**Distribution:** Occasionally major pest of rice particularly north eastern, eastern and central region. Mainly confined to vegetative phase of crop and reported migrate long distance.

**Biology:**

**Egg:** Eggs are laid singly and inserted partially beneath epidermis of tender leaves. IP – 4-5 days.

**Grub:** Small, yellowish flattened grubs feed on leaf tissue inside the leaf mine. GP – 7-12 days.

**Pupation:** Pupates in leaf mine or grub tunnel. PP – 3-5 days.

**Adult:** Beetles are small, square shaped, bluish black and shiny with spines on thorax and elytra.

**Nature of damage:** Adult scrape green matter on upper surface of leaf blade causing whitish leaf tip on young leaves giving dried up appearance. White, rectangular streak paralld to veins on older leaves which initially appear glistening membraneous, papery white, later turning pale reddish, straw coloured.

Grub feed on leaf tissue inside the leaf mine causing blister spots towards tip. Later these blotches coalesce and giving a dry up symptom.

**Management:**

1. Hand collection of beetles
2. Clipping of leaf tip of seedling while transplanting
3. Spray of Chlorpyrifos @ 2ml/l.
4. Grubs are parasitized by Bracon spp.

ETL – 2 adults/hill.

**8. Rice caseworm: *Nymphula depunctalis* (= *Paraponyx stagnalis*) (Pyralidae : Lepidoptera)**

**Distribution:** India, South East Asia, Australia

**Host plant:** Rice

**Egg:** Upper surface of leaf. 50 eggs/♀. IP – 2-6 days

**Larvae:** Larvae is pale green with orange head. LP – 14-20 days. Larva has filamentous gills on the sides of body that helps to lead a semi aquatic life.

**Pupa:** Pupation in dry cases of leaves in the hills. PP- 4-7 days.

**Adult:** Adult is small moth with whitish wings speckled with pale brown marking. TLC – 20-35 days.

**Nature of damage:** Caterpillar cuts the apical portion of leaves and rolls them to form a tubular case around them and remain inside then feed on foliage by scraping green matter. Damage appears ladder like with alternate light and dark rows of green patches. Damage is similar to leaf folder or rice hispa. However, most characteristic symptom of case worm is cut end of leaf tip.

**Management:**

1. Sprinkling kerosene on water and passing rope over the crop to dislodge and kill the larvae in cases.
2. Draining water removes the encased larvae floating on surface and checks the damage.

### 9. Paddy grass hopper

1. Rice large grasshopper: *Hieroglyphus banian*
2. Rice small grasshopper: *Oxya nitidula*

**H. banian:** Larger in size, green with three transverse dark lines on prothorax and posses bluish green hind tibia. Host: Rice, Sugarcane and other millets.

**O. (nitidula) Chinensi:** Smaller, green with longitudinal brown streak on either side of the thorax.

**Host:** Rice and grass

Nymph and adult feed on foliage by irregularly cutting leaf margins. In sense cases only midribs and stalks remains. They also cut the panicle at heading stage and are very active at night.

**Biology:** One brood/year. Hopper hatch in June-July from eggs which are laid soil in batch of 30-40 along the bund side. The nymphs feed on grasses of bunds after hatching and move to main crop when crop is planted. Nymph become adult in 2-3 months. Eggs remain in soil from October till June and hatch after first shower and lead life on grasses till paddy is planted.

#### Management:

1. Scraping field bund and summer ploughing to destroy eggs.
2. Dusting carbaryl 10 D or malathion 5D @ 10 kg lac.

### 10. Paddy swarming caterpillar: *Spodoptera mauritia* (Noctuidae : Lepidoptera):

Pest active during July-September. It occurs both in nursery and main crop. It swarm from one field to another, and feed at night but hiding during the day.

#### Biology:

**Adult:** Stout dark brown moth with conspicuous black spot on each of the forewing. Female lays eggs in mass 200-300 and cover with gray hairs. IP-3-5 days.

**Larvae:** Larvae are green in colour initially, as they grown become greying pale green with reddish and yellowish 3 stripes, across the body. LP – 20-25 days.

Pupation in earthen cocoon, PP – 10-15 days.

In nursery, larvae cut the plant at base and feed on fallen plants. In the main field, they feed on leaves leaving midrib by climbing plant. It appears like field is grazed by cattle.

### 11. Climbing cutworm: *Mythimna separate* (Noctuidae : Lepidoptera)

Pest appears swarm during November-December. Late instars have the characteristic habit of climbing and cutting ear heads in addition to defoliation. Pest becomes serious in certain years of heavy rainfall.

In nature, pest is suppressed by natural infections by entomogenous fungus *Noumuraea rileyi*.

### 12. Paddy skipper: *Pelopidas mathias* (Hesperiidae : Lepidoptera)

#### Biology:

**Adult:** Butterfly is dark brown colour, having two white spot on the forewings and curved antennae.

**Egg:** Lays eggs singly on leaf blade.

**Larvae:** Pale green elongated body with constricted neck and a red "V" mark on head.

**Pupation:** Pupa is held by a gridle and attached to the leaf blade inside leaf roll at its anal end.

**Nature of Damage:** Larvae folds the leaves back word longitudinally and fasten the edges together and feed on the green matter.

### 13. Paddy horned caterpillar: *Melanitis leda ismene*

**Adult:** Dark brown with large wings having a black and yellow eye like spot on each forewing.

**Larvae:** Green in colour, slightly flattened with two red horn like process on head and two yellow process on anal end.

**Pupa:** Chrysalis

**Nature of Damage:** Larvae feed on the leaves and defoliate.

#### 14. Paddy leaf mite/yellow mite: *Oligonychus oryzae* (Tetranychidae : Acarina)

Nymph and adults congregate on lower surface of leaf and suck sap resulting in pale whitish blotches on upper side of leaf which later turn to yellow to orange colour. Thin webs are seen on the under surface of leaves. In heavy incidence mites can be seen on upper side of leaf.

**Management:** Dicofol @ 1.7 ml/lit.

#### 15. Panicle mite/sheath mite: *Steneotarsonemus spinki* (Tarsonemidae : Acarina)

At vegetative stage, both nymph and adult colonise on midrib of leaves and lacerate the tissue causing brown necrotic patches on midrib.

At panicle initiation stage, mites move to leaf sheath to feed causing brown necrotic lesions on leaf sheath. Maximum incidence occur at boot leaf stage. At panicle emergence, mites enter florets, feed on ovaries and stamens causing sterile and discoloured grains in the panicle. Later these grain turn black invaded by saprophytic fungus.

#### 16. Other pests

1. Zigzag leaf hopper – *Racillia dorsalis*
2. Whorl maggot – *Hydrellia philippina*
3. Maggot attack leaf blades even before unfurling and initial damage is characterised by the presence of narrow stripes of whitish area in the blade margin.
4. Mealy bug: *Heterococcus reli*
5. Rice blue beetle: *Lyphgma pygmoea*

#### IPM

- Harvesting of crop close to soil/surface and deep ploughing or flooding after harvest.
- Selection of resistant/tolerant varieties
- Protection of nursery.
- Application carbofuran 200g/cent of nursery.
- Early planting.
- Creation of alleyways of 30 cm width for every 2mt. of planting.
- Avoid excess dosage of fertilizer.
- Ensure proper drainage and water management.
- Weed management.
- Monitoring of pest incidence through light or pheromone trap.
- Passing a rope over crop in vegetative phase against leaf folder and caseworm.
- Release of Trichogramma egg parasitoids.
- Application of insecticides based ETL.
- Community approach in rodent management.

#### Biological pest suppression

##### Natural Enemies:

Stem	– 85 NE	Metarhizium – BPH
PH	– 126 NE	Beauveria – Hispa
GLH	– 104 NE	<i>Pandora delphasis</i> – BPH
Leaf folder	– 54 NE	
Gall midge	– 18 NE	
Hispa	– <u>5 NE</u>	
	392	

## 2. Pests of Sorghum, Maize and Ragi

### Pests of Sorghum

#### 1. Sorghum shootfly: *Atherigona soccata* (Mscidae : Diptera)

**Distribution:** India, West Africa

**Adult:** Small dark grey fly, just like mosquitoes with 2 rows of 6 dark spots on dorsal side of abdomen in female and 4 dark spots in male.

**Egg:** Eggs are laid on ventral surface of third and fourth cigar shaped or flattened boat shaped with wing like lateral projection. EP 2-3 days.

**Maggot:** Pale yellowish, LP 6-10 days.

**Pupation:** pupation takes place inside the stem at base, PP – 7-10 days.

**Nature of Damage:** Maggot moves to the dorsal surface of leaf, wriggles down the leaf, reaches base of seedling and bore into axis destroying growing point. The central succulent core begins to decay, and maggot feeds on the rotting matter. The damage results in following symptoms

- Dead heart which can easily be pulled out giving offensive smell at cut end.
- Production of side/secondary tillers

#### **Management:**

- Early sowing before June
- Use of high seed rate @ 12 kg/ha
- Remove and destroy affected plant
- R varieties like, CSV-5, 6, 7R, 8R, CS47R, 8R, SPV 10155, IS 2205, 2312, 18551 and CSHISR.
- Seed treatment with Chlorpyrifos or imidacloprid 70 WS/65FS @ 10ml/kg or Thiamethoxam 35 FS @ 10 ml/kg of seeds.
- Fish meal is used as trap for attracting fly and killed.
- Summer plough, field sanitation, balanced fertilizer use and intercropping with legumes.
- Carbofuran 3G application

#### 2. Jowar stem borer: *Chilo partellus* (Crambidae : Lepidoptera)

Its infestation starts one month after sowing till harvest. Usually infestation succeeds after shoot fly.

**Distribution:** Country

**Alternative host:** Maize, Sugarcane, rice, Finger millet, Johnson grass

#### **Biology:**

**Adult:** Moth is straw coloured medium sized with two rows apical margin.

**Egg:** Each female lays nearly 300 eggs on undersurface of leaves. Eggs are flatish scale like, overlapping each other on under surface of leaf near midrib. IP – 7-8 days. LP – 22-28 days. PP – 7 days. TLC – 30-40.

**Larva:** Larva is cylindrical, yellowish brown with brown head and prothoracic shield and dark spots on the body. These are able to move from one plant to other by hanging through silken thread. Larvae hibernate in winter.

**Pupation:** Pupation inside the stem. Adult emerge from exit hole prepared by last instar larvae.

**Nature of Damage:** Larvae after emerging from egg mines into midrib and reaches the control shoot and causes the dead heart with no offensive smell at cut end when pulled out (If plant age is 30-40 days olds). If stem is formed no dead heart, only shot holes or pin holes are visible as leaves open up which is due to feeding across leaf spindle. Chaffy ear head at later stage. Or in later stage they feed on midrib and midrib turns reddish.

#### **Management:**

- Removal and destruction of dead heart affected plant in early stages.
- Destroy of affected plant after harvest.
- Use of resistant variety: CSH 7, 8, SPV 17, 19, 29, 58, ICSV 197, 745, 88013, CSV – 2, 3, 4, 8R, 9R, 10, 12, Swathi, CSH-7R, 8R, 9R, SPV 1015
- Setup light trap
- Biological agent: *Trichogramma minutum*, *T. chilonis*  
Larval parasitoid: *Cotesia flavipes*, *Bracon chinensis*, *Apanteles*  
Pupal parasitoid: *Xanthopimpla punctata*, *Tetrastichus ayyari*



- Placement of carbofuran 3G granules @ 4kg/ac at 35-40 DAS in leaf whorls.

### 3. Pink stem borer: *Sesamia inferens* (Noctuidae : Lepidoptera)

**Distribution:** All over country, Malaysia, Pakistan, Taiwan, Burma, etc.

**Host range:** Sorghum, maize, rice, wheat, sugarcane, bajra and ragi, barley, guinea grasses

**Adult:** Moth is straw coloured with forewings having marginal black streaks. Hind wings and thorax are white.

**Egg:** Female lays about 100 yellowish pearl like eggs between stem and leaf sheath in 1-3 rows. IP 7-12 days.

**Caterpillar:** Pinkish brown with dark head. LP: 25-54 d.

**Pupation:** Stem, PP: 8-12 days.

**Nature of Damage:** Caterpillar bore into the stem and causes pin holes, deadheart, and chaffy earhead.

### 4. Sorghum shoot bug: *Perigrinus maidis* (Delphacidae : Hemiptera)

**Distribution:** South India, Madhya Pradesh.

**Host range:** Sorghum, Maize, Rice, Millets.

**Adults:** Adult is yellowish brown to dark brown with translucent wings. The brachypterous female is yellowish while macropterous female is yellowish brown and male dark brown.

**Egg:** Eggs in groups of 1-4 inside the leaf tissue and covered with a white waxy substance.

**Fecundity:** 97 eggs/female. IP - 7 days

**Nature of Damage:** It causes losses up to 40 per cent. These bugs are found within leaf whorls or on the leaves. Both nymph & adult suck sap from tender portion of plants causing yellowing of foliage, stunted growth and scotched appearance.

- In severe infestation the top leaves turn yellow and may result in bad emergence of the earhead.
- Honey dew secreted by adults and nymphs results in sooty mold development.
- It is known to transmit "Freckled yellow virus" of sorghum and corn mosaic.

#### Management:

- Application of carbofuran 3G in leaf whorl.
- Dusting of malathion 5% or quinalphos 1.5% @ 20-25 kh/ha.
- Seed treatment with imidacloprid.

### 5. Sorghum aphid/Corn aphid: *Rhopalosiphum maidis* (Aphididae : Hemiptera) *Melanapis sacchari* – Serious in post rainy season

- It is confined to unopened leaves of sorghum, maize and other millets.
- Aphids are small, blackish – dark green in colour.
- Adult & nymph suck sap from leaves, usually infestation starts in the whorls of growing plant and spreads to other leaves on lower surfaces. Which leads to mottling with yellow patches on leaves, stunted growth, grain fail to develop in earhead, and formation of sooty mould on plants due to honey dew secretion. Fodder quality will be affected.
- Transmits maize dwarf mosaic virus Sorghum leading to death of young seedling.

#### Management:

- Coccinellids, syrphids and chrysopids. (Brown lace wing, *Micromus timidus*) suppress the population in nature
- Need based application of dimethoate @ 1.7 ml/l, acephate @ 1g/l or chlorpyrifos @ 2ml/l.

### 6. Jowar earhead bug: *Calocoris angustatus*

- It is serious pest of South India (T.N., A.P., Karnataka and Maharashtra) and causing 32% grain loss.

**Alternative host:** Bajra, Maize and Italian millet

**Adult:** Slender, long legged yellowish green and active flier.

**Egg:** Eggs are laid under the glumes or into the middle of the florets by means of long ovipositor of the female.

**Fecundity** – 150-200 eggs. Eggs are bluish ligger shaped.

**Nymph:** Light orange abdomen

**Nature of Damage:** Both adult & nymph suck sap from tender grains in milky stage results in -

- Shrivelled, unfilled chaffy grains which initially show red spots on feeding sites and later turn black.
- Whole earhead turn black and later dries up.
- Varieties with compact earheads are severely infested.

The duration of egg to adult takes about 15-17 days. The bugs infest as soon as the ears emerge out of the leaf sheath and within a short period the population ♂es. There can be at least two generation in a crop season.

**Management:**

- Timely sowing at first monsoon showers/Early sowing.
- Avoiding compact earhead varieties.
- Grow resistant varieties viz., SPV-462, SB-1079.
- Reduviid bug – *Reduviolus* sp. and lygacid bug *Geocoris tricolor* are predaceous on the insect.
- Dusting at milky stage with Malathion 5% dust @ 20-25 kg/ha.

#### 7. Sorghum midge: *Stenodiplosis* (= *Contarania*) *Sorghicola* (Cecidomyiidae : Diptera)

- It is the most devastating earhead pest of sorghum.
- It has got prime importance among all sorghum pest especially after introducing high yielding improved varieties and hybrids.
- It is also called as earhead gallfly, earhead fly and Benki hulu.

**Adult:** Adult fly is tiny, fragile, mosquito like insect with bright orange abdomen and a pair of transparent – wings. Adult mate soon after emergence from pupae and start laying eggs. Adult lives – 1-2 days.

**Egg:** Adult oviposits banana shaped eggs in spikelets during anthesis, as soon as uppermost spikelets of the head emerges from boot leaf stage. IP – 2-4 days.

**Larval period:** 9-10 days.

Pupation takes place within spikelet. PP – 5 days.

TLC – 18-21 days. The carry over of the pest from one season to the next is accomplished by the diapausing larvae in crop debris or wild hosts.

**Natural Damaging:** The maggots feed on the ovaries and destroy the developing grains causing flattening of florets.

**Symptoms:** Red ooze from spikelet when squeezed indicating the presence of maggot

- Chaffy grains with round holes indicating adult emergence.
- Empty pupal cases protruding from glumes.
- Honey dew secretion.

**Management:**

- Destroy crop residue especially panicles after harvest to kill hibernating larvae in old sorghum heads during winter /dry season.
- Timely sowing/early sowing will escape from infestation. Synchronisation in date of sowing and June sowing is advocated in endemic area.
- Use of resistant varieties – DSV-3 (ICSV-745) ICSV-197, 88013, PG890, ICSV 743, DJ 6515.
- *Tetrastichus diplosidus* & *Euplemus pupa* are good natural enemies.
- Dusting of malathion 50 EC @ ml/l.

#### 8. Earhead webbing caterpillar

- a) ***Stenachroia elongella* (Galleridae : Lepidoptera)** : Adult is medium sized with prominent veins on forewings. Forewings are straw coloured and hindwings are white. The apical margin of the forewing is round with conspicuous black spots, oviposition site: Earheads. Caterpillar is blackish grey with a whitish stripe on the back.

**Nature of Damage:** Caterpillars cut the hardened grains and make a thick webbing with bits of grains and excretory pellets, living inside the webbing.

**Pupation:** Inside the webbing.

- b) ***Cryptoblabes angustipennella* (Pyraustidae : Lepidoptera)**: Moth small with brown forewings and hind wings are light brown. Larva light brown with dark lateral lines on the body.

Larvae remain near the rachis, web together the adjacent grains and feed on them.

c) ***H. armigera***

- Polyphagous pest.
- It is also attaining a major pest status in the recent past.
- Adult moths brownish yellow forewing with prominent – black spot and broad black patch on hind wing.

- Larvae concealed in inner braches of earhead and feed on grains. Larvae feed on the hardening grains and cut grains and pellets are seen. On the ground leaving chalky appearance of partially cut grains on the ear head.

**d) *Eublemma silicula***

- Pale yellow semilooper larva webs grains in the braches of ears and feed on them.
- Adult is a small with reddish buff coloured wings with wavy lines.

**Management:** Similar with earhead midge and bugs.

**9. Sorghum armyworm: *Mythimna separate* (Noctuidae : Lepidoptera)**

It is one of serious pest of cereals crops particularly on sorghum, Maize, Sugarcane and Millets in Karnataka.

- It can cause 40-55% loss in grain yield under natural condition.
- They March in masses like army on field and armyworm/Sainik hulu. The caterpillars excretes pellets on foliage and leaf whorls. Hence, they are also called as “Laddi hulu”.
- The infestation begins between April and June, immediately after the receipt of heavy rains and continues till October.
- Adults are medium sized moths of pale brown colour.
- Egg: Greenish white round and laid at the tip of dried leaves in two parallel rows.
- Fecundity: 1000 eggs, IP – 6 days, LP-14-22 days, Pupation – Soil, PP – 11-15 days
- Larvae: Green or dark brown with brown head. The larvae prefer the high humidity. Larvae subside if heavy shower occur. If there is dry spell after good mansoon population ↑ rapidly.
- Larvae Noctural in habit during day time hide in plant whorl or in loose soil. In cloudy days they feed on leaves during day time also.

**Nature of Damage:** Larvae feed on the control tender leaf blades and other leaves during the night times leaving only midrib.

**Management:**

- Plough and burn the stubbles immediately after harvest of the crop.
- Remove alternate hosts and weed hosts to prevent breeding during off season.
- Avoid excess use of N fertilizer.
- ETL – 1 larva/plant
- Poison bait: 50 kg bran + 625 ml monocrotophos + 4-5 jaggary + 2-3 lit of water – ferment for 48 hrs.
- Application of carbofuran granules in whorl @ 8kg/ha.
- Spray Ms NPV @ 250 LE/ha.
- Promising Natural enemies  
*Cotesia ruficrus*, *Rogas aligarhensis*, *Exorista xanthaspis* (Tachinidae) – Plays an important role in bringing down pest in transitional region.

**10. Flea beetle: *Chactocnema pusaensis* (Chrysomelidae : Coleoptera)**

- It is serious in seedling stage of rabi and summer crops in North Karnataka.
- Beetles are shiny black and small, bites small holes on leaves which affect photosynthetic activity.
- Grubs are found in soil and feed on root. Pupate in soil spraying 2% Neem oil is effective.

**11. Deacan wingless grass hopper: *Colemania sphenarioides***

- Important defoliator of sorghum in Dharwad and Haveri District.
- Dr. Ignacio Bolivar in 1910 described a new species of grass hopper, *Colemania phenarioides*, from South India under monotypic genus. Coleman was 1<sup>st</sup> Director of Agril. of Mysore State.
- It is cyclic pest appear once in 8-10 years.

**Adult:** Wingless grasshopper with short antennae, Body is greenish yellow with red and blue stripes on thorax.

**Egg:** Soil with depth of 5 to 6 cm in batches of 40-60 during October-December. Eggs remain dormant in soil till the following June-July.

**Nymphs:** Nymph hatch in next June-July and develop by feeding on bund grass and move to growing crop, become adult. NP – 70-80 days.

Only one generation per year.

**Nature of Damage:** Both nymph and adults feed on foliage leaving only midrib, even florets and ripening grains are also eaten at maturity.

**Management:**

- Fall ploughing.
- Crop residue destruction.
- Collect and destroy grass hoppers using hand nets and Hopper dozers.
- Clean cultivation and trimming of bunds to make nymphs devoid of food.
- Malathion dusting on bunds and crop.

### General IPM

- Summer ploughing
- Crop residue destruction
- Early sowing during January-June
- If late sowing in July then apply carbofuran @ 7.5/ha.
- Seed treatment with Chlorpyrifos @ 5ml/kg or Thiomethoxam 35 FS @ 5ml/l.
- Use cowpea as mixed crop to avoid aphids and encourage coccinellid predators.

### Non-Insect Pest

#### Jowar mite: *Oligonychus indicus*

Mites are small, reddish, oval, found on lower surface of leaves in colonies below a thin webbing. All stages of mites may be seen below the web. N & A suck the sap leading to turn red at feeding place then leaf gradually dry up.

**Management:** Dicofol @ 1.7 ml/l.

Wettable 'S' @ 2.5 g/l.

### Pests of Maize

1. Jowar shoot fly: It attacks early stage of crop growth and causing dead heart. A *Orientalis*, A. *Soccata*, A. *Nagvii*.
2. Jowar stem borer: *Chilo partellus*
  - Dead heart
  - Shot holes or pin holes
3. Pink stem borer: *Sesamia inferens*
4. Cob caterpillar: *Helicoverpa armigera*

**Adult:** Brownish yellow coloured forewing with prominent black spot and on broad black patch on the margin of hind wing.

**Egg:** Eggs are laid singly on the silk of the cobs.

**Larvae:** Caterpillar green or various colour with white longitudinal stripes.

**Pupation:** Soil

**Nature of Damage:** These feed on the silk and tender milky grains at the tip of cob – Bored area is plugged with excreta.

#### 5. Armyworm: *Mythimna separate*

6. Sap feeders: *Pyrilla perpusilla* – Sugarcane leafhopper  
*Peregrinis maidis* – Shoot bug  
*Rhopalosiphum maidis* – Aphids

**Management:**

- Emamectin benzoate @ 0.25 g/l.
- Malathion 5% dust @ 30 kg/ha.

#### 7. Fall armyworm: *Spodoptera frugiperda*

The fall armyworm is native to the tropical regions of the western hemisphere from the United States to Argentina. The fall armyworm is a strong flier, and disperses long distances annually during the summer months. In 2016 it was reported for the first time in West and Central Africa, so it now threatens Africa and Europe. During 2018 first time it is reported from the Shivamogga district of Karnataka in India.

#### Biology:

The life cycle is completed in about 30 days during the summer, but 60 days in the spring and autumn, and 80 to 90 days during the winter.

**Egg:** Female lays the egg masses. The number of eggs per mass varies considerably but is often 100 to 200, and total egg production per female averages about 1500 with a maximum of over 2000. The female also deposits a layer of grayish scales on egg mass.

**Larvae:** There usually are six instars in fall armyworm. Larva is brownish colour with inverted 'Y' mark on the head (prominent epicranial suture) and 4 square shaped black spots on last of the abdominal segment. Larval period 14 days in summer and 30 days in winter.

**Pupa:** Pupation normally takes place in the soil, at a depth 2 to 8 cm.

**Adult:** The moths have a wingspan of 32 to 40 mm. In the male moth, the forewing generally is shaded gray and brown, with triangular white spots at the tip and near the center of the wing. The forewings of females are less distinctly marked, ranging from a uniform grayish brown to a fine mottling of gray and brown. The hind wing is iridescent silver-white with a narrow dark border in both sexes. Adults are

#### **Nature of Damage:**

Larvae cause damage by consuming foliage. Young larvae initially consume leaf tissue from one side, leaving the opposite epidermal layer intact. By the second or third instar, larvae begin to make holes in leaves, and eat from the edge of the leaves inward. Feeding in the whorl of corn often produces a characteristic row of perforations in the leaves. Larval densities are usually reduced to one to two per plant when larvae feed in close proximity to one another, due to cannibalistic behavior. Older larvae cause extensive defoliation, often leaving only the ribs and stalks of corn plants, or a ragged, torn appearance.

#### **Importance characteristic symptoms**

- Defoliation
- Ragged pin holes on the opened leaves
- Presence of huge excreta on the plant

**Management:** (Adhoc recommendation)

Monitoring: Installation of pheromone traps @ 5/acre

#### **Scouting:**

1. At seedling to early whorl stage (3-4 weeks after emergence)- if 5% plants are damaged
2. At mid whorl to late whorl stage (4-7 weeks after emergence)-if 10% whorls are freshly damaged in mid whorl stage and 20% whorl damage in late whorl stage.
3. At tasseling and post tasseling –do not spray insecticides but 10% ear damage needs action.

#### **Cultural measures:**

1. Deep ploughing
2. Timely sowing. avoid staggered sowing
3. Intercropping with pulses
4. Erection of bird perches @10/acre during early stage of the crop
5. Sowing of 3-4 rows of trap crops( napier) around maize field and spray with 5% NSKE or azadirachtin 1500 ppm as soon as the crop shows symptom of FAW damage.
6. Cultivation of maize hybrids with tight husk cover will reduce ear damage by FAW.

#### **Mechanical control:**

- Hand picking and destruction of egg masses and neonate larvae in mass by crushing or immersing in kerosine water
- Application of dry sand in to the whorl of affected maize plants soon after observation of FAW incidence in the field
- Mass trapping of male moths using pheromone traps @15/acre

#### **Bio control**

- In situ protection of natural enemies by habitat management
  - Augmentative release of trichogramma pretiosum or telenomus remus @50000 per acre weekly intervals or based on trap catch of 3 months/trap
  - Biopesticides :
1. Entomo pathogenic fungal formulations : Application of *Metarhizium anisopliae* talc formulation @ 5g/litre whorl application at 15-25 days after sowing. Another 1-2 sprays may also be given at an interval of 10 days depending on pest damage or *Nomuraea rileyi* rice grain formulation @ 3g/litre whorl application at 15-25 days after sowing. Another 1-2 sprays may also be given at an interval of 10 days depending on pest damage.
  2. *Bacillus thuringiensis v. kurstaki* formulations @ 2g/l or 400g/acre.

#### **Chemical Control**

- Seed treatment: Cyantranilprole 19.8%+ Thiomethoxam 19.8% @ 4 ml/kg
- First window (seedling to early whorl stage) :@ 5% damage to reduce hatchability of freshly laid eggs, spray 5% NSKE/Azadirachtin 1500ppm @ 5ml/l of water

- Second window (mid whorl to late whorl stage): To manage 2<sup>nd</sup> and 3<sup>rd</sup> instars larvae at 10-20 % damage spray emamectin benzoate @ 0.4 g/l of water or Spinosad @ 0.3 ml/l of water or thiamethoxam 12.6%+lambda-cyhalothrin 9.5% @ 0.5ml/l of water or chlorantraniliprole 18.5% SC @ 0.3 ml/l of water.
- Third window (8 weeks after emergence to tasseling and post tasseling): insecticide management is not cost effective at this stage. Hand picking of the larvae is advisable.

## Pests of wheat

### 1. Pink borer: *Sesamia inferens*

### 2. White ant: *Microtermes obesi*, *Odontotermis obesus*

It is most important pest of wheat, polyphagous and widely distributed across the country. The incidence will be more in loamy soil or sandy loam soil especially when there is long dry spell.

Soon after first monsoon showers winged forms (reproductive castes) leave colony for flight to select mates. Afterwards shed wings and enter soil in royal pairs. These are primary reproductives. In case one or both royal members die, supplementary reproductive develop to run colony.

Queen after fertilization enlarges in size to a length of 11 cm. Eggs are laid @ 30,000/day and longevity of queen is 5-15 years even upto 50 years. Egg period lasts for 30-90 days and NP – 6-12 moths.

Members that develop first in the colony are workers (sterile caste) which constitute 75-80% of the colony. Workers take care eggs, young ones till they live independently. They feed and tend the queen. They forage for food and cultivate the fungal garden workers are whitish yellow, soft bodied, flat and wingless. They only are injurious to crops. They feed on roots, stem of growing plants, even dead tissues of plants feeding on cellulose. As a result of damage there will be. 1) Wilting and drying at all stages of wheat crop.

#### Management :

- Locating termitarium, digging out queen and destroying is only permanent solution.
- Drenching of chlorpyrifos @ 10ml/l.
- Fumigation of mound using Aluminium phosphide @ 2 tab/m<sup>2</sup>, or Carbon disulphide or Chloroform mixture.

**Ghujia weevil: *Tanymecus indicus* (Curculionidae : Coleoptera):** IT is a common pest of young wheat and other crops in U.P. Bihar and Punjab.

**Adult:** Greyish brown, Adults hide during brighter part of the day and get active in morning and evening hours.

**Eggs:** Eggs are laid singly under clod of soil @ 80 eggs/♀.

Larvae: Develops in soil in about 3 months. Adults are formed during April-May but adults remain in soil till June.

**Nature of Damage:** Adults are destructive. The weevils cut and feeds on the plumule of young seedlings. Older seedlings of more than 6 cm ht are not attacked. In severe cases of attack, it necessitates re sowing.

**Symptoms:** Wilting of plants.

**Management:** 1. Deep ploughing 2. Dusting the soil carbaryl @ 10-12 kg/ac.

### 3. Green bug: *Nezara viridula*

**Adult** – Medium sized, oval and green coloured with 5 segmented antennae.

Both nymph & adult are confined to earhead of wheat and suck the sap from tender milky grains causing chaffy grains.

### 4. Surface grass hopper: *Chrotogonus* sp.

Adults are dull brown.

Both nymph & adult cut the plants at ground level and feed on the tender leaves by defoliation, Germinating crop suffers much. Infestation is severe if there is no grass near by field.

## 5. Aphids: *Rhopalosiphum maidis*

They infest leaves, sheath and ears. Suck the sap from leaves and ear heads resulting poor ear head quality and affects the grains.

### Management:

- Spray - Dimethoate @ 1.7 ml/l.

### Other minor pests:

1. Armyworm – *Mythimna separate*
2. Aphids – *Myzus persicae*
3. Leaf hopper – *Pyrilla perpusilla*
4. Ash weevil – *Myloccerus* sp.

## Pests of Ragi

1. Ragi pink borer: *Sesamia inferens* – Dead heart symptoms

2. Short fly

3. Cutworm – *Spodoptera exigua*

Symptoms: Defoliation in nursery. Larva feed on leaves especially in nursery.

4. **White stem borer: *Saluria inficita***

Larva feeds on root. In severe infestations, centre shoots dry up and become yellowish. Larva found at stem region and cause damage.

**Adult:** Dark brownish, Fall armyworm has white colour band at the margin.

**Egg:** Egg mass covered with tuft tuft hairs. Egg lays at leaf tip.

**Larvae:** Milky white colour with yellowish head

**Pupa:** Stem

Nature of Damage: Creamy white caterpillar found at the base of the tillers close to soil surface and attack basal part of the plant and bore into stems close to soil surface and cause dead heart symptoms.

5. **Ragi root aphid: *Tetraneura nigriabdominalis***

**Nymph and adult-** Pinkish globular aphids. Insect produce young one by parthogenic and viviparous condition. After 2-3 generation alate forms are produced and dispersed.

**Nature of Damage: Nymph and adult** attack underground parts of plants, they suck the sap from roots. Plant become weak and may wilt.

Symptoms: Wilting and drying of plants in patches. Presence of black ants *Componotus compressus* around the base of plant.

**Management:** Spray of dimethoate @ 2ml/l or drench the rhizosphere of infested and surrounding plant.

6. **Earhead caterpillar: *Helicoverpa armigera*, *Sitotroga cerealella*:** Feed on developing grains.

7. **Ash weevil: *Myloccerus* sp.:** Adult feed on leaf edge cutting is shaped pattern and defoliate the plants. Grub feeds on the roots.

8. **Wingless grass hopper: *Neorthacris* sp.**

9. **Ragi aphid: *Hysteroneura setariae*** – Found in cluster on ear head.

10. **Root grub: *Holotrichia consanguinea***

11. **Hairy caterpillar: *Amsecta alibistriga***

### 3. Pests of Pulses

#### 1. Redgram: Gram caterpillar: *Helicoverpa armigera*

Redgram in Southern states of India suffers heavy losses due to lepidopterous borers, especially by *H. armigera*, a notorious polyphagous pest with wide distribution. Variation in adult and larval phases is observed due to its polyphagous nature. This pest is going to harbour 182 host plants. Its damage ranges from 46 to 67 per cent on redgram. *Helicoverpa* readily adjusts with any new introduced variety. It is deserved throughout the year on one or other crops viz., peas, tomato, cotton, maize.

Moth has brown forewing with v shaped dark spot and dark border hind wings. Each female lays 400-500 eggs which are spherical, yellowish white, sculptured and laid singly on tender parts of flower buds, flower bracts and on tender parts of pod. Egg period– 2-4 days.

Full grown caterpillar is cylindrical 40-48 mm in length with variable colour, dark green/reddish brown/brownish and prominent lateral stripe along the body. LP – 18-25 days.

Pupation: Soil. Pupa is dark brown and adult period – 6-21 days.

The young caterpillars feed on the tender foliage and as they grow they bore into the pods and destroy seeds, while feeding it thrusts its head inside the pod leaving the rest of its body outside.

- Large round hole on each locule.

#### Management:

- Deep summer ploughing to expose the pupae.
- Growing of 2 rows of jowar to encourage and conserve natural enemies viz., *Campoletis chloridae*, *Carcelia illote*, *Apanteles saurens*, *Microbracon brevicornis*, *Chelonus narayani*, *Tetrastichus israeli*, *Exorists fallox*, *Eucelatoria* sp. (Diptera)
- Raising jowar in rows all around redgram crop will serve as guard crop.
- At the time of sowing mix 100 gm of Jowar/Pundi seeds along with pigeon pea so it serve as natural perches.
- As far as possible take up sowing before July 15<sup>th</sup> which helps in reducing damage.
- Use of early maturing varieties ICPL-87, ICPL-332 (tolerant var) LRG-41 (tolerant var)
- Clipping of terminal twig at 90-100 DAS for removal ovipositional niches (depending on moisture availability in soil).
- Erect pheromone trap @ 10/ha to monitor the pest. Light trap during August-September : November-December.
- Erect the bird perches @ 50/ha to attract predatory birds like Drongo.
- ETL: 2 eggs/plant, on 5 adults/trap/3 consecutive nights.
- Based on ETL.
  - i. Ovicidal insecticides like Methomyl @ 0.6 g/l, Thiodicarb 75 WP @ 0.6 g/l, Profenophos @ 2ml/l.
  - ii. Spray: NSKE 5%: 20 kg Neem seed kernel powder + 100 gm soap powder + 300-400 lit of water and soak for over night  
OR  
Neem products like Azadirachitin 1000 pm or 3000 ppm or 10000 ppm
  - iii. Application of HaNPV @ 250 LE/ha + 100 gm Robin blue + 500 g jaggary
  - iv. Spray of conventional insecticides like Chlorpyrifos 50 EC @ 2ml/l, Quinalphos 25 EC @ 2 ml/l or New molecules like Indoxacarb 14.5 SC @ 0.5 ml/l or Spinosad 45 SC @ 0.2 ml/l or Emamectin benzoate 5 SG @ 0.25 g/l or Flubendiamide 48 SC @ 0.15 g/l or Chlorantraniliprole 18.5 SC @ 0.3 ml/l or Novaluran @ 1 ml/l.
  - v. If necessary spray of Pyrethroid chemicals like Lambda-Cyhalothrin 5 SC @ 0.5 ml/l, Deltamethrin @ 0.5 ml/l. If spray formulations are not possible dust the crop with Quinalphos 1.5 D @ 25 kg/ha or Malathion 5% D @ 25 kg/ha.

- Note: 1. Hand picking of caterpillars if larvae are grown up because the insecticides are not effective on grown up larvae.
2. Cloudy weather prevails, use NPV.
  3. Use only recommended insecticides and dose.
  4. Don't repeat the same insecticides continuously change the insecticides every time.
  5. Use 100 lit solution/ha.
  6. Don't use battery operated system.
  7. If low volume sprayers (Power sprayer) are used double the recommended dose (2-3 times).

#### 2. Plume moth: *Exelatis atomosa*, *Spenarches caffer* (Pterophoridae : Lepidoptera)

Moth is slender, grey with long narrow wings, the forewings are divided into two lobes and hind wings into 3 lobes and provided with a fringe like border. Eggs are greenish, oval laid on flower buds or pods singly. EP – 4-5 d.

The full grown caterpillar is greenish brown, and are fringed with short hairs and spines all over the body LP 14-30 d.



Pupation is on pod surface or burrows of infested pods. Pupa is also fringed with short hairs PP-4-8 d. Pupa looks like larva except for colour which is brown.

Tiny caterpillar scrapes the pod surface and cuts a hole and thrusts the head into it and feeds on seed by remaining outside. The caterpillar bore into green pods and feed on developing seeds which are more or less completely devoured or eaten away. Also feed on flower buds. This pest is usually found at flowering and known to cause heavy damage to redgram. There is premature shedding of flower buds, flower and pods. The larvae never enters inside the pod and feeds remaining outside pod.

**Symptoms:**

1. Small hole on seeds
2. Dropping of flower buds and flowers in severe cases
3. Completely eaten and devoured seeds.

**Management:** *Apanteles* sp. parasite larvae

### 3. Red gram pod fly: *Melangromyza obtuse*

It is major pest of redgram, soybean and cowpea. It also attacks safflower, sorghum, cowpea, bhendi etc. It is major menace in north and central India and Karnataka. In NI 80% damage is reported.

Adult is black fly with strong legs and ovate abdomen. Eyes are distinct, wings are clear veined, brownish yellow at their bases.

Adult thrusts its minute eggs into the tissues of tender pods. Female lays 4 eggs per pod and 80 eggs in its life time. EP – 3 days.

Tiny maggot burrow into pods and feed on young seeds. In affected pods, no visual symptoms are observed regarding its entrance. Initially larva bores into epidermis without rupturing the seed coat. In second and third instar the larva bores into cotyledons and in most instances one seed is sufficient for the maggot to complete its development. The final instar larva leaves the seed and prior to the pupation windows the pods and pupate either in pod cavity or in pod wall tissue. The damaged seeds are unfit for consumption.

#### **Symptoms**

- Discolouration of pods.
- Exit holes visible after the adult emergence.

The pest infestation can be identified only after adult emergence of first generation. Maggot is creamy white in colour. LP – 6-10 days.

Full grown maggot pupates inside the pods. PP 8-12 d. Adult emerge by cutting the thin spot already made by maggot.

#### **Management:**

- Early sowing in endemic area.
- Prepupal stage is parasitized by *Euderus agromyzae* and pupal parasitisation by *Euderus lividus*.

### 4. Pod borer: *Etiella zincknella* (Pyralidae : Lepidoptera): Green pod boring caterpillar or Lentil pod borer on spiny pod borer.

It is pest of red gram, horse gram and other pulses. It also attacks on green manure crop like sunhemp.

Moth is small with white streak on greyish brown fore wings and pale hind wing with dark marginal line, orange coloured prothorax. They lay egg singly on tender pods.

Larvae is greenish initially turns pink before pupation. Dorsal surface of mature larvae is reddish pink, while pleural and ventral surface of body are pale green or creamy white. It has 5 black spots on prothorax. EP – 10, LP – 1-17 days, PP – 9-12 days.

Young larva bores into floral parts, marking rough and irregular cutting. Larva enters into developing in green pod disappears and leaves little evidence that pod is infested. In pods, larvae devours many seeds. Symptoms includes drooping of flowers and young pods and old pods marked with brown spot where a larvae has entered.

### 5. Spotted pod borer: *Maruca vitrata* (Pyralidae : Lepidoptera)

This pest is found throughout South India on pulses and beans. It also webs the daincha (green manure).

The moth has white patches on dark brown forewings and a dark border on the white hind wings. Eggs are laid on or near the flower buds. Larva is light green with brown head and 4 pairs of black warts present on the dorsal surface of each segment, which form four black longitudinal lines on the body with short dark hairs.

Pupates in thin silken cocoon on the pod or leaf fold, pupa is yellow with green body.

Larva webs together the leaves, flowers and feeds on them. Sometimes also webs the pods and feed on it.

Less incidence is noticed in sorghum intercrop. Less incidence is also noticed in variety having narrow type of flowers and pods. Early and long duration varieties are susceptible.

#### 6. Flower webber: *Eulemoma hemirshada* (Noctuidae : Lepidoptera)

The larvae webs the flowers in green gram, black gram cowpea and feed on them. Larva is green with a black head and long white hairs on the body. Moth has yellow forewing with purple patches and hind wing white.

#### 7. Blue butterfly: a) *Catochrysopa Cnejers* b) *Lampides boeticus*

- a. Larva flat, pale greenish or yellowish with a red line and short black hairs on the body. The larva bore into buds, pods and also on flowers and seeds of redgram, cowpea, lab-lab etc. Butterfly lays sculptured round eggs singly on unopened buds.
- b. Larvae is pale green with roughened skin and pupate on leaf, twig or pod. It feeds on flower buds and seeds of redgram, cowpea and lab-lab, Butterfly delicate bluish, a tail like process at the base of hind wing with a dot above. Below the front margin of forewing, there are half moon shaped marking.

#### 8. Pod bug: *Clavigralla gibbosa*, *Riptortus pedestris*

Bugs are brownish elongate, with slightly enlarged hind femora. Nymphs and adult suck sap from shoots and pods, shoots fade, pods shrivel and seed shrivelled and grains are unfit for germination and feed.

#### 9. Bud weevil: *Ceuthorrhynchus asperulus*

Adult is small brown weevil with a snout. It thrust the minute oval creamy white eggs into buds and cover them with a fluid. The grub feed on internal content of flower bud, such flower buds drop down. Pupation in soil.

#### Other pests

1. **Aphid, *Aphis craccivora*: Vector:** Rosetted disease in groundnut and broad bean virus in pea. It infest tender shoots and inflorescence of red gram, cowpea, green gram, black gram etc.
2. **Blister beetle, *Mylabris pustulata*:** Feed on flower and buds – adult. Eggs are laid in soil at depth of 2-3 cm, ♀ beetle lays in clusters of 60-80 eggs. Eggs are light yellowish and cylindrical in shape. Young grubs are white pupation in soil.
3. **Stink bug, *Coptosoma cribrasia*:** Greenish brown stink bug infest tender shoots of several pulses and vegetables.
4. **Stemfly, *Melanagromyza phaseoli*:** Causes withering and drying of shoots in several pulses on seedlings stage.
5. **Gall weevil: *Alcidodes collaris*:** Galls at the base of stem and plants fall down. Adult is dark colour with zigzag band on elytra. female lays eggs at collar region (Eggs are white colour spherical/ova shape). It is pest of transitional belt.

Both g and adult are damaging stages. Adult damages the young tender seedlings by nibbling the growing tip due to which growing tip gets dropped and later dries up. Adult also nibble at collar region for egg laying. In severe case complete death seedling is noticed due to egg laying injury. In grown up plant adults feed by making holes on leaves. The grub scratches the stem portion just above the ground level and enter the stem by feeding on fibrous material. As a result gall is formed at collar region. Pupation in gall.

6. **Redgram mite, *Aceria cajani*:** It infests underside of tender leaves, causing yellowing of leaves and suppression of flowering and fruiting. It transmit pigeonpea sterility mosaic virus. A single eriophyiid mite is sufficient to transmit disease.

**Symptoms:** Bushy appearance, pale green plants without flowers or pods. Leaves are small, show a light and dark green mosaic pattern.

**Management:** Destruction of perennial and volunteer pigeonpea and ratooned growth of harvested plants provide reservoir of mite vectors and pathogens.

**Tolerant varieties:** ICPL 8719, ICPL 227, Jagruthi Bahar and spray of dicofol @ 3ml/l, or wettable 'S' @ 3g/l, in early stages of plant growth will control mite vector.

**7. Jassids: *Empoasca kerri* (Cicadellidae: Hemiptera)**

Small greenish yellow nymphs and adults suck sap from leaves resulting "hopper burn" condition. Attacked leaflets become up shaped and yellow at edges, defoliation and stunting of plants.

### **Bengal gram**

**1. Pod borer: *Helicoverpa armigera***

Pest lays eggs on tender leaves and larva after hatching skeletonise the green matter on leaves and leaves dry and drop. Larvae also feed on flowers and pods.

### **Green gram**

1. Thrips
2. Aphids
3. Pod borer
4. Stem fly

**5. Spingid moth: *Agius convolvuli*, *Acherentia styx* (Sphingidae : Lepidoptera)**

Occasionally the pest become serious and fields on leaves of green gram leaving only main stem. Presence of excretory pellets near the plant indicate its presence. Caterpillar is very big, stout, soft bodied with variant colour and red diagonal spots sometimes yellowish band. Anal horn on last segment of abdomen is seen.

### **Pupation in earthen cell in soil**

Adult is bigger moth with dark coloured. In *Agius*, there is no death head symbol.

**6. Pod borer: *Cydia ptychora***

It is serious pest of soybean, cowpea and green gram in field and threshing yard. 30% loss in soybean crop but incidence is less in other pulses. Adult is tiny grey colour moth. Oviposition site : Petals, Sepals, Pods.

Feeds on flower bud, open flower and pod by webbing resulting flower drop and pod drop. In cowpea wherever pods are pointed it prefers to damage both the pod by webbing.

Larvae is pink colour. Pupation – leaf/debris. Dusting of malathion before harvesting or spray of malathion 2ml/l.

### **Cowpea**

1. Thrips: Suck the sap from the tender leaves and infest even on flowers and developing tender pods.
2. Jassids: *Empoasca* spp. Serious pest, Nymph and adult suck sap from leaves and resulting crinkling, mottling and stunted growth.
3. Aphids: *Aphis craccivora* – suck the sap and plant become stunted.
4. Leafminer: *Liriomyza triflora* – mines the leaves.
5. Pod fly: Refer redgram
6. Stemfly: *Ophiomyia phaseoli*  
Black fly smaller than housefly. Maggot mines into leaves and reaches the stem then tunnel the stem, leads to drying of leaves and plant.  
Spray of Imidacloprid @ 0.25 ml/l, Thiamethoxam @ 0.3 g/l.
7. Blue butterfly: *Lampydes boeticus*  
Caterpillar feed on leaves, flower buds. It also bore into pod and feed on the seed.

### **Field bean**

**1. Field bean pod borer/Pendal bean pod borer: *Adisura atkinsoni* (Noctuidae : Lepidoptera)**

Moth is yellowish with light brownish forewing has 'V' shaped specks there is an indistinct series of specks and pale brown marking on the hind wing.

Larvae is robust, green, resemble gram pod borer except for the presence of dark brown lateral stripes on the body and humped segment.

Pupation – in soil

Caterpillar bore into the pods and damage the green seeds. Even more than one seeds are eaten by keeping completely inside the pod.

### **Other common pests**

1. Black headed hairy caterpillar : Defoliates the leaves
2. Gram pod borer: *H. armigera*
3. Aphids: *Aphis craccivora* - suck the sap

4. Lablab sphinx: *Acherontia styx*
5. Stink bug: *Coptosoma cribraria*
6. Pod bug: *Riptortus pedestris*

**a. Management:**

- Metasystox @ 1 ml/l
- Dimethoate @ 1.5 ml/l
- Dimecron @ 1 ml/l
- Imidacloprid @ 0.5 ml/l
- Thiamethoxam @ 0.25 g/l
- Dinotefuran @ 0.4 g/l
- Buprofezin @ 1 ml/l

Systemic insecticides for all sucking pests

**b.**

- Chlorpyrifos @ 2 ml/l
- Flubendiamide @ 0.15 g/l
- Chlorantraniliprole @ 0.3 ml/l
- Indoxacarb @ 0.5 ml/l
- Spinosad @ 0.2ml/l
- Naluran @ 1 ml/l
- Thiadicarb @ 0.6 g/l
- Profenophos @ 2 ml/l

Contact insecticides for borers.

Pyrethroids like

- Lambda cyhalothrin @ 0.5 ml/l
- Cypermethrin @ 0.5 ml/l

## Pests of Soybean

### 1. Stem fly: *Ophiomyia phaseoli*, *Melanagromyza sojae*

It is major pests of blackgram, greengram and soybean. Incidence is more in rainy season.

Adult is bluish – black fly and depositing eggs on leaves by making puncture. Young plant suffer more (< 40 days).

Yellowish maggot bore into nearest vein, reach the stem through petiole, bore down stem and feed on cortical layers and may extended up to tap root resulting following symptoms.

- Distinct tunnel of stem split open.
- Death of plant or branches.

**Pupation:** Within stem at ground level. Adult fly exits through a thin semitransparent window.

**Management:**

1. Optimum seed rate and plant spacing
2. Crop rotation should be followed
3. Seed treatment with imidacloprid @ 3g/kg seeds and gives 30 days protection.
4. Spray Acephate @ 1 g/l, dimethoate @ 2ml/l or monocrotophos @ 2ml/l.

### 2. Leaf eating caterpillar: *Spodoptera litura*, *S. exigua*

Caterpillar defoliate the plants

### 3. Soybean leafminer: *Aproaerema modicella*

Brownish grey moth lays white eggs singly on underside of leaves close to midrib. Young larvae initially mine into leaflets and feed on mesophyll. Later as it grows web the leaflets together and feed. In case of severe infestation, field appear as “burnt appearance”

Full grown caterpillar is green with dark head and pupates within web.

Foliar spray of acephate @ 1 g/l, Chlorpyrifos 2 ml/l, Quinalphos @ 2ml/l are effective.

### 4. Whitefly: *Bemisia tabaci* (Aleyrodidae : Hemiptera): Both nymph and adult suck the sap from under surface of leaves and also excrete honey dew.

### 5. Girdle beetle: *Obereopsis brevis* (Cerambycidae : Coleoptera):

Grub girdles the stem and petiole and feed on internal content of stem by tunnelling the stem, which results drying up of plants.

Grub is white, soft bodied worm with dark head and adult is yellow, red, brown on head, thorax and base of elytra. Adult lays eggs by making 3 punctures in the stem.

**Defoliators**

1. Bihar hairy caterpillar : *Spilarctia oblique*
2. Gram pod borer: *Helicoverpa armigera*

**Sucking pests:**

1. Thrips: *Thrips tabaci*
2. Aphid: *Aphis* sp.

### 6. Pink pod borer: *Cydia ptychora* – Refer green gram

## 4. Pests of oil seeds (Groundnut, Sunflower, Sesamum)

### Pests of Groundnut

**Ground nut:** Crop suffers from 55-60 pests of which important ones are 5-6 in our region.

1. **Ground leaf miner:** *Aproaema modicella* (Gelechiidae : Lepidoptera)
  - Leaf miner is one of the major pests of groundnut crop, specially on the rainfed crop. It is a small moth with brown wings and a small distinction white spot on fore wings. It lays shining sculptured eggs singly on tender leave.
  - The incubation period lasts for 3 days. The larvae after hatching mines into tender leaflets, and feed inside the mines which leads to distorted leaves due to feeding and blotches seen on leaves. The late age of the larvae comes out of mines and webs the leaves together and feed on the green matter resulting in drying up of leaves. In the serious infestation whole field presents a burnt up appearance. The larval period lasts for about 14 days which is greenish with small dark head pupates in the webbing of leaves and adult emerging in 4 days.
  - Bunchy varieties are generally severe infested and the peak appearance is August during khaif crop and during February in summer crop. Similarly natural enemies are observed active after 11 week of August in TBP area where >70% parasitism is recorded. Important parasitoids observed are *Trichogramma* sp on eggs and *Bracon hebetor* and *Apanteles* sp. *Goniozus* sp. *Branchymeria* sp. on larval stages. If parasitization is seen during August no need to take up sprays.

### Other practices to be followed

1. Use light trap and attract adults
2. Destroy left over materials
3. Deep plough during summer
4. Spray monocrotophos @ 1.25 ml/l at 25, 45 and 70 days of sowing

### 2. Defoliators

1. Red hairy caterpillar: 1). *Amsecta albistriga*
  - 1) *A. Moorei*
  - 1) Behar hairy caterpillar: *Spilarctia oblique*: Arctiidae : Lepidoptera  
Brick red colour month, body crimson colour blue head. Both the species are polyphagous pests feeding on several crops like castor, green gram, B.gram, maize, sunhemp, cotton etc

*A. albistriga*: Adult possesses white wings with brownish streaks margin of the fore wing and a yellow streak along anterior margin of the fore wing and a yellow band on head. Hind wings are white with black marking.

*A. moorei*: Anterior margin of forewing and head band is red colour. Both the species are found together some times. Moths emerge immediately after the receipt of the first showers in monsoon. Adults emerge from earthen cell in the soil. The emergence takes place subsequently on receipt of rains moths mate on the same day and start laying eggs. Eggs are laid on fence, hedge and weed plants. Eggs period lasts for 2-6 days, they are cream/ bright yellow in colour, laid in group mostly on the undersurface of the leaves. Each female lays about 600-700 eggs, sometimes upto 2300 eggs. The larvae feed in group in the early stages and distribute all over the field afterwards. When they feed gregariously they skeletonise the green matter on the under surface leaving upper epidermal layer. Only one generation/ year is seen.

As they grow they feed voraciously on leaves leaving behind the petioles, midrib of leaves and main stem. After the food is exhausted in one field they move like army from field to field in thousands. Severely damaged field give the appearance of a cattle grazing and cause total loss.

Developed larva is reddish brown red head with black bands on either ends and has long reddish brown hairs all over the body arising on warts. Larvae period lasts for 40-50 days. Larval on receipt of some showers the grown up larvae burrow into the moist soil and pupate in an earthen cell, at about 10-20 cm depth. If rains are not received at this stage many get killed which is a critical stage for these larvae in the development.

The pupation takes place along the bund sides and in moist and shady areas under trees and bushes in the field. The insect undergoes pupal diapause in the soil till next year first shower.

### Management measures for RHC

1. Summer ploughing and exposure of pupal stage to natural enemies and to hot sun and destroy.
2. Setup bonfire or light trap to attract the moths and kill them between 7-9.30 pm as done in root grub management.

3. Collect egg mass as well as gregarious feeding young larvae and destroy.
4. Even grownup larvae are collected and killed manually
5. Grow castor in groundnut field to attract and kill egg mass
6. Dust or spray the crop with the following insecticides: Endosulfan 35EC @ 2ml/lit or dust 4% @20-25kg/ha; methyl parathion 2% @ 2ml/l/ dust the crop with Methyl parathion dust or quinalphos 1.5% dust (20-25kg)  
Even other insecticides like fenvalerate dust/EC; chlorpyrifos, carbaryl etc. may also be used.
7. Digg the trench between field and 1' depth and dust any of the above dust to kill in the pits.
8. If NPV of RHC in available spray @ 250 LE/ha in early stage.

2. **Ground nut aphids** : *Aphis craccivora* (Aphididae : Homoptera)

Both nymphs and adults suck the sap from shoots and leaves of tender plants resulting in reduced vigour and dry up if infestation is serious. It also acts as a vector of "Rosette" virus disease of groundnut.

3. **Thrips** 1. *Frankliniella schultzei* / *Scirtothrips dorsalis* 2. *Thrips palmi* (Thripidae: Thysanoptera)

Both nymphs and adults suck the sap from the under surface leading to silvery dave patches. It also results in downwards curling of leaves and in severe cases leaves sry up. Besides causing direct loss the thrips are known to transmit Budnecrosis disease or stem necross. Which is a serious problem in the recent pest.

4. **Leaf eating caterpillar** : *Spodoptera litura*; *Heliothis armigera* (Noctuidae : Lepidoptera)

These are polyphagous pests feeding on the foliage serious in groundnut. *Spodoptera* is serious during summer. It lays eggs in group and covers with brownish hairs on the leaves. Early instars are greenish soft bodied and feed gregariously and skeletanise the green matter. As they develop they turn dark coloured and move. Usually larva hide in soil below when they feed on the folded leaves the cut holes of similar shape or mirror image damage seen when they open in the morning and defoliate irregularly some times.

**Management:** The chemicals suggested for hairy cat take care of this.

5. **Leaf hopper:** *Empoasca kerri* (Cicadellidae : Hemiptera)

Greenish small hoppers, both nymphs and adults suck the sap from the leaves causing yellowing and curling of the leaves. The border of leaves turn reddish and some times dry up.

**Management:**

**Leaf miner**

1. Spray the crop at 25, 40 and 55 days after sowing with monocrotophos @ 1ml/lit or Dimethoate 30EC @ 1.6 ml/l or Quinalphos 25EC @ 2ml/l or Methyl parathion 50EC @ 1ml/l or lamadacyhelothrin 0.6ml Phosolane 35EC @ 2ml/l or profenphos – 2.0 ml/l
2. Set up light trap to attract and kill adult
3. Deep ploughing in summer
4. Destruction of residue

The above sprayings will take care of leaf miner, spodoptera early stage and hairy caterpillar as well as aphids, thrips and jassids. Do not spray during August if N.E pupation is high.

**For spodoptera management.**

1. Hand picking of egg mass and early stage larvae feeding in group.
2. Monitor the pest using sex phermunes to take up spraying in advance.
3. Use poison bait

50kg rice bean	ha
625 ml monocrotophos	
5 kg jaggary is 5-6 lit water	

4. Spray chlorphriphos or monocrotophos or Endosulfan or Quinalphos or any pyrethroid.
5. Bioagents: NPV @ 250 LE  
Or Bt – 0.4 g  
Or *Numoria riley* – 1.0g/l

## Pests of Sunflower

### 1. Sucking pests

- a) **Leafhopper** : *Amrasca biguttula biguttula* (Cicadellidae : Hemiptera): A serious pest causing 40% of loss. The incidence starts from seedling stage and prevails up to the end of the crop season. Summer crops suffer more. Low RH, high daily maximum temperature are congenial for pest proliferation. High 'N' application also increases the population.

**Adult:** Green yellow, wedge shaped with pair of black spots on vertex and a black spot on each of the forewings. 5 weeks in **s** and 7 weeks in **w**.

**Egg:** Lays inside the leaf vein. Fecundity : 10-15 eggs.

**IP:** 4-11 days

**Nymph:** Nymphs are greenish yellow translucent  
NP – 7 days in summer, and 21 days in winter.

**Nature of Damage:** Both nymph and adults suck the sap from the under surface of leaves and causes stunted growth, yellowing from the margin, cupped and crinkled leaves, later burnt appearance of leaf margins or entire leaf called "hopper burn" symptom.

#### b) Thrips: *Scirtothrips dorsalis* & *Frankliniella schultzei*

Both nymph and adult suck the sap from young or terminal leaves and floral parts resulting in curling and crinkling of leaves and also this pest is a vector of sunflower bud necrosis virus (SBNV)

#### Management:

1. Application of balanced fertilizer
2. Timely sowing
3. Set up yellow sticky traps and 4-5 traps/ac.
4. Growing of maize/sorghum as border crop
5. Seed treatment with Imidacloprid 70WS @ 10g/kg.
6. Spacing of chemical insecticide like Thiamethoxam, Dimethoate, Imidacloprid

#### c) White fly: *Bemisia tabaci*

**Adult:** Tiny moth like with yellowish body and wings coated with milky white wax powder AP- 15-30 d.

**Egg:** Pear shaped, white yellowish stalked.

**Nymph:** Oval, scale like, greenish – white.

Both nymph and adult suck the sap from leaves resulting in stunted growth and also secrete honeydew on which sooty mould develops.

**Management: As above**

#### d) Mealy bug: *Phenacoccus solenopsis*

Suck the sap as a result of crinkling and curling of leaves.

#### e) Aphids: *Aphis craccivora*, *A. Herii*

Both nymph and adult suck the sap from leaves, flower buds and causes stunted growth and excrete sooty mould.

### 2. Defoliators:

#### a) Tobacco caterpillar: *Spodoptera litura*

**Adult:** Stout, dark with wavy white markings on forewing and pale hind wing with brown colour margin.

**Egg:** Lays in masses on the under surface of leaves and covers them with brown hairs.

Fecundity: 500 to 600 eggs/♀. IP- 4-5 days.

**Larvae:** Greenish brown with dark markings with longitudinal grey and yellow bands.

**Pupation:** In soil, earthen cocoon.

**Nature of Damage:** Neonate larvae feed gregariously on the single leaf on the under side of leaves giving a "mesh" like appearance. Later instars completely devour the plant leaving the petiole and stalk. Eat away heads along with seeds when there is an outbreak.

**b) Bihar hairy caterpillar: *Spilarctia oblique* (Arctiidae : Lepidoptera) (= *Spilosoma*)**

Polyphagous pest. Many hosts including cotton, millets, sunhemp, castor, cauliflower, cabbage etc. It is reported to feed on 96 plant species in India.

Adult: Brown moth with red abdomen, wings are pinkish with numerous black spot.

Egg: laid in cluster on the underside of leaves.

Larvae: Yellowish brown abdomen and having numerous yellowish to black hairs.

Pupation: Soil

**Nature of Damage:** Young larvae feed gregariously mostly on under surface of leaves causing skeletonization or mesh like appearance. Later instar larvae completely defoliate the plant. Drying up of infested leaves is main symptom.

**c) Hairy Caterpillar: *Pericallia ricini***

**Adult:** Greyish brown or black colour and black spot on wings. Hind wings are pink or red colour with black spot.

**Larvae:** Robust, greyish black or blackish brown larvae with red head and thick tuft of hairs are arising from the body.

Nature of Damage: Defoliate the leaves.

**d) Green semilooper: *Trichoplusia ni*, *Thysanoplusia orichalcia***

**Adult:** Dark brown with golden yellow patch on forewing.

**Larva:** Green coloured with light wavy lines and broad lateral strip.

**Nature of Damage:** Caterpillar feeds on leaves, and defoliate completely in severe cases.

**Management for defoliators**

- Deep summer plough
- Collection and destruction of egg masses and gregarious early instar larvae present on under surface of leaves.
- Setup light trap.
- Spray of 5% NSKE,
- Apply Bt, SLNPV @ 100 LC/ac
- Spray of Quinalphos @ 2.0 ml/l. Chlorpyrifos @ 2ml/l, DDVP @ 1.0 ml/l.

**e) Capitulum borer (Head borer): *Helicoverpa armigera***

The larva get into peripheral florets and feed on ovaries. During, pre anthesis stage they feed scraping the bracts and then ray florets and finally access to immature ovaries. Matured seeds with fairly hardened seed coat are not damaged.

**Management:**

- Deep ploughing, hand collection of larvae.
- Use of light trap/pheromone trap.
- Spray of HaNPV @ 100 LE/ac + 0.4 kg Jaggary + 50 ml Depol.
- Spray of 5% Neem oil or 5% NSKE
- Spray of Cypermethrin @ 0.5 ml or Indoxacarb @ 0.5 ml/l Spinosad @ 0.25 ml/l.

Apply chemicals during after noon hours to avoid the harmful effect on pollinators.

**3. Soil pests**

**a) Termites: *Odentotermis obesus*, *Microtermes obesi*:** Pest feed on roots and internal content of main stem resulting withering of plant.

**b) Cutworm: *Agrotis* sp.:** The black coloured larvae hides in soil and cut seedling. The caterpillar feeds on the leaves of fallen seedling.

**c) White grub:** Also feeds on roots and rootlets, if severe plant withers.



## Pests of Sesamum

### 1. Gingly leaf webber/leaf roller/webworm/Gingly leaf and pod borer, *Antigastra catalaunalis* (Pyralidae : Lepidoptera)

It is one of the most common and specific pest of gingly.

**Distribution:** India, Agrica, South Europe, Burma, Bangaldesh.

**Host plant:** Sesamum, Duranta.

**Adult:** Pale brownish small moth with yellowish brown elongated wing with zigzag indistinct reddish decorative marking on them.

**Egg:** Lays shine, flat eggs on tender parot of plant. IP: 4-5 days.

**Larvae:** Full grown larva is pale green with black head and LP: 11-16 days.

Pupation within web. PP – 7-10 days.

Infestation starts when crop is 15 days old, peak activity being July-September.

**Nature of Damage:** Larva web together top leaves and bore into tender shoots and capsules and feed on them. The damage results in webbed leaves at top with young caterpillars.

#### Management:

EH 7, 57, 84, 105, 106 & 156

- Early sowing in kharif (First week of July)
- Collection and destruction of webbed leaves, infested pods at initial stage of infestation.
- Spray of Dichlorvos @ 1ml/l or Chlorpyrifos @ 2ml/l.

### 2. Gall fly: *Asphondylia sesame* (Cecidomyiidae : Diptera): It is specific pest of gingly, most important in South India and also in Rajshtan.

**Adult:** Small mosquito like fly IP 2-4 days.

**Maggot:** Small whitish LP: 15-20 days.

**Pupation:** Inside malformed capsule/pod. PP: 7-12 days, TLC: 23-27 days.

**Nature of Damage:** Maggot feed on ovaries and causing malformation of pods without proper setting of seeds. Galled buds and flowers fade and dry.

Activity starts at bud initiation, peak activity at September-November.

#### Management:

- R varieity for endemic area N-166-5.
- Removal and destruction of affected parts.
- Dusting of malathion 5D @ 25 kg/ha at 25, 35 and 50<sup>th</sup> DAS. Or Spraying of quinalphos @ 2ml/l or Dichlorvos @ 0.5 ml/l.

### 3. Sphinx caterpillar/Gingly hawk moth/Death head moth *Acherontia styx* (Herse convolvuli)

**Distribution:** India, Srilanka, Burma, Malaysia

**Host Plant:** Sesame, potato, brinjal and jasmine, greengram and blackgram.

**Adult:** Moth is large, brownish with characteristic skull like marking on thorax and violet and yellow bands on abdomen. Dark brown forewings covered with yellowish, bluish and grey powdery scales. It is known to suck honey from combs and cause annoyance to bees.

**Caterpillar:** Stout green caterpillar with yellowish oblique stripes and a conspicuous yellowish curved anal horn.

**Egg:** Singly on the under surface of leaves. IP-2-5 days, LP-60 days.

**Pupation:** Earthen cocoon in soil. PP: 14-21 days.

**Nature of Damage:** Larvae feed voraciously on leaves and defoliate the plant. Moth is honey stealer.

**Management:**

- Hand picking the larvae as best method as larvae is big and inactive and accessible.
- Spray methyl parathion @ 1ml/l/Monocrotophos @ 1 ml/l.

**4. Leaf hopper/Jassid: *Orosius albicinctus* (Cicadellidae : Hemiptera)**

**Adult:** Light brown coloured hopper.

**Nature of Damage:** Both Nymph and Adult suck the sap from leaves and transmit phyllody diseases.

**Management:** 1. Removal affected plant. 2. Spray of dimethoate 30 EC @ 1.5 ml/l, methyl demeton @ 1.5 ml/l.

**5. Aphids: *Aphis gossypii* (Aphididae : Hemiptera):** Both Nymph and Adult suck the sap from leaves resulting in curling and crinkling of leaves.

**6. Pod bug: *Elasmolomus sordidus* (Lygaeidae : Hemiptera):** Both Nymph and Adult suck the sap from young capsules and seeds in the field and as well as threshing yard. It results in appearance of black spots on the capsules. The damaged pods shrivel up. It causes reduction in oil content and seed weight.

**Adult:** Dark brown

**Egg:** Singly or batches in soil. IP: 4-5 days.

**Nymphs:** Pinkish, Nocturnal in habit, NP: 23-39 days. Hides under the weeds, cracks and crevices in soil and debris during day time.

## 5. Pests of Oil Seeds (Castor, Safflower and Mustard)

### Pests of Castor

#### 1. Castor semilooper (=Achoea) *janata*, *Acanthodelta janata*

A regular pest on castor

**Adult:** Moth is reddish brown coloured, with black hindwing having white band medially and three large white spots on the outer margin.

**Egg:** Blue green rounded and ridged eggs, ♀ lays 450 eggs. IP – 2-5 days

**Larvae:** Caterpillar is semilooper, long, smooth, greyish brown colour. First pair of legs is reduced and as such as semilooper. Caterpillar posses red or whitish side stripes. Full grown larvae has black head, a red spot on black loop and red anal tubercles.

**Pupation:** Soil, PP – 10-14 d.

**Nature of Damage:** Caterpillar feeds voraciously leaving midrib and veins.

#### **Management:**

1. Hand pricking of larvae and destroyed.
2. *Tlenomus* sp. and *Tetrastichus* sp, *Trichogramma achoea* parasitise the egg.  
**Braconid parasitoid:** "*Micropletis ophiusae*" acts as larval parasite whose cocoons may be seen attached to ventral aspect of posterior end of host caterpillar.
3. Erection of bird perches @ 10/ha.
4. Application of neem oil 5ml/l or Bt 1g/l.
5. Thiodicarb 1g/l or Spinosad @ 0.25 ml/l or methyl parathion @ 2 ml/l.

#### 2. Castor shoot and capsule borer: *Conogathes* (=Dichocrocis) *Punctiferalis* (Crambidae : Lepidoptera).

Potential pest and occasionally become serious. It is active from September to February when crop is flowering.

**Alternative host:** Ginger, cardamom, turmeric, guava, peaches, cacao, pear, mango inflorescence, sorghum earhead.

**Adult:** Medium sized, bright orange yellow coloured wings with numerous black spots.

**Egg:** Lays pinkish oval flat eggs either singly or in groups on tender developing capsule. IP- 6-7 days.

**Larvae:** Larvae is pale greenish pink tinge and fine hairs arising from warts on the body. The head and prothorax shield are brown in colour. LP- 12-16 d.

Larvae completes its period under cover of silk and fross or excreta which extend between capsule.

**Pupation:** pupates in silk cocoon in damaged stem, peduncle or capsule. PP – 7-10 d. TLC- 25-33 days.

**Nature of Damage:** Larvae bore into shoots as well as capsule and destroy them. Occasionally the larva is found at junction of the petiole with lamina and rarely in thick mid rib.

**Symptoms:** Frassy matter at bored shoots, webbed seed capsule covered with dark excreta.

#### **Management:**

- Collection and destructions of affected part.
- Spraying should be commenced from the time of formation of inflorescence and repeat again 20 days Profenophos @ 2ml/l, Monocrotophas @ 2ml/l, Quinalphos @ 2ml/l.

#### 3. Castor slug caterpillar: *Latoia lepida* (*Parasa lepida*)

**Adult:** Greenish winged moth with prominent dark patch at the base of each fore wings.

**Egg:** Flat shiny eggs on under surface of leaves, IP- 6-7 d.

**Larvae:** Caterpillar is fleshy with yellowish green body bearing a greenish blue stripe, it is called blue striped nettle grub. There are 6 rows of spiny scoli on dorsal surface while ventral body surface is flat.

**Nature of Damage:** Caterpillar feed on leaves. Neonate larvae gregarious and feed by scrapping green matter and affected leaves may dry. It is sporadic pest, larvae feed on leaves leaving only mid rib and veins.

**Management:** Spray of monocrotophos @ 1ml/l.

#### 4. Castor butterfly (Spiny caterpillar): *Ergolis merione* (Nymphalidae : Lepidoptera)

Specific pest feed only on castor

**Adult:** Brown butterfly with wavy thin lines on wings.

**Eggs:** Sculptured and laid singly on leaves.

**Larvae:** Green body covered with branched hairs and yellow stripe on dorsal side

**Pupa:** Brownish chrysalis

**Nature of Damage:** Larvae feed on leaves by remaining on upper surface of leaves. It feeds from margin and cause defoliation.

#### 5. Castor white fly: *Trialeurodes rara*, *T. ricini*

Adult small tiny moth like with waxy coating on wings lay eggs in groups below the leaves. Nymph yellowish with waxy filaments and found large number on under surface of leaves. Both adult and nymph suck the sap resulting yellowing and drying of leaves.

#### 6. Green leaf hopper: *Empoasca flavescens*

Light green to greenish yellow, both nymph and adult suck the sap from leaves keeping on under surface of leaf. Severe infestation cause curling and hopper burn.

#### 7. Castor thrips: *Scirtothrips dorsalis*, *Retithrips syriacus*

Suck the sap from upper leaves.

#### 8. Other pest

1) **Leaf miner – *Liriomyza trifolii*:** Polyphagous pest and feed on many crops and weeds.

**Adult:** Tiny fly, yellow colour, lays eggs in tissues. Maggot mines in between the epidermis causing blotches of serpentine shape. In severe infestation drying and drooping of leaves.

2) **Tobacco caterpillar**

3) **Hairy caterpillar**

4) **Bihar hairy caterpillar: *Spilarctia oblique***

**Management:** For semilooper and capsule borer – dust the crop with parathion 2% or spray of methyl parathion @ 1ml/l or pyrethroids – Feval, Cypermethrin, deltamethrin @ 0.5 ml for whitefly and serpentine leafminer – Acephate @ 1g/l. For sucking pest – Metalystore, monocrotophos.

#### Pests of Safflower

##### 1. Safflower aphid: *Uroleucon carthami* (Aphididae : Hemiptera) (= *Dactynotus carthami*)

It is regular and major pest of safflower. The incidence of pest occurs a fortnight after crop germination. It completes 4-5 generations in a cropping season.

**Alternate host:** Niger, gingelly, citrus, dhalia etc.

**Adult:** Quite large aphid with conspicuous cornicle. It appears at flowering and does not any severe damage. Female produces 30 young ones by parthenogenesis.

**Nymph:** Smaller reddish brown in colour. Both Nymph and Adults suck the sap from tender shoots and leaves, excreting honey dew resulting sooty mould development, stunted growth and plant become dry.

Natural enemies like syrphid fly, coccinellids are associated with the pest.  
*Brumus suturalis* – predator on aphid.

##### 2. Safflower caterpillar: *Prospalta conducta* (*Periga carpensis*) (Noctuidae : Lepidoptera)

**Adult:** Dark brown forewing and light brown hind wing.

**Egg:** Laid on under surface of leaves. IP – 4 days.

**Larvae:** Smooth bodied greenish with and segment slightly humped. LP-12-14 days.

**Pupa:** Soil, PP-8 days.

**Nature of Damage:** Defoliate the plant and causes loss to foliage.

### 3. Thrips: *Frankiniella sulphurea* (Thripidae : Thysanoptera)

Nymph and Adults lacerate and suck the sap from the leaves in all stages of crop and causing crinkling of leaves.

### 4. Safflower semilooper: *Eublemma rivula* (Noctuidae : Lepidoptera)

**Adult:** Small moth with buff coloured wings with oblique line in middle of each forewing.

The larvae bore into flower head, and stem and feed on the content, resulting yield loss.

### 5. Capsule borer: *Helicoverpa armigera*: Larvae of *H. armigera* cause damage to both leaves and developing seeds inside the capsule.

#### Other pests:

- *Spodoptera litura* – defoliator
- *Trichoplusia ni* - a semilooper
- (*Plusia orichalea*) *Thysanoplusia orichalcea*, (New name) etc.

#### Management:

- Sow the crop (September-October 1 week)
- Spray of dimethoate @ 1.5 ml/l, on Monocrotophas @ 1ml/l
- Dusing with Malathion 5% D @ 20 kg/ha
- Neem product spray, NSKE 5%
- Spraying border 4-5 rows prevents entry all around the field. It gives maximum production with less cost of cultivation. It should be done when we notice the aphid infestation first.

## Pests of Mustard

### 1. Mustard aphid/tumip aphid: *Lipaphis erysimi* (Aphididae : Hemiptera): It is regular pest on mustard and active from January-March.

**Distribution:** All over the country. It also attacks other cruciferous crop. Whitish green aphids reproduce sexually and parthenogenetically. Winged forms appear near end and season.

**Eggs:** Laid ovoviviparously. 3-9 eggs/day.

Nymphal period 7 days.

Both nymph and adult suck sap from leaves and floral parts causing curling and distortion of leaves, sooty mould, sickly and blighted appearance of leaves.

#### Management:

- Sowing in rows having certain rows unseeded to lessen incidence (Farmer practices).
- Early sowing escape the pest incidence.
- Growing of short duration of varieties. T-6342, RLM 514, Varuna, PK 9, RH 785, RLM 528. ETL 50-60 aphids/plant at flower bud initiation.
- Spray of dimethoate @ 2 ml/l or Monocrotophos @ 1.6 ml/l or Methyl demeton @ 2ml/l.

### 2. Mustard sawfly: *Athalia lugens proxima*

**Distribution:** It is one of the very few hymenopterous insect to infest crops in India. It is also pest on reddish and other crucifers. It is pest of cold weather, active during October to March.

**Adult:** Small orange yellow with black markings on body, smoky wings with black veins. Abdomen is broadly attached to thorax. Female posses on saw like ovipositor.

**Eggs:** Insert egg near leaf margin, singly @ 35/♀.

**Larvae:** Full grown larvae is cylindrical and dark grey with three pairs of thoracic legs and 7 to 8 pairs of abdominal legs (Prolegs without crochets) and black stripes on the abdomen.

**Pupation:** Soil. Earthen cocoon in soil. Parthenogenetic development is also observed.

**Nature of Damage:** Larva feeds on the leaves nibbling leaves initially biting holes later causing skeletonisation of leaves, heavy defoliation, on slight touch larvae falls to ground as feigning death. It feeds during morning and evening hours and prefers to stay in soil during day time.

**Management:** Foliar spray with methyl parathion @ 2ml/l.

**3. Diamond back moth: *Plutella xylostella*:** It is also pest of cruciferous.

**Adult:** Brown moth with narrow fringed wings having pale white triangular markings on inner margin of each forewing anteriorly which form diamond like white patch is dorsally when wings are folded over back at rest. Hence the name. Female lays 50-60 eggs singly along the veins of the leaves.

**Nature of Damage:** Caterpillars feed on the under surface of leaves and bite holes in leaves, causing serious damage. In severe cases, the leaves are skeletonised. Caterpillar is greenish with short thin hairs on the body and body tapers towards both ends.

**Pupation:** Silken cocoon on under surface of leaves.

**Management:** Erection of pheromone traps @ 4/ac.

- Larval parasitoid *Apanteles plutellae*, *A. ruficornis*, *Brachymeria* sp.
- Novaluron @ 1ml/l, Indoxacarb @ 1ml/l, Spinosad @ 0.25 ml/l.

**4. Painted bug: *Bagrada cruciferarum* (Pentatomidae : Hemiptera):** Serious pest of cruciferous crops, cabbage, cauliflower, radish etc.

Both nymph and adult suck sap from leaves, shoots and pods resulting in wilting and loss of vigour of the plant. It also excretes a sort of resinous material which spoils the pods.

**Management:** Spray of quinalphos @ 2ml/l or dimethoate @ 2 ml/l.

## 6. Pests of Cotton

A cotton is the one of important commercial fibre crops of our country, as many as 1326 species of insects pests are important. India 18-20 species are of major importance causing annual loss of 50-60% of total production. Cotton consumes 50% of total pesticide consumption in India.

The crop is subjected to attack by various pests since its sowing to till harvest of crop. Hence, cotton pests are categorised as follows.

1. Soil pests: a) Cutworm b) Wire worm
2. Sucking pest: a) Aphids b) Thrips c) Jassids d) White fly e) Mites (Non insect)
3. Defoliators and Stem/Shoot feeders: a) Shoot weevil b) Leaf roller c) Semilooper d) Spdoptera e) Helicoverpa.
4. Flower and boll feeders: a) Bollworms – 1. Spotted bollworm 2. American cotton bollworm 3) Pink bollworm. B) Flower midge/maggot
5. Late sucking pests: a) Cotton mite b) Red cotton bug c) Dusky cotton bug d) Mealy bug: *Phenococcus solanopsis* (Pseudococcidae : Hemiptera) e) Mirid bugs.

### 1. Soil pests:

#### a) Cutworm: *Agrotis ipsilon*

**Adult:** Stout moth with brown forewings with triangular spot. Hind wing is pale white.

**Larvae:** Larvae are dark black coloured hiding around the soil at the base of plant and cuts sprouting seeds or seedlings and feed on leaves. If soil is removed around seedlings, dark coloured larvae will be visible.

**b) Wireworm:** *Agriotes* sp. on wheat, *Melanotus* sp. on chilli potato, cabbage etc. The larva cuts the germinating sprout and affect the germination. Sometime they feed on the roots of seedling and causing death of seedling.

These above two pests are problems in transitional belt

### 2. Sucking pests

a) **Aphid:** Cotton aphid/Melon aphid: *Apis gossypii*

**Host plant:** Citrus, coffee, okra, peppers, potato, squash sesame and cucurbits.

**Adult:** Yellowish brown to black in colour with black cornicles and yellowish green abdominal tip. If reproduce parthenogenetically as well viviparously. In single day, female gives birth to 8-22 nymphs. NP- 7-9, AP-20 days. 12-14 generation/year.

Polymorphism can be seen in adult with apterous and alates within population.

**Nymph:** Yellowish or greenish brown nymphs. They are wingless normally but winged forms are often found mostly in beginning and towards the end of season.

**Nature of Damage:** Aphid cause direct damage by feeding on phdoem, excretion of honey dew which attracts sooty mould fungus resulting in reduced photosynthesis and plant vigor. Infested leaves exhibit crumpling and downward curling. Indirectly aphid causes deterioration in cotton fiber quality due to deposition of honey dew on open bolls. These are vectors of viral diseases like cotton anthocynosis virus, cotton curliness virus, cotton blue disease, cotton leaf roll and purple wilt.

Ant Association with aphid infestation is common.

#### Factors:

- Cloudy weather
- Continuous spray
- Late sowing
- Application of excessive nitrogen fertilizer

b) **Cotton leaf hopper/Jassids:** *Amrasca biguttula biguttula*

**Distribution:** All over the country

**Host Plant:** Cotton, Potato, Brinjal, Castor, Okra, Tomato, Hollyhock and Sunflower.

**Adult:** Pale green in colour with two distinct black spots on forewings and vertex, readily identified by their characteristic diagonally movement on the leaves hence referred as leaf hopper.

**Eggs:** Yellowish white in colour intensely rooted in the midribs or large veins on under surface of leaves. AP- 13-17 days, NP- 5-16 days.

**Nymph:** Light green, 11 generation per year.

**Nature of Damage:** Both nymph and adults suck the sap from plant tissue and inject toxin into it resulting “hopper burn” symptoms. The affected plant parts show curling with brown necrotic patches. Thus, the entire photosynthetic activity of plant is very seriously interfered with hopper burn i.e. leaf margin turning yellowish initially and subsequently turning reddish and curling up. Stunted growth of plant, brown necrotic patches on leaves.

**Management:**

- Growing of resistant varieties like L603, L604, LRA 5166, NHH 390, NHH44, Lam hybrid-4, H8, Saitha, Narasimha (NA 1325), MCV-5, MCV-9, MCV-3.
- Growing of tolerant varieties suitable for HDPS, like PKV 1081, NH 615 and Suraj.
- Seed treatment with imidacloprid 60 FS, Thiamethoxam 35 FS @ 5g/kg.
- Stem smearing technique with imidacloprid @ 1:20 with water at 20-25, 30-35, 40-45 days after sowing.
- ETL 2-3 nymphs/leaf.

**3. Thrips: *Thrips tabaci* (Thysanoptera : Thripidae)**

**Polyhouse**

**Distribution:** Geographically distributed to 100 countries. Europe, Asian, USSR, Africa, Australia, USA etc.

**Adult:** Small bodied insect with variant colour from yellow to brown and fringed wing.

**Egg:** Female lays minute, kidney shaped et in slites in leaf tissues. Reproduction is parthenogenetically as males are rare. IP – 5 days.

**Nymph:** Creamy to pale yellow in colour resemble the adult but however wingless. MP – 5 days, PP – 4-6 days, AP – 14-28 days. 15 generations/year.

**Nature of Damage:** Both nymph and adult lacerate and de-sap from the upper and lower surfaces of leaves, resulting brown or silvery necrotic spot. Infested plants demonstrate hampered growth, loss of vigour, leaves became wrinkled and distorted, curl upward with white shiny patches. It also results premature dropping of squares, delayed crop maturity and reduction in yield. It also transmit viral diseases like yellow spot virus and spotted wilt virus. Tobacco streak virus (TSV) – Warangal dist. AP. (*Thrips palmi* and *T. tabaci*)

**Favourable factors**

1. Hot and dry condition
2. High temperature

**4. Whitefly: *Bemisia tabaci* (Homoptera : Aleyrodidae):** It has been reported more 600 hosts world wide, it is also named as tomato, sweet potato, cotton etc. It is distributed to tropical and sub-tropical.

**Alternative host:** Brinjal, chilli, cotton, okra, potato, rapeseed, sunflower.

**Adult:** Small yellow body with white dusted wing.

**Egg:** Stalked eggs 100-120 eggs on under side of leaves. IP – 3-35 days. Insect also breed parthenogenetically. Eggs are light yellow in colour.

The hatched young ones are called crawlers which are flat and move for a day or two and fix a place for feeding where it spends all its nymphal period. Nymphs are yellow, oval, sessile, flat, scale like on under surface of leaves. Further moulting leads to reduced legs and stick on to a single place lost for 9-14 days, it is extended in winter upto 70-73 days. Normal pupal period 2-8 days. TLC 14-20 days depending on weather and life span extended up to 107 days in winter.

**Nature of Damage:** White flies cause both direct and indirect damage. The direct damage is sucking the sap from leaves resulting reduction in photosynthetic activities and reduction in vigour of plant and yield. It also secretes honey dew on which sooty mould develops. Indirect damage results honey dew contamination of lint and associated fungi and also transmit CLCuD (Cotton leaf curl disease) symptom of white fly damage is upward curling of leaves, reduced plant vigour, leaves become shiny with sugar secretion or darkened by sooty mould.

**5. Mealy bug:** 8 mealy bug species are occur in cotton.

***Phenacoccus solenopsis*** – Predominant in North and Central Zone.

***Paracoccus marginatus*** – Predominant in South zone.

***Phenacoccus solenopsis*** described originally from US is found to infest cotton in India during 2007 and causing 50% of economic damage to crop.



**Appearance:** Adult small insect covered with white mealy wax. It has 194 host plant across India. Adult female lives for 36-55 days and male for 1-3 days. Nymph undergoes 4 instars. NP – 26-47 days. Both Nymph and Adult suck the sap from all parts of plant. Plants infested with mealybugs in vegetative stage show stem distortion, twisting and bushiness of affected portion. Sooty mould development due to honey dew excretion. Most preferred alternative host is parthenium.

6. **Mirid: *Creontiades biseratense*:** With introduction of Bt-cotton and subsequent reduction in insecticidal spray for control of bollworm especially *H. armigera*, sucking pests like mirids which were controlled by broad spectrum sprays, are now emerging pest status on Bt cotton.

Indian cotton mired bug recorded in an epidemic form in Coimbatore on Bt cotton hybrid during 2006.

**Adults:** Adults are brown colour with dark brown T-shaped band on pronotum.

**Nymphs:** Greenish with dark brown wing pads.

**Eggs:** Lay eggs in petiole.

Green colour morph is also available with similar taxonomic feature.

TLC – 39-41 days.

**Nature of Damage:** Both nymphs and adult damage developing flower buds and tender bolls. The characteristic symptoms of feeding on the flower bud are described as oozing out of yellow fluid from the buds and staining of this yellow fluid on the inner surface of the bracts.

Infested tender bolls have number of black patches on all sides of outer surface of boll rind and shedding of damaged bolls. Heavy shedding of squashes and bolls which led to significant reduction in seed cotton yield of Bt cotton.

Larger squares suffer damage that may cause development of deformed bolls which is referred as “Parrot beaking”. If the infestation is severe in older bolls, the damaged locules may not develop properly and often carry stained lint.

Mirids are very active, running and hopping with short rapid flights when disturbed.

7. **Mite: *Tetranychus macforlanei*:** It is polyphagous pest and known to infest 183 species of plant. Mite are oval red coloured found feeding on lower surface of leaves in colonies. Nymph and Adult feed under the thin webbing, resulting yellowing of leaves with specks, gradually withering and drying of leaves. Yellow area often turn reddish and lower surface of leaves with fine web. Nymphs is light brown in colour and has 2 eye spots and 4 pairs of legs.

8. **Red cotton bug: *Dysdercus cingulatus* (Pyrrhocoridae : Hemiptera):** In India, the bug infest cotton in all cotton growing regions. It also infest okra, maize, mesta etc.

**Adult:** Adult is red colour, white and black stripes on ventral surface of abdomen. Adult undergo hibernation in winter month.

**Egg:** Ovoid, yellowish and laid in soil in masses and covered with soil and dry leaves. 100-130 eggs/♀. EP 4-7 days.

**Nymph:** Reddish with white band on abdomen. NP-26-89 days.

**Nature of Damage:** The nymph and adult 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 plant lose its vigour and bolls open prematurely with stained lint. Infested seeds get shrivelled, under developed. A bacterium *Nematospora gossypii* is entered at bite of injure and causes the stain.

Cannibalism is exist in this insect. The reduvid bug *Harpactor costalis* is predator on RCB, (Both nymph and adult).

9. **Cotton bug: *Oxycarenus hyalinipennis* (Lygaeidae : Homoptera):** It is found all cotton growing areas of country.

**Adult:** Small flat, dusky brown bugs with pointed head and hyaline wings.

**Eggs:** Cigar shaped, white colour laid in clusters within half opened bolls or on the bolls, flower or buds.

**Nature of Damage:** Nymphs and adult suck sap from immature seeds and stain the lint. The seeds do not ripen and get damaged. Seeds shrink and discolour and lose their germination capacity. The anthrenid bug – *Orius tantilus* is predator on nymph.

**Defoliators:**

**10. Tobacco caterpillar: *Spodoptera litura*, *S. exigua*:** It is also known as oriental leafworm, Cluster caterpillar, cotton leafworm, tobacco cutworm and tropical armyworm.

It is distributed tropical and subtropical part of world wide spread in India.

**Host:** Cotton, Castor, groundnut, tomato, cabbage and other cruciferous crop.

Moth is medium sized and stout bodied with forewing pale grey to dark brown in colour having wavy white cross markings. Hind wings are whitish with brown patches along the margin of wing.

**Egg:** 300 eggs per cluster and eggs are covered with brown hairs and they hatch in about 3-5 days.

**Nature of Damage:** Early instar caterpillars are gregarious and scrape the chlorophyll content of leaf lamina giving a papery white appearance. Later instar becomes voracious feeders making irregular holes on 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: 12 larvae/plant – Bt cotton  
4 larvae/plant – Non Bt cotton

**11. Cotton semilooper, *Anomis flava*:** Moth is reddish brown wings with black stripes larvae is green with five longitudinal white stripes and red prolegs. IP 3-4 d, LP 15-20 d, PP 8-10 days.

Caterpillars scrape green matter and skeletonise the leaves, later they eat leaves fully and attack bolls and twigs. It causes no economical damage to non-Bt cotton. Instead they serve as natural biofactories in the field allowing multiplication of parasitoids especially larval parasitoids. (Such as *Apanteles*) and entomopathogenic fungi. (Especially *Beauveria* and *Metarrhizium*). So it is advisable to discourage application of insecticides during 45-60 DAW especially in control India.

**12. Cotton leaf roller: *Sylepta derogate*:** Moth is medium sized yellow colour with brown wavy markings and “OR” mark on right wing and mirror image of “OR” mark on left.

Eggs is smooth, flat and pale white. Larvae greenish yellow in colour with dark brown head and prothorax. Pupation is takes place in rolled leaf. IP 2-3, LP 15-18 and 7-8 days.

Larva rolls the leaves from edges inwards upto midrib making like funnel shaped structure and feed inside the green matter.

**13. Shoot weevil: *Alcidodes affaber*:** Weevil is dark greyish brown with pale cross bands on elytra. Grubs are creamy yellow with dark head and apodus. Pupation inside the stem. Grub bore into top shoot and leaf axil resulting symptoms like terminal shoots with galls and bore hole surrounded by raised margin and drying of shoot. The affected plant break up due to heavy wind or intercultivation because of grub tunnelling inside the shoot. The adult female scoop on petiole and lay eggs.

**14. Stem weevil: *Pempherulus affinis*:** Dirty brown weevil and it is endemic pests of some part of South India (T.N.). Adult is small weevil, dark in colour with two small white patches on the elytra. Grubs are white in colour and apodus. By feeding, grub forms a tunnel like passage inside the stem. Young plants are killed in cases of serious infestation and matured plants survive with reduced vigour with galls at colour region of the plant. Infested plant gets killed in course of time either due to blockage of nutrients; break down at the gall region due to strong winds, intercultural operations or excessive boll lead at later stage.

It lays globular or oval shaped eggs singly in cavities scooped out by weevil at nodal region of the plant. 50 eggs/female with maximum of 121 eggs. IP 6-10 days, GP 35-37 days, AP 25-30, PP 8 days.

**Management:**

- MCU 3 is resistant variety.
- Earthing up, applications of carbofuran @ 30 kg/ha.
- Application of neem cake 25g/ha.
- *Euderus pempheriphilla* – Parasitic on grub
- Application of Profenofos @ 2ml/l DDV @ 0.5 ml/l

## Bollworms

**15. Spotted bollworms: *Earias insulana* *E. Vittella*:** Spotted bollworm is found to attack crape like cotton, okra, hibiscus, hollyhook, *Abutilon indicum* and other malvaceous crop.

*E. insulana* – Predominant species in N. India.

*E. vittella* – is found in South and control India.

*E. insulana* – Commonly known as spiny bollworm

*E. vittella* – Spotted bollworm.

**Adults** of *E. Vittella* has pale whitish forewings with a broad greenish band in the middle while *E. Insulana* has completely green forewing.

**Eggs:** Female lays about 300 eggs on young shoot, leaf bracts and squares, singly laid egg. Eggs are sky blue sculptured egg.

*E. vittella* larvae is brownish with white longitudinal white strips on dorsal side having orange dots on prothorax without finger shaped process on cream colour body. *E. Insulana* has finger shaped process on at least two thoracic segments and all abdominal segments.

**Pupa:** Covered in boat shaped tough silken cocoon, attached to plant – parts or on the fallen leaves or fruiting bodies. LP 10-12 d, PP 7-10 d, FP 3 d.

*E. vittella* commences as early as 3 weeks old crops. The damage due to spotted bollworm to fruiting bodies of age 15-16 weeks is high when ever *Helicoverpa armigera* incidence is low to moderate.

**Nature of Damage:** Larvae bore into the tender shoot causing wilting withering and drooping or drying of tender shoot in early stage of crop growth. Premature shedding of squares and young bolls, flare up of squares during square formation. Feeding holes in squares and on bolls are seen with or without larvae. Larvae do not confine to feeding on single boll and hence damage is not proportionate to their numbers. Damaged bolls often succumb to secondary infestation by bacterial and fungal pathogens.

**16. Pink bollworm: *Pectinophora gossypiella* (Gelechiidae : Lepidoptera):** It is native of Asia and become a destructive pest of cotton in South America, Africa, Asia, Australia, USA and Mexico. All 4 species of cotton, okra, country mallow, Hibiscus, sorrel, Lucerne are primary host. In India PBW is functionally monophagous.

**Adult** moth is greyish brown with blackish bands on forewings while hind wings are silvery grey. Eggs are pearly white flattened, oval, striated eggs on bolls or in between bracts or on buds and flowers.

**Larvae** are white in colour in first two instars, later instars are pink in colour. Larvae have characteristic dark brown head and prothoracic shield.

**Pupation** takes place inside seeds or soil or in Kapas. IP 4-5, LP 23-35, PP 6-20 d.

The hibernate in larval stage between March-July and damage from July and pest appear throughout.

**Natural Damage:** Larvae initially feed on the flower buds causing “Rosetted flower” and failure of bud opening and shedding. Larvae enters into the developing boll through rind feed on developing cotton seed. The entry hole get closed as boll matures. Larvae while feeding on developing seeds and also roving on adjacent seeds and locule by making hole through septum. Rosetted flower flower and square dropping, locule damage and bad opening are common symptoms.

ETL – 8 moths/trap/night over 3 consecutive nights.

**17. American bollworm: *Helicoverpa armigera*:** It is also called as cotton bollworm, tomato fruit worm, legume pod borer, and it is most devastating and polyphagous pests. It is widespread to central and Southern Europe, Asia, Africa, Australia and very recently Brazil.

The pest has 182 species of host plant. Moth is brownish yellow/greenish yellow with prominent ‘U’ shaped black spot on costal margin of forewing and a broad black patch on outer margin of the hind wing.

**Eggs** are yellowish colour and laid singly on tender parts and buds of the plant. IP 2-4 days.

**Caterpillar** are of varying colour, greenish to brownish with longitudinal streaks along the sides of the insect. TLC 25-60 days, LP 20-25 d, PP 8-12 days.

**Pupation:** Soil

I and II generation found on several crops and weeds II generation infest cotton in low number. Population increases dramatically during III & IV generation with major outbreak coinciding with peak squaring of first and rarely affecting the second flush of cotton.

**Nature of Damage:** Larvae feed on the leaves initially and then bore into squares/bolls and seed with their head thrust into boll, leaving the rest of the body outside. Excreta surrounds the entry hole. Damaged square flare up, and shed. Clear – cut round feeding holes on squares and bolls with or without larvae are seen. Larvae show preference for feeding on squares and flowers, however they feed on young bolls too. Single larvae can damage 30-40 fruiting forms during developmental period. Entry holes are large and circular at base of the boll.

Reduction of infestation of *Helicoverpa* in last decade and rarely exceeded ETL in cotton. Reason

- Introduction of Bt cotton
- Change in usage of insecticide pattern
- Decrease in pyrethroid usage
- ↑es in usage of new chemistry, and large scale implementation of IPM and IRM programme.

#### 18. Flower bud maggot – *Dasineura gossypii* (Cecidomyiidae : Diptera): Gall or Midge of cotton

The first epidemic noticed in Karnataka in Haveri dist during 2009. It is also observed in Raichur, Belgaum, Gulbarga, Bellary and Dharwad and is endemic to Karnataka.

Maggots are damaging stage and feed on anthers and stamina column leading to degradation or decaying. About 3-15 maggot have been seen in flower bud.

The infested flower buds fail to grow normally and are unable to open as the petals as well as tissue inside dries. Subsequently flower dies due to degradation of flower organs. Squares donot develop into bolls. Drying of tissue or death of flower leads to twisted or contorted stamina column/anthers. Tender bolls exhibit presence of small hole exposing necrotic tissue within.

The bolls donot reach to normal size and are characterised by abnormal fibre development. Presence of pink or whitish coloured maggot are seen when the bolls are cut open.

Pupation inside the dried flowers. Historically, the pest was reported from Coimbatore (TN) as pest of cotton referred as floral bud maggot (Ayyar 1932).

#### IPM for cotton

##### 1. Cultural practice

- 1) Deep ploughing in summer
- 2) Crop rotation with cereals/pulses/Green manure crops so to avoid cotton after cotton
- 3) Application of recommended dose of fertilizer
- 4) Use of sucking pest tolerant genotypes
- 5) Growing of trap crop okra @ 10:1
- 6) Other crops like redgram, marigold are also used to trap the eggs of bollworm and kill the eggs and larvae in early stage on redgram.
- 7) Growing of non Bt (@0% refugium) or pigeon pea around Bt cotton field.
- 8) Growing ecofeast crop like cowpea to reduce the sucking pest like aphid and increases the coccinellid.
- 9) Installation of yellow sticky trap.
- 10) Monitor the pest through pheromone trap, *H. armigera*, *Earias* sp. *Pectinophora gossypiella*, @ 5 traps/ha
- 11) Destruction of coop residue.
- 12) Donot extend the crop after march (PBW ↑es).
- 13) Nipping of crop at 90/130 days to increases symphata branch and reducing the pest infestation.
- 14) **R Varities:** Supriya, Kanchan – whiteflies, Sujata – Thrips/Jassids, Jayadhar, Vijay, Sujay – against Jassids.

##### 15) Natural Enemies:

**Egg parasitoids:** *Trichogramma achae*, *T. chilonis* / 1.0 lakh/ha

**Larval parasitoids:** *Chelonus blackburni* *H. armigera* & *Earias*

**Rogas aligarhensis** – *Earias*

**Bracon greeni** – PBW

**B. kirkpatricki** – PBW

} @ 15-20,000/ha

**Other parasitoids:** *Compoletis chloridae* – *Helicoverpa armigera*

**Predators:** *Menochilus sexmachulata* – *Helicoverpa armigera*

**Coccinellids:** *Coccinella septempunctata*, *Scymnus* sp.

**Chrysopidae:** *Chrysoperla carnea* (Green lace wing)

**Pathogens:** *HaNPV* @ 500 LE/ha

*SINPV* @ 500 LE/ha

#### ETL:

- Leafhopper/Jassids – 2 hopper/leaf
- Thrips – 10 thrips/leaf
- Aphids – 10% affected part
- Mealybug - > 40 plants per acre
- Spodopteran – egg mass/sq.mt
- *Helicoverpa* – 1 larvae/plant, 5% fruiting damage
- Pink bollworm – 8 moths/trap/night for 3 consecutive

### **I. Sucking pest**

1. Seed treatment with imidacloprid 60 FS or Thiamethoxam 35 FS @/og/kg of seeds.
2. Spray with oxydemeton methyl 25 EC @ 1.5 ml/Dimethoate 30 EC @ 1.7 ml/l @ 25-40 days.
3. Recently stem smearing with imidacloprid @ 1:20 at 25, 35, 45 days after sowing.
4. Thiamethoxam @ 0.25 g/l, Fipronil 5 SC @ 1ml/l, or Acetamiprid 20 SP @ 0.2 g/l, Flonicamide @ 200 g/ha
5. For bollworms at 55 days after sowing – spray of any one of following.
6. Decamethrin/ Cypermethrin/ Alphamethrin @ 0.5 ml/l restrict only one time.
7. Conventional insecticides alternate with pyrethroids. Quinalphos @ 2.5 ml/Chlorpyrifos @ 2ml/l, Cyfluthrin (Bulldock) – 2ml/l or Emamectin benzoate @ 0.2 g/l.
8. For mites – Dicofol @ 2 ml/l, Wetable Sulphur @ 5g/l.
9. Rotate the insecticide.

### **For mealy bug**

- Destruction of affected plant
- If it cross ETL (> 40 plants/ac) – Spray Neem oil @ 10 ml/l + Soap powder @ 10 g/l
- Chlorpyrifos @ 2ml/l + Soap powder @ 10 g/l.
- Profenofas @ 2 ml/l + Soap powder @ 10 g/l.
- Removal of weeds specially parthenium.
- Stem application or soil/soil application (near root zone) with dimethoate/acephate @ 30-40 DAS and 50-60 DAS effective or drench Acephate 2g/l, Buprofezin 25 SC @ 10ml/l.

### **IPM schedule: (Non Bt cotton)**

1. Seed treatment with imidacloprid 60 FS.
  2. Release of Trichogramma @ 1 lakh/ha
- Application of recommended dose of fertilizers especially 'N' management to avoid heavy incidence of sucking pest.
  - Seed treatment with imidacloprid 70 WS @ 5g/kg of seeds. Hybrid – 10g/kg, Thiamethoxam 5g/kg.
  - Weed management /clean cultivation.
  - Trap crop like okra, marigold, jowar, maize, cowpea.
  - Grazing of animals after last picking to avoid pupa of bollworm.
  - Clipping of terminal shoots at 90-160 days
  - Collection and destruction of egg masses of Spodoptera
  - Installation of bird perches @ 10/ha.
  - Application of HaNPV @ 250-500 LE/ha.
  - Entomopathogenic *Mtarhizium anisopliae*, *Beauveria*, *bassiana* & *Nomurea rileyi*.
  - Avoid use of pyrethroids at early crop growth period.
  - Installation of pheromone trap @ 5 traps/ha monitoring 25 traps/ha.

## 7. Pests of Sugarcane and Tobacco

### SUGARCANE

#### Sugarcane pests are categorised into

I. Borer II. Sucking pest III. Soil pests

#### I. Borer

1. Early shoot borer: *Chilo infuscatellus* (Yellow top borer): Moth is small, slender greyish brown or straw coloured with labial palpi projected upwards. A row of black dots present on the coastal margin of the forewings and white hind wing. Male is smaller than female.

Egg are flat scale like over lapping eggs are laid in 3-5 rows on the underside of leaf sheath or leaves in cluster containing 8-40 eggs. Single female lays about 300-400 eggs. Oviposition period last about 4 days IP 3-8 days.

The caterpillar is whitish with five violet stripes dorsally and dorso laterally on its body with dark brown head. LP 22-44 days.

**Pupation:** Pupal cell in the stem, pale straw coloured pupa. PP 4-6 d, AP 3-8 d. 6 generation/year.

Infestation is favoured by poor irrigation, absence of rains, high temperature and low humidity.

**Damage:** After hatching larvae hangs down by thread and get into the leaf sheath at the bottom.

**Symptoms:** Caterpillar bore into the growing stem and kills the young plant causing "dead heart", if ignored later becomes internode borer, which borer the stem at internodes. It exhibit the symptoms like –

- Presence of entrance hole at the ground level
- Deadhearts which can be easily pulled out.

#### Management:

1. Removal of dead heart, egg masses and destruction.
2. Trash mulching which is not only checks the population but also conserve the soil moisture and adds the organic matter to the soil. Mulching should be done at 3 DAP.
3. Planting in deep trenches reduces the borer incidence.
4. Adjusting the planting dates to avoid peak oviposition minimum incidence is in November and December planting. Maximum incidence is in January and February planting.
5. Quick growing varieties escape heavy infestation – Attack will be more in thin varieties than in thick one.
6. Set treatment with 0.1% chlorpyrifos.
7. Light earthening up of soil upto 4-6 week old crop to make stem in accessible to larvae followed by frequent irrigation.
8. Installation of light trap.
9. Release of egg parasitoid *Trichogramma minutum*  
*I. Australicum* (Good response and gave prominent control)
10. Resistant varieties: Co312, Co421, Co661, Co917 & Co853
11. GV  $1.1 \times 10^5$  twice on 35 & 50 DAP (Granulovirus).
12. Tachinid parasite: *Sturmiopsis inferens*
13. ETL – 15% dead heart.

**2. Internode borer: *Chilo sachariphagus indicus* (Crambidae : Lepidoptera):** Its infestation is more under low temperature and high humid condition.

Moth is small, straw coloured, Fore wing have a marginal dark line and hind wing are whitish. Scale like egg masses are laid in sheath or leaves. Each mass containing 9-11 eggs in two rows. IP 5-6 days.

Larva is white larva with 4 violet longitudinal stripes and light brown head. LP-37-53.

Pupation: Leaf sheath, PP-8 days. TLC-50 d.

**Damage & Symptoms:** The larva usually attacks sugarcane late in its and enter the stem. The tissues turn red and entry hole is plugged with excreta. Entry is generally confined to first five internodes. Affected internodes become thinner, constricted and shortened with number of bore holes and fresh excreta in the nodal region.

**Management:**

- Collection and destruction of egg mass
- Inundative release of egg parasite *Trichogramma australicum* @ 50,000/ha/week. *T. chilonis* @ 2.5 lakh/ha 6 release (4<sup>th</sup> month onwards).
- Resistant varieties CO975, CO7304, COJ46.
- Detrash at 150 & 210 DAP to dislodge the pupae which are present in leafsheath.
- **Larval parasitoids:** *Stenobracon deesae*, *Xanthopimpla nursei*, *Apanteles flavipes*
- **Pupal parasitoids:** *Tetrastichus ayyari*, *Trichopilus diatraeae*, *Xanthopimpla stemmator*

**3. Top shoot borer: *Scirpophaga excerptalis* (Crambidae : Lepidoptera) (= *S. nivella*)**

Moth is medium sized, creamy white, slightly bigger than early shoot borer. In case of certain male, each of the forewing has a black spot. Female has tuft of crimson coloured hairs at the tip of abdomen. Adult lay 250-300 dull white elongate overlapping eggs near midribs. The eggs are covered by buff coloured hairs from female and tuft. Each cluster is having 9-79 eggs. IP 7-9 d. Larvae is smooth, white/cream coloured with a red coloured mid-dorsal line and yellow head. LP 4-5 weeks. Pupation inside the stem. PP 7-10 days. TLC 40-62, 7 generation/year

**Damage and Symptoms :** Activity of the top shoot borer starts with the onset of monsoon rains in the north. Low humidity is unfavourable for pest. Caterpillar first borers into the stem from top by tunnelling into the midribs of leaves. From the midrib it tunnels towards the central core of leaves and enters the shoot to feed. As a result of biting across the spindle a row of shot holes are formed.

- A number of shot holes on affected leaves due to biting across the spindle.
- Reddish brown dead heart that can be easily pulled out.
- Interference with apical growth gives rise to side shoots and bunched top symptoms.

**Management:**

- Resistant var: Co419, Co745 & Co6516
- Tolerant var: Co859, Co1158 & Co7224
- Collect and destroy egg mass
- Ichneumonid parasitoid – *Isotima javensis* @ 100 pairs per ha (pre pupal parasitoid) (Release during November and December in Adali sugarcane is found successful).

**Egg parasitoid**

- *Telenomus beneficiens*
- *Tetrastichus schoenobi*
- *Trichogramma minutum*

**Larval parasitoid:** *Goniozus indicus*, *Chelonus* sp.

**Pupal parasitoid:** *Tetrastichus ayyari*

**4. Pink borer: *Sesamia inferens* (Noctuidae : Lepidoptera):** It is a pest of Ragi, Maize, Jowar, Caterpillar are attacking the cane and causing dead heart.

**Other borer**

**6. Stalk borer or tarai borer: *Chilo auricilia* Bessetia (=Acigona) *Steniella* (Crambidae : Lepidoptera):** Serious in some parts of UP, Haryana, Punjab and Rajasthan.

**7. Plassey stem borer: *Chilo tumidicostalis* (Crambidae : Lepidoptera)**

**II. Sucking pest**

**1) Sugarcane leaf hoppers: *Pyrilla perpusilla* (Lophopidae : Hemiptera):** Adult is soft, straw coloured with head pointing forward as snout. Wings are gable shaped at rest. They are folded over the abdomen like hood : they are densely veined and transparent. Eggs are greenish yellow, and laid generally on undersurface of leaves. The eggs are covered with white cottony waxy filaments. 10-15 eggs are found in a cluster. A total of 300-500 eggs may be laid by female.

Young ones are pale brown colour and possess a pair of characteristic long wax coated and processes. These processes bend forward and cover dorsal region at rest. When disturbed they set back and jump.

**Damage and Symptoms** : Both nymph and adult suck the sap from underside of leaves and devitalize plant. In severe case leaves dry up and plant is stunted. Due to sucking sucrose content of plant is adversely affected. It also secretes the honey dew on which sooty mould develops.

The pest generally found from August-September. Mild winter followed by mild summer with some showers help the survival of overwintering population and multiplication. Failure of monsoon cloudy weather and late action of parasitoid *Epicicania* favours the rapid multiplication of pest.

- Heavy manuring and irrigation and luxuriant growth also profuse the multiplication.

**Management:**

- Set up of light trap
- Detrash at 150 and 210 DAP
- Release of lepidopteran (*Epipyropidae*) ectoparasitoid.

*Epicicania melanoleuca* @ 4000-5000 cocoons or @ 4-6 lakh eggs/ha to check its multiplication.

- Predator: *Brumus suturalis*, *Chilomenes esexmaculatus*, *Coccinella septempuncta*

**2) Mealy bugs: *Saccharicoccus sacchari* (Pseudococcidae : Hemiptera)**

Small pinkish oval insects and covered by white waxy powder. The females are sac like with clearly segmented body. Males are winged but rare. The female deposits about 1000 eggs covered with white waxy or mealy mass in the nodal region. Egg hatch within few hours and newly hatched nymphs move rapidly for sometime, select a place on plant and settle.

**Damage and Symptoms** Both nymph and adult persist on plants and suck the cane juice from growing cane and results in reduction of plant vigour and growth, It also excretes honey dew on which sooty mould develops. The pest population builds up under drought conditions. Ants help in their dispersal to a large extent and they live in symbiotic existence.

**3) White fly: *Aleurolobus barodensis*, *Neomeskellia bergi***

	<i>Aleurolobus barodensis</i>	<i>Neomeskellia bergi</i>
<b>Adult:</b>	Pale yellow body with hyaline wings dusted with waxy bloom	Wings are translucent and pale brown with black bands on wings
<b>Nymph:</b>	Neonate nymphs are pale yellow in colour, flat and oval shape later turn shiny black and its body is surrounded by fringes of waxes.	Oval in shape and brownish in colour and their body surrounded by white wax.
<b>Eggs:</b>	Eggs are laid along midrib stalked eggs	Eggs are laid in circle

**Damage and Symptoms** : Both nymph and adults suck sap from leaves which dry up and characteristic yellow streaks appear along the length.

The Sugarcane crop raised in low lying, water logged areas and in semi dry alkaline soils suffers more due to whitefly. Infestation is seen from August-October. Due to infestation, cane juice becomes more watery and jaggery (gur) quality is adversely affected.

30-40% loss in sucrose and 20-25% loss in total solids. 15-20% loss in yield and 1-2 units loss in sugar recovery.

**4) Sugarcane scale: *Melanaspis glomerata* (Diaspididae : Hemiptera):** It is distributed in Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh and Maharashtra.

Adults are greyish black in colour, irregularly oval and slightly convex in shape. Female are flat and pyriform shape. The males are winged and smaller in size but are rare. The adult female is ovoviviparous.

The nymphs that hatch inside female come out through the genital aperture (Crawlers). Crawl about sometime and settle down after selecting suitable spot, preferably on the internodes. Freshly hatched crawlers are tiny and light yellowish in colour. They remain stationary all through their life if they are females.



**Damage and Symptoms** : Both Nymph and Adult suck the sap and devitalised plant the pest commences from formation of internodes and continues to increase as plant grows. Shrivelled cane become with shortened internodes. Formation of shiny thick encrustation on the cane, maximum on bottom and middle of the cane.

**Management:**

- Co-7706 – moderately tolerant to scale.
- Detrashing basal 4-5 internodes when shoot have atleast 6-8 internodes.

**5) Woolly aphid: *Ceretovacuna lanigera*:** A new pest to Karnataka invaded from Maharashtra, caused panic during 2002 and causing menace throughout state especially Bijapur, Bagalkot, Belgaum dist. It was reported during 1897 in Java, then reported from Bangladesh, China, Fiji, India and other countries

**Adult:** Two forms of adult viz., apterate and alate occur. Alate forms predominantly white in colour. Apterate often possesses crenulated margins of wax glands in rows. Such waxglands are absent in alate. It reproduces parthenogenetically.

**Nymph:** Alate nymphs yellowish white in colour with less powdery substance. White waxy woolly coating is covered over the body and they have no protruding cornicles.

**Damage and Symptoms** Both nymph and adult suck the sap from foliage as well as from cane leading to drying and withering of cane. The plants become stunted and lot of honey dew secreted on the foliage on which sooty mould develops.

**Natural enemies:**

1. **Dipha aphidivora:** Pyralid predator, it feeds upto 300 aphids/day and 1000 in its life, (Pralidae : Lepidoptera).
2. **Micromus igoratus:** Brown lacewing, adult and larvae predominant in field. Released @ 1000-2000/ha or cocoons are also released. (Hemeroptera : Neuroptera).
3. **Syrphid fly:** Maggot feeds on aphid.
4. **Fungus:** *Acremonium zeylicum* is also found effective

**Cultural practice:**

- Apply low 'N' and high 'K' to the crop
- Wide spacing
- Alternate row of irrigation

**Resistant varieties**

- Core-2003 – 165
- SNK – 44, 61 & 754

**Chemical measure**

- Application of phorate 10G @ 25 kg/ha / Carbofuran 3 G @ 20 kg/ha.
- Dipping of cane setts in Chlorpyrifos @ 2ml/l before planting.
- Spray of Malathion @ 2ml/l, Chlorpyrifos @ 2ml/l, Acephate @ 1 g/l, Thiomethoxam @ 0.25g/l, mix stickol @ soap powder @ 2g/l to above mentioned insecticide.

**III. Soil pests:**

**1. White grub / Root grub / May-June beetle: *Holotrichia consanguinea*, *H. serrata* (Melolonthinae : Scarabidae : Coleoptera)**

Root grub is polyphagous pest, feeding on roots of wide range of plants like pulses, groundnut, sugarcane, vegetables etc.

Adults are dark brown/reddish brown large sized stout beetle with *Lamellate antennae*. Adult is fully developed by end of November and remains in pupal cell. Adult hibernates till early showers of rain are received. They emerge immediately after first rains in May/June. Therefore they are called as May beetle/June beetle. These are nocturnal in habit and adults emerge during evening at 7.30-8 m/dusk time, mate and feed on leaves of trees viz., neem, drumstick, subabul etc. and early in the morning get back and burrow into the soil and lay the eggs and single egg per cell during May-July in soil at depth of 12-15cm. Incubation period is 8-13 days. Beetles are active during May-June months and disappear by first week of August.

Immediately after hatching grubs feed and develop on decaying materials and on roots of weeds. Grubs are smooth bodied scaabeiform, C shaped, white, measure around 3-4 cm found

in soil. These grubs feed on live roots of sugarcane between July-September and cause drying of plants. Adult hibernate. It is a major pest in adsali crop.

**Damage and Symptoms :** Grub feeds on roots and rootlets causing death of entire plant. Infestation is in patches but during epidemics entire crop in the field is wipe out.

### **2. Termites: *Odontotermes obesus*, *Microtermes obesi*, *O. assmuthi***

Termites/white ant are another destructive pest of sugarcane, omnivorous. They live underground of soil and attacking crop when sets are planted and continue till harvest of crop. They are mostly found light soil. Their attack is severe in red soils and where irrigation facilities are in adequate.

The termites damage the cut ends and buds of sets affecting their germination. Sets are completely eaten away leaving only the outer hard rinds. In attacked plants the outer leaves first show sign of drying and the attacked cane may out easily if pulled. The damage may cause 40-50% loss. Ultimately there will be reduction of yield and sucrose content.

species of termites have so far been recorded from India. Viz., *O. obesus*, *O. assumthi*, *O. probenes*, *M. anandi*, *Eremotermes nerapololis* and *Trinervitermes biformis*. These are morphologically different but habits, damage symptom are similar.

### **3. Sugarcane root borer: *Emmalocera depressella* (Carmbidae : Lepidoptera)**

The name root borer is misnomer, the pest actually feeds on stalk which is below the soil surface. Caterpillar bore at the base of the stem, which is very close to root. Although they donot actually bore into roots but since they do so near the soil surface they are called as root borer. Adult is small moth with pink head, brown thorax and abdomen, forewing and hindwing light yellow. Forewing possess light black longitudinal stripes.

**Damage and Symptoms :** It differ from stem borer that when plant is pulled, whole plant is comingout and it does not posses any bad smell.

#### **ETL for major pests**

- 1) Shoot borer: 15-22% DH
- 2) Internode borer: 17-28 bored internodes/6m row length
- 3) Stalk borer: 17 bored internodes/6m row length
- 4) Pyrilla – 3-5 in individuals/leaf
- 5) Top shoot borer: 5% DH

#### **Management practices**

##### **1. Cultural and mechanical methods**

- a) Time of planting: Early planting reduces shoot borer incidences – Autumn is avoided in stalk borer endemic area.
- b) Manuring: Avoid excess use of 'N' fertilize to minimise the incidence of stalk borer, internode borer, pyrilla and woolly aphid.
- c) Earthing up: To avoid ESB.
- d) Detrashing: @ 150 & 210 DAP to reduces activity of internode borer, stalk borer, scales and mealy bugs. White flies and as well as pyrilla.

**1) Mass collection of adult beetles of white grub:** White grub population may be suppressed by mass collection of adults through light trap or "bonfire" during nights at 8.30 to 10.00 pm after first shower.

##### **2) Vertical manipulation: (Utilisation of tolerant varieties)**

Eg: Co 62175 – Root borer, Co 6907, Co 671, Co 8014 – scales

##### **3) Biological control:**

- a) **ESB/Internode borer:** Use of *T. chilonis* 5 release @ 2.5 lakh/ha, *T. australicum* @ 50,000/ha.
- b) **Top shoot borer:** *Isotima javensis* – Tamil Nadu and Karnataka, this parasitoid eliminated the pest for past 3 decade with release of 125 ♀/ha
- c) **Pyrilla**  
*Epiricania melanoleuca* – effective in Harayana, UP, Gujarat and Maharashtra 4000-5000 cocoons or 4-6 lakhs eggs/ha.

#### 4) Pathogens

GV (Granulosis virus) – recommended in Tamil Nadu against seedling borer @ 106-107 inclusion bodies/ml + teapal @ 0.05% (0.5 ml/l) on 30<sup>th</sup> day and then at 15 days interval.

**For scales and mealy bugs:** Beetles like *Pharoscymnus horni* or *Chilocorus nigritis* @ 1500 beetles/ha has been recommended.

#### 5) Chemical control:

**ESB** – Chlorantraniliprole granules @ 8kg/ac.

**Top borer** – Chlorantraniliprole 18.5 SC @ 0.3 ml/l

**Top borer** - Fipronil 5 SC @ 1 ml/l.

For scales / Mealy bugs / Whiteflies / Pyrilla

Malathion @ 2 ml/l, Monocrotophos @ 1.5 ml/l, Chlorpyrifos @ 2 ml/l.

#### Soil pests (IPM for Rootgrub/Termite)

- Remove stubble and debris of previous crop.
- Dig the termatoria and destroy the green.
- Ploughing 4-6 times immediately after first shower.
- Setup of light trap at 7.30 to 8.30 PM after first monsoon shower to collect the adult beetles.
- Dusting of malathion on twigs of Guava, Neem, Accasia, and shaking of branches of trees.
- EPNs can be sprayed @ 100 million nematode/ac in root grub and termite infested sugarcane field or EPN infected cadavers of *Galleria/Corcyra* larvae containing live infective juveniles (IJS) are implanted in soil at plant bases @ 4 cadavers/plant during May-June and / or September for sugarcane root grub.
- In June-July – *Metarhizium anisopliae* @ 4.8 kg/ton of FYM should be applied.  
*M. anisopliae* drenching 200g + Jaggary 2 kg + 200 g of chickpea flour. *Bacillus papillae* – Dume.
- **Chemical method:**  
**For termites:** *Chlorantraniliprole* 18.5C @ 0.3 ml/l or  
*Clothianidin* 50 WDG @ 0.25 g/l.  
*Imidacloprid* @ 0.5 ml/l or  
*Chlorpyrifos* @ 3 ml/l

#### For white grub:

(Lassenta) Fipronil 40% + Imidacloprid 40% @ 0.4 g/l.

- Puddling of field and keep fallow as it is for some times in rice.
- In sugarcane crop rotation ē paddy.
- All along sugarcane field plant paddy and provide sufficient irrigation.
- Trap crop ē widely spacing crop like French bean, field bean, maize, after trap crop follow the fall ploughing to destroy grub.

#### Pests of Tobacco

1. **Tobacco caterpillar/Tobacco cutworm:** It is polyphagous and found tropical and subtropical parts of the world. Alternative hosts are cotton, castor, groundnut, tomato, cabbage and other cruciferous crop. Moth is medium sized and stout bodied with forewings pale grey to dark brown in colour having wavy white cross markings. Hind wings are whitish with brown patches along the margin of wing. Nocturnal in habit. Female lays about 300 eggs in clusters and covered by brown hairs, IP 3-5 d.

**Damage and Symptoms** 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 leaves and finally leaving only veins and petioles.

- Irregular holes on leaves initially and later skeletonization of leaves.
- Heavy defoliation, leaving veins and petioles.

Caterpillar velvety black with yellowish – green dorsal stripes and lateral white bands with incomplete ring-like dark band on anterior and posterior end of the body. LP-15-30 d, 6 instars, Pupation – soil, PP-7-15 d. Adult live for 7-10d, TLC-32-60d. 8 Generation/year.

#### Management:

- Collection and destruction of infested plant parts.
- Collection and destruction of egg mass and gregarious larvae.
- Setting up light traps.

- Installation of pheromone trap @ 12/ha for monitoring.
  - Spray of SINPV @ 250 LE/ac \* *N. rileyi*.
  - Grow castor as “oviposition trap crop” in nursery and even in main field.
  - Release of egg parasitoid: *Trichogramma* @ 50,000/ha/week for 4 times.
  - **Poison bait:** 50 kg rice bran + 625 ml Monocrotophos + 4 kg jaggary + water (6l) – 48 hrs.
  - **ETL** – one egg mass/10 plant.
  - Spray of thiodicarb @ 1g/l, or quinalphos @ 2.5 ml/l, acephate @ 1.5 g/l, Novaluron (Rhiman) @ 1 ml/l, Lufenuron (Cigna) @ 1ml/l, Interprid (Chlorofenpyr) @ 1 ml/l, Emamectin benzoate @ 0.25 g/l.
2. **Tobacco Aphid: *Myzus persicae*:** Adult aphid is small to medium sized, green with darker thorax. They reproduce both sexually and parthenogenetically, latter is more common. Nymphs undergoes 4-5 instars, taking 4-7 d for apterous and 5-8 days for alate form. Apterous adults produce 5 to 92 young ones/females while alate forms produce 8 to 49 nymphs. More young ones are produced during mid winter (Jan-Feb). Adult longevity is 15 to 27 days for alate and 10 to 25 days for apterous forms.

**Damage and Symptoms :** Aphids infest crop late in season. Both N & A feed on leaves and shoots in large number suck sap and devitalizing the plant which results in

- Sicky appearance of plants
- Leaves curling up and feeding
- Sooty mould develops on honey dew excreted
- Tobacco ring spot virus and rosette virus disease transmitted by this vector.

**Management:**

- Natural enemy, *Praon myzophagum* parasitizes aphid .
- Spray of neem oil 2% or NSKE @ 5%.
- Spray of methyl demeton @ 2ml/l, Dimethoate @ 2ml/l, acephate @ 1.5 g/l.

3. **White fly: *Bemisia tabaci***

Nymphs and adult suck the sap from under surface of leaves, leaves with watersoaked, irregular yellow patches, leaves become curled and twisted with thickened veins. **It is vector of Tobacco leaf curl and tobacco mosaic virus (TMV).**

**Management:**

- Avoid growing of brinjal and sunflower in the vicinity.
- Setting up of yellow sticky trap @ 12/ha.

4. **Tobacco stem borer: *Scrobipalpa heliopa* or stem gall former**

Adult is small dark colour brown moth, lays eggs on leaves. Caterpillar slender, whitish dark headed. Caterpillar mine into the midrib of leaves and then into stem. The mined leaves show blotches, stem bored with big hollow tunnels and causes galls at stem.

**Management:**

- Avoid planting seedling with gall
- Removal of affected plants

5. **Tobacco bud worm/Capsule borer: *Helicoverpa armigera***

Caterpillar bore the terminal shoots, buds and capsule resulting 20-30% loss.

6. **Mirid bug or tomato mired bug: *Cyrtopeltis tenuis* (Miridae : Hemiptera)**

Nymph and Adult of these small green elongate bug suck the sap from tender portion of the plants.

7. **Other pests**

- Semilooper – *Plusia signata*
- Leafhopper – *Empoasca tobaci*
- Cutworm – *Agrotis ipsilon*
- Thrips – *Thrips tabaci*

## Study of Stored grain pests

### PEST OF STORED GRAINS

Stored grains are usually affected by Excess moisture which develops fungi, presence of insects and rats. Around 7-8 % of the stored food grains are lost due to these factors. Excess moisture and mould results in deterioration of quality whereas, insects and rats feed on stored products and account for serious loss. The important insect pests seen in storage are a detailed below.

-Pest of store can be classified in two ways

1. Importance: 1. Major pests 2. Minor pests
2. Feeding habit: 1. Internal feeder: Feed inside the grain. 2. External feeder: Feed outside the grain. 3. Secondary pests: Feed on the leftover materials of primary feeders.

II method of classification is most popular

I Internal Feeder:

Here the feeding by adults or larvae internally, keeping entirely inside the grains/ kernels

#### 1. **Rice weevil** : *Sitophilus oryzae* (Curculionidae : Coleoptera)

Weevils are dark brown with extended snout. Elytra has 4 reddish/ yellowish spots. Female makes a small hole on the grain and deposit an egg and cover it with gelatinous fluid. The grub is apodous, feeds inside and pupate inside. The adult emerge out by making on irregular hole on grains. Insect feed both in storage and in field also. It attacks, Jawar, wheat, barley, Rice, maize etc.

#### 2. **Lesser grain borer**: *Rhyzopertha dominica* (Bostrychidae : Coleoptera)

Beetles is dark brown, head bent under the thorax, posterior abdominal end blunt, Antennae serrate 3 segmented. Grubs develop within kernels and adult emerge from grain. It is particularly pest on unhusked paddy, also attacks wheat jawar and other cereals.

#### 3. **Pulse beetle**: *Callosobruchus chinensis* (Bruchidae : Coleoptera)

**Other species**

*B.analis B facioli and B.attocalbus*

Small dark brown beetle, rounded abruptly in the posterior region, white oval eggs are laid on the grains (Pulses). The grub hatch and gain entry into grain and feed inside and pupate inside and adult hatch. It cause appreciable damage on all the pulses like, cowpoa, Redgram, Greengram, Bangalgram etc.

#### 4. **Angoumois grain moth**: *Sitotroga cerealella* (Gelechiidae : Lepidoptera)

Yellowish white moth, uniformly grey pointed hind wings with fringes of wings, pale fore wings, larvae feed on the internal contents of grains and pupate inside the grains inflicts severe damage to unhusked paddy it leaves a small hole. Also attack ripening grains of paddy, jawar and Ragi in the standing crop as well as in storage.

#### 5. **Potato tuber moth**: *Pthoromaea operculella*

(Already covered in tuber crop- potato)

#### 6. **Tamarind beetle**: *Caryedon serratus* : (Bruchidae : Coleoptera)

A major pest of groundnut in this region which feeds on stored ground nut pods. Adult is 4-7 mm long, reddish brown, with dark irregular marking on the elytra. It can be easily distinguished from other store pests by its broad hind femur with conspicuous spines.

Adult lays eggs on pods/ kernels, the grub burrows through the pod wall to reach kernel and cause damage. Pods lose their value, become unfit for consumption to human or for sowing. It is actually a pest on Tamarind and feed on G.nut pods.

**7. Drugstore beetle:** *Stegobium stegobium panicea* (Anobiidae : Coleoptera)

Reddish brown small beetle with striated elytra and clubbed antennae. Grub is pale white, fleshy with abdomen terminating in two dark horny pointed. It tunnels into stored products like turmeric, ginger, coriander and dry vegetables and animal matter circular pinhead sized bore holes are seen on the damage materials.

**8. Citarette beetle/ Tobacco beetle:** *Lasioderma serricorne* (Anobiidae : Coleoptera)

Light brown round beetle with its thorax and head bent down words: gives the insect a humped appearance. Grub whitish hairy, feed on stored tobacco, ginger turmeric and chillies.

**B. External feeders:**

Unlike the internal feeders which gain entry into the grains these feed on the surface of the stored grains or their products or feed after the damage caused by primary internal feeders keeping outside the seeds.

**1. The red flour beetle:** *Tribolium castaneum/T confuciu* (Smaller) (Tenebrionidae : Coleoptera)

Elongate, small, rust red coloured beetles. Larvae is flat, dull yellowish, body covered with setae. Both grubs and adults are external feeders on broken grains, oil seeds, oil cakes, dried fruits nuts and processed food materials like flours atta, soji, maida etc. Presence of these pests imparts a bad smell to the commodity giving pungent smell.

**2. Indian mealmoth :** *Plodia interpunctella* (Phycitidae : Lepidoptera)

Moth has brown forewings with a white band, the larvae feed on grains, dry fruits etc.

**3. Fig moth:** *Cadra cautella* (Phycitidae : Lepidoptera)

Grayish fore wings, small moth. Larvae webs together the grains and feed on them. It attacks stored grains cashew, ground nut, wheat etc.

**4. Rice moth:** *Corcyra cephalonica* (Galleridae : Lepidoptera)

Grayish brow moth, caterpillar webs together the grains with silk and feed within the galleries. It attacks broken grains and flour specially milled products. Larvae is creamy white feed on Jawar, Rice, maize, soji, oilcake, dried fruits etc.

**5. Khapra beetle:** *Trogoderma granarium* (Dermestidae : Coleoptera)

Beetles are reddish brown to black, oval shaped with clubbed antennae. Larva yellowish brown covered with long brown hairs, feeds on many kinds of grains, veg-products and animal products specially on wood and silk.

**6. Black carpet beetle:** *Attagenus piceus*: It is black with a yellow band in the centre of elytra, grubs hairy with long hairs on abdominal tip.

**Secondary pests and scavengers**

The larvae and adults stages feed on materials which are out of condition and damp. Usually attack the left over materials of damaged grains by internal and external feeders.

1. **Saw toothed grain beetle:** *Oryzaephilus surinamensis* (Cucujidae : Coleoptera)  
 Small, slender dark, flattened beetle, which has a row of saw like sharp teeth on each side of the prothorax. Feeds on grains, dried fruits, etc. by scraping on the grain surface or burrowing. Generally it does not cause much damage. It also feeds on the waste material products formed by the primary feeders.
2. **Long headed flower beetle:** *Latheticus oryzae* (Tenebrionidae : Coleoptera)  
 It occurs as a secondary pest in stored wheat, jawar etc. Beetles are light reddish and resemble red flour beetles.

### **Management of stored pest:**

#### **Preventive methods**

- Before storing clean the rooms/ godowns/ containers and make free from any type of insect infestation.
- Disinfect the containers or rooms by spraying Malathion 2ml/l or DDVP 0.03%
- Material stored should be clean well dried in sunlight
- Excess moisture in the grains >10% should be available, which leads to development of mould and insects, spoil the grains by caking therefore, moisture should be less than 10%.
- Bags and bins should be made damp proof by providing damage of bamboo poles/ bamboo mats/ wooden crates.
- Allow proper ventilation to room and stored bags.
- Periodical inspection is a must.
- Spray Malathion 2ml/l on the gunny bags.
- Store pulse by treating with edible oil @ 5g/kg of seeds.
- Add neem leaves in the stored grain as layer and mix in grains
- Avoid storing new produce with old stored materials
- Regular inspection of stocks for the presence of pest is a must use aspirator for pulses as mixture use sweet flag Rhizome powder 1-2%.

#### **Curetive measures**

- If the infestation is seen during regular inspection, the stock should be removed, sundried and cleaned.
- If heavy infestation is noticed it should be fumigated. Fumigation may be entire store house/ godown or cover fumigation.
- Entire store house fumigation may be done by closing all window, ventilators and other holes made for aeration purpose and sealed. Then required fumigant may be used.
- For the cover fumigation individual stake may be covered with polythene cover in the godown/ even outside godown and seal all round after inserting the fumigant, mud pasting is done all round.
- Allow for fumigation up 7 days and then remove the cover to allow the gas to move out.

**Fumigant requirement:** Al. Phosphide – Tablet – Available in 3g

For cover fumigation – 3 to 4 tablets of 3g/ tonne of grain (1gm/qt)

For shed/ godown – 1 tablet of 3g/ 4m<sup>3</sup>

Allow it for min of 5 days and max. of 7 days

- EDB ampoules -3ml/qt grains or 22gms/cmt space expose to 7 days
- EDCT – 50ml/ qt or 1lit/ 3m<sup>3</sup> space.

Caution: Oil and flours should not be fumigated.

## **Principle of grain storage**

The important objectives of storage are

1. To avoid damage by insect
2. To avoid deterioration in nutritive value of stored grain
3. To avoid the effect on germination quality.

To achieve these objectives is bit difficult but efforts should be made for better storage facilities. In India storage is done by two means.

1. Underground storage:
2. Above ground storage

### **1. Underground storage:**

The method of storing grains underground is common in almost all villages of our country which is calling "Khatties". These structures are nothing but the pits dug in the ground that could measure up to 5m deep and 5m diameter with a narrow circular opening on the top which is closed with stone and mud plastered.

The size of the pit varies depending on convenience of farmer based on the volume. Inside these Khatties the sides of wall is separated from grains with the dunnage materials like straw of paddy, Jawar, Bajra, maize etc. These structures are not suitable where ground water level is high and seepage problems are there in low lying area.

### **2. Above ground structure:**

Several methods are available to store grains above ground in our country. They are

#### **i. Kothas or Khothis:**

These are above ground structure in vogue in parts of U.P Bihar, Punjab, Rajasthan, Karnataka etc. These are normally built inside the dwelling houses with clay. They are oval in shape with a lid on top to put the grains inside and a small hole to remove grains at the base. Size depends on the availability of space. These may be constructed outside in open and provided with athatching roof.

**ii. Mud bins:** Oval chimney or box shaped mud bins with a sealed lid and small hole near the base. These are raised above ground by small wooden pillers or column of bricks

**iii. Pukka bins:** These are made with bricks and cement plastering. They may be single or multiple units in rows with common shelter above.

#### **iv. Pusabin:**

Designed by IARI, built by sun dried two brick wall with polythene sheet sandwiched in between. Structure is constructed on a brick masonry plat form plastered with cement. Amud slab or a wooden structure is provided on top with polythen sheet and also in the base to make the structure fully moisture and air tight.

#### **v. Domestic store drums:**

These are galvanised iron sheet structures, cylindrical with a lid on the top. Generally used in urban homes for storing few quantels of grains.

Empty mobile oil/ lubricant oil drums are used by painting inside.

#### **vi. Miscellaneous structure:**

Several varieties of the above structure are used in different parts of the country whose size, shape and materials differ according to their availability and need.



1. **Bukheris** : (Orissa, Bengal, Bihar, TN, Assam)  
Built on raised platforms with a bamboo frame plastered with mud mixed with straw
2. **Puras**: (Bihar, Bengal, Punjab, TN)  
These are built only with straw and used primarily for storage of paddy. Straw ropes are made and surrounded to some support making a cylindrical structure.
3. **Morai** : (Bihar parts of Bengal)  
These are built on a solid platform of earthen or masonry with ropes and straw. The grains are first poured around which a morai is gradually fashioned with straw kept in position by encircling ropes, the top is thatched
4. **Pallis**: Used in Punjab made up of date palm material rolled and tied around a masonry platform to stand erect in the form of a cylinder and provided with thatched roof. In all these grains remain well ventilated and free from infestation.
5. **Bamboo cylindrical structure**: Made of bamboo mat into a cylindrical structure. Pasted with mud all around besides and inside of structure.
6. **Godown storage**: In godowns generally gunny bags are stored providing dunnage materials.
7. Modern elevators

### **NON INSECT PESTS**

1. Mites
2. Rats
3. Crabs
4. Snails
5. Birds
6. Vertebrates

#### **Mites**

Belonging to order; Acarina class Arachnidae

These are found everywhere like insects and also few on plants and cause loss to the crops. The phytophagous mites belong mainly to the families; Tetranychidae Tarsonemidae and Eriophyidae. Mite round, possess 4 pairs of legs but in early instars they possess 3 pairs. Eriophyid mites are different from other mites (Acarina) where they have vermiform body distinctly divisible into a cephalothorax and a long tapering body. Only two pairs of legs situated near anterior body. They possess biting piercing and sucking mouthparts.

Life cycle of Tetranychid mite include egg, 3 nymphal instars and adult stage: The nymphal stages 3

- I. Protonymphal – Larva with 3 pairs of legs
- II. Deutonymphal
- III. Tritonymphal

Eriophyid mite has only two nymphal stages,(instars) which are not different from adults.

-Recently mite species are emerging as major pests due to heavy use of insecticides specially organochlorine pyrethroids killed predatory insects and outbreak occurred.

#### **The symptoms produced by various mites.**

1. Suck cellular materials: Form characteristics white blotches on leaves construct by webbing of feeds. Eg: *Tetranychus* sp.
2. Eriopyid mite: Cause deformities in plants, produce out growth. Eg: *Aceria gossypii* – Excessive hairs on cotton Jasmine- outgrowth for which thick patches on leaves mango mite- crowded buds and galls, malformation of flowers and fruits.  
Few are known to transmit – diseases  
*Aceria cajanae*: Sterility mosaic disease in Redgram  
*A. tulipae* – wheat streak disease  
Several miticides are available Wettable sulphur, Dichofol, Phosmet, Polo, etc and some insecticides also act on these mites.

### Some examples

1. **Jawar mite:** *Oligonychus indicus*
2. **Redspides mite:** *Tetranychus neocaledonichus*
3. **Rice mite:** *Oligonychus oryzae*
4. **S. Cane mite:** *Schizotetranychus andropogoni*
5. **Citrus leaf mite:** *Eutetranychus banksi*
6. **Coconut mite:** *Raoiella indica* ; *Aceria guerreronis*
7. **Jasmine eriophid:** *Aceria jasmine*
8. **Chilli mite:** *Polyphagotorsonemus latus*
9. **Redgram mite:** *Aceria cajanae*
10. **Mango mite:** *A.mangiferae*

### RATS

These are most destructive pests in field as well as in houses. Number of crops are affected by these rats specially in paddy they cause loss to the tune of 5-10%. It has been estimated that about 2500 million rats (>100 million human population) in our country. Rats damage crop in the field as well as hoard these seeds in the burrows. Of the several species of rats 4 species are important on cultivated crops in field.

Mole rat/ field rat – *Bandicota bengalensis*

Grass rat – *Millardia melitana*

Gerbil rat – *Tatera indica*

Indian field mouse – *Mus booduga*

**Management:** Difficult but some methods can be followed

1. Fumigation/ baiting with Zn. phosphate – 1 part Zn. phosphate + 9part bait
2. Bow trapping: Local in hoses.
3. Irrigation
4. For coconuts – Tin sheet banding
5. Allow snakes to live
6. Rearing
7. Rat hit- a cake available in market from Rallis warfarin 0.5 % bait

### CRABS

**Rice field crabs:** *Paratelphusa hydrodromus*

F: Decapoda

O: Crustacea

They live in holes on the side of bunds and irrigation channel. Young seedling in nursery and newly transplanted ones in the main field are damaged. Seedling are cut at ground level into small pieces and carried to holes for feeding. In the later age of crop take only inner tender portion. The waste can be seen floating. In addition to damaging crop the hole made leads to breaches and loss of water in the field.

- Crabs can be managed by trapping using wide mouthed pots buried with rim at about water level.
- Inside the pot moistened rice bran (kneaded) made into large lumps are used as bait- 10pots/ha is sufficient along with warfarin in popped rice mixed with fried onion and fish bait can be used.
- Use of carbofuran/ phorate

### Millipedes

Brownish black coloured, Adults and Juveniles have been observed to feed on tender germinating seedlings of chilli, cotton, coriander, blackgram, onion, sunflower, Jawar etc.

Eg: *Tinostreptus* sp., *Condromorpha* sp.

*Phyllogonostreptus* sp., *Gonoplectus* sp.

*Streptogonopus* sp. etc

### Management

They can be easily collected and killed in kerosene water

Baiting with – Carbaryl -10% - Jaggery – 2%- Rice bran – 10%

### Snails

Common garden snail: *Helix* spp. *Opeas gracilis* (Green house)

Giant snail: *Achatina fulica*

Native of east Africa and established in many countries. These are active during rainy season. During night they come out from hiding places and destroy crops. These are found usually in dampy areas where moisture is always available with high organic matter.

### Management

- Manually they can be collected and killed
- Among the chemicals metaldehyde is most effective as “snailkill” effective as molluscicide, 5% pellets of this compound are spread over field. It acts as a specific attractant toxicant. It is toxic by ingestion and absorption by foot.

Eg: *Limex* sp.

*Arion* sp. } Found on various crops

### Birds

Number of birds feed up on the earheads in field and on several fruits and vegetables. Since they feed partially on grains and fruits they spoil more than they feed. Important bird seen as pests are

1. The crow: *Corvus splendens*: Damage wheat, cobs of maize, fruits, figs, guava, banana etc.
2. Parrot: *Psittacula krameri*  
It cuts and feeds upon maize, jawar, sunflower, wheat etc. and fruits like Guava, fig, mango and pomegranate. Both ripe and semiripe fruits are cut and feed upon.
3. House sparrow: *Passer domesticus*  
Distributed throughout India and damage wheat, jawar, maize and Bajra and fleshy fruits. Birds damage can be prevented by

- Scaring away
- Mechanical catching
- Brumming
- Using shining red and white ribbon: They are tied to plants here and there or across the field. due to shining and the sound produced they are scared.
- Use any of the insecticides with preferred grains: Malathion, methyl Parathion are used

**Other vertebrate pest:** Among several vertebrate pests.

1. Monkey: *Macaca mullata* :They visit gardens and cause damage
2. Jaekal : *Canis* sp. Nocturnal in habit and damage maize, sugarcane, melons, groundnut etc.
3. Bats: *Pteropus edwardsii*: Mainly cause damage to coconuts, they also feed on some fruits like mango, guava, ber etc.
4. Pigs: *Histrics indica*: For all these no suck species control. Last resort is shooting
5. Squirrels: Five striped palm squirrel: *Fenambulus pennanti*  
Three strips palm squired *F. palmarum*  
Predominant in South India, feed on fruits, seeds, veg. crops but are severe in fruit gardens.
6. Indian crested porcupine: *Hystrix indica*  
It is covered with quills of deep brown to black and white alternating bands. A long crest of bristles is present on the head and rattling quills on its short tail.  
Deers, Elephant and others also cause loss to crops.

## LOCUSTS

Literal meaning of locust is “plague”. These are grass hopper of the order Orthoptera belonging to family Acrididae since time immemorial certain species of short horned grasshopper have acquired the name locust. Such species congregate in large number as nymphs and swarms to fly long distance adults destroying vegetation on their way. Those do not have this ability are simply called grasshopper.

Thus “all locusts are grasshopper but all grasshopper are not locusts”. Of the total 5000 species of grass hoppers in the world, there are some 11 species/ sub species are recognised as locusts, of which 3 species are found in our country, they are

1. Desert locust: *Schistocerca gregaria* : Pak, Arab, N. African countries
2. Migratory locust: *Locusta migratoria* : Europe, Africa, Pakistan, Australia, E and S Asia
3. Bombay locust: *Patanga succincta*. Sri Lanka, Malaysia

### I. Desert locust: *S. gregaria*

Most destructive of all locusts, it invades 30 million square kilometer area, spreading over 60 countries from the West and North Africa to Assam in India and is 50% of this area breeding can occur.

The adults of this species, occurs in two phases

1. Solitary phase or solitaria phase: Insect remain scattered.
2. Gregarious phase or gregaria phase: Insect congregate as nymphs and swarm as adults.

Both hoppers (nymphs) and adults of these phase differ ,markedly in colour, behaviour and certain anatomical features. Solitaria: nymphs green, no black marking, adults greenish or grey throughout.

## LIFE CYCLE:

- Single female lays about 500 eggs in about 5 egg pods deep in soil about 2-4" depth. After laying eggs secrete a frothy substance which becomes hard after exposing to air forming water proof pod.
- As many as 5000 eggs may be laid in 1m<sup>2</sup> area which is recognised by the presence of pencil diameter holes.
- Eggs : Resemble rice grain in colour and shape with 7-9 mm long
- The summer breeding occurs during June – Sept, monsoon, in the desert of Gujrat and Rajasthan and Sindh in Pakistan
- While the winter breeding occurs during Jan- March (Spring) in Baluchistan (Pak), Arabia and Iran.
- Since breeding depends on rains, there is migration of summer brood to winter breeding ground and winter brood to summer breeding ground at the end of rains in these areas. The winds blowing during these times help in the migration from breeding grounds in Africa and India. If rains happen to be good during 2-3 consecutive years, locust outbreak is likely to occur in any one of the breeding grounds.
- **Host plants:** They eat all kind of vegetation except a few namely, yakka (*Calatropis procera*), neem, Dhatura, Jamun (*Psidium cumini*), sheesham (*Dalbergia sissoo*) and Anjeeer (*Ficus carica*)
- **Damage:** Both nymphs and adults cause damage when in swarm. They can cause immense destruction leading to famine. During 1926-31 the swarms estimated to cause damage to the tune of 100 million rupees, besides damaging forest, orchards and crop.
- Apart from this the nuisance when they get into the houses, climbing walls, beds and invading kitchen dead locust on railway lines and roads made them sticky and slippery so that traffic was made a halt.
- They fell into wells lakes and drinking water sources in millions making water unfit for use.
- An average locust swarm spread over 10sq km and a km of swarm may contain as much as 300 tonnes of locust. A swarm as large as of 300 sq km is on record.
- Record of outbreak: 1889 - Across red sea with 2000 sq miles
- 1869 – In England from W. Africa
- 19408 & 19508- Lasted for 10-15 years at list
- 65 countries of Africa and others.

## II. Migratory locust: (*L. migratoria*)

This occurs in Rajasthan and Gujarat an country. The distinguishing features are the absence of ventral tubercle and eyes strips, hind wings hyaline in the young and yellow in the old adult. It breeds twice winter – spring breeding occurs in Baluchistan (Pak) and summer – monsoon breeding in Rajasthan and Gujarath. Therefore, it may have many broods in a year. The swarms of this species was observed in India during 1878 in Madras, in 1954 in Bangalore and concentrated breeding occurred in Gujarat during Sept- Oct 1059.

## III. Bombay locust: *Patanga succincta*

Activities of this locust is generally confined to the area extending from Gujarat in the north to T.N in (Madras) in the south.

- Adult is smaller than the desert locust, bears an acute (pointed) ventral (Prosternal) tubercle, 8 eye strips and conspicuous yellow strips laterally on its pronotum. The fore wings have oblique dark markings and the hind wings become rose coloured basally after the insect has spent a month as a fledgeling. It breeds during monsoon in the western ghats and has only one brood a year. Its plague occurred during 1835-45, 1864-68 and 1901-08.

## Control measure

The control is carried out at every stage of its development. Eggs: the eggs are destroyed by the soil and collect the eggs for destroying.

Nymphs: It is the vulnerable stage for control and their stage can be managed by several ways.

1. Digging a trench around breeding ground, so that when the nymphs emerge, they are buried in soil or dusted with chemicals (Chlorpyrifos), earlier BHC was used.
2. The hopper march is bands therefore, trenches of 30-45cm wide and 60 cm deep can be dug before marching hoppers or they should be guided to fall into trenches.
3. These can be burnt with flame throwers when resting during night on bushes.
4. Poison baiting: As prepared in baiting using bran and insecticides it can be controlled.
5. Mostly use of insecticides, dust/ spray to kill the hoppers. Earlier BHC/ Aldrin were used they are not available now. We can use any chemicals like. Chlorpyrifos, carbaryl, pyrethroids etc.

## For adult management

1. Beating to death by thorny sticks/ brooms
  2. Burnt by flame throwers during nights or early mornings when the adults are bit sluggish. They rest on tree tops in cold condition during nights, shake the tree, they are swept together and burnt/ buried.
  3. During day time the swarms can be scared by waving white cloth/ beating drum.
  4. The locust flight can also be killed by flame / insecticides spray using air craft.
  5. Using biological agents: A beetle: *Troxproceras*, the larvae of this beetle feed on locust eggs.
  6. Locust pheromones are also used  
Which are in trial
1. Phenyl acetonitrile
  2. Z-9 pentacosen
  3. Neem product also can be used as antimoultent  
Bacteria: Bt/ fungus, Metarhizium can also be employed  
Birds like the common myna and tiliar are used against locust hunt.

## Antilocust organisation

A permanent locust warning organisation was set up in 1939 in India. It is working under P.P advisor to government of India, HQ at Delhi. The scheduled desert area comprise some 2,05,785 sq km in Rajasthan, Gujarat, Maharashtra, and Haryana. Whole area is divided into 10 zones and grouped into 4 circles with HQ at Bikaner, Jodhpur, Barmer and palampur (Gujarat). Each circle has an Entomologist who is responsible for control of locust in his circle. The functions of antilocust organisation are to.

1. Record locust density in breeding areas and take up control measure
2. Inform about locust movement to various state locust control and watching officers to enable to get prepared for control.
3. To keep watch on extra Indian originating swarms, size, directions, movements and measures.
4. Give tech and material Assistance to state.
5. Coordinate with in India by issuing fortnightly bulletins on locust.

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DHARWAD, KARNATAKA**



**Practical Manual**

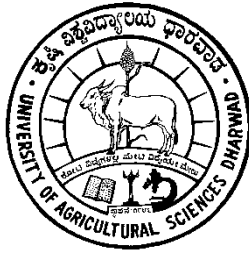
**PESTS OF CROPS AND STORED GRAIN AND  
THEIR MANAGEMENT**

**AET 301 (2+1)**

**Department of Agricultural Entomology  
University of Agricultural Sciences, Dharwad**

**2020-21**

# UNIVERSITY OF AGRICULTURAL SCIENCES, DHARWAD



## PRACTICAL MANUAL FOR

# PESTS OF CROPS AND STORED GRAIN AND THEIR MANAGEMENT AET 301 (2+1)

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Batch: \_\_\_\_\_ Year: \_\_\_\_\_

Department of Agricultural Entomology  
University of Agricultural Sciences, Dharwad  
2020-21



# UNIVERSITY OF AGRICULTURAL SCIENCES, DHARWAD

DEPARTMENT OF AGRICULTURAL ENTOMOLOGY

UAS, DHARWAD- 580 005



## CERTIFICATE

This is to certify that Mr/Ms \_\_\_\_\_

I.D.No. \_\_\_\_\_ of the **III.B.Sc.(Hons.)Agri/ AgMaco** class of this college has satisfactorily completed the practical work assigned to him / her in partial fulfillment of the requirements for the course “**Pests of Crops and Stored grain and their Management (AET 301)**” during I-Semester of **2020-21**.

**Date:**

**Signature of the Teacher**

**Marks obtained:**

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Sl. No.	Title of the Practical	Page No.	Remarks
1.	Pests of paddy		
2.	Pests of sorghum, maize, wheat and ragi		
3.	Pests of pulses (Pigeonpea, chickpea, blackgram, greengram, cowpea and soybean)		
4.	Pests of oil seeds (Groundnut, sunflower and sesamum)		
5.	Pests of oil seeds (Castor, safflower and mustard)		
6.	Pests of cotton		
7.	Pests of sugarcane and tobacco		
8.	Pests of fruit crops (Mango, guava, grapes and banana)		
9.	Pests of fruit crops (Citrus, sapota, pomegranate and ber)		
10.	Pests of vegetables (Brinjal, tomato and potato)		
11.	Pests of vegetables (Sweet potato, chilli, onion, garlic, okra and amaranthus)		
12.	Pests of cruciferous vegetables		
13.	Pests of cucurbitaceous vegetables		
14.	Pests of coconut, arecanut, betelvine, coffee and tea		
15.	Pests of turmeric, zinger and curry leaf		
16.	Pests of cardamom, cashewnut, coriander and pepper		
17.	Pests of ornamental plants (Rose, jasmine, chrysanthemum, crossandra, anthurium, gladiolus, tuberose, gerbera)		
18.	Study of coleopteran, lepidopteran and other stored grain pests		

### Instructions to Students

1. The students are advised not to takeout the specimens from the cabinet box.
2. Insect pests collection covering different crops should be made in accordance with the specimens shown in the class.
3. The insect collection having no pest status will not be considered for evaluation.
4. Students are advised to mount the specimens properly along with neat labels and submitted.
5. The insect pests collection should be arranged in accordance with the crops/groups of crops like Cereals, Oil seeds, Pulses, Commercial crops, Fruit crops, Vegetable crops and Plantation crops.
6. All the students should submit the insect collection and return all the insect collecting materials on the day of practical examination only.
7. For drawing the diagrams students are advised to use colour pencils and also bring text books from the library make use of charts/ photographs given in the practical classes.
8. The laboratory manuals completed in all the respects should be submitted on the day of the practical examination only.
9. Naming insect pests in the lab manual should have common name, scientific name, family and order in sequence.
10. The students will not be permitted to change the batches for the practical examinations unless it is very genuine.

## PESTS OF PADDY

Rice is an important staple food crop for more than two third of population of India and more than 65 per cent of world population. Many biotic and abiotic constraints have to be addressed to meet the productivity gap. Among the various biotic stress constraints damage due to insect pest is substantial and need regular attention. The annual yield loss due to insect varies from 21-51 percent in India and 26-34 percent across the world. About 1400 insects covering 100 species are reported all over the world of which 20 species are of national economical significance and 12 are of state significance.

Pests of national significance	Pests of regional significance
Yellow stem borer, Brown plant hopper, Paddy leaf roller, Paddy earhead bug and Paddy gall fly	Climbing cutworm, Case worm, Panicle mite, Yellow stem borer

### 1. Yellow stem borer: *Scirpophaga (=Trporyza) incertulas* (Walk.) (Crambidae: Lepidoptera)

The female moth is 2 cm long, slender, bright yellowish with a clear single black spot on each forewing, having snout like labial palps. Tuft of hairs are present at the tip of abdomen in the female moth. Eggs are creamy white, flattened, laid in mass near the tip of tender leaves and covered by hairs. Caterpillars are white to pale yellow, 2 cm long and bore into central shoots of paddy seedlings and cause dead hearts. In earhead stage the caterpillars bore at the base of the earhead and cause chaffy earheads or white ear.

### 2. Brown plant hopper (BPH): *Nilaparvata lugens* (Stal.) (Delphacidae: Homoptera)

Plant hopper adults are brownish black with yellowish brown body in colour, 4-5 mm long and more or less wedge shaped and macroptera forms are strong fliers. The female inserts the eggs in two rows on either side of the midrib of the leaf sheath. Nymphs and adults congregate at the base of the plant above water level and suck the plant sap. Heavy infestation causes yellowing and complete drying up of the plant and condition is commonly known as 'Hopper burn'. These are also vectors of grassy stunt virus disease.

### 3. White backed planthopper (WBPH): *Sogatella furcifera* Hor. (Delphacidae: Homoptera)

The adult measures 3.5 to 4.0 mm in length. The body is creamy white with meso notum abdomen black dorsally. The forewings are uniformly hyaline with darker veins. There is prominent white band between the juncture of wings. The pronotum is pale yellow. This planthopper generally appears during early growth stage but sometimes-serious infestation occurs at post flowering stage. The adults and nymphs usually concentrate at the base of the plant causing similar damage as that of the brown planthopper.

### 4. Leaf roller: *Cnaphalocrocis medinalis* (Guen.) (Crambidae: Lepidoptera)

The moths small with brownish orange coloured wings possessing two and one distinct dark wavy lines on fore and hind wings respectively. The outer margin of both the wings have dark brown patch. Eggs are laid singly or in pairs on the underside of tender leaf blade. Pale yellowish green larva attacks the leaf blades. They fold leaf margins longitudinally and feed the rolled leaves by scraping chlorophyll. The affected leaf dries up.

### 5. Paddy earhead bug: *Leptocorisa acuta* (Thunb.) (Alydidae: Hemiptera)

Brown coloured adult with prominent legs and antennae. Female lays 200 - 300 eggs on leaf blade in long rows of 10 - 20 eggs and the incubation period is about 6-8 days. The nymphs are slender and greenish. Both nymphs and adults emit a foul smell after disturbance. They feed on the sap of peduncle, tender stem and milky grains making them chaffy. At the spot of puncture water soaked spot appears and becomes brown with a white centre. The quality of the affected grain gets deteriorated

### 6. Paddy gall fly: *Orseolia oryzae* (Wood-mason) Mani (Cecidomyiidae: Diptera)

Adult is a small delicate fly, resembling mosquitoes; body is bright red or yellowish brown with long legs. Eggs are reddish, elongate and tubular and are laid singly or in groups of 2 to 6 on or just below or above the ligules of leaf blade. The maggots are reddish or yellowish,

measure 3 mm in length, enter into growing point and cause damage to the growing points producing characteristic gall. Elongated tubular gall is produced in the place of shoot which is called "Silver shoot" or 'Anekombu' or 'Kane'.

**7. Case worm: *Parapoynx stagnalis* (Zeller) (Crambidae: Lepidoptera)**

The adult is a tiny delicate moth with white wings speckled with pale brown markings. Eggs are laid singly arranged in rows at the tip of the leaves. Full-grown caterpillar is 1.5 cm long, light green, and found in tubular cases attached to the leaf blade. The caterpillar is found hanging in the tubular case, which skeletonises leaves in ladder like form.

**8. Green leaf hopper: *Nephotettix nigropictus* Stal.; *N.virescens* (Dist.) (Cicadellidae: Homoptera)**

They are small wedge shaped, green to dark green hoppers with prominent black spots on the apical margin of the fore wings. These hoppers are generally found on the leaves. Both nymphs and adults suck the sap and infested leaves become brown. They are known to transmit the virus diseases namely rice tungro, rice yellow dwarf and rice transitory yellowing

**9. Paddy Hispa: *Dicladisa armigera* (Olivier) (Chrysomelidae: Coleoptera)**

Adult is a small bluish black beetle with a number of spines on the elytra. Female makes a minute slit towards the tip of tender leaf blade and lays eggs singly. Eggs hatch out into flat yellowish grubs, which mine into leaves and produce blotches. They pupate in the leaf mines. Egg, larvae and pupae are found on the leaves. Adult beetles scrape the green matter of the leaf causing characteristic white parallel streaks.

**10. Rice butterfly / Rice horned caterpillar, *Melanitis leda ismene* (Guen.) (Nymphalidae: Lepidoptera)**

The butterfly is dark brown with black and yellow eye spot on each of the forewings. Caterpillars are green, slightly flattened with rough body surface and possess two reddish/brown coloured horn-like processes on the head and two yellow processes at the anal end. Larva defoliates from the margins or tip irregularly. Pupa hangs from the leaf attaching its anal end to leaf (Chrysalis).

**11. Skipper butterflies: *Pelopidas mathias* (Hesperiidae: Lepidoptera):**

Butterfly with brown coloured wings and curved antennal tip. Caterpillar is pale green with large and tapering body. Caterpillars fold the leaves longitudinally (backward rolling of leaves) & feed on the green matter from within.

**12. Paddy thrips: *Stenchaetothrips biformis* (Bagnall) (Thripidae: Thysanoptera)**

Adults are tiny, elongated, dark brown insects with narrow fringed wings. They are usually seen at the tip of the leaves and sheaths. The female lays the eggs singly within the leaf tissues. Both nymphs and adults lacerate the leaf tissue and suck plant sap resulting the curling of leaf margins and in severe cases seedlings are die.

**13. Rice Blue beetle, *Leptisma pygmaea* (Chrysomelidae: Coleoptera)**

Adults are small bluish, elongated beetles with parallel sides. Grubs are small, green coloured. Both adults and grubs scrape leaves resulting in irregular white streaks on the upper surface.

**14. Paddy grasshopper: *Hieroglyphus banian* (F.) (Acrididae: Orthoptera)**

Adults are large measuring about 3.75 cm long with three transverse dark bands on prothorax. Hind tibiae are bluish green in colour. Adults lay the eggs in the soil. Both nymphs and adults feed on the leaves in regular manner thus defoliating the plant leaving only the midribs and stalks. At flag leaf stage they nibble at the florets or inflorescence stalks causing formation of white ears.

### **15. Rice panicle mite or rice sheath mite: *Steneotarsonemus spinki* Smiley**

**(Tarsonemidae: Acari)**

This mite causes brown discoloration on flag leaf sheath, chaffy grains, discoloration of filled or unfilled grains on panicle, grain sterility and also acts as carrier of various pathogenic fungi like *Acrocylindrium (Sarocladium) oryzae*, *Fusarium moniliformae*, *Helminthosporium oryzae* etc.

### **16. Leaf mite: *Oligonychus oryzae* (Hirst) ( Tetranychidae: Acari)**

Mites colonize on the under surface of leaves and suck sap from leaves which results in whitish specks or patches on leaves. These patches later turn to ash color leading to drying of leaves. Yellowing, stunting of growth and whitish patches are common symptoms.

### **17. Rodents:** are most important non - insects pests of agricultural crops, particularly rice.

- Lesser bandicoot rat: *Bandicota bengalensis*
- Field mouse: *Mus booduga*
- Indian gerbil: *Tatera Indica*
- Soft furred field rat : *Rattus meltada*

In drained nurseries rodents run freely inside the bed spoiling all germinated seed. Later, they also cut the seedlings 1-2 inches above the water level. In transplanted field, initially rodent's cuts tillers and damage appears in patches and after some time, all these small patches become into one big patch. Damage increases with the onset of panicle initiation and continues up to panicle emergence.

### **IPM package for paddy pests:**

- Summer ploughing, trimming of bunds and crop residues destruction.
- Clipping of tips of seedling before transplanting
- Use of resistant varieties
- Application of recommended dose of fertilizer and avoid the excess use of "N" fertilizer
- Use of coir rope for dislodging case worm, cut worm and swarming caterpillar
- Release of Trichogramma egg parasitoids @ 50000/ha at 20 days after transplanting
- Installation of pheromone traps @ 20 traps /ha as mass trapping and 5 traps /ha as monitoring tool for yellow stem borer
- Creation of alley ways and maintenance of proper spacing
- Avoid indiscriminate use of pesticide especially pyrethroids.
- Adaptation of ecological engineering *i.e.* planting marigold and sunhemp on rice bund for conserving and encouraging the natural enemies population and reducing root knot nematode
- Utilization of biorationals
- Application of insecticides based on ETL

## PESTS OF SORGHUM, MAIZE, WHEAT AND RAGI

Cereals are the important staple food crop of human beings. These are kept pace with growing population. Still then it is estimated that on an average 15 per cent of the food-produced annually in our country is lost due to insects. In this context, insect pests of major cereals are summarised as below.

### SORGHUM:

Pests of national significance	Pests of regional significance
Shoot fly, Stem Borer, Sorghum midge, white grub	Armyworm, cut worm, Grasshopper, shoot bug, earhead caterpillar, earhead bug, mite

#### 1. Sorghum shootfly: *Atherigona soccata* Rondani (Muscidae: Diptera)

Adult is a small fly and appear like miniature housefly. It is grayish brown coloured with 6 black spots on dorsal side of abdomen. Eggs are small, white, cigar shaped and deposited singly on the lower surface of leaf blade. Maggots are cylindrical, apodous and yellow coloured. The larva migrates to the upper side of the leaf, and moves along the leaf whorl until it reaches the growing point where the maggot cut the growing point. As a result the central leaf dries up forming a dead heart, which can be pulled out easily and produces a rotting smell. Only 2-4 weeks old seedlings are infested.

#### 2. Sorghum stemborer: *Chilo partellus* (Swinhoe) (Crambidae: Lepidoptera)

Moths are straw coloured, measuring about 2 cm in length and possess a row of small black dots on the outer margin of forewings. Hind wings paler. The eggs are laid on the underside of a leaf near the midrib in 3-5 rows, in groups of 10-100. They are flattened, oval. Full-grown caterpillar measures about 2-5 cm in length. Body is dirty white or dusky or creamy pink with series of black dots. It bores in to the stem and causes typical deadheart in early stage and pinholes on the whorl of newly opened leaves. In later stage, the larva tunnels the stem and peduncle, which results in partial/full chaffy ears.

#### 3. Sorghum earhead midge: *Contarinia sorghicola* (Coquillett) (Cecidomyiidae: Diptera)

Adult is a very small soft-bodied reddish mosquito like fly with long legs, moniliform antennae with whorls of hairs. Female fly lay eggs in the spikelets. Maggots are tiny, crimson coloured and feeds on the ovary and result in chaffyness. The pupal cases can be seen at the tip of each glume, which is very characteristic.

#### 4. Armyworm: *Mythimna separata* (Walker) (Noctuidae: Lepidoptera)

Moths are stout with brown forewings and pale white hind wings. Eggs are laid in small batches within the leaf sheath or leaf folds and on the tips of dried leaves of dead hearts. Eggs are shining white and spherical with fine ridges. Caterpillars are smooth, green coloured with white longitudinal stripes on the body. Full-grown caterpillar is dirty brown to dark brown with three dark brown dorsal lines. There is a darker yellow stripe on each side. It is found in the whorls of the leaves or under the soil. Caterpillars are active during night, feeding on the leaves from margin inwards. In severe cases, only midribs are left and lot of excreta is seen near leaf whorl. Pupation takes place in soil.

#### 5. Deccan wingless grasshopper: *Colemania sphenarioides* Bol. (Acrididae: Orthoptera)

Medium sized wingless grasshopper, measures 4-5cms in length. Antennae short and the body is light green coloured with pink and yellow stripes on lateral sides. Nymphs and adults feed on the leaves and in severe cases, the leaves are completely eaten.

#### 6. Sorghum shoot bug: *Peregrinus maidis* (Ashmead) (Delphacidae: Homoptera)

Bugs are small, active, light brown in colour, found in colonies inside the whorl and on the leaf sheath of tender crops. Nymphs and adults suck the sap from plants. Sugary secretion is noticed on the infested plants, which favours the development of sooty mould resulting stunted growth and in severe cases the plant dies.

## 7. Sorghum earhead caterpillars:

- a. *Stenachroia elongella* Hmps. (Pyralidae: Lepidoptera)
- b. *Cryptoblabes angustipennella* Hamps. (Pyralidae: Lepidoptera)
- c. *Helicoverpa armigera* Hb. (Noctuidae: Lepidoptera)

*Stenachroia elongella* adults are medium sized. Forewings are straw coloured with prominent veins and hind wings are white. The apical margin of the forewing is rounded with conspicuous black spots. Adult lays eggs directly on earheads. Caterpillar is dark with long stripes. Caterpillars cut the grains and make thick webbing and live within. The other two caterpillar species feed on the developing grains and cause considerable damage.

## 8. Sorghum earhead bug: *Calocoris angustatus* (Lethierry) (Miridae: Hemiptera)

Adult is an active slender yellowish green bug with long prominent legs, measures about 1 cm in length. The bugs hover over the earhead at the time of earhead formation. Nymphs are Green or yellowish, in severe infestation crowded on the earheads. Both nymphs and adults suck the milky juice of the grain before ripening which causes reduction in grain size. Severe damage causes chaffyness of the earhead.

## 9. Sorghum mite: *Oligonychus indicus* (Hirst.) (Tetranychidae: Acarina)

Mites are small, reddish, oval, found on the lower surface of the leaves in colonies. Nymphs and adults suck the sap and attacked portion turns red, then the leaf gradually dries up. In severe cases the mites may invade and web sorghum panicles.

## 10. Sorghum aphid: *Melanaphis sacchari* (Zehntner) (Aphididae: Homoptera)

The aphid is yellow to buff. Each female gives birth to 60-100 nymphs in 13-20 days. The life cycle is completed in 6-7 days during the dry season. It prefers to feed on the under surface of older leaves and the infestation progresses upwards. The nymphs and adults suck sap from the lower surface of leaves, leading to drying of leaves, stunted plant growth and plant mortality in severe infestations. Usually infestation becomes severe by panicle initiation stage. It produces honeydew, which favours development of sooty molds on the leaves. This pest not only affects the grain and fodder yield but also the fodder quality either directly or indirectly.

## MAIZE (CORN)

Pests of national significance	Pests of regional significance
Stem borer, pink stem borer, shootfly	pink stem borer, white grub, cut worm, , aphids, army worm, Thrips, Termite, chafer beetle

1. **Jowar stem borer:** *Chilo partellus* (Swinhoe) :Refer under Sorghum
2. **Armyworm:** *Mythimna separata* (Walker):Refer under Sorghum
3. **Cobworm:** *Helicoverpa armigera* Hub. (Noctuidae: Lepidoptera)

The moth is stout-bodied with brownish forewings and a dark border on the hind wings. 'U' shaped speck is present on the forewings. It lays spherical, yellowish eggs on the silk of the cob. The caterpillars are 3 to 4.5 cm long and greenish with dark gray lines laterally on the body. They feed on the silk and tender milky grains at the tip of the cob. Bored area of the cob is plugged with excreta. This is a polyphagous pest.

## WHEAT

Pests of national significance	Pests of regional significance
Termites, Aphid, Army worm, American pod borer, Pink stem borer, shootfly, brown mite	Thrips

1. **Termites:** *Microtermes obesi* Holm. ; *Odontotermes obesus* Rhmb. (Termitidae: Isoptera)

Workers, which are small, pale white, soft bodied and wingless are found at the damaging site. Queen termite eggs and nymphs are found inside the termitoria. Reproductive forms are winged. Workers feed on the roots inside the soil and cause wilting and drying of all stages of the crop.



## **2. Green plant bug: *Nezara viridula* (Pentatomidae: Hemiptera)**

Adult bugs are medium sized, oval and green with five segmented antennae. Both nymphs and adults are confined to the earhead of wheat, suck the sap from the tender grains causing chaffiness.

## **RAGI (FINGER MILLET)**

### **1. Pink stem borer: *Sesamia inferens* (Walk.) (Noctuidae: Lepidoptera)**

Moths are straw coloured. Veins of the forewing are very prominent. Eggs are yellowish, deposited in rows inside the leaf sheath. Caterpillars are smooth, cylindrical, pink with red head. The full-grown larva measures about 2.5 cm, which bores in to the central shoot causing "Dead heart" in the early stage of the crop and chaffy earhead in later stage. Bored holes are plugged with excreta. It also attacks maize and wheat.

### **2. Aphids: *Rhopalosiphum maidis* fitch (Aphididae: Homoptera)**

The aphid is dark bluish green and somewhat ovate, 2 mm long with black legs, cornicles and antennae. Winged or wingless forms occur. They are found in clusters on the leaves and earhead. Both nymphs and adults suck the plant sap resulting yellowing and stunting of growth. It also secretes the honey dew on which sooty molds develop. Honeydew may hinder harvesting.

### **3. Ragi leafhopper: *Cicadulina bipunctella bipunctella* (Cicadellidae: Homoptera)**

Wedge shaped greenish brown hoppers with two black spots on the vertex. Wings are held rooflike and longer than the body. One or two rows of spines are present on hind tibia. Both nymphs and adults suck the sap from the leaves producing white specks and later dry up. They also transmit the viral mosaic disease.

### **4. Ragi root aphid: *Tetraneura nigriabdominalis* (Aphididae: Homoptera)**

The adults are pinkish globular aphids suck the sap from roots resulting in wilting and drying of plants in patches. Presence of black ants around the base of plants indicate pest incidence.

**PESTS OF PULSES****(PIGEONPEA, CHICKPEA, GREENGRAM, BLACKGRAM, COWPEA AND SOYBEAN)**

Pulses constitute an essential part of the Indian diet for nutritional security and environmental sustainability. The poor production performance of the pulse is attributed by many abiotic and biotic factors. Among the biotic factors insect pests are considered as major constraints and are summarised as below.

**A) PIGEONPEA**

Pests of national significance	Pests of regional significance
Pod borer, Pod fly, Leaf webber, Spotted pod borer, Plume moth, pulse beetle	Pod borer, Spotted pod borer, Blister beetle, Pod weevil, Aphid

**1. Gram caterpillar: *Helicoverpa armigera* Hub. (Noctuidae: Lepidoptera)**

Refer under maize for description. Here the caterpillars feed on flower buds and later bore into the pods and feed on the seeds. While, feeding it inserts its head inside the pod leaving the rest of its body outside. Damaged pods show the entry holes.

**2. Redgram pod fly: *Melanagromyza obtusa* (Malloch) (Agromyzidae: Diptera)**

The fly may appear black to the naked eye, but the thorax and abdomen have a distinct, green metallic sheen if examined under magnification, inserts the eggs into tender pods. The maggot feeds on developing seeds inside the pods. It pupates inside the pod.

**3. Redgram pod borer: *Etiella zinckenella* Treit. (Pyralidae: Lepidoptera)**

Moths are small with white streaks on the grayish brown forewings and pale hind wings. It lays the eggs singly on tender pod. The larva is greenish and has five black spots on the prothorax. The grown up larva becomes pinkish. The larva bores into pods and feeds on the developing seeds. It also feeds on horsegram, lablab, pea and cowpea.

**4. Spotted pod borer: *Maruca vitrata* (=testulalis) Geyer (Crambidae: Lepidoptera)**

Moth has a white cross band on the dark brown forewings and a dark border on the white hind wings. Moths are nocturnal and attracted to light. Caterpillars web flowers, feed on them, also bore into pods and feed on the seeds.

**5. Red gram plume moth: *Exelastis atomosa* W. (Pterophoridae: Lepidoptera)**

Adult is a slender small moth with brownish fringed wings. Eggs are greenish, oval and laid on flower buds or pods singly. Larvae is greenish brown with spines radiating all over the body from tubercles. The larva feed on flowerbuds and seeds of pods by remaining outside which is very characteristic feature of pest.

**6. Pulse beetle: *Callasobruchus chinensis* (L.) (Bruchidae: Coleoptera)**

It is a pest of both field and storage. Adult beetle is pale brown with pubescent elytra and rounded abruptly posteriorly. Grub is pale white and feeds on the inner content of seeds.

**7. Blister beetle: *Mylabris pustulata* Thunberg (Meloidae: Coleoptera)**

Adult is a black elongated shining beetle, elytra with characteristic wavy reddish bands. They appear in large numbers during flowering season and damage the flowers by feeding on petals. The larval stages develop within the soil and first instar grubs feed on the ootheca of grasshoppers.

**8. Bud weevil: *Ceuthorrhynchus asperulus* Fst. (Curculionidae: Coleoptera)**

Adult is a very small greenish brown weevil with a snout. Weevil bites a hole in the calyx portion of the bud and lays minute, oval and creamy white eggs and covers them with fluid. Sap oozes through the hole, dries up into a reddish pustule. Thus, the buds are damaged. Grubs also feed on the flowers.

**9. Redgram gall weevil: *Alcidodes collaris* (Curculionidae: Coleoptera)**

Both adult and grub are damaging stage. Adult nibble at collar region for egg laying. In severe case, death of plant may occur due to ovipositional injury. The grub scratches the stem

portion just above ground level and enter the stem by feeding on fibrous material. As a result gall is formed at collar region. It also attacks greengram, blackgram and cowpea.

**10. Pod bugs: *Claviralla gibbosa*; *Riptortus pedestris* F.(Coreidae: Hemiptera)**

*Claviralla gibbosa*: Adults are brownish grey with spine like projections on the prothorax.

*Riptortus pedestris*: Adults are brownish, slender bodied with elongated legs.

Nymphs and adults are brownish elongate, with slightly enlarged hind femora. Adults and nymphs of these bugs suck the sap from tender shoots and developing seeds in the pods. Damaged seeds become shriveled and develop dark patches. Seeds spoiled by bugs neither germinate nor acceptable as human feed. All these bugs lay eggs in cluster on leaves and pods. Adults live for more than a month.

**11. Tur bud mite/ Eriophyid mite: *Aceria* (=Eriophyes) *cajani* Channa Basavanna.**

**(Eriophyidae: Acari)**

This is a microscopic whitish mite which transmits the sterility mosaic disease. Eruptions can be observed on leaves and leaves curl in severe cases. This disease is wide spread in Karnataka (Gulbarga districts), Andhra Pradesh and Tamil Nadu. The diseased plants do not produce flowers and pods.

**12. Pod borer: *Adisura atkinsoni* Moore (Noctuidae: Lepidoptera)**

Moths are straw coloured with prominent veins on wings. The forewing has a curved line apically formed by a series of black dots. Caterpillars are green coloured with thin white longitudinal stripe on dorsal side and has a brownish lateral markings. The caterpillars bore into the pods and damage the green seeds.

**IPM for Pigeonpea:**

- Summer ploughing,
- Follow the recommended date of sowing
- Mixing of 100 gm sorghum or mesta seeds in 5 kg seeds of pigeon pea
- Installation of pheromone traps @ 5 traps /ha for monitoring helicoverpa pod borer
- Errection of bird perches 10 per acre
- Mechanical shaking plant to disloge the caterpillar
- Inscticide spray based on ETL,
- First sray: Application of ovicidal insecticides like profenophos 50 EC @ 2 ml/l or methomyl @ 0.6gm/l or thiodicarb @ 0.6 gm/l
- Second spray: NSKE @ 5 % or Azardiractin 1500 PPM @ 2ml /l
- Third Spray: Ha NPV @ 100 LE /ac + Jaggary @ 1% +Blue 1 % or GCKE extract @ 5%
- Fourth spray: Indoxacarb @ 0.3 ml/l or sinosad @ 0.1 ml/l or flubendiamide 480 SC @ 0.07 ml /l or Chlorantraniliprole 18.5 SC @ 0.3 ml /l.

## B) CHICKPEA

Pests of national significance	Pests of regional significance
Gram pod borer	Gram pod borer

### 1. Gram caterpillar: *Helicoverpa armigera* Hub. (Noctuidae: Lepidoptera)

Caterpillars feed on the leaves, thus defoliate completely if severe during vegetative stage. During reproductive stage, the caterpillars feed on flower buds and later bore into the pods and eat the seeds. While feeding it inserts its head inside the pod leaving the rest of its body outside. Damaged pods show the entry holes.

## C) GREEN GRAM AND BLACK GRAM

Pests of national significance	Pests of regional significance
Gram pod borer, Spotted & Spiny pod borer, Blue butterfly, Grass blue butterfly, BHC, Stem fly, Pod weevil, Bean Aphid, Leaf hopper, Podfly, thrips, whitefly, blister beetle	Red Spider mite, Hawk moth, White grub

### 1. Stem fly: *Ophiomyia phaseoli* (Agromyzidae: Lepidoptera)

Adult shiny black fly. Maggot whitish yellow coloured, tunnel into the tender stem or side branches of seedlings and cause wilting and death of the seedlings. Dried leaves with swollen petioles can be seen.

### 2. Greengram pod weevil: *Apion amplum* (Apionidae: Coleoptera)

Adult weevils are black in colour. The eggs are inserted into the tender pods. The grubs, which are white in colour, feed on the developing seeds. Adult weevils emerge out by making small holes on the pods. It also attacks blackgram equally.

### 3. Spingid moth: *Acherontia styx* Medusa, *Herse convolvuli* (Sphingidae : Lepidoptera)

Moth is very large brownish with a characteristic skull like markings on the thorax and violet and yellow bands on the abdomen. Caterpillars are greenish with yellowish oblique stripes and yellow curved anal horn and feeds on leaves.

### 4. Aphids: *Aphis craccivora* Koch. (Aphididae: Homoptera)

Damage the crop by sucking the sap from the plant. (Refer under groundnut)

### 5. Leaf hopper: *Empoasca kerri* (Cicadellidae: Hemiptera)

Adults are green and nymphs yellow. Both adults and nymphs suck sap from undersurface of leaves. Infestation leads to yellowing and cupping of leaves, later turning to reddish-brown. Loss of vigour and reduced yield is the severe form of damage. More severe in Northern India during Sept–Jan.

## D) COWPEA

Pests of national significance	Pests of regional significance
leaf miner, aphids, pod borer, bean fly, spider mite, leaf hopper, cut worm, bean shoot borer	Whitefly, serpentine leaf miner

### 1. Pod borer: *Cydia ptychora* L. (Tortricidae: Lepidoptera)

### 2. Stem fly, *Ophiomyia phaseoli* (Agromyzidae: Lepidoptera)

### 3. Bean Aphid: *Aphis craccivora* Koch. (Aphididae: Homoptera)

### 4. Spotted pod borer: *Maruca vitrata* (= *testulalis*) Geyer (Crambidae: Lepidoptera)

**5. Whitefly, *Bemisia tabaci* (Aleurodidae: Hemiptera)**

It is a vector of yellow mosaic virus on cowpea

**6. Copper Butterflies: *Lampides boeticus* L. Lycaenidae: Lepidoptera)**

Butterfly is delicate and has a tail like process at the base of the hind wing with a dot above. Below the front margin of the forewings there are half moon shaped markings. Caterpillar is long, stout and green in colour, bores into the pods and feeds on seeds.

**E) Soybean**

Pests of national significance	Pests of regional significance
Stem fly, Girdle beetle, semilooper, Tobacco caterpillar	Stem fly, semilooper, leaf miner

**1. Stem fly: *Ophiomyia phaseoli* (Agromyzidae: Lepidoptera)**

**2. Soybean leaf miner: *Aproarema modicella* (Zell.): Refer under Groundnut**

**3. Green Semilooper: *Thysanoplusia orichalcea* (Noctuidae: Lepidoptera)**

The adults are light palish brown with a large golden patch on each forewing. The caterpillars are plump and palish green. They cause damage by biting round holes into leaves. On walking, they form characteristic half loops. Feeds on leaves.

**4. Tobacco leaf worm (cutworm): *Spodoptera litura* (Noctuidae: Lepidoptera)**

Moths are medium sized, stout, dark coloured with zigzag white markings on the forewings and hind wings are white without markings. Eggs are laid in group on tender leaves and covered with tuft of anal hairs. Caterpillars are smooth, dark green with cross black band on the thoracic region at early stage. Nocturnal in habit and hide during day time. Grown up larva is stout, fleshy, cylindrical with number of longitudinal stripes and black spots on the sides, measure about 3 to 4 cm long. The young caterpillar skeletonises the tender leaves, whereas the later stages defoliate the plants completely.

**5. Soybean pink pod borer: *Cydia ptychora* L. (Tortricidae: Lepidoptera)**

Body of the female moth is covered with grayish yellow and that of male moth with dark-gray coloured scales. Forewings with 3 black spots, translucent and pearly white, spherical with flat base. Eggs are laid on pods, early instars larvae is white but becomes pink in later instars. The larva bores in to the pod and eats the seeds. Excretory pellets are found near the entry hole.

**PESTS OF OIL SEEDS**  
(GROUNDNUT, SUNFLOWER AND SASAMUM)

Oilseeds occupy an important position in agriculture and industrial economy. So, management of pest problems and using possible control techniques could increase the quality and quantity of the products. A large variety of pests damage oilseeds and cause significant losses in the farms or storages. Among which insect pests are a significant factor in the economics of oilseed production. There are also several vertebrate pests such as rats, slugs and birds.

**A. GROUNDNUT**

Crop suffers from 55 - 60 pests of which Important ones are 5 - 6 in our region

Pests of national significance	Pests of regional significance
Jassid, Aphids, Bruchid, Leaf miner, Termite, Thrips, Tobacco caterpillar, White grub	Red hairy caterpillar, Gram pod borer, Tobacco caterpillar, Leafminer

**a. Sucking pests:**

**1. Jassid: *Empoasca kerri* Pruthi (Cicadellidae: Homoptera)**

Both adults and nymphs suck the sap from young leaves, from the undersurface resulting yellowing and stunted growth.

**2. Aphid: *Aphis craccivora* Koch (Aphididae: Homoptera)**

Adults and nymphs congregate on growing tips and young foliage and desap plants resulting in chlorotic patches and curling up of leaves. Act as vectors of Rosette virus.

**3. Thrips: *Frankliniella schultzei* (Trybom), *Thrips palmi* and *Scirtothrips dorsalis* Hood (Thripidae: Thysanoptera)**

Adults and nymphs lacerate and feed on leaf surface. The injury results in the development of dull yellowish green patches on the upper surface and brown necrotic areas on the lower surface and the leaves curl up. *T. palmi* transmits bud necrosis virus disease.

**b. Leaf feeders**

**1. Groundnut leafminer: *Aproaerema modicella* (Deventer) (Gelechiidae: Lepidoptera)**

It is a major pest of groundnut in South India. Adult is a dark brown tiny moth with a white spot on the costal margin of each forewing. Eggs are laid singly on tender shoots. The larva after hatching mine into the leaves and produces white blotches. Later stage larva webs together the leaves and feeds on them by remaining inside the fold. The full-grown larva is green in colour with dark head and prothorax. The affected field gives burnt appearance. It is also called surali poochi.

**2. Red headed hairy caterpillar: *Aloa* (= *Amsacta*) *albistriga* (Wlk.); *A. moorei* (Erebidae: Lepidoptera)**

These are major pests of groundnut, most problematic in endemic areas. The *A. albistriga* moth has white forewings having brownish markings and streaks. Hind wings are with black spots. There is a yellow band on the head and a yellow streak along anterior margin of fore wings. *A. moorei* moth has red coloured streak on anterior margin of forewing and red band on the head. Eggs are laid in batches of hundreds or more. The larva is reddish brown and densely hairy with a red head. Larva is a voracious feeder and act as defoliator.

**3. Bihar hairy caterpillar: *Spilarctia* (= *Spilosoma*) *obliqua* (Wlk.) (Erebidae: Lepidoptera)**

Adult is a brick red coloured, medium sized moth with black spots on the wings. The body is crimson coloured with black spots. Eggs are laid in clusters on the lower surface of leaves. Larva is hairy with black head, feeding voraciously on leaves and defoliates the plants.

**4. Tobacco caterpillar: *Spodoptera litura* (F.) (Noctuidae: Lepidoptera)**

Larva defoliates the plants. (Refer under tobacco)

**c. Root and pod feeders:**

**1. Termites: *Odontotermes obesus* (Rambus) (Termitidae: Isoptera)**

These insects cause wilting and death of plant. They feed on pod leading to the invasion of soil fungi resulting in rotting of the pods.

**2. Root grubs: *Holotrichia serrata* (Fab.) (Scarabaeidae: Coleoptera)**

It is an endemic severe pest of groundnut. The 'C' shaped grub feeds on the functional roots of the plant, leaving behind only tap root. They also burrow into the stem, close to the soil surface and kill the plant. Grub infested plants turn pale, leaves and branches drop down, the plant withers and can be easily uprooted. Withering of plants in patches is common damaging symptom.

**3. Pod bug: *Elasmolomus sordidus* (Lygaeidae: Hemiptera)**

The bugs are dark brown in colour. Both adults and nymphs suck the sap from pods both in field and stores.

**IPM for Groundnut:**

1. Summer ploughing
2. Seed treatment with imidacloprid 70WS @ 2g/Kg
3. Set up bonfire or light trap or use "Petromax"
4. Collection and destruction of egg mass or young larvae of defoliators.
5. Growing of castor trap crop in groundnut for RHHC and *Spodoptera*
6. If AINPV is available spray @ 250 LE/ha in early stage.
7. Use poison bait technique for *Spodoptera*:
  - a. 50 kg Rice / Wheat bran+ 625 ml monocrotophos 36 SL+ 2 kg jaggery +
  - b. 5-6 lit water for one ha.
8. Utilization of foxtail millet as intercrop with Groundnut (1:7) or along the bund
9. Application of *Nomuraea rileyi* @ 2 g/l against *S.litura*

**B. SUNFLOWER:**

<b>Pests of national significance</b>	<b>Pests of regional significance</b>
Tobacco caterpillar, Head borer, Thrips, Jassids, Semilooper, Cut worm, BHC, Termite	Armyworm, Whitefly, Tobacco caterpillar, Head borer

**1. Sucking pests: Aphids, Leafhoppers, Whiteflies etc.**

**2. Foliage feeders: Bihar hairy caterpillar (*Spilarctia obliqua*), Tobacco caterpillar (*Spodoptera litura*) and Green Semilooper: *Thysanoplusia orichalcea***

Caterpillars feed on leaves

**3. Sunflower head borer: *Helicoverpa armigera* (Hb.) (Noctuidae: Lepidoptera)**

(Refer under maize for adult characters) caterpillar bore into the back portion of the head and feeds on the developing seeds by making zig zag tunnels on the heads.

**4. Non insect pest - Parrot: *Psittacula krameri* (Scopoli) (Psittacidae: Aves)**

Birds feed on the developing seeds during morning and evening hours and causes heavy losses.

### C. SESAMUM, NIGER, LINSEED

Crop	Pests of national significance	Pests of regional significance
Sesamum	Leaf webber, Gall fly, Leaf hopper	Hawk moth, BHC,RHHC, Pod bug, Pentatomid bug, Aphid

#### 1. The leaf webber: *Antigastra catalaunalis* D. (Crambidae: Lepidoptera)

It is one of the most common and important pest of gingelly. The larvae web together the top leaves or tender shoots and capsules and feed on them, resulting drying webbed portion. The moth is reddish yellow colour and forewing with zigzag indistinct reddish marking and hind wings are pale yellow.

#### 2. The gall fly: *Asphondylia sesami* Felt (Cecidomyiidae: Diptera)

Adult is a mosquito like insect. Eggs are laid in ovaries of flower buds. The small whitish maggots feed on the ovary and causes malformation of pod without proper setting of seeds.

#### 3. Leafhopper: *Orosius albicinctus* (Cicadellidae: Hemiptera)

Light brown coloured hoppers. Both nymphs and adults suck the sap and transmits sesamum phyllody.

#### 4. Sphinx moth or Death head moth: *Acherontia styx* (Sphingidae : Lepidoptera)

See under Green gram.



**PESTS OF OIL SEEDS  
(CASTOR, SAFFLOWER AND MUSTARD)**

**A. CASTOR**

Pests of national significance	Pests of regional significance
Tobacco caterpillar, Castor semilooper, Shoot and capsule borer	BHC,RHHC, whitefly, Thrips, hairy caterpillar, castor spiny caterpillar, castor slug, Jassid, Tussock caterpillar

**a. Foliage and capsule feeders:****1. Castor semi looper: *Achaea janata* Linn. (Noctuidae: Lepidoptera)**

It is one of the severe pests of castor. Larvae found feeding gregariously and defoliating the plants leaving only midribs during severe infestation. Adult is a greyish brown moth with the hind wings having oblique white patch at middle and three marginal white patch on outer margin. The full-grown larva is smooth and grayish brown in colour with pale white stripes.

**2. Bihar hairy Caterpillar: *Spilarctia (=Spilosoma) obliqua* (Wlk.) (Erebidae: Lepidoptera)**  
(Refer under Groundnut)**3. Spiny caterpillar: *Ergolis merione merione* C. (Nymphalidae: Lepidoptera).**

It is a specific pest on castor. Butterfly is medium sized snuff coloured with wavy bands on wings. Caterpillar is green with short branching hairs all over the body and feeds on the leaves by remaining on the upper surface of leaves.

**4. Castor slug caterpillar: *Latoia (=Parasa) lepida* Cramer (Cochlididae: Lepidoptera)**

Adult moth is green wings with prominent dark patch at the base of each forewing. Larvae feed on the leaves leaving only midrib and veins. Caterpillar is fleshy with yellowish-green body bearing greenish blue stripe with six rows of spiny scoli on dorsal surface while, ventral body is flat, which cause irritation upon touch due to glandular secretion.

**5. Castor shoot and capsule borer: *Conogethus (=Dichocrocis) punctiferalis***  
**(Crambidae: Lepidoptera)**

It is a polyphagous pest feeding on a number of crops like castor, cardmom, guava, zinger, turmeric etc. Moth is yellowish color with black spots on both pair of wings. Eggs are laid on the tender parts of the plant. The larva bores into the terminal shoots and capsules. Larvae web the capsules together with galleries made of silk and frass. The larva is reddish brown in colour with numerous tubercles on the body.

**b. Sucking pests:****1. Jassids: *Empoasca* sp. (Cicadellidae: Homoptera)**

Both adults and nymphs suck the sap from leaves which leads to hopper burn and stunted growth and development.

**2. White fly: *Trialeurodes ricini* Misra (Aleyrodidae: Homoptera)**

Files are creamy white colour and found feeding on the lower surface of the leaf causes water soaked spots on the leaves which becomes yellow and dry up.

**3. Thrips: *Scirtothrips dorsalis* H. (Thripidae: Thysanoptera)**

Both adults and nymphs are lacerate and suck the sap from leaves leads to crinkling and silverying of leaves.

## B. SAFFLOWER

Pests of national significance	Pests of regional significance
Gram pod borer, Safflower caterpillar, Safflower aphids, Capsule fly/safflower bud fly	Safflower aphids, Safflower caterpillar

### 1. Safflower Aphid: *Uroleucon carthami* HRL. ; *U. compositae* (Theobald) (Aphididae: Homoptera)

It is a regular pest and attacks one month crop old. These are black colour big sized aphids congregate on leaves, shoots and capsule and suck the sap resulting stunted growth.

### 2. Safflower caterpillar: *Prospalta conducta* Gen. (= *Perigoea capensis*) (Noctuidae: Lepidoptera)

Adult possess dark brown fore wings and light brown hind wing. The full-grown caterpillar is smooth, greenish to brownish with humped anal segment. Caterpillar defoliates the crop and also damage the young capsules.

### 3. Gram Caterpillar: *Helicoverpa peltigera*, *H. armigera* (Noctuidae: Lepidoptera)

Feed on leaves and also bores in to flower heads (capsules) and devours the developing seeds.

### 4. Stemfly (Agromyzid fly): *Melanagromyza obtusa* Malloch. (Agromyzidae: Diptera)

The maggots girdle the plant and bore in to the stem which causes small swellings on stem leads to drying and wilting. The fly is medium sized with dark metallic blue and black hatters. Eggs are thrust into the tissues. Young maggots are small and white initially and turns turn yellowish white later. Pupates inside the stem and adult emerge through exit hole.

## C. MUSTARD

Pests of national significance	Pests of regional significance
Mustard aphid, Mustard saw fly, Mustard leaf miner, painted bug	BHC, Cabbage head borer, DBM, leaf webber

### 1. Mustard aphid: *Lipaphis erysimi* Kaltenback and *Myzus persicae* (Aphididae: Homoptera)

Adults are pear shaped, light yellowish in colour. Both adults and nymphs suck the sap from under surface of leaves, tender twigs.

### 2. Mustard Sawfly: *Athalia lugens proxima* (Klug) (Tenthredinidae: Hymenoptera)

The adult is black fly. Abdomen is broadly attached to thorax without any constrictions between thorax and abdomen. Body and femora are yellow with transparent and smoky wings. Eggs are thrust singly with the help of saw like ovipositor into leaf tissue. Larva is smooth bodied, dark and marked with longitudinal lines. Resembles lepidopterous larva (caterpillar) except for the possession of 8 pairs of prolegs (without crochets). It causes severe defoliation. Pupation takes place inside earthen cocoons in the soil.

### 3. Painted bug: *Bagrada cruciferarum* Kirkaldy (Pentatomidae : Hemiptera)

Adults are small, black in colour with red and yellow lines. Both adults and nymphs suck the sap from the leaves and tender parts including pods.

## PESTS OF COTTON

Cotton is one of the commercial fiber crop of our country which suffers from about 200 species of insect pests and mites in India, of which 18-20 are of major important resulting in an annual loss of 50-60% of total production. The crop is subjected to attack by various pests from emergence till the harvest of the crop.

Pests of national significance	Pests of regional significance
American bollworm, Spotted bollworm, Pink bollworm, Tobacco caterpillar, Thrips, Whitefly, Leaf hopper	Aphids, Stem weevil, Shoot weevil, Mirid bug, Flower bud maggot, Mealy bugs

### A. Sucking insects:

#### 1. Cotton Thrips: *Thrips tabaci* Lind. *Scirtothrips dorsalis* Hood (Thripidae : Thysanoptera)

Small yellow to brown insects with fringed wings. Both nymphs and adults lacerate the tissue and suck the oozing sap from leaves. Hence the leaves get crumpled which curl upwards with shiny white patches. The sucking leads to silvery brown necrotic spots. Further, in severe conditions the affected leaves get toredoff.

#### 2. Cotton leafhopper: *Amrasca biguttula biguttula* (Ishida) (Cicadellidae: Homoptera)

It is one of the major pests of cotton and commonly called as jassids. Adult is wedge shaped, active and pale-green coloured insect with black spots on posterior part of the fore wings. Both adults and nymphs suck sap severely and inject their saliva into the plant system. Curling and crinkling of leaves is commonly seen. Due to systemic action of saliva the leaves turn yellowish from the margin and leaf reddening is noticed. This is called leaf hopper burning in cotton.

#### 3. Cotton aphid: *Aphis gossypii* Glover (Aphididae: Homoptera)

These aphids are yellowish brown to black coloured. The adults have both winged and wingless forms. They reproduce parthenogenetically and viviparously as well. Nymphs are wingless and smaller than adults in size. Both adults and nymphs feed on tender parts as a result of which the leaves curl down and tender portions fade gradually. Sooty mould develops on sugary secretions. It indirectly affects the quality of the fibre also due to honey dew secretion on the open bolls.

#### 4. Cotton whitefly: *Bemisia tabaci* (Gennadius) (Aleyrodidae: Homoptera)

Adult whitefly is tiny, soft-bodied insect, measures 1.0 mm in length having milky white wings and yellowish body lightly dusted with waxy bloom. Crawler is pale yellow and flattened in appearance with bristles on margin. Nymphs are scale like, depressed, pale greenish in colour with degenerated legs. Both nymphs and adults suck the plant sap resulting in premature defoliation, development of sooty mould on honeydew excreted by whitefly, shedding of squares and bolls and bad boll opening. This is vector for cotton leaf curl virus.

#### 5. Cotton Mealy bug: *Phenacoccus solenopsis* (Tinsley) (Hemiptera: Pseudococcidae)

This has emerged as a serious pest of cotton during 2006 in North India (Punjab/Haryana/Rajasthan) and caused 30-45% loss to cotton yield. The mealy bugs usually feed on phloem tissue of leaves, stem and even appear on squares /boll. Due to severe de-saping the leaves become yellowish. In severe case plants may die. They secrete large amount of honeydew on the plant leading to sooty mold growth on all parts of plants. This mealy bug has multiple advantages of parthenogenesis and ovisacs for population explosion. It can withstand

extreme temperatures from 0 to 45°C. Also infests many solanaceous crops viz., brinjal, tomato etc and *Parthenium* is regular weed host.

## **B. Foliage feeders:**

### **1. Cotton Cutworm: *Agrotis ipsilon* (Hufnagel) (Noctuidae: Lepidoptera)**

Adults are black coloured medium sized moths with dark brown fore wings and dull white hind wings. Catterpillars are dark brown and cut the tender stem at ground level.

### **2. Cotton leaf roller or folder : *Sylepta (=Heritalodes) derogata* Fb. (Crambidae: Lepidoptera)**

The moth is medium sized with yellowish wings, bearing brown waxy markings on them. The damage appears in the form of leaves turning into funnel shaped structures and each funnel harbor one to few leaf folder larvae feeding within by scaping on the lamina. Larvae are often enclosed by soft silken web and surrounded by frass.

### **3. Semilooper: *Anomis flava* Fab. (Noctuidae: Lepidoptera)**

Adult is a medium sized brown moth. The larva is long and green in colour with yellowish bands between segments. One pair of prolegs is missing and hence they loop while moving. The green semilooper devours whole fully opened mature leaves feeding from margin causing large holes. It is a pest of peak vegetative stage.

## **C. Stem feeders:**

### **1. Shoot Weevil: *Alcidodes affaber* Fb. (Curculionidae: Coleoptera)**

Weevils are dark grayish brown with pale cross bands on elytra. Both adults and grubs injure the top shoots and leaf stalks. Grubs enter inside the shoot and feed on internal content moving up and down. Branches become weak and break due to heavy winds at affected points. Saw dust like fed material can be on leaves. (Also refer under Bhendi)

### **2. Stem weevil: *Pempherulus affinis* Fst. (Curculionidae: Coleoptera)**

Adults are small weevils, dark in colour with tow white small patches on the elytra. Eggs are laid in the bark after burrowing at the point of node and are sealed with gummy secretion. The grubs are white in colour and apodous. These grub by feeding make tunnels within the stem and weaken the stem resulting into breakage and death of the plant.

## **Flower Feeders:**

### **1. Cotton flower bud maggot, *Dasineura Gossypii* Fletcher. (Cecidomyiidae: Diptera)**

Soft bodied orange colored weak adult fly, prefers to lay eggs in square tips. Maggots are initially white transparent later become orange color and feed upon the floral parts, anthers and stalk of stamen. Damaged flower bud dry up and disintegrate. Pupation in a silken cocoon on bracts.

## **D. Boll Worms:**

### **1. American bollworm: *Helicoverpa armigera* Hb. (Noctuidae: Lepidoptera)**

American bollworm is a major pest of cotton and one of the most polyphagous and widespread species. The larvae feed on the leaves initially and then bore into squares/bolls and seed with their head thrust into the boll, leaving the rest of the body outside. Excreta surround the entry hole. Damaged squares flare up, have feeding or damage holes on them and are shed. Clear-cut round feeding holes on squares and bolls with or without larvae are seen. Adult moths are stout bodied, greenish yellow to buff brown with darker brown or blackish markings.

### **2. Spotted bollworm: *Earias vittella* (Fab.)**

#### **Spiny bollworm: *Earias insulana* (Boisduvel) (Noctuidae: Lepidoptera)**

*E. vittella* is seen in south and central India while *E. insulana* is predominant species in north India, on cotton. Terminal shoots dry and withers away when the larvae bore into the pre-squaring plants. The main stem collapses, if the growing point is affected. Feeding holes in

squares and on bolls are seen with or without larvae. Flare up of squares and their shedding, premature dropping or opening of attacked bolls are common. *E. insulana* vary from silver green to straw yellow while *E. vittella* moths are creamy white or peach with a central green wedge running from proximal to the distal edge of the forewing. Moth lays 2-3 eggs on bracts, leaf axils, veins on the under surface of leaf, single female lay up to 385 eggs, total life cycle ranges from 20-22 days. The larva has spiny body with black spots in *E.insulana* where as only black spots in *E.vittella*.

### **3. Pink bollworm: *Pectinophora gossypiella* (Saunders) (Gelechiidae: Lepidoptera)**

Pink bollworm *Pectinophora gossypiella* has become economically destructive pest of cotton. Larvae initially feed on the flower buds that results in failure of bud opening and shedding. Larvae enter into the developing boll through the rind, feed on developing cotton seeds. In younger bolls entire content can be destroyed, in older bolls larvae feed up to 3-4 seeds. Within a boll more than one larva can be seen. Rosetted flower is the typical symptom of pink bollworm infestation. Quality of lint deteriorates due to the presence of larvae and lint gets stained by the pest. *P gossypiella* lay eggs singly or in groups of four to five. Eggs are pearly white, flattened, oval about 0.5 mm in length and 0.25 mm wide. Larvae are white in colour in first two instars, later instars are pink in colour. The larvae have characteristic dark brown head. Pupae are dark brown. The adult moth is grayish brown with blackish bands on forewings while hind wings are silvery grey.

### **4. Tobacco caterpillar, *Spodoptera litura* Fabricius**

Tobacco caterpillar is also known as oriental leafworm, cluster caterpillar, cotton leafworm, tobacco cutworm and tropical armyworm. Larvae attack the crop in large numbers and are damaging and gregarious in nature. Adults lay eggs in masses and the larvae feed by scraping the leaves leaving behind the veins and veinlets. Caterpillars are smooth, dark green with cross black band on the thoracic region in younger stage. Grown up larva is stout, fleshy, cylindrical with number of longitudinal stripes and black spots on the on dorsal side, measure about 3 to 4 cm long.

## **E. Bugs and Mite:**

### **1. Red cotton bug: *Dysdercus cingulatus* Fb. (Pyrrhocoridae: Hemiptera)**

Bright red coloured bugs with eyes, scutellum and antennae are black with a series of white transverse bands on the ventral side of the abdomen. Adults and nymphs suck the sap of developing green bolls. The quality of the lint gets affected as it transmits a bacterium (*Nematospora gossypi*), which stains the lint. The oil content and germination of the seeds are also affected.

### **2. Dusky cotton bug: *Oxycarenus hyalinipennis* Costa. (Lygaeidae: Hemiptera)**

The adult is a small flat bug with dusky brown colour. Eggs are laid within the half opened bolls or on the bolls, flowers and buds. Adults and nymphs suck the oil from the seeds, which fail to ripen. They also stain the lint when crushed during ginning.

### **3. Mirid bug, *Creontiades* (=Poppiocapsidea) *biserrata* Distant (Miridae: Hemiptera)**

Adult are brown in colour with dark brown T-shaped band on pronotum. A green colour morph is also available with similar taxonomic features. Nymphs are greenish in colour with dark brown wing pads. The females preferred to lay eggs in petiole. Both nymphs and adults damage developing flower buds and tender bolls. The characteristic symptoms of feeding on the flower bud are described as oozing out of yellow fluid from the buds and staining of this yellow fluid on the inner surface of the bracts. Infested tender bolls have number of black patches on all sides of the outer surface of boll rind and shedding of most of the damaged tender bolls is observed. Sometimes the bolls fed by mirid bug retained on plant show beaked bolls.

### **4. Cotton mite: *Tetranychus macfarlanei* (B&P) (Tetranychidae: Acari)**

Small, reddish, oval and are found on lower surface of the leaves in colonies below a thin web. Both young ones and adults suck the sap and attacked leaf portion turn purplish red, which drop off.

**Cotton:**

- 1) Application of recommended doses of fertilizers. Nitrogen management is important to avoid heavy incidence of sucking pests.
- 2) Utilization suitable sucking pest resistant varieties/ Hybrids.
- 3) Sowing of okra as trap crop @ 10:1 (Cotton : Okra) for shoot weevil and boll worms (American and Spotted bollworm). Shoot weevil adults should be collected in the morning hours from okra plant and disposed.
- 4) Growing of cowpea as eco-feast crop all along the bund
- 5) Grow one row of maize as border crop (as a ecofeast crop) to encourage predatory population.
- 6) Installation of species specific pheromone trap@ 5 trap/ha for monitoring American, spotted and pink bollworm separately
- 7) Nipping of terminal shoots at 90-100 days after sowing to restrict aphid readings and oviposition by American bollworm moths.
- 8) Set up of yellow sticky trap @ 25 trap/ha for whitefly monitoring.
- 9) Release *Trichogramma chilonis* (cotton strain) @ 1,00,000/ - ha / week (2–3 releases) at 40 – 50 days after sowing
- 10) Application insecticide based on ETL.
- 11) Growing refugia is important in Bt cotton.

## PESTS OF SUGARCANE AND TOBACCO

### I. PESTS OF SUGARCANE:

There are over 100 species of insect pests which infest the crop among them about a dozen are of economically important. The insect pests cause a loss of about 20% to the cane and the mill suffer a reduction of about 15% in sugar recovery. Ratoons suffers badly due to borers and pests.

Pests of national significance		Pests of regional significance	
Borers	Sucking Pests	Borers	Sucking Pests
Early shoot borer, Pink borer, Top shoot borer, Internode borer, Root borer, Stalk borer, Root grub	Leafhopper, woolly aphid, whitefly, Mite	Root grub, early shoot borer, Top shoot borer	Whitefly, scales, woolly aphid

#### 1. Early shoot borer: *Chilo infuscatellus* Snell. (Crambidae: Lepidoptera)

Moths are small, slender, straw coloured with labial palps projecting forward. A row of white dots is present along the outer margin of forewings. Eggs are white, scale like, oval, overlapping and are laid in 2-3 rows on the ventral surface of leaves. Caterpillars are white with brown markings. Full-grown caterpillar measures about 2 to 2.5 cm. They enter in to shoot and cut off the growing point causing dead heart.

#### 2. Top shoot borer: *Scirpophaga novella* (= *Tryporyza excerptalis*) (Fb.) (Crambidae: Lepidoptera)

Moths are medium sized, creamy white, slightly bigger than seedling borer moth. Female has tuft of crimson coloured hairs at the tip of the abdomen. Eggs are flat, oval laid in groups on the upper surface of the leaves covered with hairs. Caterpillars are pale white and 2.5 to 3.0 cm long. Caterpillars bore into the midribs and mining its ways to the base and feeding in the shoot results in dead heart in grown up canes which cannot be pulled. Side shoots grows leading to bunched top appearance.

#### 3. Internode borer: *Chilo saccharifagus indicus* (Crambidae: Lepidoptera)

**Adult:** Small, straw coloured, forewings have a marginal dark line and hind wings are white. Female moth lays scale like white eggs in batches of 9-11 eggs in two rows on sheathing leaves. **Larva:** white with dark spots and brown head. Caterpillar bore at the nodal region. Affected internode become thinner, constricted and shortened with number of bore holes and fresh excreta in nodal region. Affected tissue become reddened.

#### 4. Root grub: *Holotrichia serrata* (F.) (Scarabaeidae: Coleoptera)

Adult is a large sized reddish brown stout beetle measuring 2 to 2.5 cms in length. Adults emerge immediately after the first rains in April-May. Eggs pearl like, white, enclosed in earthen cell inside the soil. Grubs are smooth bodied, scarabeiform, white colour and found always inside the soil. They feed on live roots during June-October resulting drying of plants. Damaged is caused in patches but in epidemic area entire crop in field may be wiped out.

#### 5. Termites: *Odontotermes obesus* (Rambo), *Microtermes obesi* Holm. (Termitidae: Isoptera)

In this case the worker termites attack the newly planted sets and feeding on roots of the cane results in the death of the cane and affect germination.

#### 6. Sugarcane mealy bug: *Ripersia sacchari* Ckll. (Pseudococcidae: Homoptera)

Mealy bugs are soft bodied, oval flat, pinkish brown, their body covered with white mealy matter. These insects congregate at lower nodal region of stem particularly under leaf sheath. Both nymphs and adults persist on plants and suck the sap from the cane. This reduces the vigour of the plant. It acts as vector of sugar cane spike disease.

### **7. Sugarcane scale: *Melanospis glomeratus* (Green) (Diaspididae: Homoptera)**

these are grayish black and circular and covering the nodal regions and forming a thick encrustation on the entire stem. Nymphs and adult females feed by sucking the sap and cause shriveling up and stunting of canes. Female reproduces ovoviviparously.

### **8. Sugarcane leafhopper: *Pyrilla perpusilla* Wlk. (Lophopidae: Homoptera)**

It is a severe pest in North India. Adult is straw coloured with the head projected in the form of a snout. Nymphs are white with waxy filamentous projections at the tip of the abdomen. Both adults and nymphs suck the sap. Due to heavy infestation plants loose vigour, becomes shrink and both tonnage and quality of juice gets very much affected. It also secretes honeydew on the foliage, which leads to the development of black sooty mould.

### **9. Sugarcane woolly aphid: *Ceratovacuna lanigera* (Zehntner) (Homoptera: Pemphigidae)**

The nymphs and adults of aphids suck sap from the lower surface of leaves by inserting their stylets into the leaves which results in yellowing and drying of leaves leading to stunted plant growth and reduction in tonnage in severe infestations. In addition, they also excrete honey dew on which black sooty mould develops, which hinders the photosynthetic activity of the plant. Reproduction is both by asexual method and parthenogenetically. It passes through four instars in about 12-24 days. The early instars are very active and settle at one place on the lower surface of leaves a late from. Thus the infestation in the field can be easily detected. Its infestation usually occurs in patches in the beginning and then spreads into the entire field within a short span of two-three weeks. Third and fourth instar nymphs and apterous adults covered with white woolly secretions. Adults are black in colour with pair transparent wings.

### **10. Sugarcane whitefly: *Aleurolobus barbodensis*; *Neomaskellia bergii***

#### **(Aleurodidae: Hemiptera)**

Adults of *A. barbodensis* are tiny, moth-like with white powdery coating, while *N. bergii* have spotted translucent wings. Eggs are laid in a line (about 50 eggs) on the lower surface of leaves. EP 8-10 days, NP 15-30 days. Both nymphs and adults suck the sap from leaves which show characteristic *yellow streaks*. In severe cases the leaves dry and plants remain stunted. Yield and sucrose content are drastically reduced.

#### **IPM for SUGARCANE:**

1. Select pest free setts for planting.
2. Early planting during December – January escapes the early shoot borer incidence.
3. Partial earthing up on 45 days after planting reduces the incidence.
4. Application of recommended dose of fertilizer and avoid use excess use of N fertilizer.
5. Install pheromone traps @ 10Nos. /ha for surveillance and monitoring,
6. Paired row system or wider row of planting with suitable intercrops like wheat, chickpea, mustard, pea, onion in october-november planted and lady finger, green gram, black gram, ground nut cowpea, maize in Feb-March planted sugar cane
7. Detrash the crop on 150th and 210th day of planting.
8. Release of parasitoid *Epiricania melanoleuca* @ 1600 to 2000 pupae or 5,00,000 eggs / ha for leaf hopper
9. Release of *Dipha aphidivora* (*Pyralidae: Lepidoptera*) @ 2000 larvae or pupae/ha or *Micromus igoratus* (*Hemeroptera: Neuroptera*) @ 2000 larvae or pupae/ha for woolly aphid
10. Release egg parasitoid, *Trichogramma chilonis* @ 20,000/acre six releases at fortnightly intervals starting from 4th month onwards.
11. Erect owl perches @ 5-6/acre to promote natural control of rodents
12. Entomopathogenic nematodes (EPNs) can be sprayed at the rate of 100 million nematodes per acre, in root grub and termite infested sugarcane fields OR EPN infected cadavers of *Galleria/Corcyra* larvae containing live infective juveniles (IJs) are implanted in soil at plant bases at the rate of four cadavers per plant during May/June and/or September for sugarcane root grub control.



## II. PESTS OF TOBACCO

### 1. Tobacco leaf worm (cutworm): *Spodoptera litura* (Noctuidae: Lepidoptera)

Moths are medium sized, stout, dark coloured with zigzag white markings on the forewings and hind wings are white without markings. Eggs are laid in group on tender leaves. Covered with tuft of anal hairs. Caterpillars are smooth, dark green with cross black band on the thoracic region in younger stage. Nocturnal in habit and hide during day time. Grown up larva is stout, fleshy, cylindrical with number of longitudinal stripes and black spots on the sides, measure about 3 to 4 cm long. The caterpillars feed on leaves of seedlings and often cut seedlings at the base in nursery. The young caterpillar skeletonises the tender leaves, whereas the later stages defoliate the plants completely.

### 2. Stem borer: *Phthorimaea heliopa* Lower (Gelechiidae: Lepidoptera)

Adult is a tiny dark brown coloured moth, active at dark, female moth lays eggs scattered on leaves. Caterpillars are slender, dark headed and pinkish. They first mine into the midrib of leaves and then into the stem. The mined leaves show blotches, the stems become zigzag, hallow and swollen.

### 3. Black cutworm: *Agrotis ipsilon* (Noctuidae: Lepidoptera)

It is a polyphagous pest. Moth is stout and has wavy lines and spots on brownish fore wings. Hind wings pale in colour. Eggs are laid in groups on the under surface of leaves. Caterpillars are dark brown and active during night time and cut the seedlings at ground level. Pupation in soil.

### 4. Capsule borer: *Conogathes punctiferalis* (Pyralidae: Lepidoptera)- See under Castor

### 5. Tobacco aphid: *Myzus persicae* S.; *M. nicotiana* (Aphididae: Homoptera)

These are polyphagous, green coloured, winged or wingless with cornicles on the abdomen, found in clusters on the lower surface of the leaves. Both nymphs and adults suck the sap from the leaves. The leaves become curled and crinkled. Honey dew excretion, and sooty mould development are noticed.

### 6. White fly: *Bemisia tabaci* (Aleyrodidae: Hemiptera)

They are small, white insects, body yellowish dusted with waxy powder. Eggs are laid on the leaves. Vector of tobacco leaf curl virus. Nymphs and adults suck the sap from leaves and the leaves become crinkled and curled. Excret honey dew on which sooty mould develops.

**PESTS OF FRUIT CROPS  
(MANGO, GUAVA, GRAPES AND BANANA)**

**A. MANGO**

Pests of national significance	Pests of regional significance
Mango hopper, Mealy bug, Inflorescence midge, Fruit fly, Stem borer, Bark eating caterpillar, Stone Weevil, Stem borer, Shoot gall psylla, Leaf webber, Eriophyid mite, RED Ant, Termites, Stone weevil,	Scale insects, Shoot borer, Shoot gall psylla, Leaf webber, Thrips, Red spider mite, Fruit fly

**1. Mango hoppers: *Amritodus atkinsoni* L., *Idioscopus niveosparsus* L., *I. clypealis*, *Amrasca splendense* Ghouri (Cicadellidae: Homoptera)**

Tiny wedge shaped brown hoppers measure about 0.5 cm in length. Among the these species, *A. atkinsoni* is the biggest, *I. niveosparsus* is of medium sized and the last species is the smallest. Adults and nymphs suck the sap from flowers and leaves during blossom period. Damaged flowers fail to set fruits. In severe infestation they secrete honeydew on which black sooty mould develops.

**2. Fruit fly: *Bactrocera (Dacus) dorsalis* Hendel (Tephritidae: Diptera)**

Adult is a brownish coloured fly with bright yellow markings on the body. Wings are marbled, female with fairly well developed flat ovipositor. Maggots are white apodus and feed on the pulp inside. The affected portion rot and the fruit finally drop off.

**3. Mango stem borer: *Batocera rufomaculata* Deg. (Cerambycidae: Coleoptera)**

It is known to attack fig, rubber, Jack, eucalyptus etc. The mango varieties Amlet and Mulgoa are highly susceptible. Adult is a big beetle measuring 50 mm with long antennae. Pink dots and lateral spines are present on the thorax. The grub is the damaging stage. It tunnels through the branches and causes wilting. Pupation takes place inside the tunnel.

**4. Mango leafwebber: *Orthega exvinacea* Hampson (Crambidae: Lepidoptera)**

Larvae is pale greenish with brown head and prothoracic shield. Larvae webs the terminal leaves together and feed by scrapping green matter. Later clusters of webbed leaves become dry and brownish.

**5. Mango nut weevil /stone weevil: *Sternochetus mangiferae* (Fb.) (Curculionidae: Coleoptera)**

Weevil is dark brown in colour and stout. The grub is apodous, fleshy, light yellow with dark head. The grubs after hatching tunnel through the pulp, endocarp, seed coat and reach the cotyledon and feed on them. The tunnel gets healed up. Pupation takes place in the cotyledon. This affects the foreign exports and germination of the nuts.

**6. Bud mite: *Aceria mangiferae* Sayed. (Eriophyidae: Acari)**

Causes floral and vegetative malformation.

**B. GUAVA**

Pests of national significance	Pests of regional significance
Fruit fly, Bark eating caterpillar, Fruit borer	Fruit fly, Kajji bug, Mealybug, Coccids, Aphids

**1. Fruit fly: *Bactrocera (Dacus) dorsalis* Hendel (Tephritidae: Diptera):**

See under Mango.

**2. Guava Kajji bug: *Helopeltis antonii* St. (Miridae: Hemiptera)**

Reddish brown, elongate bug with black head, red thorax with peg like projection on the dorsal side of the prothorax and black and white abdomen. Legs and antennae are long. . Both adults and nymphs suck the sap from tender shoots, developing ovaries and fruits resulting in wilting. Young fruits dry up and drop. Scab develops on fruits at the feeding site resulting in corky appearance.

**2. Scale insect: *Pulvinaria psidii* Maskell (Coccidae: Homoptera)**

Young female and nymphs are pale green in colour, nearly oval shaped and flat. Adult female produces white ovisac. Males are small and dipterous. Both female bugs and nymphs suck the sap from the leaves and devitalize the crop. In severe cases, leaves fall off, twigs dry up. Secret honey dew on which sooty mould develops.

**3. Spiralling whitefly: *Aleurodicus dispersus* Russel (Aleyrodidae: Homoptera)**

Pest appeared recently on fruit crops. Polyphagous in nature attacks many fruit and ornamental plants, but guava is most preferred. The adults lay eggs in a spiral manner and the young ones suck sap from leaves. As a result of heavy infestation, lot of honeydew is secreted on which sooty mold develops and leaves drop down.

**4. Citrus fruit sucking moth: *Eudocima* (=Othreis) *fullonica* (Linn.), *E. maternal*, *E. ancilla* (Erebidae: Lepidoptera)**

See under Citrus

**C. GRAPES**

Pests of national significance	Pests of regional significance
Mealy bugs, Flea beetle, Girdle beetle, thrips, Hoppers, Leaf eating caterpillar, Stem borer, Grape leaf folder	Red mites, Grape leaf roller, scales, Mealy bugs,

**1. Grape mealybug: *Maconellicoccus hirsutus* (Green): (Pseudococcidae: Homoptera)**

Females are wingless and sac like light pink coloured. Males with one pair of delicate wings, possesses white caudal filament on each side of the ninth abdominal segment. Female lays pinkish 80-100 eggs in masses and are covered by waxy filaments. After hatching pink coloured crawlers move to succulent parts of leaves, petioles, bunches, settle and thereafter become sedentary. The pinkish nymphs covered with waxy coating suck the sap from tender parts including berries leading to i) malformation of growing shoots and leaves ii) sticky honeydew excreted by mealybugs attracts mouldy growth. Heavily infested berries shrivel and drop. Grape bunches become unfit for marketing and lose preference for consumption.

**2. Thrips: *Scirtothrips dorsalis* Hood (Thripidae: Thysanoptera)**

These are dark brown coloured tiny insects. The feeding results in crinkled leaves and scab development on berries.

**3. The flea beetle: *Scelodonta strigicollis* (Chrysomelidae: Coleoptera)**

The beetle is coppery brown with six spots on elytra and measures about 1 cm in length. Adults bite holes on tender leaves and feed on tender leaf buds. The female oviposits in the bark or in the soil. The grubs feed on roots and develop in the soil. Pupation takes place in an earthen cell.

**4. Stem girdler: *Sthenias gresator* Fb. (Cerambycidae: Coleoptera)**

This insect is a medium sized longicorn beetle. It has a peculiar habit of ringing the vines and often killing the same. The beetle girdles at night and inserts the eggs underneath.

**5. Grape stem borer, *Coelosterna scabrator* (F.) (Cerambycidae: Coleoptera)**

Adults are 20-28mm in size, have mottled grey elytra, metathorax have small projection pointing forward on each of its sides. Antennae of males are as long as the body and those of females twice the body length. Grubs bore into the stem and branches. Initially reddish sap oozes from wounds. Chewed particles of wood are seen below the damage. Sap translocation is affected and affected branches wither and die. Complete only one generation in a year.

#### D. BANANA

Pests of national significance	Pests of regional significance
Banana rhizome weevil, stem weevil, leaf eating caterpillar, aphids, thrips, lacewing bug, leaf and fruit scarring beetle	Fruit fly

##### 1. Rhizome weevil: *Cosmopolites sordidus* G. (Curculionidae: Coleoptera)

Adult is a dark brown to black coloured beetle with elongate snout and geniculate antennae. It measures about 1 cm in length. Grub is pale yellow white in colour and legless. Head is dark brown in colour, body is stout and the last instar measures about 1 cm in length. Grubs bore into the rhizome resulting in the wilting of the plant.

##### 2. Banana Pseudostem weevil: *Odoiporus longicollis* (Curculionidae: Coleoptera)

Female lays eggs in the leaf sheath and on hatching grubs start feeding on tissues around leaf sheath and then bore into the pseudo-stem which results in weakening and rotting of pseudo-stem. Such infested plants break down with strong blow of wind.

##### 3. Banana aphid: *Pentalonia nigronervosa* Cog. (Aphididae: Homoptera)

It is a vector of the banana bunchy top virus and cardamom mosaic. The aphids are dark brown in colour and occur in colonies at axils of leaves and in the central whorls of leaves.

##### 4. Banana skipper/ leaf roller: *Erionota torus* (Hesperiidae: Lepidoptera)

Adult butterflies lay small, yellow eggs on the under sides of the banana leaves. Caterpillar rolls the banana leaves (rolls can be up to 15 cm long) and remain inside the roll and feeds on leaves. Leaf damage decreases banana yields due to delayed reduced bunch size and may also be delayed fruit maturity.

**PESTS OF FRUIT CROPS  
(CITRUS, SAPOTA, POMEGRANATE AND BER)**

**A. CITRUS**

Pests of national significance	Pests of regional significance
Aphids, Citrus psylla, Leaf miner, scales, Fruit fly	Fruit sucking moth, Stem & shoot borer, Mites, Blossom midge

**1. Leaf miner: *Phyllocnistis citrella* Staint (Gracillariidae: Lepidoptera)**

This is a serious pest on lime and other citrus varieties. The adult moth is small, greyish silvery white in colour. Wings are fringed with hairs. Prominent a black spot is present on tip of fore wings. Lay eggs along midribs of tender leaves. Caterpillar is pale green and mines in between epidermal layers of leaf in a zig-zag manner resulting in curling and wilting of leaves. The mines later become silvery white (distorted leaf) and the affected leaves get twisted and deformed. Larva is apodus and pupates inside the mines in silken web.

**2. Citrus fruit sucking moth: *Eudocima fullonica* (Linn.); *Eudocima materna* (Linn.); *Eudocima ancilla* Linn. (Erebidae: Lepidoptera)**

Adults are the damaging stage, which suck the juice from the ripe fruits resulting in dropping of fruits. It also attacks mango, grapes and pomegranate fruits. Adult is a large sized moth beautifully coloured with orange coloured hind wings having bean shaped black spot in the centre in case of *E. fullonica* and circular black spot in case of *E. materna*.

. Caterpillars feed on foliage of weeds like *Tinospora cardifolia* and *Cocculus hirsutus* etc. Eggs are laid on weed plants the caterpillars feed on these plants and develop and pupate in the leaf folds. It also attacks mango, grapes, guavas, apple, peach, tomato and pomegranate fruits.

**3. Stem borer: *Chelidonium cinctum* (Guer) (Cerambycidae: Coleoptera)**

Adult is an elongate beetle measuring about 1-1.5 inch in length with dark metallic greenish blue shiny body. There are transverse yellow bands in the middle of elytra. The full-grown grub measures about 1½ inch in length. The grub is pale yellowish white in colour with broad anterior and narrow posterior ends. They bore into the branches resulting in the drying up of twigs. Ejection of chewed wood through the holes is seen prominently.

**4. Citrus butterfly: *Papilio demoleus* L. (Papilionidae: Lepidoptera)**

Adult is a beautiful butterfly with bluish green wings ornamented with yellow spots. Hind wings with brick red oval patches at the anal margin. Young caterpillars are greenish in colour with white and black patches look like bird droppings. The larvae feed on tender leaves. The full-grown caterpillar measures about 5 cm in length, stout and dark green in colour. Pupates on twigs in a chrysalis, which is suspended on the plant by a thin silken thread. Other food plant is curry leaf.

**5. Citrus Black fly: *Aleurocanthus woglumi* (Aleurodiade: Homoptera)**

Nymphs suck the sap from lower side of leaves and resulting in browning of leaves and reduction of fruit yield.

**B. SAPOTA**

Pests of national significance	Pests of regional significance
Leaf webber, Green scale, Fruit fly, Bud borer, Seed borer	Mealy bug

**1. Leaf webber: *Nephoteryx eugraphella* Rag. (Pyralidae: Lepidoptera)**

Moth is grayish in colour and lays pale yellow eggs on leaves singly. Larva is pinkish, webs the leaves and feeds on them.

**2. Bud worm/Bud borer: *Anarsia* sp. (Gelechiidae: Lepidoptera)**

Adult moth is grey coloured and hind wings are fringed. Caterpillar is small, slender, pinkish brown with yellowish brown prothoracic shield and black head. Caterpillar webs together floral buds or flowers and feed on them.

**3. Sapota seed borer: *Trymalitis margaris* (Tortricidae: Lepidoptera)**

The newly hatched caterpillar borers tiny sized fruit and finally caterpillar enters into seed of the fruit and completes its life cycle there only. Fruits with tiny exit holes are only indication of the pest. Pupation on green leaf or even on dried fallen leaves on the ground.

**4. Hairy caterpillar: *Metanastria hyrtaca* C. (Lasiocampidae: Lepidoptera)**

Female moth is stout with grayish brown wings. The male is smaller and has a white spot in the centre of a black patch on forewings. Antenna is pectinate. Long stout grayish hairy caterpillar has a black head and a median dorsal brownish band extending upto second abdominal segment. Caterpillars feed on leaves voraciously.

**C. POMEGRANATE**

Pests of national significance	Pests of regional significance
Anar butterfly, Stem borer, Whitefly, Shot hole borer, Thrips, Fruit borers	Fruit sucking moth, Fruit borers, Mealy bugs, Anar aphids

**1. Anar butterfly: *Deudorix* (= *Virachola*) *isocrates* Fb. (Lycaenidae: Lepidoptera)**

Adult is a medium sized, bluish brown or coppery brown butterfly has an orange spot on each of forewing and black spot on hind wing. hind wing has tail like projection on anal margin. The compound eyes and antenna are banded with white scales. The eggs are laid singly on flowers and tender fruits. The caterpillar bores into the fruit and feeds on the internal content. The affected fruits are subsequently attacked by fungus and bacteria resulting in rotting. The conspicuous symptoms of damage are offensive smell, excreta of larvae coming out of the entry holes and the litter sticking around the holes and anal segment of the caterpillar plugged with bored hole. It is known to attack mulberry, croton, casurina, mango etc.

**2. Shot hole borers: *Xyleborus parvulus* E.; *X. perforans* Wollastan (Curculionidae: Coleoptera)**

These are small brown to dark brown beetles measuring about 2-3 mm in length. The female lays oval shaped creamy white eggs singly in the bark. The whitish grub bores into the trunk exhibiting shot holes. These holes are plugged with brown coloured frass. Infested plant wilts in severe case. The grub pupates in the stem or branch. *X. perforans* is reported from Bijapur for the first time in the World.

**3. Pomegranate thrips: *Rhipiphorothrips cruentatus*, *Retithrips syriacus* (Thripidae: Thysanoptera)**

Attacks leaves and fruits.

**4. Pomegranate white fly: *Siphoninus phyllireae* ((Aleyrodidae: Homoptera)**

It infests in large numbers on the undersurface of leaves.

**5. Pomegranate aphid: *Aphis punicae* (Aphididae: Homoptera)**

It is pale green in colour. Both nymphs and adults suck the sap from tender shoots

**6. Fruit sucking moths: *Eudocima fullonica* (Linn.); *Eudocima materna* (Linn.); *Eudocima ancilla* Linn. (Erebidae: Lepidoptera):**

Refer under Citrus

**7. Hairy caterpillar: *Trabala vishnu* L. (Lasiocampidae: Lepidoptera)**

Adult is a medium sized moth with light greenish wings. The full grown caterpillar is grayish brown in colour and covered with thick tuft of brownish hairs. Pupation takes place in the saddle shaped cocoon. The caterpillars feed on leaves and tender shoots.

**D. BER**

<b>Pests of national significance</b>	<b>Pests of regional significance</b>
Fruit fly, Green slug caterpillar, Mite, Gray hairy caterpillar	Bark eating caterpillar, Leaf miner

**2. Ber fruit fly: *Carpomyia vesuviana* C. (Tephretidae: Diptera)**

Adult is small fly with black spots on the thorax and dark spots on the wings. The maggots bore into the riped fruits and feed on the pulp.

**2. Ber fruit borer: *Meridarches scyroides* Meyr. (Carpocinidae: Lepidoptera)**

The larva is reddish and adult is dark brown in colour. The larva bores into the fruits and feeds on the pulp around the seed.

**3. Ber seed weevil: *Aubeus himalayanus* Voss (Curculionidae: Coleoptera)**

Adult is a small brownish weevil. Eggs are laid on small fruits. Grub enters into pebble size fruit and feeds on developing seed. Entry hole gets healed up. Only one grub per fruit can be seen. Infested fruits become round and never increase in size. In case of infested fruits, the first half portion becomes reddish brown rough surface and second half towards naval region is normal. In Karnataka, this pest has been reported from the Bijapur for the first time.

**PESTS OF VEGETABLES  
(BRINJAL, TOMATO AND POTATO)**

**A. BRINJAL**

Pests of national significance	Pests of regional significance
Shoot and fruit borer, Jassids, Hadda beetle, Whitefly, Aphids, Spider mites	Shoot and fruit borer, Termites, Tobacco cut worm, Lacewing bug

**1. Shoot and fruit borer: *Leucinodes orbonalis* Guen. (Crambidae: Lepidoptera)**

Medium sized moth with brown and red patches on milky white wings. The larva bores into tender shoots resulting in dropping and drying of the tip. It also bores into flower buds and developing fruits. The affected fruits become unfit for marketing. The full-grown caterpillar is light pinkish in colour with warts and hairs. It pupates in the tough cocoon in the affected plant.

**2. Lady bird beetle/Hadda beetle: *Henosepilachna (=Epilachna) vigintioctopunctata* (F.) (Coccinellidae :Hemiptera)**

--Refer under potato--

**3. White fly: *Bemisia tabaci* (Genn.) (Aleyrodidae: Homoptera)**

Both adult and nymphs suck the sap from undersurface of leaves causing yellowing and drying of leaves.

**4. Lace wing bug: *Urantius hystriellus* (Richt.) (Tingidae: Hemiptera)**

Adults are straw coloured dorsally and dark brown to blackish ventrally, pronotum and forewing extended and reticulated (netted). Adults thrust the eggs into leaf tissue. Nymphs possess prominent spine on body and black colour. The nymphs and adults suck the sap mostly from the upper surface of leaves and cause yellowing of leaves in patches.

**5. Leaf weevil: *Myllocerus subfasciatus* G. (Curculionidae: Coleoptera)**

Ash or brownish coloured weevil feed on foliage by notching leaf margin and grub feed on the roots causing wilting.

**6. Brinjal mite: *Tetranychus urticae, Tetranychus cinnabarinus* (Tetranychidae: Acari)**

Both nymphs and adults suck the sap from lower surface of leaves resulting in yellowing of leaves.

**B. TOMATO**

Pests of national significance	Pests of regional significance
Gram pod borer, Tobacco caterpillar, Whitefly, Serpentine leaf miner, Thrips, Spider mite	Aphid

**1. Fruit borers: *Helicoverpa armigera* (Hb.) (Noctuidae: Lepidoptera)  
*Spodoptera litura* (Fab.) (Noctuidae: Lepidoptera)**

(Refer under maize and tobacco respectively for adult characters) The caterpillars bore in to the fruit and tender foliage. A circular hole is seen which reduce the quality and market value.

**2. Leaf miner: *Lyriomyza trifolii* (Agromyzidae: Diptera)**

The adult is a tiny metallic pale yellow in colour. The maggot mines in to the leaves below the epidermal layer in a zigzag manner and pupates inside the leaf mines. In severe cases the mined leaves dry up. It also attacks cotton, safflower, peas, beans and vegetable crops.



**3. Fruit sucking moth: *Eudocima fullonica* Linn.; *E. meterna* Linn.; *E. ancilla* Linn.  
(Erebidae: Lepidoptera)**

Adults are damaging stages. The adults puncture the fruits with proboscis and suck the sap resulting in rotting of fruits.

**4. Pin worm/ South american leaf miner: *Tuta absoluta* : (Gelechiidae: Lepidoptera)**

It's a quarantine pest. The moth has a grey-brown colour with black spots on narrow wings. Eggs are laid singly on underside of leaves, on buds or on the calyxes of green fruit. Caterpillar usually found between upper and lower leaf epidermis, feeding on mesophyll tissues and causing mines or blotches on leaves. It also causes damage to fruit by making pin holes which is plugged with frass. Pupation is in the soil / on the surface of a leaf, in a curled-up leaf or in a mine. Other Solanaceous crops are also act as alternate hosts for this pest.

**C. POTATO**

Pests of national significance	Pests of regional significance
Potato tuber moth, Jassids, Whitefly, Aphids	Leaf miner, Spider mites, Tobacco caterpillar,

**1. Potato tuber moth: *Phthorimaea operculella* Z. (Gelechiidae: Lepidoptera)**

Moth is a small dark brown moth. Fore wings are grey brown with minute dark spots Both pairs of wings are narrow and fringed. It is pest of both field and storage. In field, the larvae mine into leaves and bore into tender shoots and exposed developing tubers. In storage, caterpillar bore into the tubers and fill the holes with excreta. The caterpillars are light green or pale yellowish pink in colour. The caterpillar pupates in a coarse silken cocoon on the potato or on the gunny bag in which tubers are stored.

**2. Cutworm: *Agrotis ipsilon* (Hofn.) (Noctuidae: Lepidoptera)**

This is a polyphagous and nocturnal insect Adult is a black coloured medium sized moth, fore wings are dark brown in colour with spots in the centre and wavy lines at the margin. The hind wings are dull white with smoky margin. The larva is dark brown in colour. Larvae feed on leaves and also cut the tender stems of young and growing points.

**3. Lady bird beetle/Hadda beetle: *Henosepilachna vigintioctopunctata* (F.)  
(Coccinellidae: Coleoptera)**

These beetles are hemispherical and pale brown with 28 black spots on the elytra. The grubs are yellowish with a number of spines on the body. Both adults and grubs scrape the epidermis of the leaves from the upper side and produce characteristic streaks and skeletonizing the leaves totally. The affected leaves dry and fall off. It also attacks brinjal and tomato crops.

**4. Potato Shoot borer: *Leucinodes orbonalis* Guen. (Crambidae: Lepidoptera)**

The larva bores into tender shoots resulting in drooping and drying of the tip.

**PESTS OF VEGETABLES**  
(SWEET POTATO, CHILLI, ONION, GARLIC, BHENDI AND AMARANTHUS)

**A. SWEET POTATO****1. Weevil: *Cylas formicarius* (Fb.) (Brentidae: Coleoptera)**

Adult is an ant like weevil, steel black in colour with reddish brown thorax and legs. Grubs are whitish in colour and legless. They bore into vines causing wilting of branches. They also feed on tubers by making tunnels. Adults nibble the vines and tubers.

**2. Tortoise beetle: *Aspidomorpha miliaris*; *Cassida circumdata* (Chrysomelidae: Coleoptera)**

Adults are broad oval/shaped, brownish red in colour with black dots. Grub is flattened yellowish green with spiny processes covering the body. The 2 rows of 5 square round black spot on thoracic area and 7 rows of 2 narrow rectangular black spots on abdominal region. Both adult and grubs bite holes on leaves.

**3. Leaf miner: *Acrocercops prosacta* (Gracillariidae : Lepidoptera)**

Moth is tiny, with brown forewings and grey hindwings. Larvae mine and cause blotches on leaf lamina, attacked leaves curl and become deformed.

**B. CHILLI**

Pests of national significance	Pests of regional significance
Gram pod borer, Tobacco caterpillar, Aphids, Thrips, Yellow mites	Gram pod borer, Whitefly, Aphids, Thrips

**1. Chilli fruit borer: *Helicoverpa armigera* Hb. (Noctuidae: Lepidoptera)**

The larvae feed voraciously on fruits making a large hole and completely devouring the internal contents. Caterpillar while feeding on fruits keeps half of its body outside. The affected fruits become white in colour

**2. Tobacco caterpillar: *Spodoptera litura* (Hubner) (Noctuidae: Lepidoptera)**

Caterpillars act as defoliator and once the fruits are formed bore into fruits and fruits rotten if it rains.

**3. Thrips: *Scirtothrips dorsalis* Hood (Thripidae: Thysanoptera)**

These are elongate yellowish brown small insects measuring 2-3 mm. Both adults and nymphs lacerate and imbibe the sap from tender leaves resulting in inward curling of leaves, stunted plant growth and dropping of flower buds and fruits. In severe infestation, affected leaves become brittle. These are known to transmit leaf curl mosaic virus.

**4. Chilli yellow mite: *Polyphagotarsonemus latus* (Banks) (Tarsonomidae: Acari : Acarina)**

These are yellowish green in colour and translucent in nature and measure about 0.1 mm in size. They appear in the terminal or auxiliary tender shoots. Nymphs and adults suck sap from lower surface of the leaves resulting in downward curling of leaves, brittle and shiny coating on leaves.

### C. ONION AND GARLIC

Pests of national significance	Pests of regional significance
Onion thrips, Onion maggot, Bulb mite, Eriophid mite, Red spider mite	Cut worm, Tobacco caterpillar, Gram pod borer

**1. Thrips: *Thrips tabaci* Lind. (Thripidae: Thysanoptera)**

Adults are pale yellow in colour and possess fringed wings. Both adults and nymphs are congregated, under leaf sheath and suck the sap by lacerating the leaf tissue resulting in the formation of white speckles. The leaves dry downwards from tip. In severe cases the entire plant becomes wilted.

**2. Onion maggot: *Hylemya antiqua* (Muscidae: Diptera)**

Bulb and stem are bored by maggot.

**3. Onion bulb fly: *Delia antiqua* (Antomyiidae: Diptera)**

Adult is slender, grayish fly having large wings. Maggots burrow down into the underground portion of stem and bulb. This results in withering of plants and rotting of bulbs in storage.

**4. Leaf eating caterpillar: *Spodoptera litura* F. & *S. exigua* (Noctuidae : Lepidoptera)**

Caterpillars act as defoliators

### D. OKRA

Pests of national significance	Pests of regional significance
Shoot and fruit borer, Gram pod borer, Jassids, Aphids, Whitefly, Red spider mite	Red cotton bug, Ash/gray weevils, Stem fly

**1. Shoot and fruit borer: *Earias vittella* (F.) (Noctuidae: Lepidoptera)**

The caterpillars bore into the fruits resulting in reduction in quantity and quality of produce which is unacceptable in market (Refer under cotton).

**2. Leafhopper: *Amrasca biguttula biguttula* Ishida (Cicadellidae: Homoptera)**

Adults and nymphs suck the sap from the lower surface of the leaf resulting in curling and crinkling of leaves and stunted growth (For details refer under cotton).

**3. Whitefly: *Bemisia tabaci* (Genn.) (Aleyrodidae: Homoptera)**

These are responsible for transmission of the vein clearing disease i.e. yellow vein mosaic virus disease. (Refer under cotton also).

**4. Shoot weevil: *Alcidodes affaber* Auriv. (Curculionidae: Coleoptera)**

Adult is grayish brown weevil with pale cross bands on the elytra. The hind wings are membranous and smoky in colour. The weevil measures 8.5 mm in length. Adults feed on leaf buds, petioles and tender terminal portion. The grubs are apodous and yellowish white in colour. The initial feeding by the grub results in gall like swelling. Further, the grub bores downwards into the stem making exit holes through which a frothy mucilaginous mass comes out. The affected plant is stunted bearing less number of flowers and fruits. It pupates in the stem.

### E. AMARANTHUS

**1. Leaf caterpillar: *Hymenia recurvalis* (Crambidae: Lepidoptera)**

Small black coloured moth with slender body. Wing is dark brown in colour with broad white lines in the middle and outer margins with fringes of hairs. Larva – Greenish with white lines. Scraping of epidermal layer, webbing of leaves with silken threads and drying up of webbed leaves.

### PESTS OF CRUCIFEROUS VEGETABLES

Crop	Pests of national significance	Pests of regional significance
Cabbage	DBM, Head borer, Cabbage aphid, Leaf webber, Cabbage butterfly, Tobacco caterpillar	DBM, Tomato fruit borer, Leaf eating caterpillar, Serpentine leaf miner

#### 1. The Diamond back moth: *Plutella xylostella* (L) (Plutellidae: Lepidoptera)

The moth is grayish brown with narrow wings having pale white triangular marking at the anal margin, which forms diamond like white patch dorsally when at rest. Eggs are deposited singly on the under surface of leaves along the veins. The larva is greenish with thin hairs. It feeds on the foliage, bites holes and damages the cabbage. The full-grown caterpillar is greenish with the anterior region pale brown in colour. Pupation takes place in a white silken cocoon, which is often exposed.

#### 2. Cabbage aphid: *Brevicoryne brassicae*, *Myzus persicae* Sulz. (Aphididae: Homoptera)

These aphids are green in colour. Both young ones and adults are found in colonies and suck the sap resulting in the retardation of growth. Sooty mould development makes the produce unfit for market.

#### 3. Leaf webber: *Crociodolomia pavonana* (Fabricius) (= *Crociodolomia binotalis* Z.) (Crambidae: Lepidoptera)

Adult is a pale yellowish brown moth marked with wavy black lines and speckles on fore wing. Male moth is characterized by the presence of tuft of hairs at the base of costal margin of fore wings. Eggs are flat and laid in masses. The larva is green with red or reddish brown head and longitudinal brown stripes on the body. They web the leaves with silken thread and feed. Pupation either in the plant or in the soil.

#### 4. Cabbage Butterfly: *Pieris brassicae* L. (Pieridae: Lepidoptera)

The butterfly is fairly large, yellowish-white in colour with black distal margins on the fore wings. Hind wings are also pure white with black apical spot. The caterpillars are conspicuous in colour (mixture of black and yellow), with a covering of fine hairs. The full-grown caterpillar is about 1.9 cm long. The chrysalis is naked and tied by a girdle. The larvae defoliate leaves and damage the crop.

#### 5. Cabbage head borer: *Hellula undalis* Fb. (Crambidae: Lepidoptera)

The moth is small with wavy lines and a central elliptical marking on its forewing. It lays yellowish shiny eggs on the leaves. The brownish larva has a black head and four longitudinal lines on the body. The larvae web the leaves or bore into stem, stalk or leaf veins. Thus they become unfit for marketing.

#### 6. Cabbage Green Semilooper: *Trichoplusia ni* Hb. (Noctuidae: Lepidoptera)

The moth is stout, brown in colour, with light wavy markings and a more slender Y mark on fore wings. The female lays greenish white spherical eggs singly on the under surface of leaves. The caterpillar is green in colour with light wavy white lines and a broader lateral strip. It pupates in a thin cocoon on the under surface of the leaflets. Under heavy infestation, entire leaf is skeletonised leaving only the midrib.

#### 7. Painted bug: *Bagrada cruciferarum* F. (Pentatomidae: Hemiptera)

Adult is small dark brown bug with red and yellow markings on the body and appears as if painted and measures 0.5 cm in length. The vigour of the crop is reduced by its feeding.

#### IPM for Cruciferous vegetable:

- ✓ Soil solarization: Cover the beds with polythene sheet of 45 gauge (0.45 mm) thickness for three weeks before sowing for reducing the soil borne pests.

- ✓ Apply neem cake @ 100 kg/acre at the time of transplanting for reducing nematodes and borer damage.
- ✓ Trap crop: Sowing 2 rows of bold seeded mustard as a trap crop for every 25 rows of cabbage to attract moths to mustard. Plant the first row 12 days before transplanting and the second row 25 days after transplanting
- ✓ Install pheromone traps @ 4-5/acre for monitoring of DBM
- ✓ Release egg parasitoid, *T. chilonis/pretiosum* @ 20,000/acre 4-6 times at weekly interval. Release larval parasitoids, *Diadegma semiclausa* @ 1,00,000/acre or *Cotesia plutellae* @ 20,000/acre from 20 days after planting for DBM
- ✓ Foliar spray with 5% NSKE or azadirachtin 3000 ppm @ 1 ml/l
- ✓ Install yellow sticky traps, yellow water pan traps @ 12/acre to monitor alates aphids
- ✓ Erecting of bird perches for encouraging predatory birds such as mynah, drongo etc for tobacco caterpillar
- ✓ Use of ovipositional trap crops such as castor @ 250 plants/acre and collection of larvae from flowers for tobacco caterpillar.

**PESTS OF CUCURBITACEOUS VEGETABLES**

Crop	Pests of national significance	Pests of regional significance
<b>Cucumber</b>	Fruit fly, Pumpkin beetle, Hadda beetles, Serpentine leaf miner, Aphids, Pumpkin leaf caterpillar, Tobacco caterpillar	Fruit fly

**1. Fruit fly: *Bactrocera (=Dacus) cucurbitae* Coq. (Tephritidae: Diptera)**

Adult fly is bigger than housefly and characterized by its conical abdomen and brown markings on the membranous wings. The female fly thrusts the white elongate eggs into flowers and tender fruits. Whitish maggots feed on the pulp and seeds inside resulting in the premature fall of the fruits. Affected fruits may become soft and rotten. The maggots pupate in the soil. This insect attacks fruits of snake gourd, bitter gourd, melons and cucumbers.

**2. Pumpkin beetles: *Aulacophora foveicollis* (Lucas), *A. intermedia* Jacoby.  
*A. cincta* Fabr. (Chrysomelidae: Coleoptera)**

In *A. foveicollis* the elytra are reddish brown, while in *A. intermedia* they are bluish black in colour and *A. cincta* the elytra are yellow in colour with black border. These beetles bite holes on leaves and also feed on flowers. The eggs are laid in the soil. The grubs are white and feed on the roots resulting in the retardation of growth.

**3. Semilooper: *Thysanoplusia orichalsia* F. (Noctuidae: Lepidoptera)**

It is a polyphagous pest. Among the vegetables, besides cucurbitaceous and cruciferous, it also attacks tomato and other solanum species. The caterpillars are plump and palish green. They cause damage by biting round holes into cabbage leaves. On movement, they form characteristic half loops. The adults are light pale brown with a large golden coloured patch on each forewing.

**PESTS OF COCONUT, ARECANUT, BETELVINE, COFFEE AND TEA**

**A. COCONUT**

Pests of national significance	Pests of regional significance
Red palm weevil, Rhinoceros beetle, Black headed caterpillar, Mite	Chafer beetle, Eriophid mite

**1. Red palm weevil: *Rhynchophorus ferrugineus* F. (Curculionidae: Coleoptera)**

Adult is a reddish brown weevil measuring about 3-4cm in length and possess six dark spots on the thorax. The male weevil conspicuous long snout has tuft of hair, while it is absent in the female. The oval white eggs are laid in the scoops, or in the wounds on the trunk or crown. The full-grown grub is apodous and light yellowish with red head. Only grubs are injurious. They tunnel the trunk extensively resulting in the death of the palm. A few small holes plugged with fibrous material and oozing out of brown liquid are the indications of early infestation.

**2. Rhinoceros beetle: *Oryctes rhinoceros* L. (Scarabaeidae: Coleoptera)**

The beetle is a black to reddish black with horn on the pronotum, which is long in the male and short in the female. The beetle measures 5 cm long. The female lays oval creamy white eggs in manure pits to a depth of 5-15 cm. The grub feeds on the decaying matter. It is stout, sluggish and scarabeid form. The grub is white in colour with pale brown head. Adults are responsible for the damage. They attack the palm in the crown region and cut across the leaf in its folded condition. Attacked fronds when fully opened exhibit a characteristic geometric cut. In young plants, central spindle is cut. The chewed fibrous material is seen plugging the entry hole.

**3. The black-headed caterpillar: *Opisina arenosella* Meyr. (Oecophoridae: Lepidoptera)**

Moth is brownish gray in colour with a wing expanse of 2.5 to 3 cms. Margins of wings are slightly round and fringed. Eggs are scale like laid in groups on the ventral surface of the fronds on the fross. Larva is greenish brown with a dark brown head and prothorax and reddish meso thorax. Larvae live on under surface of leaflets within galleries of silk and frassy material and feed by scrapping green matter. Damaged fronds show dried up patches of leaf lets. Pupation takes place inside the galleries.

**4. The coconut eriophyid mite: *Aceria (=Eryophyes) guerreronis* K. (Eryophyidae: Acari)**

This pest has been reported in 1998 as a serious pest of coconut in Kerala and Tamil Nadu. Now it has spread to almost all coconut growing States. Mites are congregate beneath the perianth of developing nuts and suck the sap from the tender meristematic mesocarp tissues. Damage initially appears as triangular bands or patches at level of perianth. These patches turn yellow and then become brown, resulting in *warts* and numerous *longitudinal fissures* on the husk of developing nuts. The mite completes one life cycle in 9 to 12 days. One female lays about 18 eggs.

**5. Termite: *Odontotermes obesus* (Termitidae : Isoptera)**

Damages coconut seedlings and also grown up trees. Makes earthen galleries on the stem and feeds inside. Under sever infestations the tree may collapse.

**B. ARECANUT**

**1) Inflorescence caterpillar: *Tirathaba mundella* (Pyralidae: Lepidoptera)**

Moth is small with ashy wing. Larva dirty yellow or white with brown head. Caterpillar bore into the spathe by making small holes and feed on inflorescences and rachillae. Webbing and feeding the inflorescence leads to delayed opening of spathe. Presence of small holes with frass and drying of spathe are characterstic symptoms.

2) **Root grubs:** *Leucopholis lepidophora* Blanch; *L. burmeisteri* Brenske; *L. coniphora*

**Burn (Scarabidae: Coleoptera)**

Adult is medium sized chestnut brown beetle. Grubs are 'C' shaped softbodied with brown head. Grubs feed on young roots of palm throughout the year. Yellowing of leaves-tapering of the stem, reduced inter nodal length, reduced number of bunches. Palm becomes weak and show sickly appearance. Fell down during the heavy windy or rainy days. In case of seedlings damage they can be pulled easily.

3) **Termite:** *Odontotermes obesus*

Damages arecanut seedlings and also grown up trees. Makes earthen galleries on the stem and feeds inside. Under sever infestations the tree may collapse.

4) **Spindle bug:** *Carvalhoia arecae* Goel (**Miridae: Hemiptera**)

Adult is a red and black bug measuring 6 mm long. Nymphs are greenish with reddish brown patches. Adults and nymphs remain clustered within the top most leaf axils and suck sap from central shredded and stand erect and yield is reduced.

5) **Scale Insects:** *Aonidiella orientalis* (Newstead) (**Diaspididae: Hemiptera**)

They suck the sap from the fronds and sheaths and adversely affect vitality of plant.

**C. BETELVINE**

1) **White fly:** *Dialeurodes pallida* (**Aleyrodidae: Homoptera**)

Adults are minute insects, body covered with white waxy bloom. Nymphs are oval in outline. Both nymph and adults suck the sap results in chlorotic spots on the leaves.

2) **Aphid:** *Aphis gossypii* - See under cotton -

3) **Betelvine scale:** *Lepidosaphes cornutus* (**Diaspididae: Hemiptera**)

Nymphs and adults. Yellowing of Betelvine leaves with grey coloured armoured scales covering them. Leaves, stem and petioles are covered.

**D. COFFEE**

1. **The coffee white borer:** *Xylotrechus quadripes* Ch. (**Cerambycidae: Coleoptera**)

Adult is an elongate dark brown beetle with two white cross bands on the elytra. Eggs are laid in cracks and crevices of the bark on the stem. Grub is pale yellow in colour and slightly swollen towards the anterior end. The grub tunnels into the stem and branches resulting in the death of the plant and wilting of the branches. Galleries are filled with fross. Yellowing leaves and swellings on the stem are the symptoms of the attack by this pest. The larva pupates inside the stem. It is a serious pest on arabica coffee.

2. **Shot hole borer:** *Xylosandrus compactus* E. (**Curculionidae: Coleoptera**)

Beetle is small cylindrical and dark brown in colour. It measures 3mm. Adult excavates galleries in which eggs are laid. Grub is small, dirty white in colour. The grubs bore into the twigs resulting in the drying of affected branch. From the infested branches powdery matter is thrown out. Pin holes and die back are characteristic symptom of this pest. The pupation takes place inside the tunnels. Adults emerge through shot holes in the bark.

3. **The coffee red borer:** *Zeuzera coffeae* (**Cossidae: Lepidoptera**)

Larva is orange red coloured and smooth. Wilting of branches or plant. Presence of bore holes plugged with excreta at the base of the plant.

4. **Coffee berry borer:** *Hypothenemus hampei* (**Curculionidae: Coleoptera**)

Beetles dark coloured. Females winged and males are wingless. Female beetles bore into the berries and make tunnels. A typical pin hole at the tip of the berries indicates the presence of the pest. Pupation takes place inside the tunnels.



**5. Coffee green bug: *Coccus viridis* (Gr.) (Coccidae: Hemiptera)**

The scale is 3 mm long, flat, oval and slightly convex and yellowish green in colour. Males are apterous. Both adult and nymphs suck the sap from tender leaves and shoots. The vigor of the affected plant is lost.

**6. Coffee green grasshopper: *Aularchis miliaris* W. (Acrididae: Orthoptera)**

These are foliage feeders. The adults are light green with dull yellow spots on the tegmina. The life cycle resembles other short horned grasshoppers.

**E. TEA**

Pests of national significance	Pests of regional significance
Tea mosquito bug, Thrips	Mites, Leaf roller, Aphids

**1. Tea mosquito bug: *Helopeltis antonii* Stainton (Miridae: Hemiptera)**

(Refer under Cashewnut)

**2. Tea thrips: *Taeniothrips setiventris* (Thripidae : Thysanoptera)**

The nymphs and adults lacerate the leaf tissue and suck the sap. The affected parts dry-up.

**3. Red spider mite: *Oligonychus coffeae* (Tetranychidae: Acarina)**

The infested leaves turn to bronze colour and in severe cases leaves become crumpled.

**Scarlet mite: *Brevipalpus* sp.**

**Purple mite: *Calacarus carinatus* (Green)**

**Pink mite: *Acaphylla theae* Watt (Eriophyidae: Acari)**

They suck the sap from tender leaves, so leaves become brownish and crumbled.

**4. Tea red borer: *Zeuzera coffeae* Neitner (Cossidae: Lepidoptera)**

Moth is white with many small black spots on the forewings. The larvae bores into bark, tunnels down through main stem and reach upto tap root. Affected branches wither and die.

**PESTS OF TURMERIC, ZINGER AND CURRY LEAF****A. TURMERIC AND GINGER****1. Castor capsule borer: *Conogethes (=Dichocrosis) punctiferalis* Guen. (Crambidae: Lepidoptera)**

The caterpillar enters into aerial stem killing the central shoot which results in the appearance of dead heart.

**2. Turmeric Rhizome fly: *Mimegralla coeruleifrons* Macquart (Micropezidae: Dipera)**

It is a secondary pest. It feeds on rotting rhizomes.

**3. Bihar hairy caterpillar: *Spilarctia (=Spilosoma) obliqua* Wlk. (Erebidae: Lepidoptera)**

Caterpillars defoliate the leaves.

**4. Turmeric skipper: *Udaspes folus* C. (Hesperidae: Lepidoptera).**

It is a specific pest. The greenish larva remains feeding in the leaf folds and pupates there itself.

**5. Coccid: *Aspidiotus hartii* C. (Diaspidae : Homoptera)**

Infests rhizomes under storage.

**B. CURRY LEAF**

<b>Pests of national significance</b>
Citrus butterfly, Citrus psylla, Scales, Mealy bugs, Aphids, Tortoise beetle, Citrus leaf miner, Two spotted mites

**1. Citrus butterfly: *Papilio demoleus*: (Papilionidae: Lepidoptera)**

Adult is dark brown swallow tailed butterfly with numerous pale yellow markings. Early instar larva resembles bird droppings. Grown up larva is cylindrical, stout and green with brown lateral oblique bands. It causes defoliation of tender leaves.

**2. Psyllid: *Diaphorina citri* (Psyllidae: Hemiptera)**

Adults are small, soft bodied insects with wings having pink coloured veins. Nymphs are yellowish in colour. Both adults and nymphs congregate on tender shoots and leaves and suck the sap. These insects excrete honeydew on which sooty mould develops.

## PESTS OF CARDAMOM, CASHEW, CORIANDER AND PEPPER

### A. CARDAMOM

Pests of national significance	Pests of regional significance
Cardamom thrips, Capsule borer, Early capsule borer, Root grub	Cardamom whitefly, Hairy caterpillars, Shoot fly, Lace wing bug, Cardamom aphid, Cutworm, Midrib caterpillar, Rhizome weevil, Red spider mite

#### 1. Cardamom thrips: *Scirtothrips cardamomi* (Rank.) Bhatti (Thripidae: Thysanoptera)

These are tiny black elongated insects with fringed wings. Adults and nymphs lacerate and suck the sap from leaf sheaths, flowers and developing green capsules. Affected capsules are malformed due to the scab development on the pods. It also causes shedding of flowers and pods.

#### 2. Capsule borer: *Conogethes (=Dichocrosis) punctiferalis* (Guenee) (Crambidae: Lepidoptera)

Adult is a medium sized light yellow moth with number of black spots on both the pairs of wings. Caterpillar is pinkish in colour with dark warts and short hairs. The larva tunnels into the leaf whorls and stem causing dead heart. It also bores into inflorescence, capsules and damages the seeds. The entry holes are plugged with excreta.

#### 3. Hairy caterpillars: *Eupterote cardamomi* L.; *Eupterote canaraica* M. (Eupterotidae: Lepidoptera)

Moths are large stout, yellowish to brown in colour with black wavy markings. Eggs are laid in masses on the leaves of the shade trees. Full-grown larvae possess brown hairs, which are irritating upon touch. Larvae feed voraciously and defoliate the crop. Caterpillars congregate at the base of tree trunks during the day. Pupation is in the soil.

### B. CASHEW

Pests of national significance
Tea mosquito bug, Stem borer, Leaf miner, Thrips, shoot & Blossom webber

#### 1. Tea mosquito bug: *Helopeltis antonii* Stainton (Miridae: Hemiptera)

Adult is a mosquito like reddish brown bug with long legs and antennae. The thorax has a characteristic horn. The nymphs are amber coloured. Both the adults and nymphs attack the tender shoots, inflorescence, rachis and tender fruits by puncturing and sucking the sap. At every puncture a brownish black lesion appears. The affected shoot / panicle dries up.

#### 2. Cashew root and shoot borer: *Plocaederus ferrugineus* L. (Cerambycidae: Coleoptera)

This longicorn beetle is medium sized with reddish brown body colour. The grubs are white in colour and tunnels the stem and move downwards and bore into roots, where in it pupates in calacareous chamber. In severe case gummosis of stem and yellowing followed by drying. It is a major pest in costal Karnataka.

### C. CORIANDER

#### 1. Whitefly: *Bemisia tabaci* (Aleyrodidae: Homoptera)

The adults and nymphs suck the sap from the plants and adversely affect the growth.

#### 2. Aphid: *Hyadaphis coriandri* Das. (Aphididae: Homoptera)

Both adults and nymphs are yellowish green in colour and both suck the plant sap, which leads to twisted leaves, and glistening appearance on plants due to honey dew and sooty mould.

**3. Mealy plum aphid: *Hyalopteus pruni* (Aphididae: Hemiptera)**

Adults appear grey. Both nymphs and adults suck sap from leaves resulting crinckling, plants appear glistening because of honey dew and sooty mould.

**D. PEPPER**

Pests of national significance
Pollu beetle, Top shoot borer, Leaf gall thrips

**1. Pollu beetle: *Longitarsus nigripennis* (Chrysomellidae: Coleoptera)**

Adults are oblong beetle with broad body and shiny black elytra and enlarged femur. Young grubs with transparent body and grown up grubs yellowish or brownish. Berries with exit holes are seen. Affected berries dry up and turn back, become hollow and crumble when pressed. Irregular feeding holes are seen on leaves.

**2. Berry gall midge: *Cecidomyia malabarensis* (Cecidomyiidae: Diptera)**

Affect the berries, so affected berries appear larger with maggots inside.

**PESTS OF ORNAMENTAL PLANTS  
(ROSE, JASMINE, CHRYSANTHEMUM, CROSSANDRA, ANTHORIUM,  
GLADIOLUS, TUBEROSE AND GERBERA)**

**A) ROSE****1. Plant lice: *Macrosiphum rosaformis* (D.) (Aphididae: Homoptera)**

These often attack tender leaves, shoots and flowers of rose. The honeydew secretion will affect the marketing quality of the produce by means of sooty mould development.

**2. Thrips: *Rhipiphorothrips cruentatus* H. (Thripidae: Thysanoptera)**

The nymphs and adults lacerate and suck the sap from the leaves and flowers. In severe case affected part become sickly and dryup.

**3. Scale: *Aonidiella arantiae* F. (Coccidae: Homoptera)**

The scales suck the plant sap from tender shoots and deform the rose plant.

**4. Slug caterpillar: *Latoia* (=Parasa) *lepida* Cramer (Cochlididae: Lepidoptera)**

Greenish blue larva posses spines, which give irritation upon touch. They feed on leaves and act as defoliators. The alternate hosts include castor, mango, banana, pomegranate etc

**5. The leaf caterpillar: *Euproctis fraterna* (M.) (Lymantridae: Lepidoptera)**

Adult moths are medium sized with three black spots at the apical region of forewings. The female lays eggs on the under surface of leaves and cover them with hairs. Larvae posses hairs on the body and feed on leaves and flowers. Pupation in silken cocoon.

**B) JASMINE****1. Jasmine bug: *Antestiopsis cruciata* F. (Pentatomidae: Hem.)**

Specific pest of jasmine. It is an active flattish oval shaped stink bug. It causes serious damage by sucking the sap from tender shoots and buds preventing flower formation.

**2. Mealy bug: *Phinococcus ornatus* (Coccidae: Homoptera)**

Mealy bugs attacks the tender leaves and shoots of Jasmine and suck the sap resulting yellowing of plant and wilting. These insects secretes honeydew on wich sootymold develops.

**3. Red scale: *Aonidiella aurantii* (Coccidae: Homoptera)**

These suck sap from the tender shoots and buds and make the plants to fade.

**4. Bud worm: *Hendecasis duplifascialis* Hmps. (Crambidae: Lepidoptera)**

Adult is a small, white moth with black palpi and three lines on abdomen. Larva is dark green with black head. Larvae webs the buds with silken thread and feed on the inner content and then make a hole and move to another head.

**5. Thrips: *Isoneurothrips orientalis* L. (Thripidae: Thysanoptera)**

Female lays 15-20 eggs; the incubation period is 5-7 days. The prepupal period is one day. Pupate in soil and debris. Nymphs and adults lacerate the leaves and flowers resulting upward curling of leaves.

**6. Mite: *Aceria jasminae* Channabasavann (Eriophyidae: Acari)**

Mites colonized and feed on foliage resulting white hairy out growths on the leaf surface, on tender stem and on the flower buds. Consequently reduction in flower production. This whitish patch is called as "Erinium".

**7. Blossom midge: *Contarinia maculipennis* Felt (Cecidomyiidae: Diptera)**

It damages flower bud shows purple discolouration.

## C) CHRYSANTHEMUM

### 1. Thrips: *Haplothrips ramakrishni* (Thripidae: Thysanoptera)

Both nymph and adult feed by lacerating on the leaves and flowers.

### 2. Leaf miner: *Lyriomyza trifolii* B. (Agromyzidae: Diptera)

The adults and young ones are black and yellow in colour respectively. The maggots mine into the leaves and leaflets and feed on leaf content.

### 3. Black aphid: *Macrosiphoniella sanbarni* G. (Aphididae: Homoptera)

These are black in colour; both nymphs and adults suck plant sap from leaves, flowers and tender shoots results in yellowing and drying.

### 4. Mealy bug: *Pseudococcus citri* (Coccidae: Homoptera)

These insects infest leaves and shoots and secrete sugary substance. The development of sooty mould affects the quality of the flowers.

## D) CROSSANDRA

### 1. Tussock caterpillar: *Dasychira mendosa* Hb. (Lymantriidae: Lepidoptera)

The adult is smoky brown with pale grey hindwings and a patch in the centre of forewings. Larva is light brown with reddish brown spots. Full grown larva measures 3.8 cm. Caterpillars cause damage by feeding on leaves.

### 2. Leaf scale insect: *Temnaspidotus excissus* (Gr.) (Diaspididae: Hemiptera)

Suck the sap from the leaves and turn them yellow. The affected leaves ultimately drop.

### 3. Aphid: *Aphis craccivora* Koch (Aphididae: Hemiptera)

Both adults and nymphs feed by sucking the sap from tender leaves and inflorescence. The affected inflorescence fails to open and leaves dry off.

## E) GLADIOLUS

### 1. Aphid: *Aphis gossypii* Glover (Aphididae: Homoptera)

These are yellow to green coloured adults and suck the plant sap from the leaves and tender shoots.

### 2. Thrips: *Taeniothrips simplex* (More) (Thripidae: Thysanoptera)

Adult is black with lighter markings on wings. Nymphs are light yellow in colour. Both adult and nymph suck the sap resulting irregular opening of flower buds or unopened flower bud. Affected parts show unnatural glistening, whitish-grey colour.

### 3. Mealy bug: *Pseudococcus maritimus* (Coccidae: Homoptera)

### 4. Wireworm: (Elateridae: Coleoptera)

The grubs feed on the roots and bore into the petiole of leaves and flowers.

### 5. *Helicoverpa armigera* (Hb.) (Noctuidae: Lepidoptera)

Larvae feed on all parts of the plant.

### 6. Seed corn maggot: *Hylemya cilicura* (Anthomyidae: Diptera)

Maggots feed on seeds of Gladiolus by entering the capsules in the field or webbing the seeds in storage.

## F) TUBEROSE

### 1. Red spider mite: *Tetranychus urticae* Koch (Tetranychidae: Acarina)

Mites suck the sap which results in yellow stripes and streaks on the foliage. In due course of time the leaves become yellow, silvery/ bronze and distorted.

**2. Thrips: *Thrips tabaci* Lind. (Thripidae: Thsanoptera)**

Feed on leaves, flower stalks and flowers. They suck sap from all these parts and ultimately damage the whole plant.

**3. Cabbage butterfly: *Pieris brassicae* Linn. (Pieridae: Lepidoptera)**

Young larva bores into the buds and feed on the internal contents.

**G) GERBERA**

**1. Broad mite: *Hemitarsonemus latus* Banks (Tasronemidae: Acarina)**

The mite infests leaves and cause bronzing of lower leaf surface and distortion of flowers, stunted growth. In case of sever infestation extensive necrosis of young buds leads to reduction in yield and growth of the plant.

**2. Leaf miner: *Liriomyza* sp. (Agromyzidae: Diptera)**

The maggots mine into leaves leaves and infested parts die prematurely.

## STUDY OF COLEOPTERAN, LEPIDOPTERAN AND OTHER STORED GRAIN PESTS

Storage insects belong to two orders namely coleoptera (beetle pests) and lepidoptera (moth pests). In storage, insects causes damage by feeding on grains resulting quantitatively and qualitatively loss. Some of the storage insects are known to infest the grains in the field itself. eg. Weevils, Bruchids, Angoumois grain moth, etc). They may be grouped as internal feeders and external feeders.

### A. COLEOPTERAN PESTS

#### 1. Rice weevil: *Sitophilus oryzae* Linn. (Curculionidae: Coleoptera)

This is a small dark brown to black weevil with prolonged snout. The female scoops a small pit on the grain, lays an egg and covers it with gelatinous material. Grubs burrow into the seed and feed within seeds and making the grain hollow. Emerging adults cause holes on the seeds. It is a severe pest of cereals like rice, wheat, maize, jowar, paddy etc.

#### 2. Lesser grain borer: *Rhizopertha dominica* (Fabr.) (Bostrychidae: Coleoptera)

The beetle is dark brown, measures 3 mm long with a cylindrical body. The head is bent under the thorax. Antenna is serrate with 3-segmented. Grubs are small and white in colour with bent body. Both adults and grubs bore into the cereal grain and feed inside making irregular holes. It is a serious pest of cereals including paddy.

#### 3. Red flour beetle: *Tribolium castaneum* (Herbst); *Tribolium confucium* (Tenebrionidae: Coleoptera)

Beetles are small, elongate rust red coloured measuring 3-4 mm in length. Grub is flat, dull yellowish and body is covered with setae. Both adults and grubs are external feeders, feeding on broken grains, oilseeds, oil cakes, dried fruits, nuts and processed products like flours, soji, atta, maida etc. It also imparts bad smell to the commodity. The two species occur together and they can be distinguished based on the antennae.

#### 4. Saw toothed grain beetle: *Oryzaephilus surinamensis* Linn. (Silvanidae: Coleoptera)

This is a dark red flat beetle with 6 teeth like projections on either side of the pronotum and hence the name. It measures 3-4 mm in length. Adults and grubs are surface feeders and feed on grains, milled products, dried fruits, nuts, tobacco, dried meat etc.

#### 5. Khapra beetle: *Trogoderma granarium* (Everts.) (Dermestidae: Coleoptera)

Beetle is reddish brown to black; oval shaped measuring 1.5-3.0 mm with clubbed antennae. Larva campodeiform yellowish brown coloured with long brown hairs. Larva is the damaging stage, feeds on many kinds of grains and other products of vegetable origin. It also infest on products of animal origin.

#### 6. Pulse beetle: *Collosobruchus chinensis* (Linn.) (Bruchidae: Coleoptera)

These beetles exclusively feed on stored grain pulses like red gram, black gram, green gram, horse gram, cowpea etc. White eggs are visible on grains. Adults don't feed, grubs bore into the grain and feeding on the internal content. Adults are stout bodied beetles with serrate or pectinate antennae. Wings short and exposing the tip of the abdomen uncovered (Pygidium).

#### 7. Groundnut seed beetle/Tamarind beetle: *Caryedon serratus* L. (Bruchidae: Coleoptera)

It is the only major pest of groundnut in storage. The adult is 4-7 mm long and reddish brown, with dark irregular markings on the elytra. It has large prominent eyes and can be easily distinguished from other storage pests by its broad hind femur with conspicuous comb of spines. Female lays eggs on the pods or kernels. After hatching, grub burrows through the pod wall to reach the kernel and causes damage. The attacked groundnuts loose their commercial value and ultimately become unfit for human consumption.

### B. LEPIDOPTERAN PESTS

#### 1. Rice moth: *Corcyra cephalonica* Stainton (Pyralidae: Lepidoptera)

Adult is a pale grayish brown moth with a wing expanse of 2.5 to 3 cm. Larva is creamy white with reddish brown head and measures 2 cm. Larva is the damaging stage, which webs



together the broken grains with silk and fross and feeds on them. It feeds on Jowar, rice, wheat, maize and milled products like soji, oil cakes, dried fruits etc.

**2. Angoumois grain moth: *Sitotroga cerealella* Oliv. (Gelechiidae: Lepidoptera)**

This is a small moth; yellowish in colour with a wing expanse of 1 cm. Wings are narrow and fringed. It is an internal feeder. Larva is the damaging stage, which bores into a number of cereals including paddy.

**3. Fig moth / Almond moth: *Cadra cautella* W. (Pyralidae: Lepidoptera)**

Adult is a small gray moth. Larva is pale white and attacks flour and broken grains. Damage is similar to rice moth.

**4. Mediterranean flour moth: *Anagasta kuehniella* Linn. (Pyralidae: Lepidoptera)**

Adults are small gray coloured moths. Larva is pale white in colour and attacks flour and broken grains. Damage is similar to rice moth.

**5. Indian mealmoth: *Plodia interpunctella* (Hubner) (Pyralidae: Lepidoptera)**

Moth is partly copper coloured and whitish grey. They infest grains, meals, dry fruits and feed under thin silken web.

### C. OTHER STORED GRAIN PESTS

**I) RODENTS:** Rodents include rats, bandicoots, gerbils, Squirrels and Porcupines.

**A) Rats:**

Some of them occur in houses and others in fields and stores. Some of them burrow the land, floors, feed on grains, cause spillage of grains and collapse of stacks. In the field, they are serious pests on many cereals and oilseed crops. They contaminate the food stuffs with urine, hairs and their excreta.

**1. The house mouse: *Mus musculus* L.**

It can live indoors in close association with the house rat. It is the smallest measuring 2-3 inches. It destroys clothes, sacs, paper etc. and feeds on food materials.

**2. House rat: *Rattus rattus* L.**

It is the commonest house rat distributed all over India and the world. It weighs 150-300 g with slightly longer tail. It can occur in fields of coconut and other crops. It cannot burrow but can make nest in the trees.

**3. Brown or Norway rat: *Rattus norvegicus* W.**

It is found mainly at ports in tropical countries. As compared to *R. rattus*, it has blunt muzzle, smaller ears and tail. It is also found in sewages.

**4. Common field rat: *Rattus meltdada* Gray**

It has rounded earlobes and soft fur. It is found in irrigated fields, bunds, hedges and grasslands.

**5. Common Indian field mouse: *Mus booduga* Gray.**

It dwells in shallow burrows.

**6. Indian mole rat: *Bandicota bengalensis* Gray.**

It is found all-over India. It measures 6-9 inches and weighs 300 g. Live in extensive burrow. It destroys many crops.

**B) Bandicoot: *Bandicota indica* L.:** Largest in size.

**C) Gerbils: *Tatera indica* Hardw.**

They differ from rats in having their tails clothed in fur and ending in tassel. Live in unplanned burrows.

## **II) BIRD PESTS:**

Birds are important pests in fields and cause severe damage to the crops at milky stage, sometimes the damage being very severe in crops like sunflower, Jowar, pulses and also in fruits. They also feed on stored grains in store houses and threshing yards. Some birds feed on crop pests and are thus beneficial (eg. Myna).

1. Common house crow, *Corvus splendens* L.
2. Rose ringed parakeet, *Psittacula krameri* Scopoli
3. House sparrow, *Passer domesticus* L
4. Common myna, *Acridotheres tristis* L
5. Pigeon, *Columba livia* Gmelin
6. Peacock, *Pavo cristatus* L.

## **III) MITES:**

*Acarus siro*: In bagged storage formation of dust is the characteristic symptom. If an infested sample is kept in hand itching sensation is the sign of presence of mites. It attacks germ and other parts of grain *ie.* quality loss. One life cycle is completed in 5-11 days.