

R.S.M PG COLLEGE

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B.Sc.(Ag.)(Fourth Semester)

*Economic Entomology Including
Crops(ICAR), Paper- Fifth*

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Economic importance of insects

We live in a world teeming with insects. The number of individual species of

insects so far known is over a million and each of these species numbers into millions even billions of individuals. Doubtless, insects are harmful to us in one way or another but the benefits they offer in so many visible and invisible ways are also great that they cannot be assessed in terms of money. One radical quote on insects reads "*If all mankind were to disappear, the world would regenerate back to rich state of equilibrium that existed ten thousand years ago; if insects were to vanish, the environment would collapse into chaos*" – Edward O. Wilson. Man's future on this earth may very well depend on how well we understand the insect world – how well we fight our insect enemies and protect ourselves against them- how well we protect our insect friends. A study of the insects which are variously related to the welfare of mankind is referred to as economic entomology. Such studies are usually made with reference to the habits and habitats of the insect species. Insects are generally classified into three convenient groups from the point of view of the economic nature, namely harmless, harmful and beneficial insects. This classification, however, is not a rigid one and is often subject to alterations depending on conditions. Certain insects which are considered not harmful may under some other favourable conditions become serious pests and vice versa.

The scope of the present course is not the study on how many ways insects are beneficial to us but on how many ways they are harmful to us particularly as pests of crops and stored grain. In this section, different ways in which insect pests are harmful to us are classified.

1. Destroying crops and valuable plants:

Insects destroy all kinds of growing crops and other valuable plants by feeding on leaves, stem, bark, roots, buds, flowers and fruits. They also bore or tunnel into shoots, stems, roots and fruits feeding on internal contents. Insects are known to cause cancerous growth/ galls within which they live and feed. They cut and carry parts of plants for construction of nests or shelters. Many species of insects are reported as vectors disseminating microorganisms of plant diseases, namely, viruses, bacteria, fungi etc.

2. Annoying and injuring man and animals:

There are several ways in which insects annoy and injure man and animals, both domesticated and wild. Droning, humming and buzzing they produce is annoying to everyone. The foul odour they emit, offensive taste of their secretions/excretions they leave on fruits, food and dishes cause suffering. Pinching and causing painful disfiguring blisters on any part of the body, they may come in contact with. Accidental entry into the eyes, ears, nostrils or alimentary canal causes myiasis, a painful muscle damage.

3. Injecting venoms:

Many insects are venomous injecting venoms into our body by stinging (bees), piercing their mouth parts (mosquitoes, bed bugs) and nettling hairs (larvae of some moths) and leaving caustic and corrosive fluids on our body.

4. Making home in and on our body:

Some insects make their home on our body or on the bodies of some animals as

external parasites (lice, bird lice). Larvae of some flies tunnel into muscles of any organ system – nose, ear, urinogenital passages and alimentary canal as internal parasites causing mechanical injury and infection leads to starvation and death (horse bot fly).

5. Disseminating diseases in man and animals:

Many insects transmit disease causing pathogens like viruses, bacteria, spirochaetes, rickettsias, protozoa, nematodes and fungi to man and animals. The blood sucking insects acquire the pathogens when biting the diseased persons or animals /wild animals which are reservoirs of some pathogens and transmit them when they bite the healthy ones.

6. Destroying useful articles:

Insects destroy almost everything that man uses; stored food, clothing, woollens, rugs, drugs, furniture, bridges, telephone poles, animal and plant collections in museums, papers, books and so on. They can destroy anything or depreciate the value by feeding, contaminating with their own secretions, excretions, eggs, their own dead bodies or exuviae or simply by inhabiting them.

In the sections that follow, pests including insects and non insects that damage field crops, horticultural crops and the stored products are discussed in detail.

Major insect's,life history and management of following crops

PESTS OF RICE

RICE STEM BORER / YELLOW STEM BORER

Scirpophaga incertulas

Pyralidae: Lepidoptera

The pest is widely distributed in all Asian countries, monophagous and is a major pest on rice in India. Other stem borers on rice include dark headed borer, *Chilo suppressalis*; white stem borer, *Tryporyza innotata*; pink rice borer, *Sesamia inferens*. In South India, incidence of *S.incertulas* is serious during October-January.

The female moth has bright yellowish brown forewings with a clear single black spot and the anal end having tuft of yellowish hair. The male is pale yellow and the spots on the forewings are not conspicuous. Male is smaller than female.

Eggs are laid near the tip on the upper surface of tender leaf in small masses, covered with a felt like buff coloured mass of hair and scales. Single female lays 2 or 3 clusters of eggs, each having 15-80 eggs. Eggs hatch in about 5-8 days.

Newly hatched larvae which are pale white with dark brown head and prothoracic shield, move downward and wander about on plant surface for 1-2 hours. They hang down by silk thread, get blown off to other clumps or land on water, swim freely and get to the plants. They enter leaf sheath and feed on green tissues for 2-3 days, then bore into the stem near nodal region to feed. They disperse from one plant to another.

Usually one larvae is found inside a stem. There are 6 larval instars and full grown larva measures 20 mm long and is white or yellowish white with a well developed prothoracic shield. Larval duration is 33-41 days. Before pupation, the larva prepares an exit hole with thin webbing.

Pupation takes place inside the stem near base in a white silken cocoon. Moth emerges in 6-10 days or in about a month depending on climate. Moths are attracted to light. There are 3-5 generations in South India. Cold weather, high humidity and low temperature in October-December are favourable.

The pest can be identified with the aid of following symptoms

- ❖ “Dead-heart” at vegetative stage which turns brownish, curls and dries off
- ❖ “White ears” at heading stage with empty, partially filled grains
- ❖ Presence of egg masses near the tips of tender leaf blades
- ❖ Activity of moths in the vicinity
- ❖ Frass at the feeding site

MANAGEMENT

Monophagous nature and peculiar boring habits of yellow stem borer make control with insecticides difficult.

- Harvesting of crop close to soil surface, ploughing or flooding the field after harvest to kill hibernating larvae in the stubbles
- Selection of varieties resistant to yellow stem borer : Swarnamukhi (NLR 145), Pothana (WGL 22245), Varsha (RDR 355)
- Clipping the tips of the seedlings prior to transplantation aids in the elimination of egg masses
- Seedling root-dip with chlorpyrifos (0.02%) @ 200 ml in 200 litres of water in a plot of 3 m x 3 m for 12-14 hours. If 3 kg urea is added, 3 hours is sufficient. Seedlings thus treated are sufficient to transplant one acre. Seedling root-dip is effective for 30 days in the main field against stem borer, gall midge, BPH and GLH.
- Setting light traps or pheromone traps for monitoring the pest
- Collection and elimination of egg masses
- Encouraging natural enemies

Egg parasitoids: *Tetrastichus schoenobii*, *Telenomus beneficiens*, *Trichogramma chilonis*, *T.japonicum*,

Larval parasitoids: *Goniozus indicus*, *Apanteles ruficrus*, *A. schoenobii*, *Bracon chinensis*

Pupal parasitoids: *Elasmus albopictus*, *Tetrastichus ayyari*, *Xanthopimpla emaculata*

Predator : a carabid, *Chlaenius* sp.

- Economic threshold levels (ETL)
- Nursery : 1 egg mass or 1 moth / m²
- Main crop : 1 egg mass or 1 moth / m² , 5% dead hearts
1% white ears
- Vulnerable stages of the pest to the insecticides are at brood emergence when moths and eggs are observed and when majority of eggs hatch and larvae in wandering stage.
- Need based application of insecticides on ETL basis

Nursery:

- 5 days before pulling the nursery application of carbofuran 3G @ 200 g/cent of nursery in a little water (seedling root-dip not required) (or)
- Foliar sprays with monocrotophos 1.6 ml/l or chlorpyrifos 2.0 ml/l at 10 and 17 DAS

Main field:

- Foliar sprays with chlorpyrifos 2.5 ml/l or phosphamidon 2.0 ml/l or acephate 1.5 g/l or cartap hydrochloride 2.0 g/l or chlorantra niliprole 0.4 ml/l
- At panicle initiation stage: cartap hydrochloride 4 g @ 8 kg/acre,
- Carbofuran 3 g @ 10 kg/acre

RICE GALL MIDGE

Orseolia oryzae

Cecidomyiidae: Diptera

The pest is endemic and is distributed in most parts of India. It is a major pest in Telangana, North Coastal region of Andhra Pradesh and mainly a pest of *kharif*.

Fly is mosquito like and is 3-3.5 mm long. Female has bright orange red abdomen, swifter with a reddish telescopic body. Male is darker and smaller. Adult longevity is 1-3 days.

Eggs are laid singly or in groups of 2-6 just below or above ligule *i.e.*, on leaf blade or leaf sheath. Single female lays 100-300 eggs. The reddish, elongate eggs hatch in 3-4 days.

Maggot which is pale reddish, apodous moves down to the shoot apex without boring into plant tissue. Throughout its development it feeds at the base of the apical meristem leading to suppression of apical meristem, formation of radial ridges from inner most leaf primordium and elongation of leaf sheath. The symptoms of attack are

❖ Hollow whitish to pale green cylindrical tube in tillers known as gall / silver shoot/onion shoot bearing at its tip a green, reduced leaf blade complete with ligules and auricles. Gall is a modified leaf sheath.

❖ Vigorous subsidiary tillering if infested in early growth period

The pest infests even nursery but prefers tillering stage. Infested tillers do not bear panicles. At panicle initiation stage, the maggot cannot cause damage. Only one larva develops at shoot apex, remains throughout its development inside the gall. Larval duration is 15-20 days. The full grown larva is 3 mm long and pale red in colour. Pupation is at the base of the gall, but the pupa wriggles up to the tip projecting halfway out. Pupal period is 2-8 days. The gall dries up after fly emergence. It spends its entire larval and pupal period inside a single tiller.

The fly gets active at the onset of monsoon, completes 1-2 generations breeding on ratoon grasses like *Cynodon dactylon*, *Eleusine indica*, *Ischaemum ciliare*, *Panicum sp.*, *Paspalum scrobiculatum* and then migrates to newly planted rice.

Early rains making flies active and subsequent dry spell and delayed plantings will favour the pest. It is mostly confined to first crop. Light rainy or cloudy weather during July – September coupled with high RH favours build up of the pest.

MANAGEMENT

- Avoid late transplanting in endemic areas. Early planted *kharif* crop escapes pest
- Selection of variety resistant to a biotype of the region is imperative since six biotypes of rice gall midge have been identified in India.
- **Biotype** is a biological strain of an organism morphologically indistinguishable from other members of its species but exhibiting distinctive physiological characteristics, particularly in its ability to utilize pest resistant host successfully. According to 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 the same species.

- **Geographical distribution of gallmidge biotypes**

Biotype 1: Hyderabad, Warangal, Maruteru (A.P)

Sambalpur (Orissa), Raipur (M.P)

Biotype 2: Cuttack, Bhubaneswar (Orissa).....East coast

Mangalore (Karnataka), Goa.....West coast

Sakholi (Maharashtra).....Central India

Biotype 3: Ranchi (Bihar).....North

Wangbal (Manipur)..... North East

Jagityala (A.P)

Biotype 4: Srikakulam and Vizianagaram (A.P)

Bhadra (Sakholi) (Maharashtra)

Biotype 5: Moncompu (Kerala)

Biotype 6: Manipur

- **Varieties resistant to different biotypes of gallmidge**

Biotype Varieties

Biotype 1 Kakatiya, Potana, Kavya, Dhanyalakshmi (BPT 1235),

Phalguna, Vikram, Surekha, IR 36, Lalat.

Biotype 2 Phalguna, Vikram, Vikramatya, Lalat.

Biotype 3 Surekha

Biotype 4 IR 36

Biotype 5 Phalguna, Kavya, Dhanyalakshmi, Kakatiya, Divya.

Biotype 6

- Some varieties resistant to gall midge in AP: Phalguna (RPW 6-17), Vasundhara (RGL 2538), Suraksha, Srikakulam sannalu (RGL 2537), Surekha, Sumathi (RNR 18833), Pothana (WGL 22245), Kavya (WGL 48684), Divya (WGL 44645), Kesava (WGL 3825), Rudrama (RDR 7555), Pelala Vadlu (RDR 8702), Jagatial Sannalu (JGL 1798), Polasa Prabha (JGL 384), Varalu (WGL 14377), Vorugallu (WGL 3962), Bhadrakali (WGL 3962), Siva (WGL 3943), Varsha (RDR 355), Indur samba (RDR 763), Srikurma (RGL 2332)

- Seedling root dip with chlorpyrifos 0.02%

- The larvae are naturally parasitized by *Platygaster oryzae*, *Polygnotus sp.*, and *Propicrosscytus mirificus*

- ETL

Nursery : 1 gall / m²

Main field in tillering stage: 5% affected tillers, 1 gall /hill

- Application of granules in nursery 5 days before pulling the nursery – phorate 10 G 60 g/cent or carbofuran 3G @ 200 g/cent

- Application of granules in the main field at 10-15 DAT: phorate 5 kg/ac or carbofuran 10 kg/ac in endemic areas.

BROWN PLANTHOPPER

Nilaparvata lugens

Delphacidae: Hemiptera

This is distributed in most of the rice tracts of India. Adults are ochraceous – brown dorsally and deep brown ventrally. The female is 5 mm long and male 4.5 mm. Female exists in two forms, the fully winged macropterous and the truncated – winged

brachypterous.

Eggs are thrust within parenchymatous tissues of the plant along the midrib of leaves in bunches of 2-12 eggs, A female lays, about 232 eggs. The egg is white elongated and shaped like a curved club. It hatches in 7-9 days.

Brownish nymph undergoes five instars during a nymphal period of 10-18 days.

Both nymphs and adults suck sap from basal portion of plant clustering at the base of rice clump. They inject toxic saliva while feeding which results in "hopper burn".

Population of white backed plant hopper (WBPH), *Sogatella furcifera* is commonly seen in association with that of BPH on rice. WBPH dominates during vegetative phase while BPH dominates from PI stage.. the symptoms include

- ❖ Premature yellowing of leaves and drying of plants in isolated circular patches
- ❖ Drying of plants spreads in a circular fashion
- ❖ Sooty mould
- ❖ Exuviae at the base of plants
- ❖ Affected stems turn soft and are unfit for use as straw

BPH is reported as vector of grassy stunt and ragged stunt virus. Apart from rice, it infests *Cyperus rotundus* and *Panicum repens*. The pest is serious from PI to booting till post flowering. Higher doses of N and high plant density per unit area invite the pest problem. Thick vegetation and direct sown rice preferred.

Detection of BPH biotypes worldwide

Biotypes Region Countries

- 1 South East Asia Philippines, China, Japan, Malaysia, Taiwan, Thailand
- 2 South East Asia Philippines, Solomon Islands, Vietnam
- 3 South East Asia Philippines, Taiwan
- 4 South Asia Bangladesh, India, Srilanka
- 5 South East Asia Philippines

MANAGEMENT

- Avoiding monoculture of susceptible varieties
- Growing resistant varieties like Chaitanya (MTU 2067), Godavari (MTU 1032), Krishnaveni (MTU 2077), Indra (MTU 1061), Vajram (MTU 5249), Vijetha (MTU 1001), Pratibha (MTU 5293), Cottondora Sannalu(MTU 1010), Nandi (MTU 5182), Surya (BPT 4358), Deepti (MTU 4870), Chandan (RNR 74802), Tolakari (MTU 1031), Pushyami (MTU 1075)
- Seedling root dip with chlorpyrifos 0.02%
- Formation of alleys or pathways of 20 cm width for every 2 metres of planting to facilitate aeration, light, basal spraying, monitoring and other farm operations.
- Draining the field during the middle of the season to suppress the pest population
- Conservation of natural enemies

Spider : *Lycosa pseudoannulata*

Mirid bug : *Cyrtorhinus lividipennis*

Aquatic bug : *Gerris tristan*

Coccinellids : *Coccinella arcuata*

Egg parasitoids : *Anagrus sp.*, *Oligosita sp.*,

Nymphal and

Adult parasitoid : *Haplogonatopus orientalis*

- ETLs

Tillering stage : 10 hoppers / Hill

Heading stage : 20-25/Hill

- Foliar sprays (directing the spray towards base of plants) with any of the following insecticides viz., ethofenprox 2 ml/l; acephate 1.5 g/l; BPMC 2 ml/l; imidacloprid + ethiprole 80 WG 0.25 g/l; monocrotophos 2.2 ml/l; carbofuran 3G 10 kg/ac

RICE GREEN LEAFHOPPER

Nephotettix nigropictus

N. virescens

Cicadellidae: Hemiptera

These are small, active wedge shaped leafhoppers, distributed in all rice tracts in India. *N. nigropictus* is about 5 mm long and possesses two black spots in the males which extend up to the black distal portion of the forewings. Males have a black tinge along anterior margin of pronotum and black submarginal band on the crown of the head. Female is generally entirely green without any black tinge on pronotum.

N. virescens can be easily distinguished by the black spots in the male not extending up to black distal portion of forewings and the absence of black tinge on the pronotum and black band on the crown. It causes more damage to rice than *N. nigropictus*.

Yellowish eggs are laid in rows under epidermis of leafsheath @ 53 eggs per female. Incubation period is 6-7 days.

Nymph passes through 5 instars, becomes adult in about 18 days and it takes about 24 days to complete the life cycle. Both nymphs and adults suck sap from leaves causing the following symptoms.

- ❖ Yellowing, stunting and withering of plants
- ❖ Leaves turning brown with small scratch like marks on leaf in severe infestation
- ❖ Uniform yellowing from mid half of leaf

Serious damage is inflicted when leafhoppers transmit virus diseases. *N. nigropictus* is known to transmit rice dwarf, rice yellow dwarf, rice transitory yellowing and rice tungro, while *N. virescens* transmits rice tungro, rice transitory yellowing and rice yellow dwarf. Rice green leafhoppers 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 left over nursery
- Removal of alternative hosts during off season such as *Panicum spp.*, *Echinochloa spp.*, *Cyperus spp.*, and other grasses
- Seedling root dip with chlorpyrifos 0.02%
- Varieties resistant to green leafhopper IR-20, Vani, Vikramarya
- Eggs are parasitised by *Oligosita nephotetticum*
- ETLs : Nursery: 1-2 hoppers/m²

Tillering: 10/hill,

Heading: 20/hill,

Tungro endemic areas: 1/hill

- Same insecticides recommended for BPH are effective. For immediate knockdown of high population monocrotophos 2 ml/l + dichlorvos 1 ml/l

RICE HISPA

Dicladispa armigera

Hispidae: Coleoptera

This is known to occur in all rice tracts in India, especially in Andhra Pradesh, West Bengal and Bihar. It is serious on young rice, it also infests sorghum, maize, bajra, sugarcane and grasses.

Beetle is a small 4.5 – 5 mm long, square shaped, bluish black and shiny with spines on thorax and elytra. Adults scrape green matter on upper surface of leaf blade causing

- ❖ Whitish leaf tips of young leaves giving dried up appearance
- ❖ White, rectangular streaks parallel to veins on older leaves, which initially appear glistening, membranous, papery white, later turning pale reddish, straw coloured

Eggs are laid singly, partially inserted beneath the epidermis of tender leaves generally towards the tip @ 55 eggs/ female. The egg hatches in 4-5 days. Small, yellowish, flattened grubs feed on leaf tissue inside the leaf mine causing

- ❖ Blister spots towards leaf tip

After feeding for 7-12 days, it pupates in leaf mine or grub tunnel and the beetle emerges in 3-5 days. Adult longevity is about 78 days.

Heavy rains in July, abnormally low rainfall in Aug -Sept., steady temperatures coupled with high RH is congenial for build up of the pest.

MANAGEMENT

- Clipping of leaf tips of seedlings while transplanting eliminates eggs laid towards the tip

- Removal of left over nursery

- Grubs are parasitized by *Bracon sp.*,

- ETLs

2 adults / hill

2 damaged leaves / hill

- Foliar sprays with profenophos 2 ml/l or monocrotophos 1.6 ml/l or chlorpyriphos 2.5 ml/l.

RICE LEAF FOLDER

Cnaphalocrocis medinalis

Pyralidae: Lepidoptera

This is widely distributed in India occurring in all rice growing tracts. Moth is small with a wing span of 15 mm, brownish orange coloured with light brown wings having two distinct dark wavy lines on forewings and one line on hind wings. Both wings have dark brown band on their outer margin. Adult longevity is 3 -4 days.

Flat oval, yellowish eggs are laid singly on the under surface of tender leaves which hatch in 4-7 days.

The larva folds 3-4 leaves of young plants feeding from within. In grown up plants, it folds leaf longitudinally from tip downwards bringing together the margins with silken threads, lives in tubes thus formed feeding on chlorophyll. Single larva damages several leaves causing the following symptoms.

- ❖ Whitish membranous folded leaves with typical white streaks

- ❖ Faecal pellets when leaf opened

- ❖ Reduced vigour of the plant

The pest causes more loss at boot leaf stage. Pale yellowish green larva

measuring 16-20 mm long becomes full grown in 15-27 days.

Pupation is inside the leaf fold and the moth emerges in 6-8 days. Total life cycle takes 26-42 days. The pest is abundant during rainy season with optimum temperature and high RH.

MANAGEMENT

It is better to manage effectively the first generation of the pest to prevent the build up of the population at boot leaf stage.

- Early clipping of infested, folded leaf tips
- Removal of alternative hosts *Echinochloa spp.*, and *Panicum spp.*, and other grasses
- The *ichneumonid*, *Xanthopimpla emaculata* is parasitic on the pest larvae
- Passing a rope 2-3 times over the crop at tillering stage mechanically to dislodge caterpillars
- ETL : 1 larva/hill

2 damaged leaves/hill

- Foliar sprays with chlorpyrifos 2.5 ml/l or acephate 1.5 g/l or cartap hydrochloride 2 g/l or granules of cartap hydrochloride 4 G 8 kg/ac

RICE EARHEAD BUG/GUNDHI BUG

Leptocorisa oratorius

Coreidae: Hemiptera

This is present in all rice growing tracts and is a regular pest in certain parts of Telangana and Rayalaseema regions of Andhra Pradesh. The bugs emit characteristic unpleasant odour indicative of their presence in the field, hence the name, gundhi bug. The pest appears on rice just before flowering stage and continues until panicles ripen. The adult is active, diurnal, elongated bug with long legs. It is olive brown and ventrally green measuring 15.5-17 mm long.

Eggs are laid in single or double rows close to midrib on the upper surface of leaves @ 10-20 per cluster. Each female lays about 100 eggs. Dark reddish brown egg is boat shaped. Egg hatches in about 7 days.

Nymphs are pale yellowish green possessing odoriferous glands on the fifth abdominal segment. Nymph passes through 5 instars in about 15-21 days. The total life cycle takes about a month. After the harvest of rice, the bug over-winters in millets and wild grasses.

Both nymphs and adults suck juice from grains in milky stage, also from peduncle, leaves and stem causing the following symptoms

- ❖ Affected grains become shrivelled and chaffy
- ❖ Brown spot is observed at the feeding site where sooty mould develops
- ❖ Lower grain quality and broken grains when infested at soft dough stage

MANAGEMENT

- Clean cultivation
- Collection of bugs by hand nets
- ETL : 1 or 2 bugs/hill
- Foliar sprays in the evening hours at milky stage starting from borders of the crop with dichlorovos 1 ml/l + endosulfan 2 ml/l or chlorpyrifos 2 ml/l or malathion 2 ml/l
- Dusting with endosulfan 4 D 10 kg/ac or carbaryl 10 D 10 kg /ac.

GRASSHOPPERS

Rice large grasshopper : *Hieroglyphus banian*

Rice small grass hopper : *Oxya nitidula*,

Acrididae: Orthoptera

Nymphs and adults feed on foliage by irregularly cutting leaf margins. In severe cases only midribs and stalks remain. They also cut the panicle at heading stage and are very active at night time.

Scraping field bunds and summer ploughings to destroy eggs, dusting cabaryl 10D or malathion 5D @ 10 kg/ac or foliar spraying with fenitrothion 2 ml/l or endosulfan 2 ml/l found effective in their management.

RICE ROOT WEEVIL

Ehinocnemus oryzae

Curculionidae: Coleoptera

It is semi aquatic in habit. Newly hatched grubs feed on stem epidermis initially, enter soil and attack tender roots of transplanted crop causing poor tillering and stunted growth. Upon investigation, grubs can be seen adhering to roots.

Seedling root dip with chlorpyrifos 2.5ml/l, application of neem cake @ 100 kg/ac or superphosphate @ 80 kg/ha to deter grubs at active feeding zone of roots are effective in its management.

RICE SWARMING CATERPILLAR

Spodoptera mauritia

Noctuidae: Lepidoptera

Caterpillar nibble at first, later become voracious feeder eating the seedlings in the nursery and reducing the plants to mere stumps. They migrate from field to field feeding at night and hiding during the day.

Flooding the nursery brings out hiding larvae which are picked up by birds. Foliar sprays with dichlorvos 1 ml/l or chlorpyrifos 2 ml/l are effective.

CLIMBING CUTWORM

Mythimna separata

Noctuidae: Lepidoptera

It appears in swarms at earhead stage in Nov-Dec. Late instars have the characteristic habit of climbing and cutting earheads in addition to defoliation. The pest becomes serious in certain years of heavy rainfall.

In nature, population is suppressed by natural infections by entomogenous fungus, *Nomuraea rileyi*. Foliar sprays with chlorpyrifos 2.5 ml or endosulfan 2 ml in combination with dichlorvos 1 ml per litre of water in the evening hours following irrigation are effective.

RICE CASEWORM

Paraponyx stagnalis

Pyralidae: Lepidoptera

Larva cuts the leaf blades into short lengths and constructs a tubular case inside which it remains and feeds on the foliage scraping green matter in streaks. Damage appears ladder like with alternate dark and light rows of green patches.

Sprinkling kerosene on water and passing a rope over the crop to dislodge and kill the larvae in the cases. Stagnant water along with leaf cases is drained.

Monocrotophos 1.6 ml/l or chlorpyrifos 2.5 ml/l is effective.

RICE WHORL MAGGOT

Hydrellia philippina

Ephydriidae: Diptera

Maggots attack the leaf blades even before unfurling and the initial damage is characterised by the presence of narrow stripes of whitish area in the blade margins. Boot leaf and spikelet damage has also been noticed. The maggots feed on spikelets and cause shrivelling.

Maintenance of irrigation water during initial establishment stage of seedlings and application of carbofuran 3 G @ 33 kg/ha is effective.

PADDY LEAF MITE / YELLOW MITE

Oligonychus oryzae

Tetranychidae: Acarina

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

Foliar sprays of wettable sulphur 3 g/l or dicofol 5 ml/l are found effective.

PANICLE MITE / SHEATH MITE

Steneotarsonemus spinki

Tarsonemidae: Acarina

At vegetative phase, both nymphs and adults colonise midribs of leaves and lacerate tissues up to maximum tillering stage causing brown necrotic patches on midribs. At panicle initiation stage mites move to leaf sheath to feed causing brown necrotic lesions on leaf sheath. Maximum incidence occurs 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 grains turn black invaded by saprophytic fungus.

Dicofol 5 ml/l or profenophos 2 ml/l once at maximum tillering stage when brown lesions on midribs appear and second spraying at panicle emergence are recommended in its management.

INTEGRATED PEST MANAGEMENT (IPM)

There are many definitions of IPM, but the basic concept is the containment of a pest below economically damaging levels, using a combination of control measures. Following four primary components of IPM are usually recognized.

1. Host plant resistance
2. Manipulation of the farming system to minimise pest infestation or damage
3. Enhanced natural control practice
4. Selective use of biorational and synthetic pesticides

IPM Practices in Rice:

Various approaches in the management of pests of rice fit into the above primary components of IPM.

- Harvesting of crop close to soil surface and deep ploughing or flooding after harvest
- Selection of resistant / tolerant varieties against key pests suitable to local situations
- Protection of nursery from pests
- Application of carbofuran 200 g/cent of nursery in a little water 5 days before pulling nursery for protection against stem borer, gall midge, brown planthopper and green leafhopper for 30 days in the main field

- Clipping tips of leaf blades before transplanting to eliminate eggs of rice stem borer and hispa
- Early planting in gall midge endemic areas
- Formation of alleys or path ways of 20 cm width for every 2 metres of planting to facilitate basal spraying and for aeration and light
- Avoiding of excessive doses of nitrogen
- Ensuring proper drainage and water management
- Weed management
- Monitoring incidence of pests through light traps or pheromone traps for rice stem borer, leaf folder
- Monitoring pest and natural enemy ratio (2:1)
- Passing a rope over the crop in vegetative phase against leaf folder and caseworm
- Inundative release of *Trichogramma* egg parasitoids @ 20,000/ac three times within 30-45 DAT
- Use of botanical pesticides such as neem seed kernel extract, neem oil etc.
- Application of insecticides on ETL basis
- Community approach in rodent management.

PESTS OF SORGHUM & OTHER MILLETS

SORGHUM SHOOTFLY

Atherigona soccata

Muscidae: Diptera

The pest is found distributed in India and West Africa infesting sorghum, maize, ragi, bajra etc. Its severe incidence necessitates resowing.

Fly is a small 3 mm long, dark grey housefly like with its abdominal segments marked with two rows of six dark spots in female and four dark spots in male. Single female fly lays 40 eggs.

Eggs are laid singly on the ventral surface of mostly the third and fourth leaves of seedlings. Egg is whitish cigar shaped or flattened boat shaped with wing like lateral projection. The egg hatches in 2-3 days.

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

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

Full grown maggot is pale yellowish measuring 10 mm in length. Larval duration is 6-10 days. Pupation takes place inside the stem at the base with a pupal duration of 7-10 days. Population reaches the minimum in December-June.

MANAGEMENT

- Use of a higher seed rate of 12 kg/ha instead of normal rate of 10 kg/ha and removal of affected and extra plants at the time of thinning four weeks after sowing since shootfly affects only young plants of 4-5 weeks age
- Timely sowing of kharif sorghum before July 15th, however for highly susceptible variety CSH-1, the above measures prove ineffective.
- Some varieties found resistant to shootfly : IS 1054, IS 1071, IS 2394, IS 5484, SPV

86, SPV 462

- Application of carbofuran 3 G granules @ 2 g/one metre row length in furrows at sowing time
- Foliar spray with endosulfan 2 ml/l at weekly intervals (7,14,21 DAS)

SORGHUM STEM BORER

Chilo partellus

Pyralidae: Lepidoptera

Its infestation starts one month after sowing till harvest. This is ranked as the most important among the pests of sorghum and maize in India and is distributed all over the country. It also infests sugarcane, rice and Johnson grass.

Moth is medium sized, straw coloured with black specks along caudal margin of forewings. A single female lays nearly 300 eggs on undersurface of leaves. Eggs are scale like, flattish, overlapping and laid in batches. Eggs hatch in about seven days. Larvae bite their way into the stem feeding on the internal tissue and killing the central shoot in young plants. The damage results in

- ❖ Shot holes due to biting across leaf spindle
- ❖ Dead heart with no offensive smell at cut end when pulled out
- ❖ Chaffy earheads in later stages

The larva is cylindrical, yellowish brown with a brown head and a prothoracic shield and dark spots on the body. It measures about 25 mm long. Larval duration is 28-35 days. Larvae hibernate in winter. Full grown caterpillar prepares an exit hole before pupation inside the stem. Pupa within the stem is oblong, reddish brown with 6 spines at caudal end. Pupal stage lasts 7-10 days

MANAGEMENT

- Uprooting and burning affected stubbles after harvest to destroy hibernating larvae
- Adoption of higher seed rate, pulling and destroying affected plants in the early stages
- Selection of sorghum varieties resistant to stem borer CSH 7,8; SPV 17, 19, 29,58; ICSV 197, 745, 88013
- Maize varieties / hybrids Ganga 5, DHM 101, 103, 105 have been found resistant to *C.partellus*
- Preservation of natural enemies

Egg parasitoid : *Trichogramma chilonis*

Larval parasitoids : *Cotesia flavipes*, *Bracon chinensis*

Pupal parasitoids : *Xanthopimpla punctata*, *Tetrastichus ayyari*

- Placement of carbofuran 3 G granules @ 4 kg/ac at 35-40 DAS in leaf whorls since first instar caterpillars congregate in leaf whorls.
- Foliar spray with endosulfan 2 ml/l at 30 and 45 DAS. Spray should be directed towards leaf whorls.

RAGI PINK BORER

Sesamia inferens

Noctuidae: Lepidoptera

This is a serious pest of ragi in South India. It also infests sorghum, maize, bajra, rice, wheat, sugarcane, wheat, grasses etc.,

Moth is medium sized, straw coloured with forewings having marginal black streaks. Hindwings and thorax are white. The female lays about 100 yellowish pearl like

eggs between the stem and the leaf sheath in 1-3 rows. The incubation period is 7-12 days.

Caterpillars bore into the stem and kill the central shoot causing

- ❖ Dead hearts
- ❖ Chaffy earheads later

There may be up to five larvae inside a stem. A single caterpillar can damage number of plants. Oblong and elongate shot holes can be seen on unfolding leaves. The full grown larva measures 20-26 mm and is pale yellow with a purple pink tinge and reddish brown head. The larval period lasts for 25-54 days. Pupation is inside the stem and the adult emerges in 8-12 days.

MANAGEMENT

- Pull out and destroy by burning dead hearts and affected plant parts
- Placement of granules in central whorls as detailed under sorghum stem borer
- Foliar spray with endosulfan 2 ml/l

SORGHUM MIDGE

Stenodiplosis sorghicola

Cecidomyiidae: Diptera

One time a minor pest of sorghum in India has assumed the status of a major pest with the introduction of high yielding varieties and hybrid sorghum. It is distributed in all sorghum growing tracts of the country.

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

Eggs are laid singly within spikelets of sorghum when the pollen is being shed. Single female lays 30-35 eggs @ 6-10 in each floret. Egg hatches in 3-4 days. The maggots feed on the ovaries and destroy the developing grains causing flattening of florets. The damage results in the following symptoms.

- ❖ Red ooze from spikelet when squeezed indicating the presence of maggot
- ❖ Chaffy grains with round holes indicating fly emergence
- ❖ Empty pupal cases protruding from glumes

Larval duration lasts for 7-11 days. Pupation is within damaged spikelets. The adult emerges in 3-5 days. The carry over of the pest from one season to the next is accomplished by the diapausing larvae in crop debris or on wild hosts.

MANAGEMENT

- Burning panicle residues and chaff after threshing to destroy diapausing larvae
- Adoption of uniform date of sowing to make varieties flower at same time
- Early sowing at monsoon to escape midge damage
- Selection of resistant varieties ICSV 197, 745, 88013, PJ 890.
- Larvae and pupae are parasitised by *Tetrastichus coimbatorensis*
- Spraying earheads when blooms first appear on panicles with endosulfan 2 ml/l or carbaryl 5 g/l or dusting carbaryl on earheads @ 8 kg/ac.

SORGHUM EARHEAD BUG

Calocoris angustatus

Miridae: Hemiptera

It is a major pest of sorghum in South India; it also infests bajra, maize and Italian millet. Adults are slender, long legged, yellowish green, about 1 cm long and are active

fliers.

Eggs are laid under the glumes or into the middle of the florets by means of long ovipositor of the female. A single female lays 150-200 eggs @ 1-16 in each floret. Bluish cigar-shaped eggs hatch in about 10 days.

Nymphs with light orange abdomen initially turn green as they grow. Nymphal stage lasts 10-16 days. Both nymphs and adults suck sap from tender grains in milky stage resulting 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 increases. There can be atleast two generations in a crop season.

MANAGEMENT

- Timely sowing at first monsoon showers

- Avoiding compact earhead varieties

- A reduviid bug, *Reduviolus sp.*, and a *lygaeid bug*, *Geocoris tricolor* are predaceous on the insect

- Shaking of infested earheads in kerosinated water to destroy nymphs

- As soon as earheads emerge, dusting them with carbaryl @ 8-10 kg/ac, second dusting a week after if needed or foliar sprays with endosulfan 2 ml/l or phosalone 2.5 ml/l

RED HAIRY CATERPILLAR

Amsacta albistriga,

A. moorei

Arctiidae: Lepidoptera

These are distributed all over India. *A.albistriga* is the predominant species in South India while *A.moorei* in North India. In South India it is very serious pest of dry crops especially groundnut in most of the rainfed tracts in *kharif* season. It also infests young sorghum, maize, cotton, castor, cowpea, bajra. Red soils are more suitable.

Moth is medium sized having white forewings with brownish markings and streaks and white hind wings with black spots. There is a yellow band on the head and a yellow streak along costal margin of the forewings in *A.albistriga* while the band on the head and streak along costal margin of the wing are red in *A.moorei*. Moths emerge with the onset of monsoon from diapausing pupae in June-July. The emergence occurs in waves following rains. Adults pair almost immediately after the emergence and oviposit the same night. Oviposition is spread over 2-3 days.

Eggs are cream or bright yellow and are laid in masses on young foliage or on the soil, clods of earth, stones or occasionally on other vegetation. A single female lays about 1000 eggs in clusters of 50-100. Larvae hatch in about 3-4 days.

Dark larvae feed gregariously on the lower surface of leaves scraping for 4-5 days. In about 10 days, they turn ashy brown and slowly spread from plant to plant feeding voraciously. Larvae become full grown in about 40-50 days. They are reddish brown with a red head and dense large hair and body. On either end of the body, larva has black bands enclosing a red band in between. These larvae feed on leaves in large

numbers and march from field to field in thousands resulting in following symptoms.

- ❖ Heavy defoliation
- ❖ Entire crop looks as though grazed by cattle

Full grown larvae await next sharp showers. Failure of rains at this critical stage may result in annihilation of larvae due to their inability to pupate for want of sufficient soil moisture. In the presence of sufficient moisture, full grown larvae burrow into the soil and pupate along bunds, shady moist places under trees etc. at a depth of 10-20 cm. Pupae remain in soil till next year *i.e.*, from Oct-Nov. to the following July-Aug in South India.

MANAGEMENT

- Deep ploughing to expose pupae after harvest
- Bonfires at night between 7-11 pm within 48 hours after monsoon rains to attract and kill

emerging moths

- Collection and destruction of egg masses and gregarious larvae
- Growing cowpea or castor as trap crops
- Placing shoots of *Jatropha*, *Ipomoea* on the field bunds to attract and kill migrating larvae
- Larvae are parasitised by *tachinids*, *Exorista civiloides*, *Sturmia inconspicua* and preyed upon by a pentatomid predator, *Eocanthecona furcellata*
- Digging trenches around the field and dusting them with methyl parathion (Folidol)
- Dusting with methyl parathion or quinalphos @ 10 kg/ac for early instars
- Foliar sprays with dimethoate 2 ml/l or monocrotophos 1.6 ml/l for grown up caterpillars
- Distribution of poison baits (rice bran 10 kg + jaggery 1 kg + quinalphos 1 litre or methomyl 350 ml + water in sufficient quantity for making balls) in the evening hours.

DECCAN WINGLESS GRASSHOPPER

Colemania sphenarioides

Acrididae: Orthoptera

It causes appreciable damage to rainfed millets. Both nymphs and adults feed on the leaves in early stage of the crop. However, the crop suffers at the earhead stage. Grasshoppers devour flowers and ripening ears wholly, sometimes leading to total loss of crop.

Deep ploughing after harvest to expose eggs and dusting all around borders and then entire crop with carbaryl 10 D or endosulfan 4D @ 10 kg/ac are effective measures.

SORGHUM APHID / CORN APHID

Rhopalosiphum maidis

Aphididae: Hemiptera

It is confined to unopened leaves of sorghum, maize and other millets. Nymphs and adults suck sap from leaves and tender earheads leading to mottled appearance with yellow patches, failure of grains to develop in earhead and formation of sooty mould due to honeydew excretion on the plants. It transmits maize dwarf mosaic virus in sorghum leading to death of young seedlings.

Coccinellids, syrphids and chrysopids suppress the population in nature.

However, need based treatments with dimethoate 2 ml/l or monocrotophos 1.6 ml/l or

acephate 1 g/l are recommended.

MAIZE SHOOT BUG

Peregrinus maidis

Delphacidae: Hemiptera

It is one of the important sap feeders of millets in South India. These bugs are found within leaf whorls or on the leaves. Both nymphs and adults suck sap from tender portions of plants causing yellowing of foliage, stunted growth and scorched appearance. The ants, *Camponotus compressus*, *Monomorium destructor* are seen attending on the bugs for honeydew on which sooty mould develops. It is a vector of stripe disease of sorghum, maize, sugarcane and other millet crops.

If predatory population is not found sufficient, dusts of carbaryl 10 D or endosulfan 4 D @ 10 kg/ac or foliar sprays with dimethoate 2 ml/l or monocrotophos 1.6 ml/l are effective.

FLEA BEETLE

Chaetocnema pusaensis

Longitarsus sp.

Chrysomelidae: Coleoptera

Beetles bite small holes on leaves which affect photosynthetic activity. Leaves or seedlings of various millets such as sorghum, maize and bajra are damaged. Grubs are not destructive and are found in the soil.

Dusting carbaryl @ 10 kg/ac or spraying 2% neem oil is effective.

BLISTER BEETLES

Orange banded blister beetle : *Mylabris pustulata*

Brown blister beetle : *Gnathospastoides rouxi*

Meloidae: Coleoptera

Blister beetles prefer yellow and red flowers. Beetles attack inflorescence and feed on flower petals, pollen adversely affecting grain set. They can also feed on tender foliage.

Beetles can be collected by hand nets and destroyed. They are highly phototropic and get attracted to light traps. Dusting earheads with endosulfan or carbaryl @ 10-15 kg/ha is effective.

RAGI CUTWORM

Spodoptera exigua

Noctuidae: Lepidoptera

It infests among millet crops, ragi, sorghum and bajra. It is widely distributed in India and highly polyphagous. The pest is serious in ragi nurseries feeding on leaves causing extensive defoliation. The grown up larva coils with slightest touch and drops down. The larvae hide during day time in the soil and feed on the foliage at night.

In nature, larvae are infected by entomopathogenic fungus, *Nomuraea rileyi* and parasitised by Bracon sp. Thiodicarb 1 g/l or acephate 1 g/l or chlorpyrifos 2.5 ml/l as foliar sprays are recommended.

RAGI ROOT APHID

Tetraneura nigriabdominalis

Aphididae: Hemiptera

Pale greenish, plumpy aphids suck sap from roots of ragi plants in nursery as well as main field resulting in gradual fading and drying up of plants. Activities of ants

which move about at collar region of plant for honeydew indicate the infestation by aphids. Upon examination aphids are seen attached to roots when pulled. Collar region turns black.

Mixing crude oil or emulsion of OP compound in irrigation water is a common method. Drenching the soil with a solution of dimethoate 0.05% is effective.

ARMY WORMS / CUTWORMS

Agrotis basiconica, *A. flammata*, *A. ipsilon*, *A. spinifera*

Mythimna separate

Noctuidae: Lepidoptera

Caterpillars are defoliators of ragi, maize, bajra and sorghum. They also feed on earheads. They cut tender stems of young and growing plants. Larvae hide during day time in the soil and become active at dusk. In severe cases, entire leaf is eaten. The field looks as if grazed by cattle.

Dusting or spraying during afternoon or evening hours with carbaryl 10 kg/ac or methyl parathion 2 ml/l or chlorpyrifos 2.5 ml/l or dichlorvos 1 ml/l is effective.

PESTS OF SUGARCANE

EARLY SHOOT BORER

Chilo infuscatellus

Pyralidae: Lepidoptera

It is a major pest in South India, distributed all over the cane growing regions of India

Moth is small, slender, greyish brown or straw coloured with labial palpi projected upwards. Males are smaller than the females with a wing expanse of 19-26 mm compared to 23-35 mm in females. A row of white dots is present along the outer margin of forewings.

Flat, scale like, overlapping eggs are laid in 3-5 rows on the underside of leaf sheath or leaves in clusters containing 8-40 eggs. Single female lays about 300-400 eggs. Oviposition period lasts about 4 days. Egg period varies from 3 -8 days.

The larvae that hatch out from the eggs get scattered and young larva enters the stem by passing into the space between the leaf sheath and stem.

The caterpillar bores into the growing stem and kills the young plant causing dead heart, if ignored later becomes internodal borer, which bores the stem at internodes. In young tillers, caterpillar bites holes through the stem at the ground level and feeds inside and exhibits the following symptoms

- ❖ Presence of an entrance hole at the ground level.
- ❖ Dead hearts which can be easily pulled out. The dead heart emits offensive smell.
- ❖ If infested canes are split opened, the larvae or pupae are seen inside.

The full grown caterpillar is 20-25 mm in length. The caterpillar whitish with five violet stripes dorsally and dorso laterally on its body with dark brown head. Larval period ranges between 22-44 days depending upon the climate

Pupation takes place in a pupal cell at the end of the larval tunnel and the pupa is pale straw coloured. After 4-6 days moth comes out. The adult survives for 3 -8 days. There are six generations in a year.

The pest attack is usually severe in the early stages of the crop growth during the

hot pre monsoon period. The attack of the borer is a continuous process from sprouting stage to cane formation. Even after cane formation, it acts as an internodal borer affecting the internodes. Infestation is favoured by poor irrigation, absence of rains, high temperature and low humidity.

MANAGEMENT

- Systematic collection of egg masses and their destruction.
- Removal of dead hearts and their destruction.
- Trash mulching which not only checks the population but also conserves soil moisture and adds the organic matter to the soil.
- Planting in deep trenches reduces the borer incidence.
- Adjusting the planting dates to avoid the peak oviposition. Minimum incidence is in November and December planting. Maximum incidence is in January and February planting.
- Quick growing varieties escape heavy infestation – Attack will be more in thin varieties than in thick ones.
- Set treatment with 0.1% malathion or chloripyriphos.
- Light earthing up of soil up to 4-6 week old crop to make the stem inaccessible to larvae followed by frequent irrigations.
- Installation of light traps.
- The release of egg parasites, *Trichogramma minutum*; *T. australicum* is reported to have given good control of this pest at many places (Chagallu sugar factory area).
- By spraying endosulfan 2 ml / l at 4th, 6th, 9th and 12th week after planting..
- Application of Phorate 10G @ 1.0 kg a.i. /ha at 4th week age of the crop in equal splits to the soil and leaf whorls.

INTERNODAL BORER

Chilo sacchariphagus indicus

Pyralidae: Lepidoptera

The insect is found throughout India and usually occurs on sugarcane late in its growing phase. Its multiplication is rapid under conditions of low temperature and high humidity and the infestation ranges from 20 to 50%. It is serious on sugarcane in Andhra Pradesh, Karnataka, Kerala, Tamilnadu and Uttar Pradesh.

Moth is small, straw coloured. Forewings have a marginal dark line and the hind wings are whitish.

Scale like white eggs are laid in batches, each batch containing 9-11 eggs in two rows on the sheath or leaves. The incubation period is 5-6 days.

The larva usually attacks sugarcane late in its growing phase. The caterpillar bores at the nodal region and enters the stem. The tissues turn red and the hole is usually plugged with excreta. A larva may attack a number of nodes.

Caterpillar has a white body with dark spots and a brown head. The larva becomes full grown in 37 to 53 days and pupates in the leaf sheath. The pupal period lasts for 8-10 days. The total life cycle takes 50-70 days. There are six broods in a year.

Its multiplication is rapid under conditions of low temperature and high humidity.

MANAGEMENT

- Collection of egg masses and their destruction.
- Inundative release of the egg parasite *Trichogramma australicum* at 50,000

parasites/ ha/ week.

- The pest can be controlled by spraying endosulfan 2 ml / l at fortnightly intervals from 120 days age of the crop. Normally two sprayings are sufficient.

TOP SHOOT BORER

Scirpophaga nivella

Pyralidae: Lepidoptera

It is distributed all over the country, but it is more serious in North India. It is also found in South-East Asia, Japan *etc* . Besides sugarcane, it attacks a number of wild plants belonging to the genus *Saccharum*.

Moth is medium sized, creamy white, slightly bigger than early shoot borer moth. Female has tuft of crimson coloured hairs at the tip of the abdomen. In case of certain males, each of the forewings has a black spot.

About 250-300 dull white elongate overlapping eggs are laid in clusters, each cluster having 9-79 eggs, usually near mid ribs. The eggs are covered by buff coloured hairs from female anal tuft. Eggs hatch in 7-9 days.

The caterpillar first bores into the stem from top by tunneling into the mid ribs of leaves, leaving markings on the 2nd through 5th 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.

The damage results in the following symptoms

- ❖ A number of shot holes on affected leaves due to biting across the spindle
- ❖ Reddish brown charred dead heart that can not be easily pulled out.
- ❖ Interference with apical growth gives rise to side shoots and bunchy top symptoms.

Full grown caterpillar is creamy white in colour with yellow head.

The top shoot borer damage starts when the sugarcane is 2 -3 months old.

The larval period lasts for 25 -42 days

Pupation is inside the stem. The pupal period lasts for 7-10 days. The life cycle may range from 40-62 days. It completes 7 generations in a year.

Activity of the top shoot borer starts with the onset of the monsoon rains in the north. Low humidity is unfavorable for the pest.

MANAGEMENT

- Collection and destruction of egg masses.
- Collection of affected tillers and destruction.
- Release of egg parasitoid *Trichogramma minutum* and larval parasitoid, *Isotima javensis* during November and December in Adali sugarcane is found successful.
- Spraying of endosulfan 2 ml / l.

SUGARCANE SCALES

Melanaspis glomerata

Diaspididae: Hemiptera

This armoured scale is of considerable importance in Andhra Pradesh, Gujarat, Karnataka, MP and Maharashtra. It is reported that the pest gained entry into AP in 1966 into Nizamabad district of AP and from there to East Godavari district in 1968 and from there to West Godavari and Krishna. Now the pest persists in latter three districts and in the former district it is not of much consequence.

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 some time and settle down after selecting suitable spot, preferably on the internodes. Freshly hatched crawlers are tiny and light yellowish in colour. The tiny nymphs after settling down insert their mouthparts into the tissue and start sucking the plant sap. They remain stationary all through their life if they are females. The formation of the protected covering *i.e.*, scales starts soon after a nymph gets settled and becomes thicker and increases in size.

Infestation commences with the formation of the internodes and continues to increase as the plant grows. Plant sap is sucked and the plant is devitalised. In severe cases, even it infests the leaf sheath and the lamina including the mid rib. Varieties having persistent leaf sheaths are attacked to a greater extent and a definite correlation exists between number of stomata in the stem epidermis and the intensity of attack. In a highly susceptible variety of sugarcane, the germination was reduced by about 20 per cent, further the weight of canes, juice sucrose content, bulk density and purity reduced by about 13, 47, 28 and 26 per cent respectively.

- ❖ Shrivelled canes become with shortened internodes.
- ❖ Formation of shiny thick encrustation on the cane, maximum on the bottom and middle of the cane.

On account of its sedentary habits and minute size, the scale insect escapes the notice of the cane grower. It is only after severe damage, its existence is revealed. In Nizamabad (AP), the pest flares up in July and vividly seen in October to November. In coastal AP it is seen first in June – July and persists on the crop right up to July

MANAGEMENT:

- Planting of varieties having a close leaf sheath and are almost self stripped in endemic areas of this pest.
- A variety CO – 7706 has been found moderately tolerant to scales
- Immersion of setts before planting in dimethoate 2ml/l or malathion 2ml/l solution for at least 15 minutes or drenching the cane setts kept in the furrow with 0.1% dimethoate solution @ 450-500 litres per hectare before covering them with earth.
- When the shoots have atleast 6-8 internodes, detrashing the basal 4-5 internodes ensuring that the top most detrashed node is free from scale insect (Before end of July).
- Spraying with malathion 2ml/l or dimethoate 1.7 ml/l on the exposed basal nodes twice at an interval of 10-15 days whenever the stage of the crop and its growth permits.
- Application of carbofuran 3G at the base of clumps 5"-6" deep before July.
- Release of predatory coccinellids, *Pharoscymnus hornii* or *Chilocorus nigritus* in the detrashed fields after July.

SUGARCANE LEAFHOPPERS

Pyrilla perpusilla

Lophopidae: Hemiptera

It is a potential pest occurring in an epidemic form in UP and Punjab. It is also seen in Bihar and Maharashtra. It infests wheat, sorghum, rice, mango, oats, barley etc.

Adults are straw coloured with two pairs of wings folded like a roof on the back and the head prominently drawn forward as a sort of rostrum.

About 600 – 800 pale greenish yellow eggs are laid on the underside of leaves in clusters, covered over with a white filamentous waxy material secreted by the female. Eggs hatch in 7-10 days in summer. Newly hatched nymphs are milky white in color with a pair of characteristic processes or filaments covered by wax. They are very active and are found in very large numbers on sugarcane. Nymphal period lasts one to two months. Life cycle is completed in about 2 months. There are 3-4 generations in a year.

Both adults and nymphs suck sap usually from the underside of leaves and divitalize the plant. In severe cases, the leaves dry up and the plant is stunted. Due to feeding the sucrose percentage of juice is adversely affected. Besides sucking the sap, they excrete honey dew that spreads on the leaves on which a black fungus develops adversely affecting photosynthesis and ultimately the yield

- ❖ Affected plants present sickly and blighted appearance.
- ❖ Development of sooty mould.
- ❖ Swarms of these insects in all stages on the tender foliage. Fading and drying up of the leaves.

Mild winter followed by mild summer with some showers help the survival of overwintering

population and their multiplication. Failure of monsoon, cloudy weather and late action of the parasitoid *Epiricania* favours rapid multiplication of the pest.

MANAGEMENT

- Cultural practices like prompt destruction of trash after harvest.
- Selection of tolerant varieties
- Mechanical methods of collecting and destroying egg masses in the initial stage *i.e.*, during April-May.
- *Tetrastichus pyrillae* and lepidopteran parasite, *Epiricania melanoleuca* naturally suppress the population.
- Foliar sprays with endosulfan 2 ml/l or malathion 2 ml/l

WHITE GRUB

Holotrichia serrata, *H. consanguinea*

Scarabaeidae: Coleoptera

Grubs of *Holotrichia* spp are found feeding on roots and root hairs of sugarcane.

The attacked clumps dry up. The pest is active in monsoon period. It is a major pest in adsali crop. The detailed biology is covered under pests of groundnut.

Effective management practices include ploughing the field deep after the crop. application of phorate 10G 8 – 10 kg / ac in furrows on both sides of cane row at planting or standing crop, and spraying with carbaryl 5 g/l or endosulfan at 2.0 ml/l on leaves of neem, subabul, drumstick as the beetles emerge in June after the break of monsoon and are active at night and feeding on them and erection of light traps to collect beetles which are phototropic.

SUGARCANE MEALY BUG

Saccharicoccus sacchari

Pseudococcidae: Hemiptera

Small pinkish oval insect attached to the lower nodes, protected by leaf sheaths

and covered by a white waxy powder. Adults and nymphs of these bugs are found in large number near the nodes. The females are sac like with clearly segmented body. Males are winged but rare.

The female deposits about 1000 eggs covered with a white waxy or mealy mass in the nodal region. Eggs hatch within a few hours and the newly hatched nymphs move rapidly for some time, select a place on plant and settle.

Both nymphs and adults persist on plants and suck the cane juice from the growing canes and excrete honey dew on the leaves. Sooty mould develops on the infested portion. The pest population builds up under drought conditions. Ants help in their dispersal to a large extent and they live in symbiotic existence. The total life cycle take in about a month.

The infestation can be identified by the presence of mealy bugs at the nodes within the leaf sheath, reduced plant vigour and growth, movement of ants and mould on infested area.

Destruction of crop residues, immersion of setts in malathion 2 ml/l or dimethoate 1.7 ml/l solution for 15 minutes before planting, selection of pest free sets for planting and detashing and spraying malathion 2 ml/l or dimethoate 1.7 ml/l are effective measures.

TERMITES

Microtermes obesi

Odontotermes obesus

Termitidae: Isoptera

These are the most important pests of wheat in India and are present wherever wheat is cultivated. *M.obesi* causes up to 25% destruction of the germinating grains *O.obesus* includes both mound builders and subterranean forms. These termites are polyphagous, widely distributed in Andhra Pradesh. Loamy soils or sandy loams are more suitable.

Soon after first monsoon showers winged forms (reproductive castes) leave colony for flight to select mates. Majority perish due to predations by birds and other natural enemies. Survivors alight again on the soil, shed wings and enter soil in royal pairs. They are confined to royal chamber at enormous depth, copulate several times and start a colony. These are primary reproductives. In case one or both royal members die, supplementary reproductives develop to run the colony.

Queen, after fertilization enlarges in size to a length of 11 cm. Eggs are laid @ 30,000/day and the longevity of the queen is 5-15 years, even up to 50 years. Males undergo little morphological changes but become more flattened. Egg period lasts for 30-90 days and nymphal period 6-12 months.

Members that develop first in the colony are workers (sterile caste) which constitute 75-80% of colony. Workers take care of eggs, young ones till they live independently. They feed and tend the queen. They forage for food and cultivate fungal gardens. 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

❖ Wilting and drying at all stages of wheat crop

❖ Plants may succumb

Soldiers (sterile caste) can be readily identified with powerful mandibles and are

found at damaging site.

MANAGEMENT

- Locating termitarium, digging out queen and destroying is the only permanent remedy
- Fumigation of ant hill with carbon disulphide or chloroform mixture
- Destruction of crop residues which form sources of infestation
- Seed treatment with chlorpyrifos @ 6 ml/kg of seed
- Soil application of chlorpyrifos 50 EC @ 10 ml/l as a soil drench at sowing time in termite prone soils.

WHITEFLIES

Aleurolobus barodensis, *Neomaskellia bergii*

Aleurodidae: Hemiptera

Only these two species have been recorded damaging sugarcane in India.

Both nymphs and adults suck sap from leaves which dry up and characteristic yellow streaks appear along the length. Nymphs are stationary. Severely attacked plants become stunted.

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 attack by this pest, cane juice becomes more watery and the jaggery (gur) quality is adversely affected. A loss of 30-40 per cent in sucrose and 20-25 per cent in total solids was estimated due to its attack. It is reported that the loss to be of 15-20 per cent in yield and 1-2 units in sugar recovery due to the pest attack on crop. Whiteflies prefer broad leaved succulent varieties.

Avoid ratooning in low lying areas, prompt clipping and destruction of affected parts, foliar sprays with quinalphos 2 ml/l against young nymphs and fenetrothion 1 ml/l against puparia are effective measures.

WOOLLY APHID

Ceratovacuna lanigera

Pemphigidae: Hemiptera

Adults colonise on either side of mid rib, covered with white puff material on under side of leaves. Nymphs develop white waxy and mealy filamentous material from third instar. Nymphs and adults suck sap from undersurface of leaves resulting in white and yellow spot on leaves, drying of leaves, sooty mold on honeydew and activity of ants.

Earthing up to destroy infested material, weed management, restricting movement of seed material from infested areas, biological control by neuropteran predator, *Chrysoperla carnea*; lepidopteran predator: *Diapha aphidivora* and foliar spray with endosulfan 2 ml/l or acepahte 1.5 g/l are effective management practices.

MITES

Oligonychus indicus, *Schizotetranychus andropogoni*

Tetranychidae: Acarina

Red mite (*O. indicus*) occurs in hot weather mostly in years when a few summer showers are received. The leaves turn red in patches.

The white mite (*S. andropogoni*) appears a little later in May, June and July. It occurs under characteristic oval webbings and the chlorophyll is depleted in oval

patches. Hot dry conditions favour their increase.

Conservation of phytoseiid predator, *Phytoseius* sp., foliar spray with dimethoate 3 ml/l, wettable sulphur @ 3-6 gm/l or dicofol 2.7 ml/l are effective measures.

INSECT PESTS OF COTTON

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

SPOTTED BOLLWORM

Earias vitella

Earias insulana

Noctuidae: Lepidoptera

Earias vitella and *E. insulana* are serious pests of cotton. These insects are very widely distributed. These pests attack a number of other plants of the family malvaceae viz., bhendi Hollyhock, *Hibiscus cannabinus*, *Abutilon indicum* and other malvaceous plants.

Adult of *E. vitella* has pale whitish fore wings with a broad greenish band in the middle while *E. insulana* has completely green forewings. The adult body length is about 1 cm while the wing span is about 2.5 cm.

The female moth lays spherical, sculptured bluish eggs singly or in groups on tender parts of the plant viz., fresh leaves, fresh squares (flower buds), and flowers. On an average each female moth lays 60-80 eggs. Egg stage is about 2-10 days.

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

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

The caterpillars of both the species have a number of black and brown spots on the body and hence the name spotted boll worm. Full grown larva measures 14 mm in length. The larval stage lasts for about 9 -25 days.

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

MANAGEMENT

- Destruction of plants, crop residues and alternative weed hosts which harbour pests in off season
- Collection and destruction of infested shoots, squares and bolls and the fallen material.
- Adopting crop rotation

- Deep ploughing in summer
- Intercultivation with sorghum, greengram, cluster bean, jowar etc.
- Setting of pheromone traps @ 12/ha
- Conservation and use of natural enemies like *Trichogramma evanescens* which parasitises the eggs and *Bracon lefroyi*, *B. greeni*, *B. hebetor*, *B. brevicornis*, *Apanteles* sp and *Elasmus* sp which parasitise the larval stage and *Chelonus* and *Chalcis* species that parasitise pupal stages.
- Release of first instar larvae of *Chrysoperla* sp. @ 1,00,000/ha
- Foliar spray with *Bacillus thuringiensis* @2g/l of water
- ETL 10% damaged shoot (or) 5% damaged bolls
- The parasitoid activity in the field should be carefully assessed before the insecticidal application
- Foliar spray with endosulfan 2.0 ml; quinalphos 2.5 ml; chlorpyrifos 2.5 ml; acephate 1.5 g; triazophos 2 ml; thiodicarb 1.5 g and profenphos 2 ml/l
- The insecticidal application should coincide with the peak of hatching of eggs, so that the just hatched larvae may get the fatal dose before entering the plant tissue

AMERICAN BOLLWORM

Helicoverpa armigera

Noctuidae: Lepidoptera

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

Moth is stout, medium sized with brownish/greyish forewings with a dark cross band near outer margin and dark spots near costal margins, with a wing expanse of 3.7 cm.

The spherical, yellowish eggs are laid singly on tender parts and buds of plants.

The egg period lasts for 2-4 days.

Caterpillars are of varying colour, initially brown and later turn greenish with darker broken lines along the side of the body.

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

❖ Fed leaves shoot and buds.

❖ “Flared or open” squares. Bolls are bored at the base of flower buds which are hollowed out, bracts of damaged flower buds spread out and curl downwards.

❖ Premature boll opening and shedding

The larval period lasts for 18-25 days. Body covered with radiating hairs. When full grown, they measure 3.7 to 5 cm in length. The full grown caterpillar pupates in the soil in an earthen cell and emerges in 16-21 days.

The activity of *Helicoverpa* starts on greengram, summer vegetables and maize and continues their generation by Aug-Sept months synchronizing with cotton crop. It thrives on cotton crop even in the subsequent generation until the pigeonpea crop comes to flowering (second fortnight of Nov.) then it continues on chickpea, tomato, sunflower, castor during Jan-Feb. months.

MANAGEMENT

- Destruction of crop residues

- Hand picking up of the grown up larvae
- Encouraging new crop rotation
- Nipping terminal buds when 16 to 18 sympodias are present in the plant within 80 – 100 days to reduce the egg load
- Growing intercrops such as cowpea, onion, maize, coriander, urdbean in 1:2 ratio for conservation of natural enemy population.
- Growing sorghum or maize in 4 rows all around cotton crop as guard crop.
- Use of ovipositional trap crops such as marigold @ 100 plants / acre and collection of larvae from flowers.
- Erecting of bird perches for encouraging predatory birds such as king crow, mynah, drongo etc.
- Growing early maturing and tolerant varieties such as Abadita, LK 861, LPS 141, NA 1280 and G 27.
- Installing pheromone traps @ 4 / ac (ETL 10 moths/trap/day)
- Releasing of egg parasitoid *Tricogramma chilonis* at weekly interval @ 1.5 lakhs/ ha or release of 2nd instar larvae of *Chrysoperla carnea* @ one lakh/ha at 75 and 90 days after sowing
- Application of HaNPV @ 200 LE/ac in combination with jaggery 1 kg, sandovit 100 ml or Robin Blue 50 g thrice at 10-15 days interval on observing the eggs or first instar larvae in the evening hours.
- Larval parasitoid such as *Campoletis chloridae* (Ichneumonidae); *Eriborus angenteopilorus*; *Diadegma fenestalis*; *Bracon brevicornis*; *Peribaca orbata* etc.
- ETL 10% of damaged buds (or) 5% of damage bolls or one egg / plant or one larva / 10 plants
- In severe incidence, sprays with indoxacarb 1 ml/l or spinosad 0.3 ml/l or emamectin benzoate 0.5 g/l after collecting late instars.

PINK BOLLWORM

Pectinophora gossypiella

Gelechiidae: Lepidoptera

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

Besides cotton, bhendi, hollyhock, mesta, *Abutilon indicum*, hibiscus and other malvaceous crops are infested.

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

Female lays flattish scale like whitish eggs singly on various parts of young shoots. However, half developed bolls are preferred when available. Egg period ranges from 4-25 days.

The freshly hatched larvae are white and turn pink as they grow older. The larvae do most spectacular damage to practically mature cotton bolls which they enter mostly at such a tiny stage of just hatched larvae that their entry holes get healed and in which

they remain, devouring both seed and fiber forming tissues. The infestation at times is so severe that up to 10 larvae are found in each boll and 75-100 per cent bolls are found infested. The damage results in

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

Larva is full grown in 25 – 30 days. The full grown, uniformly pinkish larvae measures about 8-16 mm with dark brown head and prothoracic shield. The larva undergoes generally only 3 moults.

Pupation occurs in flimsy cocoon in boll, often in seed hollowed out by larva. The pupation period lasts for about 6-20 days depending on the season.

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

- Growing early maturing varieties: bolls mature before heavy population builds up
- Taking up timely sowings. Avoid staggered sowings.
- Use acid delinted seeds: soak seed in concentrated sulphuric acid (80 – 100 ml / kg seed) for 2 – 3 minutes, wash with water 2 – 3 times followed by washing with lime supernatant, shade dry.
- Use of organic manures, recommended doses of N
- Keeping the crop free of weeds
- Monitoring through field scouting and pheromone traps (Gossyplure)
- Destroying PBW in rosette flowers and periodically remove and destroy dropped squares dried flowers and premature bolls.
- Avoiding ratooning and summer cotton.
- After final picking, allowing cattle, sheep and goats to graze upon immature green bolls to prevent carry over of pest to next season.
- Destroying cotton stubbles to prevent carryover.
- Restrict the movement of cotton seed from other areas / states.
- Seed fumigation with methyl bromide @ 0.4 kg / 1000 cu ft. or aluminium phosphide (Quickphos, Phosfume, Phostoxin) @ 50 tablets (each 3 g)/ 1000 cu ft.
- Need based use of insecticides. ETL: 10 % PBW infested rosette flowers. In particular, persistent insecticides like quinalphos 2.5 ml/l; chlorpyrifos 2 ml/l; at 15 days interval.
- In severe incidence cypermethrin 2 ml/l or lambda cyhalothrin 1.5 ml/l or thiodicarb 1.5 g/l on need basis towards the end of crop season.
- Even at ginning mills, burning the stained kapas is suggested.

TOBACCO CATERPILLAR

Spodoptera litura

Noctuidae: Lepidoptera

It is found through out the tropical and sub tropical parts of the world, wide spread in India.

Besides tobacco, it feeds on cotton, castor, groundnut, tomato, cabbage and various other cruciferous crops.

Moth is medium sized and stout bodied with forewings pale grey to dark brown in colour having wavy white crisscross markings. Hind wings are whitish with brown patches along the margin of wing. Pest breeds throughout the year. Moths are active at night. Female lays about 300 eggs in clusters. The eggs are covered over by brown hairs and they hatch in about 3-5 days.

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

ETL: 1 egg mass/10 plants.

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

Caterpillar measures 35-40 mm in length, when full grown. It is 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. It passes through 6 instars. Larval stage lasts 15-30 days

Pupation takes place inside the soil, pupal stage lasts 7-15 days.

Adults live for 7-10 days. Total life cycle takes 32-60 days. There are eight generations in a year.

MANAGEMENT

- Collection and destruction of the infested material from the field.
- Plucking of leaves harbouring egg masses / gregarious larvae and destroying.
- Setting up light traps for adults.
- Setting up of pheromone traps @ 12/ha
- Spraying NSKE 5 % against eggs and first instar larva.
- Spraying NPV @ 200LE/ac in combination with jaggery 1 kg, sandovit 100 ml or Robin Blue 50 g thrice at 10-15 days interval on observing the eggs or first instar larvae in the evening hours.
- Release of egg parasitoid *Trichogramma* @ 50,000/ha/week four times
- ETL: one egg mass / 10 plants.
- Foliar spraying with endosulfan 2ml/l or thiodicarb 1.5 g/l or quinalphos 2.5ml/l. in severe incidence novaluran 1 ml/l or lufenuron 1 ml/l.
- Baiting with rice bran 10kg + jaggery 2 kg+ chlorpyrifos 750 ml or thiodicarb 300g in sufficient quantity of water in form of small balls and broadcasting in evening hours in one acre.

LEAFHOPPERS

Amrasca biguttula biguttula

Cicadellidae: Hemiptera

They are distributed in all cotton growing regions of India. They are mostly

confined to leaf surface infesting okra, potato, brinjal, castor, tomato, hollyhock, *Abutilon indicum* besides cotton.

It is a small insect, varying from less than 1 mm to about 3 mm. Its adult stage is subjected to seasonal changes in colour. It is reddish in winter and greenish yellow in summer. The adult is a wedge shaped insect about 3.5 mm in length. There is a black spot on each forewing and two small black spots on the vertex. Both nymphs and adults move diagonally, when disturbed.

Female lays about 30 eggs. The eggs are usually inserted full length into the spongy parenchymatous tissue between the vascular bundles and the epidermis. The eggs hatch in 4-11 days.

Nymphs are also pale greenish in colour like the adults but are wingless and are found in large numbers on lower surface of leaves. The nymph moults five times and the nymphal period last for 7-21 days. The whole life cycle is completed in about two weeks to more than a month and a half, depending on environmental conditions. There are 8-10 overlapping generations.

At the nymphal stages as well as the adult, they inflict the same type of damage. They suck the cell sap from the plant tissue. During desapping the plant, they also inject a toxin through saliva into the plant tissue, resulting in hopperburn. In susceptible varieties, the attack results in mottling accompanied by the curling of the entire lamina with brown necrotic patches. Thus, the entire photosynthetic activity of the plant is very seriously interfered with.

❖ Hopper burn *i.e.*, the leaf margins turning yellowish initially and subsequently turning reddish and curling up.

❖ Stunted growth of the plant.

❖ Brown necrotic patches on the leaves.

Irrigated conditions in the north and humid conditions in the south; high humidity and high temperature are favourable.

ETL: 2-3 nymphs/leaf

MANAGEMENT

• Growing resistant / tolerant varieties against leafhoppers.

○ L603 Saitha

○ L 604 Narasimha (NA 1325)

○ LRA 5166 NHH 44

○ NHH 390 H 8

○ Lam hybrid – 4

• For sap feeders in general

• Seed treatment (after acid delinting) with

○ Carbosulfan - 40 g/kg

○ Imidacloprid 70 WS - 5 g/kg

○ Thiamethoxam 70 WS - 4 g/kg gives protection for 30 days against sap feeders

• Soil application carbofuran 3G 33 kg/ha (1 kg a.i./ha) at sowing

• Stem application (if seed is not treated) with insecticides using brush

○ Monocrotophos or methyl demeton 1:4 with water

○ Imidacloprid 200 SL 1: 20 with water

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

- ETL: 2 – 3 nymphs / leaf.

- Foliar sprays with monocrotophos 1.5 ml/l or imidacloprid 0.4 ml/l or methyl demeton 2 ml/l or acetamiprid 0.2 g/l or acephate 1.5 g/l or phosalone 2 ml/l or phosphamidon 0.5 ml/l at 15 & 30 DAS

WHITEFLY

Bemisia tabaci

Aleyrodidae: Hemiptera

It is known to infest about 50 different species of plants but it becomes quite a serious pest of cotton in certain regions of the country. The infestation by this pest adversely affects the physiology of the cotton plant at all its stages of growth.

It is distributed in all cotton growing regions of the world. It also infests radish, water melon, cucumber, chillies, brinjal, tomato, potato, tobacco etc

Adult is minute insect measuring about 0.5 mm in length having white or greyish wings, a yellowish body and red medially constricted eyes.

A single female of this species lays about 70 stalked eggs singly on the undersurface of leaves, mostly on the top and middle leaves of plant. The insect can often breed parthenogenetically. The eggs are light yellow in the beginning but turn brown later on. Egg period ranges from 3-33 days.

Nymphs are oval shaped, scale like, greenish yellow with marginal bristle like fringes. The nymphs remain stationary once they settle down. Nymphs moult thrice. Nymphal period lasts for 9-18 days. There are about a dozen overlapping generations in a year. Both nymphs and adults suck sap from lower side of leaves resulting in

- ❖ Chlorotic spots which later coalesce forming irregular yellowing of leaves which extends from veins to outer edges.

- ❖ The vegetative growth retarded and boll formation seriously hampered.

- ❖ Shedding of the bolls accentuated and proper opening of the bolls interfered with.

- ❖ Low quality lint and low oil content.

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

The maximum infestation on cotton occurs during July. High temperature and low humidity are reported to be conducive to the multiplication of this pest.

MANAGEMENT

- A chalcid parasite attacks the older nymphs and the parasitisation is at times more than 30 per cent. Also, there are a few predators like some species of *Chrysopa* and coccinellids, which feed on the whitefly stages.

- Growing of tolerant varieties such as Kanchana (LPS 141); LK 861; NA 1280.

- ETL 5-10 nymphs/leaf

- Chemical control same as under cotton leaf hopper.

RED COTTON BUG

Dysdercus cingulatus

Pyrrhocoridae: Hemiptera

In India, the bug infests cotton in all cotton growing regions. Also infests bhendi, maize, mesta etc., are other host plants.

The nymphs and adults suck sap from tender leaves, petioles and shoots in early stages and then infest flower buds and immature bolls and bolls that have just opened. Resulting plants lose their vigour and bolls open prematurely with stained lint. Infested

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

COTTON LEAF ROLLER

Sylepta derogata

Pyralidae: Lepidoptera

Besides cotton, bhendi and several other malvaceous plants are infested by this pest.

It is primarily a sporadic pest of cotton in India. The larva rolls the leaf and feeds on the green tissue in the early stage and eats up a large portion of the leaf as it grows. Severe attack results in the presence of a large number of leaf rolls and the plants become stunted ultimately.

Natural enemies viz., egg parasitoid: *Trichogramma* sps; larval parasitoids: *Brachymeria bengalensis pulchellae*; *Elasmus indicus*; *Apanteles* spp.; *Bracon lefroyi*; *Microbracon recinicola*; and Pupal parasitoids: *Trichospilus pupivora* and *Xanthopimpla* spp., and foliar spraying with carbaryl 3 g/l or monocrotophos 1.5 ml/l are effective measures.

INTEGRATED PEST MANAGEMENT IN COTTON

Number of sucking pests like aphids, leafhoppers, thrips and whiteflies infest cotton during early vegetative growth. Of these leafhoppers and whiteflies occur more regularly and predominantly. Hence strategies for managing sucking pests have direct impact on success of IPM strategies for boll worms which emphasize survival and build up of natural enemies in cotton ecosystem.

IPM FOR SUCKING PESTS

- Growing tolerant / resistant varieties or hybrids against leafhoppers and white flies.
 - Leafhoppers: Many varieties like MCU – 5, LRA 5166, L 604, L 603, Narasimha (NA1325) & hybrids like NHH 44, Saritha, H8, jk Hy – 1, LAHH – 1
 - Whiteflies: glabrous varieties like Kanchana (LPS 141), LK 861, L615, NA 1280, Supriya
- Soak the seed in concentrated sulphuric acid (100 ml/kg seed) for 2 – 3 minutes, wash with water 2 – 3 times followed by washing with lime supernatant, shade dry and treat with carbosulfan 40 g or imidacloprid 5 g along with little gum to protect against early season sucking pests.
- If untreated seed is sown, apply carbofuran 3G 12 – 14 kg/ac or phorate 10G 4 – 5 kg/ac nearer to the base of seedlings when the soil is moist.
- If the seed treatment is not done or granules are not applied, stem application using small brush with
 - Monocrotophos or methyl demeton in 1:4 dilution
 - Imidacloprid in 1:20 dilution at 20, 40, 60 DAS against sucking pests up to 75 days without harming natural enemies and environment and minimizing insecticide quantity.

- Growing intercrops like blackgram, greengram, soybean, clusterbeans, cowpea, groundnut, *Setaria* contribute to build up of natural enemies and give extra income. High yielding varieties in two rows with 90 cm spacing, hybrids in three rows with 120 cm spacing.
- In whitefly endemic areas, keeping yellow empty tins smeared with greese as trap. Wipe out trapped whiteflies every day and apply greese again.
- In non IPM plots, spray monocrotophos 1.6 ml/l or dimethoate 2.0 ml/l or triazophos 2.5 ml/l or methyl demeton 2 ml/l or imidacloprid 0.4 ml/l
 - When there are 5 – 10 whiteflies / leaf
 - 1 – 2 leafhoppers / leaf
 - 15 – 20 % aphid infested plants
- For mealy bug, dichlorvos 1 ml/l or methyl parathion 1 ml/l.
- For mites, sulphure 3 g/l or dicofol 5 ml/l

IPM FOR BOLLWORMS

- Deep ploughing exposes and eliminates hibernating insects and expose pupae to sun and predating birds.
- Balanced organic fertilization keeps crop healthy and tolerant to pest attack.
- Border crop with jowar, maize in 2 or 3 rows not only serves as a barrier for migration of insect pests but also pollen of maize helps in attraction of beneficial *Chrysoperla* to the field.
- Growing trap crops @ 100 plants/ acre.
 - Castor as an ovipositional trap crop against *S. litura*: egg masses, gregarious larvae of *S. litura* on castor should be removed once in a week and destroyed.
 - Marigold as ovipositional trap crop against *Helicoverpa*
 - Okra (bhendi) against spotted bollworm moths.
 - Spray marigold / okra plants with endosulfan or phosalone to minimize larval population
- Keep 10 – 15 pheromone traps / ha to attract male moths. Egg scouting from square initiation stage is desirable.
 - ETLS – PBW: 8 moths, ABW: 10 moths, *S. litura*: 20 moths, SBW: 15 moths per trap per night.
- Topping (removal of leaf terminals) for 80 – 100 days old crop during October – November since tender leaves and tips are preferred for egg laying.
- Spray 5% neem seed kernel extract (NSKE) (soak 10 kg neem seed powder in 200 litres of water for 24 h and filter through muslin cloth) to repel moths from egg laying and to kill eggs and early instar larvae.
- Install 'T' shaped or long dried twigs as bird perches to attract predatory birds @ 20 / ac.
- Spray NPV @ 200 LE / ac in combination with jaggery 1 kg, sandovit 100 ml or Robin Blue 50 g thrice at 10-15 days interval on observing the eggs or first instar larvae in the evening hours. The diseased larvae die after 4 – 5 days showing tree top symptoms.
- Spray commercially available *B. t* formulations (DIPEL, DELFIN, BIOBIT, HALT) @ 400 g or 400 ml/ac against *Helicoverpa*

- On the basis of ETLs spray the following insecticides, endosulfan 2 ml/l or chlorpyrifos 2 ml/l or quinalphos 2 ml/l or methylparathion 1 ml/l or carbaryl 3 g/l or triazophos 2 ml/l or thiodicarb 1.5 g/l or profenophos 2 ml/l
- Mixing mustard oil with endosulfan 1:2 or chlorpyrifos 1:4 improves toxicity
- In the entire schedule of spray, do not spray synthetic pyrethroids for more than two rounds.
- **Role of B.t Cotton:** Advances in biotechnological approaches facilitated introduction of *B.t* transgenic cotton which offered greatest protection against American bollworm. Oflate *B.t* cotton have dramatically changed the plant protection scenario in cotton worldwide. Growing of *B.t* cotton has been highly successful against bollworms. This is evident in increased area under *B.t* cotton in India from 72,000 acres in 2002 to 10.15 m. ha in 2009 -10. *B.t* cotton varieties with Cry IAc toxin protein (*B.t.* 1) have been targeting American bollworm, Spotted bollworm and Pink bollworm but not tobacco caterpillar. However gene pyramiding of Cry IAc and Cry IIAb (*B.t.* 2) could offer protection against tobacco caterpillar.in addition to bollworms.

PESTS OF PULSES

All the pulse crops are infested by a variety of insects and mite pests. These pests are responsible for both direct and indirect losses.

Based on growth habit, redgram is divided into determinant (clustering) and indeterminate (branching types). Damage to pods of early and mid maturing cultivars of determinate habit by lepidopterous borers is very severe. Pod fly is much more important in late maturing cultivars.

GRAM CATERPILLAR

Helicoverpa armigera

Noctuidae: Lepidoptera

Redgram in southern states of India suffers heavy losses due to the 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. Damage ranges from 46 to 67 per cent on redgram due to this pest. If one larva per plant infests then the damage caused will be about 34 per cent. *Helicoverpa* readily adjusts with any newly introduced variety. It is observed through out the year on one or the other crops viz., peas, tomato, cotton, maize, tobacco, safflower, groundnut, chillies etc.

Moth is stout with dark yellow olive grey or brown wings crossed by a dark band near outer margin and a dark spot near costal margin of forewings and hindwings pale with a dark apical border.

Yellowish shiny, sculptured eggs are laid singly on tender parts of plants. Each female lays 300-400 eggs. Egg period is 2-4 days.

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

❖ Large round on each locule

Full grown caterpillar is cylindrical 40 – 48 mm in length with variable colour, dark green or reddish brown or brownish and marked with a white broken lines and a prominent white line along lower part of sides. Larval period 18-25 days.

Full grown caterpillar drops down and pupates in soil. Pupa is dark brown and adult

emerges in 6-21 days.

IPM

It is a major pest on redgram and gram. Hence IPM is important.

A. Initial crop growth phase

- Deep summer ploughing to expose pupae in soil
- Crop rotation with less favourable crops like jowar, gingelly, blackgram, horsegram, dry paddy (in redgram)

B. Raising intercrops like greengram, blackgram in 7 rows in *kharif* redgram and jowar in 2 rows in *rabi* redgram encourage and conserve natural enemies viz., *Campoletis chloridae*, *Carcelia illote*, *Apanteles sauros*, *Microbracon brevicornis*, *Chelonus narayani*, *Tetrastichus Israeli*, *Exorista fallox*, *Eucelatoria sp.*(Diptera), NPV, *Nomuraea rileyi*, *B.t.*

- Raising jowar in 4 rows all around redgram crop will serve as guard crop
- In bengalgram, mustard, coriander as intercrops
- Selection of tolerant varieties like ICPL – 332, LRG – 41 and varieties with recuperating ability like LRG – 30.
- Clipping of a terminal twig upto one foot at 90 – 100 DAS to remove ovipositional niches (depending on moisture availability in soil)
- Raising of *rabi* redgram to avoid pest.

C. From flowering

- Erect pheromone traps @ 10/ha to monitor the pest. Light traps during August – September; November – December
- Erect bird perches @ 50/ha to attract predatory birds like Drongo.
- When eggs and early instar larvae are noticed spray NSKE 5 % or neem based insecticides
- Use of microbial insecticides
 - NPV 200 LE/ha
 - *B.t* formulation 400g or 400 ml/ac thrice at weekly interval in evenings in winter.
- Mechanical shaking of redgram plants and collection and destruction of dislodged grown up larvae
- Avoid indiscriminate use of insecticides, synthetic pyrethroids and mixtures.
- On need basis spray
 - Chlorpyrifos 2.5 ml/l at initiation of flowers
 - Quinalphos 2 ml/l or acephate 1.5 g/l at flowering and fruiting using 750 – 1000 l of spray fluid with High Volume sprayer.
 - In severe incidence, indoxacarb 1 ml/l or spinosad 0.3 ml/l
- Adopt community approach.

REDGRAM POD FLY

Malanagromyza obtusa

(Agromyzidae: Diptera)

It is a major pest of redgram, soybean and cowpea. Attack is more in north and central India and Karnataka. In North India 80 per cent damage to crop is reported. The other hosts are sorghum, cowpea,

safflower, bhendi *etc.*

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

Small black fly thrusts its minute eggs into the tissues of the tender pod and flower buds. Fly pierces pericarp with ovipositor and lay eggs which are seen like needles projecting inwards from the pods. Female fly lays 4 eggs per pod and 80 eggs in its life time. Egg period is 3 days.

Tiny maggots 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 the second and third instar stages, 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 pupation, windows the pods and pupates either in the pod cavity or in the pod wall tissue. The damaged seeds are unfit for consumption. Diagnostic symptoms are

- ❖ Discolouration of the infested pods visible in green podded varieties.
- ❖ At the later stage of infestation, the holes about 1mm in diameter covered with a thin membrane readily seen on the infested pod.
- ❖ 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. Larval period is 6-10 days. Under abundant moisture condition, two broods can be seen in a year.

Full grown maggot pupates inside larval grooves in pods. Pupal period is 8-12 days. Adults emerge by cutting the thin spot already made by maggot.

MANAGEMENT

- Early sowing in endemic areas
- Removal of affected pods of first brood during winter.
- Pre-pupal stage is parasitized by *Euderus agromyzae* and pupa is parasitized by *Euderus lividus*.
- Foliar sprays with monocrotophos 1.5 ml/l or dimethoate 2 ml/l are effective against larva and endosulfan 2 ml/l against adult flies.

GREEN POD BORING CATERPILLAR OR LENTIL POD BORER

Etiella zinckenella

Pyralidae: Lepidoptera

It occurs on redgram, horsegram and other pulses and green manure crop like sunhemp. The larvae feed on floral parts, newly formed pods and seeds in developing pods. Faecal pellets inside damaged pods and small round holes on redgram pods plugged with excreta can be noticed.

Management of gram caterpillar is effective against this pest.

PEA LEAF MINER

Phytomyza atricornis

Agromyzidae: Diptera

Mustard, cauliflower, cabbage, lentil, potato are infested by this pest. Eggs are inserted into the leaf tissue, maggots mine into mesophyll of leaf leading to irregular blotches on leaves,. Pupation is inside leaf

mine. Both winter and summer are passed in pupal stage. Maggots are parasitized by Braconids, Eulophids. Foliar spray with methyl demeton 2 ml/l or dimethoate 2 ml/l was effective.

TOBACCO CATERPILLAR

Spodoptera litura (Fabricius)

Noctuidae: Lepidoptera

It is found throughout the tropical and subtropical parts of the world, widely spread in India. Besides castor it feeds on tobacco, cotton, groundnut, tomato, cabbage and various other cruciferous crops.

Moth is medium sized and stout bodied with forewings pale grey to dark brown in colour having wavy white crisscross markings. Hind wings are whitish with brown patches along the margin of wing. Pest breeds throughout the year. Moths are active at night. Female lays about 300 eggs in clusters. The eggs are covered over by brown hairs and they hatch in about 3-5 days.

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

ETL 1 egg mass/10 plants.

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

Caterpillar measures 35-40 mm in length, when full grown. It is 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. It passes through 6 instars. Larval stage lasts 15-30 days

Pupation takes place inside the soil, pupal stage lasts 7-15 days.

Adults live for 7-10 days. Total life cycle takes 32-60 days. There are eight generations in a year.

MANAGEMENT

- Collection and destruction of the infested material from the field.
- Plucking of leaves harbouring egg masses / gregarious larvae and destroying.
- Setting up light traps for adults.
- Setting up of pheromone traps @ 12/ha
- Spraying NPV @ 250LE/ha.
- Release of egg parasitoid *Trichogramma* @ 50,000/ha/week four times
- ETL: one egg mass / 10 plants.
- Foliar spraying with endosulfan 2ml/l or thiodicarb 2ml/l or quinalphos 2.5ml/l.
- Baiting with rice bran 12kg + jaggery 2.5kg+carbaryl 50WP1kg in 7.5lt water/ha during evening hours to attract and kill the caterpillars

PESTS OF GROUNDNUT

WHITE GRUB OR ROOT GRUB

Holotrichia consanguinea, *H. serrata*

Scarabaeidae: Coleoptera

Root grub is a polyphagous pest, feeding on the roots of a wide range of plants like pulses, groundnut, sugarcane, vegetables *etc.* and it is a serious pest on groundnut in Kurnool and Anantapur districts.

Adult is fully developed by the end of November and remains in the pupal cell. Adult hibernates till early showers of rain are received. Adults emerge out of soil during first monsoon showers at dusk, mate and feed on the leaves of the trees *viz.*, neem, drumstick, subabul *etc.*, and early in the morning get back and burrow into the soil and lay the eggs @ single egg per cell during April – July in the soil at a depth of 12 -15 cm. Incubation period is 8-13 days. Beetles are active during May-July months and disappear by first week of August.

Upon hatching grubs feed on nodules, fine root lets and also girdle the main root ultimately killing the plants. They become full grown by September end and move deeper down into the soil.

❖ In case of severe infestation the patches of dead plants are seen in the infested fields.

❖ The cut end of the attacked stem of a dead groundnut plant is swollen. Full grown grubs are creamy white with a brown head and reach 2” in length. They are curled up in position.

Pupation takes place in an earthen cocoon in soil. Pupal period is 7 - 10 days. Adult is fully developed by the end of November and remains in the pupal cell. Only one generation in a year. Total life history from egg to adult is 171 days

MANAGEMENT

- Deep ploughing after summer showers would expose the pupae and beetles to hot sun or birds predations.
- Mass collection and destruction of beetles from the branches of neem, subabul, *Acacia*, ber trees immediately after receiving summer showers.
- Spraying surrounding trees with carbaryl 3 g/l at first monsoon showers
- Flooding the field for 24 hours kills grub population.
- Utilisation of fungal pathogens like *Metarhizium anisopliae*, *Beauveria brongniartii* is now under consideration
- Seed treatment with chlorpyrifos 6 - 10 ml/kg seed is effective against root grubs.
- Application of phorate 10 G 15 kg/ha at sowing time.

RED HAIRY CATERPILLAR

Amsacta albistriga, *Amsacta moorei*

Arctiidae: Lepidoptera

Among the whole group of hairy caterpillars, red hairy caterpillars are most injurious to agriculture throughout India. Although the red hairy caterpillars are found in southern and northern regions of the country, they are said to belong to two species of the genus *Amsacta*. Their habits, nature of damage *etc.*, are similar. They are polyphagous, also feeds on sorghum, cowpea, cotton, finger millet, castor, cotton *etc.*

This is a serious and devastating pest of rainfed *kharif* crop. It is an

endemic pest. Its seasonal outbreak in various tracts is largely dependent on climatic conditions, edaphic factors and the local agricultural practices. It appears in great numbers as regular plague after the receipt of first monsoon showers during early June.

A. albistriga : The adult is a medium sized moth. The forewings are white with brownish streak all over and yellow streak along the anterior margin and the hindwings are with black markings. A yellowish band is seen on the head.

A moorei: The anterior marginal streak of forewings and the band on the head are red in colour.

After the receipt of rains in June-July months, on the second evening by about 4 pm the moths emerge from earthen cells in the soil. They mate and commence oviposition on the same day.

The creamy or light yellowish eggs are laid in groups mostly on the under surface of leaves, on clods, stones, dry twigs *etc.* Single female lays 300-1000 eggs. Incubation period is 3-4 days

The caterpillars in early stages are found in groups on the underside of leaflets and feed on them. Later they disperse to surrounding plants. As they grow they feed voraciously on leaves leaving behind the petiole and mid ribs of leaves and the main stem of plants. They may be seen marching from one field to another in thousands. Often it results in total loss of crop.

Full grown caterpillars of both these species are reddish brown with black bands on either end and have long reddish brown hairs all over the body arising on warts. The head and prothorax are red. Larval period is 40- 50 days.

The grown up larva burrows into the moist soil and pupates in earthen cell at a depth of 10-20 cm. mostly along field bunds and in moist and shady areas under trees in the field. The insect undergoes pupal diapause in the soil till next year. There is only one generation per year.

MANAGEMENT: In view of the wide spread outbreak of the pest over a vast area, it is necessary that the farmers adopt the management on a community basis.

- Deep summer ploughing after harvest to expose diapausing pupae
- Collection and destruction of egg masses and gregarious larvae.
- Setting bonfires or light traps to attract the moths within 24 h after receipt of monsoon showers.
- Placing shoots of *Jatropha* or *Ipomoea* on bunds to attract migrating larvae and spraying on shoots
- Growing cowpea and castor as trap crops.
- Trenching around the field and dusting with carbaryl or methyl parathion dust @ 250 g /one meter length.
- Natural enemies include a predatory pentatomid bug attacking larvae and larval parasites, *Apanteles flavipes*, *A. creatonoti* (Braconidae), *Exorista civiloides*, *Sturnia inconspicua* (Tachinidae)
- Spraying with dimethoate 2ml/l, monocrotophos 1.6 ml/l
- Poison baiting for late instars with rice bran 10 kg + jiggery 1 kg + quinalphos 1 litre or methomyl 350 ml + water.

PESTS OF MUSTARD

MUSTARD APHID

Lipaphis erysmi

Aphididae: Hemiptera

It is a regular pest on mustard, active from January – March. Whitish green aphids reproduce sexually and parthenogenetically. Winged forms appear near end of season.

Eggs are laid ovoviviparously, each female laying 3-9 eggs/day.

Nymphal period is one week. Both nymphs and adults 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 (farmers practice)
- Early sowing by 10 – 15 days
- Growing short duration varieties: T 6342, RLM 514, Varuna, PK 9, RH 785, RLM 528
- ETL: 50 – 60 aphids per plant at flower bud initiation
- Foliar sprays with dimethoate 2 ml/l or monocrotophos 1.6 ml/l or endosulfan 2 ml/l or methyl demeton 2 ml/l

MUSTARD SAWFLY

Athalia lugens proxima

Tenthredinidae: Hymenoptera

This is one of the very few hymenopterous insects to infest crops in India. It is also a pest on raddish and other crucifers

Adult is small orange yellow with black markings on the body, smoky wings with black veins. The female possesses a saw - like ovipositor.

Eggs are laid singly @ 35 / female very near the leaf margins. Incubation period is 4-5 days

The larva feeds on the leaves nibbling leaves initially, biting holes later causing

- ❖ Skeletonisation of leaves
- ❖ Heavy defoliation
- ❖ On slightest touch, larva falls to ground feigning death.

Full grown larva is cylindrical and dark grey with three pairs of thoracic legs and seven to eight pairs of abdominal legs and five black stripes on the abdomen. It measures about 15-20mm. Larval period is 13- 18 days.

Pupation is in an earthen cocoon in the soil. Pupal period is 10-15 days

MANAGEMENT:

- Collection and destruction of the larvae.
- Foliar spray with methyl parathion 2ml/l or carbaryl 3 g/l.

DIAMOND BACK MOTH

Plutella xylostella

Plutellidae: Lepidoptera

This pest is reported to have worldwide distribution on cruciferous plants. It is confined to the plants of *Brassica* spp. cauliflower, *Brassica oleracea* var. *capitata*, turnip, *Brassica rapa*. The pest is active throughout in the cold weather.

Grayish brown moth with narrow fringed wings having pale white triangular markings on inner margin of each forewing anteriorly which form diamond like white patches dorsally when wings are folded over back at rest. Hence the name, diamond back moth.

Female lays 50-60 small whitish eggs singly along the veins of the leaves at night times on the undersurface. Eggs hatch in about 7 days. Caterpillars feed on under surface of leaves and bite holes in leaves and cause serious damage. In severe cases, the leaves are skeletonised.

- ❖ Holes on leaves
- ❖ Skeletonised leaves on affected plants
- ❖ Withered appearance of leaves

Full grown caterpillar is greenish with short thin hairs on the body and body tapers towards both ends. Larval period is 14 days

It pupates in a flimsy silken cocoon on under surface of leaves. Pupal period is about 7 days.

MANAGEMENT:

- Regular monitoring and surveillance.
- Collection and destruction of the larvae and infested leaves.
- Erecting pheromone traps @ 4/acre
- Larval parasitoids *Apanteles plutellae*, *A. ruficrus*, *Brachymeria* sp.
- Application of *B. t* 1g/l
- Spraying with endosulfan 2 ml/l or dichlorvos 1ml/l or thiodicarb 1.0g/l or novaluron 1ml/l or indoxacarb 1ml/l or spinosad @ 0.33ml/l .

PAINTED BUG

Begrada cruciferarum

Pentatomidae: Hemiptera

Serious pest of cruciferous crops, cabbage, cauliflower, radish etc and is widely distributed. Both nymphs and adults 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.

Spraying with endosulfan 2 ml/l or quinolp hos 2 ml/l or dimethoate 2 ml/l is effective.

PESTS OF BRINJAL

EPILOACHNA BEETLE /SPOTTED LEAF BEETLE

Epilachna vigintioctopunctata

Epilachna dodecastigma

Coccinellidae: Coleoptera

This is one of the important pests of brinjal. Its incidence starts in July-August. It also infests tomato, bittergourd, *Datura*, *Physalis*.

Beetle is small round to slightly oblong in shape measuring about 5 mm in length and 3.5 mm in width. The underside of the beetle is flat

while the upper side is convex. It is light brick red or pinkish in colour bearing 12-28 small black dots on the pronotum and elytra. These black dots are symmetrically placed in a crescent manner. Adult lives for one month to more than two months.

The yellow elliptical eggs are laid generally on the undersurface of leaves in batches of hundreds, glued to the leaf surface in a vertical position. They hatch in 3-4 days.

The minute grubs on hatching start damaging the plant by feeding on the fresh matter of the leaf surface leaving veins and veinlets. The freshly hatched grub is yellowish and turns to cream yellow white, when full grown. The grub is broad in front and narrows posteriorly and is covered with spiny structures all over. The grown up grubs become voracious feeders, found in batches. Both the grubs and adults confine their feeding activities generally to the undersurface of leaves. The activity of the pest is more on the lower leaves resulting in

- ❖ Damaged leaves presenting a lace like appearance as the green matter in between the veins is eaten away (skeletonisation of leaves).
- ❖ Affected leaves, depending upon the area damaged, drying up and in severe infestation, presenting sickly appearance.

Larval period lasts for 10-35 days.

Pupation takes place on the leaf surface. The full grown grub attaches the last segment of its abdomen to the leaf surface by means of a sticky secretion and the pupa is formed within the last larval skin which splits on the dorsal side. The pupal period varies from 3-6 days after which the adults emerge. Total life cycle takes 17 to 50 days.

MANAGEMENT:

- Hand picking will prove effective as the beetles are sluggish during the morning hours
- If the area is small, collection and destroying the egg masses which can be spotted easily.
- Egg parasitoid *Tetrastichus ovularum*, larval parasitoid *Uga menoni* suppress the population during March – July
- Organic compounds of plant origin are effective.
- Foliar spray with DDVP 1 ml/l in nursery as well as planted crop or carbaryl 3 g/l or profenofos 2ml/l or quinalphos 2 ml/l.

BRINJAL SHOOT AND FRUIT BORER

Leucinodes orbonalis

Pyralidae: Lepidoptera

It is one of the serious pests of brinjal throughout the country. It also infests potato, *Solanum nigria*, *S.xanthocarpum*, bittergourd.

Moths are medium in size with white wings having large brown patches and red markings. Wing span measures about $\frac{3}{4}$ of an inch. The head and thorax are blackish brown.

The female moth lays about 80-120 eggs singly on tender shoots and developing fruits of brinjal. Incubation period is 3-5 days

If infestation occurs during vegetative phase, caterpillars enter into

the petiole, midribs and young shoots. During fruiting stage caterpillars enter into fruits make holes and feed inside. Initially, the entry hole is so small that it is not visible. Later, fruits bear large circular holes plugged with excreta. The infested fruits are unfit for consumption and marketing. The infestation may go as high as 70 per cent on brinjal. The pest is active throughout the year except winter. In Nursery no damage is observed. Transplanted seedlings are attacked. The damage results in

- ❖ Drooping of tender shoots and wilting in vegetative stage
- ❖ Holes on the infested fruits filled with excreta

The full grown caterpillar is pinkish with sparingly distributed hairs on warts on the body with a brownish head. It measures 16-20 mm long. Larval period lasts 15 days.

The full grown caterpillar generally pupates outside the bore holes on the stem, fruit stalks etc .in a dark buff coloured cocoon in dirty brown silk. Moth emerges in about 6 -8 days.

MANAGEMENT

- The damaged portions of the plants should be removed and destroyed.
- Continuous cropping of brinjal and potato in the same area encourages the pest activity and hence proper rotation should be followed.
- Variety Bhagyamathi is tolerant to the pest damage and suitable for coastal Andhra.
- Erecting pheromone traps @4/acre
- Larval parasitoids, *Pristomerus testaceus*, *Trathala flavoorbitalis*, *Microbracon greeni*, *Pseudoperichaeta* sp suppress the population.
- Three spraying with carbaryl 3 g/l or profenofos 2ml/l or cypermethrin 1 ml/l at 10 day interval from 3 weeks after transplanting

Note: Acaricidal spray should be given after two rounds of spray with carbaryl as mites may flare up.

PESTS OF CUCURBITACEOUS VEGETABLES

CUCURBIT FRUITFLY

Bactrocera cucurbitae (Big size)

B. dorsalis (Medium size)

B. ciliatus (Cosmopolitan)

Tephritidae: Diptera

It is one of the important pests on gourds like bittergourd, snakegourd, melons, coccinia etc., throughout the country

Fly is reddish brown with lemon yellow markings on thorax with spotted wings. It is active throughout year. Adults hibernate during winter and they become active in hot weather. Adult flies emerge from pupae during morning hours and mate at dusk. Longevity is 14 days

The female fly oviposits on soft fruits. Cavity is made by sharp ovipositor and 12 cylindrical eggs are laid in the evening time and exuding gummy substance covers, cements and makes it water proof. Female lays 58-95 eggs in 14-54 days. Egg period is 1-9 days.

Only maggots cause damage by feeding near ripe fruits, riddling them and polluting pulp. Maggots bore in to the fruit and feed on pulp forming lesions. Fruits decay due to secondary bacterial infection. Damage is more serious in melons. Fruits at early stage also are attacked. Such fruits do not develop. Infestation results in

- ❖ Premature drop of fruits.
- ❖ Decay of fruits due to secondary bacterial infection

The damage is more in monsoon season. The maggots are apodus, acephalous, dirty white, wriggling creatures, thicker at posterior end and tapering at the other to a point. Larval period is 13 days in summer and about three weeks in winter.

Mature maggots come out and jump to ground and select suitable place, enter soil and pupate. Pupa is barrel shaped. Pupal period lasts 6-9 days.

MANAGEMENT

- Early maturing varieties are less affected than later ones.
- Changing of sowing dates.
- “Arka Tinda” among round gourd and “Arka Suryamukhi” among pumpkin are resistant to *B. cucurbitae*.
- Affected fruits collected and destroyed.
- Harvesting of fruits before ripening.
- Slight ploughing and raking of soil after the harvest to expose pupae from the soil.
- “CUE LURE” is an effective attractant being used to trap cucurbit fruit fly.
- Poison baiting with malathion 100 ml + sugar/jaggery 100 g as saturated solution + water 1 litre distributed in earthen lids.
- Foliar sprays with endosulfan 2ml/l or malathion 2ml/l or carbaryl 3g/l, 3-5 rounds at fortnightly intervals.
- Foliar sprays with carbaryl 3g/l for flies resting on undersurface of leaves.
- Before each spraying the fruits should be harvested.

PUMPKIN BEETLES

Raphidopalpa foveicollis

Aulacophora cincta

Aulacophora intermedia

Galerucidae: Coleoptera

They infest bittergourd, snakegourd, melons, pumpkin, coccinia etc .

R. foveicollis has reddish brown elytra, *A. intermedia* blue black

elytra and *A. cincta* grey with black border elytra.

Beetles are more destructive. They bite holes on leaves and also feed on flowers. Beetles injure the foliage, flowers and cotyledons by biting holes into them. Early sown cucurbits are severely damaged necessitating resowing. Beetle damage results in

- ❖ Numerous of holes on leaves.

Brownish elongate eggs are laid in the soil and each female may lay about 150 to

300 eggs singly or in groups of 8 -9 near the base of plants. Egg period is 5-8 days. Grubs after hatching, feed on roots of plants below soil surface.

Grubs bore into vines, feed on fruits that come in contact with the soil.

Grubs are creamy white with darker oval shield at back. Grub period is 13-25 days.

Pupation takes place in an earthen cocoon. Pupal period is 7-17 days. Total life cycle takes 26 -27 days. There are 5 to 8 generations in a year.

MANAGEMENT

- Deep summer ploughing exposes the grubs and pupae.
- Collection and destruction of adults
- Dusting the plants with ash temporarily repel the beetles .
- Dusting the soil and foliage with carbaryl 10D /endosulfan 4D
- Foliar spray with carbaryl 3g/l/ or methyl parathion 2 ml/l or dimethoate at 2 ml/l or malathion 2 ml/l and drenching the soil at root zone so as to kill the grubs.
- Synthetic pyrethroids show phytotoxic symptoms resulting in whitening of foliage

PESTS OF CRUCIFEROUS VEGETABLES

DIAMOND BACK MOTH

Plutella xylostella

Plutellidae: Lepidoptera

It is distributed worldwide infesting cruciferous plants of *Brassica* sp. cauliflower, *Brassica oleracea* var. *capitata* , turnip *Brassica rapa* etc .

The moth is greyish brown with narrow wings having pale white triangular markings on inner margin of each forewing which form three diamond shaped white patches dorsally when wings are folded over back at rest. Hence the name, diamond back moth. The pest is active throughout the year

Each female lays 50-60 small whitish eggs singly along the veins on underside of leaves at night times. Egg hatches in about 7 days.

Caterpillars feed on undersurface of leaves and bite holes in leaves and cause serious damage causing

- ❖ Holes on leaves.
- ❖ Withered appearance of affected leaves.
- ❖ Skeletonised leaves.

Larva is greenish with short thin hairs on the body. Full grown caterpillar measures 1-1.5 cm and its body tapers towards both ends.

Larval period is 14 days.

Pupation takes place inside a thin loose mesh of silken cocoon. Pupal period is about 7 days.

MANAGEMENT (IPM)

- Removal and destruction of plant remnants, stubbles, debris after harvest and ploughing the field.
- Transplanting 2 rows of mustard as a trap crop for every 25 rows of

cabbage to attract moths to mustard.

- Larval parasites *Apanteles ruficrus*, *A. plutellae* and pupal parasite *Brachymeria excarinata* suppress population.
- Foliar spray with 5% NSKE for killing the eggs. To obtain 5% neem seed extract, take extract from 5 Kg kernel powder in 100 litres of water. About 12.5 Kg kernel powder is needed to cover 1 ha with 250 litres in high volume sprays for crops like chickpea.
- Foliar sprays on 30, 45 DAT with *B. t.* formulations 1g/l.
- Foliar spray with endosulfan 2 ml or spinosad 0.3 ml/l. (Last spray should be 15 days before harvesting).
- Under severe infestation, fenvalerate 1ml/l or cypermethrin 1ml/l or deltamethrin 1ml/l is recommended.

PESTS OF MANGO

MANGO HOPPERS

Amritodus atkinsoni (largest)

Idioscopus clypealis (smallest)

I. niveosparsus (medium)

Cicadellidae: Hemiptera

These insects are monophagous on mango and occur as regular pests.

They are wedge shaped measuring 3 to 7 mm in length and move diagonally.

Among these

A. atkinsoni is the largest and light brown having two black spots on scutellum, the anterior margin of pronotum and vertex.

I. clypealis is the smallest and lighter in colour with two spots on the scutellum dark spots on the vertex. Clypeus is entirely black.

I. niveosparsus is slightly smaller with three spots on the scutellum and prominent white bar crossing its dusky wings. It is the most injurious species in South India.

The June-August generation hoppers are seen on mango tree trunks while February-April generation is confined to the foliage and causes severe loss. Adult hoppers spend winter in the cracks in the barks of the tree. Hoppers prefer shady and damp places

After spending winter in the adult stage, the female lays eggs about 100-200, singly within the tissues of flower buds, tender leaves during February – March. The eggs hatch in 7-10 days. The nymphs soon after hatching begin to suck the plant sap. Nymphs are smaller than the adults. The nymphal period lasts for 2-4 weeks. There are two peak generations of this insect during a year i.e. during February – April and June-August periods.

During flowering, the hoppers develop enormously in number, suck juice from the inflorescence and other tender plant parts reducing the vigour of the plant leading to reduction in fruit set and even premature fruit fall. The infestation also leads to development of sooty mould on the honeydew excreted by the insects. Egg laying also inflicts injury to the inflorescence. The infestation ranges from 25 to 50 per cent and in severe case it may lead to total loss of crop. During the remaining part of the year (off season), these hoppers occur in small numbers inside barks or on leaves of mango. High humidity in the air during flowering time encourages

insect multiplication. The damage results in the following

- ❖ Affected flowers wither and drop down.
- ❖ Presence of black sooty mould on floral and other tender plant parts.
- ❖ High humidity in orchards due to waterlogging, shading and overcrowding of trees favour the buildup of the pest.

MANAGEMENT

- Keeping orchard clean
- Avoiding overcrowding and waterlogging
- Proper pruning of the tree after harvesting to facilitate proper sunlight and air that minimises hopper population
- Spray schedule is recommended as follows
 - At flower bud initiation, endosulfan 3 ml/l or carbaryl 3 g/l
 - At emergence of inflorescence stalks and before flower opening (anthesis), dimethoate 2 ml/l or thiamethoxam 0.3 g/l or imidacloprid 0.3 ml/l
 - During anthesis and pollination, insecticides should not be sprayed. In case of very high population of hoppers at this stage, endosulfan 2ml/l is recommended
 - When fruits are of pea size, phosphamidon 1ml/l or dimethoate 2ml/l or acephate 1g/l
 - Adding sulphur 3.5g/l to the insecticide based on need to check mites and sooty mould, *Capnodium mangiferum*
 - Directing the spray first to stem/ trunk, then branches, twigs, leaves and finally inflorescence is a recommended method.

MANGO MEALYBUG

Drosicha mangiferae

Pseudococcidae: Hemiptera

This giant mealybug is a serious problem in North and Central India.

Female lays eggs in clusters within ovisacs in soil under the trees 5-15 cm deep during April and May. The adult female crawls down the tree in April-May and enter the soil for laying eggs which hibernates till November. The eggs hatch during November-December. The nymphs ascend the trees and settle on inflorescence. Nymphs and adults suck sap from inflorescence, fruit stalks, fruits *etc.* leading to flower drop, pre mature fruit drop *etc.* They also excrete honey dew on which sooty mould develops and the fruit development is hampered. Both nymph and adults suck sap from other tender plant parts thus reducing the plant vigour.

Deep summer ploughing up to base of the tree trunks, after harvesting to expose eggs of mealy bugs.

Dusting methyl parathion 2D or endosulfan 4D around tree and incorporating in to the soil.

Spraying with dichlorvos 1 ml or imidachloprid 0.3 ml/l or phosphamidon 1ml/l when severe mealybug infestation noticed on the twigs.

Wrapping 25 cm wide, 400 guage polythene sheet on the tree trunk 30 cm above ground level and pasting greeze over it to prevent migration of freshly hatched first instar nymphs during winter (Nov-Dec) from soil to trees, one week before their emergence. Crawlers collecting beneath the polythene sheet may be scraped with a

knife.

PESTS OF CITRUS

CITRUS BUTTERFLY

Papilio demoleus

Papilio polytes

Papilio helenus

Papilionidae: Lepidoptera

These are most destructive pests of citrus seedlings. This pest is widely distributed in Burma, Bangladesh, Sri Lanka, India and Pakistan. It infests almost all citrus varieties though Malta (*Citrus sinensis*) is its preferred host. It can feed and breed on all varieties of cultivated or wild citrus and various other species of family Rutaceae. Besides citrus, it also attacks ber, wood apple, curry leaf.

P. demoleus is a big beautiful butterfly with yellow and black markings on all the four wings, having wing expanse of about 50-60 mm. Its hind wings have a brick red oval patch near the anal margin and there is no tail like extension behind though common in Papilionidae. *P. polytes* males are black and females vary in form. *P. helenus* has black wings with three white distal spots.

Yellowish white, round, smooth eggs are laid singly on tender leaves and shoots by *P. demoleus*. Egg hatches in about 3 – 8 days.

Freshly hatched caterpillars are dark brown and soon develop irregular white markings on their body resembling bird's drop. The caterpillars feed voraciously on tender leaves right up to the mid ribs and defoliate the entire seedlings or the tree leaving behind the only midribs. Thus the symptom of damage is

❖ Leaves fed up to midribs

The full grown caterpillar is deep green and cylindrical in form and measures about 40-50 mm in length with a hump in front and has a horn like structure on the dorsal side of the last body segment. When the caterpillar is disturbed, it pushes out from the top of its prothorax a bifid, purple structure called osmeterium which emits a distinct smell. The larval duration varies between 11 – 40 days.

Pupation takes place on plant parts. Pupa which is a chrysalis is seen girdled by a fine silken thread on a twig of the plant. Adult emerges in a week in summer and in 12 – 20 weeks in winter.

Hibernation is in pupal stage and there are 2-4 overlapping generations per year.

MANAGEMENT

- In small orchards and nurseries with mild infestation, hand picking and destruction of various stages of the pest.

- Natural enemies enumerated below suppress the pest population

Egg parasitoids: *Trichogramma evanescens*; *Telenomus* sp.

Larval parasitoid: *Distatrixpapilionis*; *Brachymeria* sp.

Pupal parasitoid: *Pterolus* sp.

- Spraying of monocrotophos 1.6 ml/l or dichlorvos 1 ml/l or methyl parathion 2 ml/l when the caterpillars are small. *B. t.* formulation HALT at 9 g/l is also recommended.

CITRUS LEAF MINER

Phyllocnistis citrella

Gracillariidae: Lepidoptera

It is widely distributed from Australia to Africa. It attacks all species of citrus but prefers sweet oranges. It also infests Ponagamia, jasmine etc. The pest is active all-round the year, except during severe winter (December – February). Maximum damage is caused during May-June and also during August-October, if the temperature is high enough.

Adult is a silvery white small moth with brown striped forewings having a prominent black spot near the tip and white hindwings. Both pairs of wings are fringed with hairs. The adult moth measures 6 mm in wing span.

Minute, flat and greenish yellow eggs are laid singly on tender leaves and young shoots. Egg period is 2-10 days.

The tiny red, apodous larva mines in between the epidermal layers of the leaf in a zigzag manner and feeds on chlorophyll which results in distortion of the leaf lamina. The tunnel appears silvery white. New and tender leaves are preferred. Sometimes, the larva mines the outer layer of young green twigs. Serious infestation causes retardation in growth. The infestation predisposes the leaves to canker growth. Symptom of damage is

❖ Characteristic silvery white zigzag galleries below the epidermis of tender leaves. The full grown caterpillar is slender, yellowish green with brownish mandibles. It is found inside the gallery formed in leaf tissue. Larval period is 15-30 days. Pupation takes place inside the leaf mine. Pupal period is 5-25 days. Total life cycle takes on an average 20-60 days depending on the climate. There are 9-13 overlapping generations in a year

MANAGEMENT

- Pruning of affected parts during winter and burning
- Spraying of Neem cake solution 5% or neem oil 5% or monocrotophos 1.6 ml/l or dimethoate 2 ml/l or imidachloprid 0.5 ml/l twice at 10 days interval at every new flush time i.e. during June – July, Sep – Oct, Dec – Jan

CITRUS PSYLLA

Diaphorina citri

Psyllidae: Hemiptera

This is widely distributed in India and is considered as a major pest in Punjab. In these regions the pest is active from February to November and has 16 generations per year.

Adults are reddish with jumping legs. Eggs are laid in tender shoots and anchored in the tissues by means of short stalks and the egg period is 8-35 days depending on the season. A single female lays 180 to 860 eggs.

The damage is caused by the nymphs which crowd on the terminal shoots and buds and suck up the juice which results in

- ❖ Curling and cupping of leaves,
- ❖ Defoliation and death of young shoot in severe infestation and
- ❖ the fruits turning undersized and juice content reduced.

There are five nymphal instars and the nymphal period is 9-38 days. Adult life span is 135 days for males and 145 days for females.

MANAGEMENT

- Spraying of methyl demeton 2 ml/l or dimethoate 2 ml/l or imidacloprid 0.5 ml/l at seedling stage on fresh foliage twice at 10 days interval.

PESTS OF APPLE

WOOLLY APPLE APHID

Eriosoma lanigerum

Aphididae: Hemiptera

It has worldwide distribution, originally a native of America. First it was detected in India in 1909 at Simla. Apple trees in all the hilly tracts of India are attacked. It can also cause damage to pear and other plants. It is a serious pest throughout the year except December-January.

Aphids are purplish, minute 1.0 mm long and are covered by white cottony mass, hence the name woolly aphids. The cottony mass covering females is rounded and that covering males is elongated. Winged and wingless forms are seen in the life cycle. The winged forms are common in Kumaon hills during July-October.

The insect reproduces both sexually and asexually. Parthenogenetic reproduction is more common. A single female can give birth to 300-400 nymphs. The crawlers fix themselves on host plant and suck plant sap. They secrete waxy covering over the body. Nymphal period is 30-40 days. There are 6-7 overlapping generations in a year. The insects overwinter as nymphs.

The nymphs and adults suck sap from bark of the trunk and the roots. It also infests fruit stalks and calyx. The colonies are more to the base of the trunks just below the soil in winter.

- ❖ The twigs shrivel and die. Young orchard and the nursery suffer the most.
- ❖ Gall like swellings are seen at the feeding site on roots and tree trunks during winter.
- ❖ The vigour of the trees is reduced.

MANAGEMENT:

- Resistant root stocks such as merton type Nos. 778, 779 and malling type XIII are used.
- A parasite *Aphelinus mali* and a predator *Coccinella septumpunctata* suppress the pest.
- Aerial infestation can be managed by spray application of systemic insecticides.
- Soil fumigation with PDCB up to 15 cm deep soil 2 metres away around the base of the tree is recommended.

PESTS OF STORED GRAIN

Grain in storage is subject to depredations of insects, mites, rodents, birds and moulds of which insects account for huge losses. In India losses during post harvest handling and storage estimated at 15 % annually. FAO estimate of total world losses in storage is 10% annually. Out of total storage in India 65 to 70 % being stored at farmers level and 30 to 35 % by traders and Government agencies. Pests of stored grain causes different types of losses, namely, weight loss, food loss, quantity loss, monetary loss, loss of good will and seed loss. These losses are caused by

1. External / Physical factors like temperature, light, moisture
2. Internal / biotic factors like insects, mites, rodents, birds *etc.*,

Sources of infestation

1. Field infestation: rice weevil, bruchid, grain moth.
2. Migration from infested sources: rice weevil, red flour beetle, grain moth.
3. Wooden or bamboo granaries, floor cracks and crevices.

4. Bins, old gunnies with grains.
5. Nearness to feed rooms and other stock of feed.
6. Seed received from infested sources.
7. Waste grain or seed
8. Temporary storage in villages
9. Grain stored in open or poorly constructed structures.
10. During transport

Types of infestation

Hidden infestation (Field infestation): Insects like Bruchids, *Sitotroga* fly from stores to field and lay eggs on maturing grains or pods which hatch out in favourable condition when grain reaches stores. This is termed as hidden infestation.

Cross infestation: Insects from old stocks / grain lying in cracks and crevices in emptied godowns and containers crawl or fly to fresh stocks, and infest them. This is termed as cross infestation.

Insects that damage stored grain can broadly be placed in two groups as follows

STORED GRAIN INSECT PESTS

Hard bodied beetles Soft bodied moths

Internal feeders Internal feeders

- Grain weevil • Grain moth
- Lesser grain borer
- Khapra beetle
- Pulse beetle
- Groundnut bruchid

External feeders

External feeders • Rice moth

- Red flour beetle
- Saw toothed beetle
- Cigarette beetle

GRAIN WEEVILS

Rice weevil: *Sitophilus oryzae*

Maize weevil: *S. zeamais*

Granary weevil: *S. granarius*

(Curculionidae: Coleoptea)

They are distributed worldwide and throughout India. All the three species are similar in appearance and found together on rice, wheat, maize and jowar. Among these *S. oryzae* is commonest and widely distributed and also found in paddy fields.

Beetles are small reddish brown, dark brown or black with long slender snout.

Wings have four light reddish or yellowish spots. Adults live for 4 – 5 months. Adults on emergence cut circular holes and feed.

Female weevil makes a depression with mandibles on grain and lays eggs up to 400.

The eggs are sealed by a gelatinous secretion. Egg period is 6 – 7 days.

Upon hatching from eggs tiny grubs bore into grain and feed internally. Grubs are small white, apodous with yellow brown head. Both grubs and adults cause heavy damage in monsoon. Damage symptoms are

- ❖ Hollowed out grains

- ❖ Kernels reduced to powder
- ❖ Heating

Pupa is dirty white initially and turns to dark brown. Pupal period is 6 – 14 days. 3-4 generations in a year are completed

KHAPRA BEETLE

Trogoderma granarium

Dermestidae: Coleoptera

It is a native of India. It is more confined to extreme dry climate as in Punjab, Haryana, U.P., M.P. and Rajasthan. It is less common in coastal areas. It is highly destructive to wheat, also infesting maize, jowar, rice, pulses, dried fruits, oil seeds and their cakes.

Small, dark brown beetles are 2 – 3 mm long. There is distinct division of head, thorax and abdomen. Body is convex, oval in shape. Males are smaller, darker and incapable of flying. Adults do not cause damage.

Fecundity is 13 – 85 per female. Egg period is 3 – 5 days.

Being a primary pest, grub alone is destructive to grain starting with germ portion, surface scratching and devouring the grain. It reduces grain into frass. Excessive moulting creates public discrimination, loss of market appeal due to insanitation caused by the cast skins, frass, and hair. Crowding of larvae leads to unhygienic conditions in warehouses. Damage is confined to peripheral layers of bags or 30-45 cm in bulk storage. Infestation is indicated by

- ❖ Presence of cast skins, frass and hair on bags

Full grown grub is yellowish brown, with brown head, clothed with long hairs of 40 mm. Hiding habits in cracks and crevices are most distinctive. Grub period is 20 – 40 days. Pupation takes place in last larval skin among the grain. Pupal period is 4 – 6 days. It completes 4 – 5 generations are observed per year.

PULSE BEETLE

Callosobruchus maculatus

Bruchidae: Coleoptera

It is a pest of gram, mung, peas, lentil, redgram, cotton seed, sorghum and maize.

Brownish grey beetle with characteristic elevated ivory like spots near the middle of the dorsum of the body. Abdomen is conspicuously swollen. Elytra do not cover the abdomen completely. Every grain is infested.

Female lays 30 – 100 @ 1 – 37 / day and one egg / grain. Egg period is 14 – 16 days. Young grub bores into the grain eat up the grain kernel and completes the development. Symptoms indicative of its infestation are

- ❖ Damaged grain unfit for consumption.
- ❖ Damaged grain converted to flour by traders give off flavour.

Grub is fleshy, curved, white, creamy in colour, with black mouthparts. It moults four times. Grub period is 10 – 12 days but hibernation in winter is for 117 – 168 days. Full grown grub lies at periphery next to seed coat and pupates. Pupa is oval in shape and white in colour. Pupal period is 4 – 28 days. 7 – 8 overlapping generations are completed per year.

FLOUR BEETLES

Rust red flour beetle *Tribolium castaneum*

Confused flour beetle *Tribolium confusum*

Tenebrionidae: Coleoptera

They are of worldwide distribution, commonest in wheat flour. They also feed on broken grains, milled products, dry fruits, pulses, corn flakes.

Beetles are small, reddish brown or brick red beetles, smooth and 3.5 mm long.

T. castaneum: More common with functional wings, antennae gradually thickened, 3 segmented.

T. confusum: Without functional wings antennae suddenly bulged and.

White cylindrical sticky eggs are laid loosely in grain or flour. Fecundity is 400 – 500/ female.

The grub is worm like, white creamy and turns to reddish yellow and hairy. Faint stripes and two spine like appendages are present at the end segment. Length is up to 5 mm. Larval period is 3-12 weeks. Both adults and larvae are incapable of feeding on sound grain. They damage milled products. Flour beetles are secondary pests of all grains and primary pests of flour and other milled products. In grains, embryo or germ portion is preferred

❖ Flour greyish and mouldy giving disagreeable odour.

Pupation loosely in the grain and pupa is naked. Pupal stage lasts 5-9 days. Life cycle is completely in 4-5 weeks

GRAIN MOTH / ANGOUMOIS GRAIN MOTH

Sitotroga cerealella

Gelechiidae: Lepidoptera

It is distributed worldwide as a pest of paddy, maize, jowar, barley, wheat. It does not attack milled rice and other cereal products.

Adult is buff, brown or straw coloured with narrow pointed wings, fringed with long hairs which are prominent along posterior margin. Small, whitish eggs are laid singly or in batches on or near grain which later turn reddish. Egg period is 4 – 8 days. Caterpillar is 5 mm long, white with yellow brown head. Larval period is 3 weeks. Larvae are destructive feeding on grain kernels. Larva bores into grain, feeds inside up to 30 – 50 percent seed is damaged. Sometimes whole grain is damaged.

❖ Infestation confined to upper 30 cm depth.

❖ Damaged grain give out unpleasant smell.

Pupa is reddish brown. Pupation in a silken cocoon in a cavity made during feeding.

Pupal period is 7 – 13 days. It hibernates in winter in pupal stage. Adult emerges out through a circular hole with a flap. 3 - 4 generations are seen in a year.

MANAGEMENT OF STORED GRAIN PESTS

Preventive / prophylactic measures

1. Near mature crops treated with safer insecticide like malathion to prevent the transport of infestation (eggs) from field to stores.
2. Threshing yards clean and away from stores.
3. Gunny bags new and insect free.
4. Grain dried to have less than 10% moisture, before filling in bags.
5. Transport carriers free of infestation.

6. Stores moisture free and rat proof.
7. Before storing, cracks and crevices on walls, floor closed.
8. Dirt, rubbish, sweepings removed and white washed.
9. Disinfestation of stores by treating walls, dunnage, ceilings of empty godown with malathion 50 EC 1: 100 or DDVP 100EC 1: 300 @ 3 litres / 100m²(DDVP is a constant and fumigant)
10. Maintenance of good storage conditions by providing dunnage, leaving gangway or alleyway of 0.75 – 1.0 mt all around for aeration, inspection and operations
11. Air charging or treating alley ways with malathion 1: 100 or DDVP 1: 300 @ 1 litre of spray fluid per 270 m³
12. Stack spraying over the bags with malathion 50 EC 1: 100 @ 3 litres/ 100m².
 - ❖ Do not spray directly on food grains
13. Prophylactic treatment of seeds or grains for small scale storage
 - If for seed purpose, mix 1 Kg of activated Kaoline or Lindane 1.3 D or malathion 5 D for every 100 Kg of seed, store in gunny or polythene lined bags
 - If for grain purpose, mix 1 Kg of activated Kaoline for every 100 Kg of grain and store
 - To protect pulse grains, activated kaoline or any edible oil @ 1Kg/100 kg of grain.
 - Mix neem seed kernel 1 kg for every 100 kg of cereals or pulses and store
 - ❖ never mix synthetic insecticides with grains meant for consumption. This is legal offence.

Curative measures

Most useful and practical curative method is fumigation and fumigants. Process of applying toxins in fumes or gases to infested grains for certain period in reasonably airtight chamber or room is called fumigation. Depending upon the need, fumigation may be

- Shed fumigation
- Cover fumigation
- Fumigation in air tight containers

Choose the fumigant and work out the requirements based on the recommendation.

Aluminium phosphide:

- For cover fumigation or air tight containers - 3 tablets of 3g each/ tonnes of grain
- In case of cover fumigation, mud plastering and sand snakes to be used for preventing leakage of toxic gas.
- For shed fumigation – 21 tablets each weighing 3g / 28 m³
- Period of fumigation – 5 days

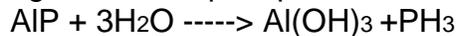
Other fumigants earlier used are EDB, EDB + EDCT. MBr are now banned and no longer permitted.

Process of fumigation:

- Insert required number of aluminium phosphide tablets in between bags in different layers all around stack and above the stack..
- Cover the bags immediately with fumigation cover.
- Seal it with mud or sand snakes.

- Keep the bags for 5-7 days under fumigation.
- After fumigation period, lift covers in a corner to allow residual gas to escape.
- Aerate the stocks.
- Follow similar steps to ensure leak proof conditions in shed or container fumigation.
- Fumigants have no residual effect on new immigrants, so sample periodically and fumigate stored grain based on need.
- Handle fumigants with utmost care as per specifications.

3g aluminium phosphide tablets releases 1g of phosphine (PH₃)



Phosphine is a deadly poison. 3g tablets should be supplied through Govt. agencies only under close monitoring of technical personnel. Now 12 g tablets (Quickphos) giving same dose of phosphine (1g) as 3g tablet are marketed to facilitate easy and direct availability to farmers. In 12g tablet, safety is incorporated by the size, addition of bitterants to aid vomiting in case of accidental poisoning.

Other curative methods:

- Mechanical methods

Light traps against *Ephesia*, *Lasioderma* for monitoring and mass trapping

- Use of centrifugal force: subjecting infested commodities at a speed of 2000 – 3000 rpm kills insects.
- A device ENTOLETOR for milled products is effective.

LOCUSTS

Locusts are the major agricultural pests of the world. Out of 5000 different species of grasshoppers, those which can live in two different phases viz. solitary & gregarious phase are called locusts. Of these, only nine species have been recognised as locusts, three species belonging to Indian subcontinent. Economic losses due to locust plagues estimated as £ 30 million /year

SPECIES (Acrididae: Orthoptera):

1. Desert locust : *Schistocerca gregaria*
2. Migratory locust : *Locusta migratoria*
(Important only in Maharashtra, Gujarat, and Rajasthan)
3. Bombay locust: *Patanga succineta*

Of three species, desert locust is considered the most important pest all over India. It is regarded as an international pest. Constant control efforts are made through International Locust Control Organisation of FAO (Food and Agriculture Organisation). In India, anti locust organisation operates both at central and state level

PHASES: Desert locust is found in 2 phases which differ in colour, morphology, physiology, which is easily mistaken for different species

1. Solitary phase

Nymphs: Colour varies according to surrounding vegetation

Adults: Greenish grey throughout life

2. Gregarious Phase

Nymphs: Yellow or pink with distinct black markings

Adults: Pink on emergence, gradually turn grey finally yellow when sexually mature. When numbers rise, they become gregarious and migrate in dense groups

GROUPS: Two types of groups are found.

1. **Swarms** are composed of winged adults
 2. **Bands** are composed of hoppers (nymphs)
- One swarm can cover an area of 1000 sq. km

PLAGUES:

Swarms or bands remained in many countries for periods lasting several years – called plagues causing great damage to crops. Duration of plague lasts for 5-10 yrs and recession period 1-8 years. Both swarms and bands rest on crops and trees at night, morning they hop and fly to form a swarm when temperatures rise. They are voracious feeders; feed on any vegetation often causing famine. *Calotropis*, *Datura* sp. are not fed by locusts.

Desert locust is an inhabitant of dry grassland of desert area, found in many countries. In India, breeding grounds are located in Rajasthan, parts of Gujarat and Haryana. Swarms fly quite high, known to cross mountains as high as 4600 mts. A previous swarm had brought all trains to a halt in western Rajasthan as the wheels kept slipping on the oily discharge of the locusts. In previous locust invasion during 1993, fifty full grown swarms entered India from Africa, invaded Rajasthan and parts of Gujarat.

LIFE HISTORY: Three developmental stages, egg, hopper and adult are found. Mature adults are yellowish, sluggish reluctant to fly and cluster on ground (which maturing male clings to female back), young adults bright pink, (mature turn bright yellow). Pink adults are very active, causing much damage. Yellow adults are not so destructive but lay eggs giving rise to nymphs

Egg laying starts after 8-24 hours of mating in damp soil. About 500 eggs are laid per female in 5 pools. Before oviposition, female bores a hole in loose sandy soil 2-4 inch deep with its ovipositor and lays eggs in 1-4 hours and secretes frothy material over eggs which makes pool water-proof on drying and hardening. Ground used for oviposition can be easily recognized by numerous holes of pencil diameter. About 5000 eggs are found per one square yard area. Egg period is 3-4 weeks in February – March, 12-15 days in May- September. In very dry soil, eggs remain till showers of rain.

Nymphs are called hoppers. Freshly hatched are light yellow, soon turn black (in gregarious brood). They feed on all kinds of vegetation and move in bands. Five moults are observed. Nymphal period is 6 -8 weeks in spring and 3-4 weeks in summer.

BREEDING SEASON: Breeding depends upon rainfall and subsequent vegetation. Eggs are laid in damp soil. Two breeding seasons are observed during the year in India.

1. Summer breeding season
2. Monsoon breeding season

Among swarms produced in monsoon,

- Some fly westward to Baluchistan, Russia, Eastern Arabia.
- Many formed in Rajasthan and Sind, fly north east and south, thus invade all parts of India and damage *kharif* crops
- some swarms overwinter in North Western India and become active when temperatures are suitable and damage 'rabi crops'

MANAGEMENT

Management is most effective and practicable against hoppers through taken up

against all stages

1. Ploughing, digging and harrowing of places where eggs are laid on large scale and destroying – laborious.
2. When swarms settle on vegetation or ground, they are beaten to death, swept together, buried in heaps (or)
3. They can be burnt with fire torches (flame throwers) at night or early morning when sluggish.
4. Digging trenches (45 cm deep and 30 cm across) the front of marching hoppers, trapping and burying in ditch dusted with lindane / chlorpyrifos (1st instars more vulnerable).
5. Neem kernel suspension serves as deterrent to locusts.
6. Kites and crows, common mynahs are predaceous on locusts. Grubs of beetle *Trox proceras* feed on locust egg. *B.t.*, fungus *Metarrhizium flavoviride* are employed.
7. Dusting or spraying lindane, chlorpyrifos on top of flying locusts or on ground. (In 1993, malathion was sprayed through aircrafts).
8. Poison baits with wheat or rice bran plus an insecticide (chlorpyrifos) + attractant (molasses) + enough water scattered in morning or evening when hopper