

Lec. 1(p.1 – 2): Introduction of Economic Entomology and Economic Classification of Insect Pests

Lec. 2-5 (p.3- 15)

Rice: Yellow stem borer, gallmidge, brown planthopper, green leafhopper, hispa, leaf folder, ear head bug, grasshoppers, root weevil, swarming caterpillar, climbing cutworm, case worm, whorl maggot, leaf mite, panicle mite, IPM practices in rice.

Lec. 6-8 (p.16- 25)

Sorghum and other millets: Sorghum shoot fly, stem borer, pink borer, sorghum midge, ear head bug, red hairy caterpillar, deccan wingless grasshopper, aphids, maize shoot bug, flea beetle, blister beetles, ragi cutworm, ragi root aphid, army worm.

Wheat: Ghujia weevil, ragi pink borer, termites.

Lec. 9-11 (p. 26- 33)

Sugarcane: Early shoot borer, internodal borer, top shoot borer, scales, leafhoppers, white grub, mealy bugs, termites, whiteflies, woolly aphid, yellow mite.

Lec 12- 14 (p.34- 47)

Cotton: Spotted bollworm, american bollworm, pink bollworm, tobacco caterpillar, leafhopper, whiteflies, aphid, mites, thrips, red cotton bug, dusky cotton bug, leaf roller, stem weevil, grasshoppers, mealybug, IPM in cotton.

Lec. 15 (p.48 - 51)

Jute: jute semilooper, jute stem weevil, jute stem girdler, Bihar hairy caterpillar

Mesta: Hairy caterpillars, stem weevil, mealy bugs, leafhopper, aphid.

Sunhemp: Hairy caterpillars, stem borer, flea beetle.

Lec. 16-17 (p.52- 59)

Pulses: Gram caterpillar, plume moth, pod fly, stem fly, spotted pod borer, cowpea aphid, cow bug, pod bug, leafhopper, stink bug, green pod boring caterpillar, blue butterflies, redgram mite.

Pea: pea leaf miner and pea stem fly

Soyabean: Stem fly, ragi cutworm, leaf miner, whitefly.

Lec. 18 (p.60- 63)

Castor: Semilooper, shoot and capsule borer, tobacco caterpillar, leafhopper, butterfly, whitefly, thrips, castor slug, mite.

Lec 19 (p.64- 68)

Ground nut: White grub, leaf miner, red hairy caterpillar, tobacco caterpillar, leafhopper, thrips, aphid, pod bug, jewel beetle.

Lec. 20 (p.69- 71)

Sesamum: Leaf and pod borer, gall fly, sphinx caterpillar.

Safflower: Aphids, leaf eating caterpillars.

Lec. 21(p.72- 75)

Mustard: Aphid, saw fly, diamond back moth, painted bug.

Sunflower: *Helicoverpa* and *Spodoptera*, leafhopper, Bihar hairy caterpillar, thrips.

Lec. 22 (p.76- 80)

Brinjal: Epilachna beetle, shoot and fruit borer, stem borer, mealy bug, aphid, leafhopper, lacewing bug, leaf webber and red spider mite.

Lec. 23 (p.81- 83)

Bhendi: Shoot and fruit borer, leafhopper and whitefly, spider mite

Tomato: Serpentine leaf miner, fruit borer, whitefly

Lec. 24 (p.84- 87)

Cucurbits: Fruitflies, pumpkin beetles, semilooper, serpentine leaf miner, pumpkin leaf eating caterpillar,

Coccinia: Coccinia gall fly and aphids.

Lec. 25 (p.88- 91)

Crucifers: Diamond back moth, cabbage head borer, leaf webber, aphid, painted bug, tobacco caterpillar, cabbage butterfly, IPM practices

Lec. 26 (p.92- 95)

Potato: Tuber moth.

Sweet potato: Sweet potato weevil, hairy caterpillar, tortoise beetle.

Moringa: Hairy caterpillar, budworm.

Lec. 27 (p.96- 99)

Chillies: Thrips, pod borers, aphid, mites, blossom midge

Amaranthus: Leaf eating caterpillar, stem weevil.

Lec. 28 – 29 (p.100- 106)

Mango: Leafhoppers, stem borer, nut weevil, fruitfly, shoot borer, fruit borer, mealy bug, aphids, leaf webber, termites, thrips, red tree ant, leaf gallmidges, red spider mite.

Lec. 30 (p.107- 111)

Citrus: Butterfly, fruit sucking moths, leaf miner, psylla , rust mite, bark eating caterpillar, blackfly, leaf mite.

Lec. 31 (p.112- 115)

Grapevine: Flea beetle, thrips, mealy bug, stem girdler, stem borer, leaf eating caterpillars, root grub.

Lec. 32(p.116- 118)

Cashew: Tree borer, shoot and blossom webber, tea mosquito bug, thrips, leaf miner

Lec. 33(P.119- 122)

Pomegranate: Butterfly, thrips, fruit sucking moths.

Guava: Tea mosquito bug, mealy bug, fruitflies, spiraling whitefly.

Lec. 34(P.123- 125)

Sapota: Leaf webber, parijatha hairy caterpillar, mealy bugs.

Ber: Fruitfly, fruit borer, fruit weevil

Lec. 35(P.126- 129)

Banana: Rhizome weevil, skipper, aphid, pseudostem weevil,

Apple: Woolly aphid, Codling moth

Custard apple: Mealy bug

Lec. 36(P.130- 135)

Coconut: Black headed caterpillar , rhinoceros beetle, red palm weevil, slug, termites, scale, mite.

Lec. 37(P.136- 138)

Tobacco: Tobacco caterpillar, aphid, whitefly, stem borer.

Lec. 38(P.139- 141)

Coffee: White borer, red borer, green scale
Tea: Tea mosquito bug, thrips, red spider mite, pink mite, purple mite and scarlet mite

Lec. 39 (P.142)

Turmeric and ginger: Rhizome fly, Lace wing bug.

Lec. 40 (P.143)

Betelvine: Shoot bug, tobacco caterpillar

Lec. 41 (P.144- 145)

Onion: Thrips, *Spodoptera exigua*
Coriander: Aphids, leaf eating caterpillar.

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Rose: Thrips, scales, leaf eating caterpillars, chafer beetles.
Jasmine: Stink bug, bud worm, gall mite.
Chrysanthemum: Aphid.

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Lec. 48 (p.166 - 172)

Rodents: Rodents damaging crops in field and stores, key for identification of rodents, management of rodents in field and storage, coconut rodents and their management.

Birds: Various birds infesting crops and their management.

References

- Atwal, A.S. 1976. *Agricultural Pests of India and South East Asia*. Kalyani Publishers, Ludhiana.
- Butani, D.K. and Jotwani, M.G. 1984. *Insects in Vegetables*. Periodical Export Book Agency, New Delhi.
- Butani, D. K. 1984. *Insects and Fruits*. Periodical Export Book Agency, New Delhi.
- Dennis S Hill 1987 *Agricultural Insect Pests of tropics and their control*, Cambridge Universtiy Press, New York
- Khare, S.P. 1993. *Stored Grain Pests and Their Management*. Kalyani Publishers, Ludhiana.

- Nair MRGK. 1986. *Insects and Mites of crops in India*. Indian Council of Agricultural Research New Delhi.
- Ramakrishna Ayyar, T.V. 1963. *Handbook of Economic Entomology for South India*. Government Press, Madras.
- Upadhyaya K.P. and Kusum Dwivedi. 1996. *A Text Book of Plant Nematology*. Aman Publishing House, Meerut.
- Vasantharaj David, B. 2003. *Elements of Economic Entomology*. Popular Book Depot, Coimbatore.
- Vasantharaj David, B and Aanathakrishnan, T.N.. 2006. *General and Applied Entomology*. Tata McGraw-Hill Publishing House, New Delhi.

INTRODUCTION OF ECONOMIC ENTOMOLOGY AND ECONOMIC CLASSIFICATION OF INSECT PESTS

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.

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 *Propicroscytus 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	:	<i>Lycosa pseudoannulata</i>
Mirid bug	:	<i>Cyrtorhinus lividipennis</i>
Aquatic bug	:	<i>Gerris tristan</i>
Coccinellids	:	<i>Coccinella arcuata</i>
Egg parasitoids	:	<i>Anagrus sp., Oligosita sp.,</i>
Nymphal and Adult parasitoid	:	<i>Haplogonatopus orientalis</i>
- 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 chlorpyrifos 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 carbaryl 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

Parponyxa 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 WHEAT

GHUJIA WEEVIL

Tanymecus indicus
Curculionidae: Coleoptera

It is a common pest of young wheat and other crops in Uttar Pradesh, Bihar and Punjab.

It is grey or greyish brown weevil measuring 5 mm long. Adults hide during brighter part of the day and get active in the morning and evening hours. Adults are destructive. The weevil cuts and feeds on the plumule of the young seedlings. Older seedlings of more than 6 cm in height are not attacked. In severe cases of attack, it necessitates resowing. The damage results in the following symptom.

- ❖ Seedling stems severed and wilting plant lying on ground.

Adults become sexually mature by the end of October (4-5 months after emergence from soil during June-July).

Eggs are laid singly under clods of soil @ 80 eggs/ female. Eggs hatch in 15-50 days depending on climate. Larvae develop in soil in about 3 months. After 2 months of pupation, adults are formed during April – May but adults remain in soil till June and come out with rains in June and when sorghum is available in field.

MANAGEMENT

- Deep ploughing during April-May to destroy pupae
- Dusting the soil with carbaryl @ 10-12 kg/ac and raking it into the soil at the time of sowing is effective.

RAGI PINK BORER

Sesamia inferens
Noctuidae: Lepidoptera

It is a polyphagous pest infesting rice, wheat, maize besides other millet crops. On wheat, damage is caused by larvae which bore into the stem killing the central shoot and causing dead hearts.

(See pests of sorghum and other millets for other details and management)

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.

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 Adkali 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, detrating the basal 4-5 internodes ensuring that the top most detrated 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 detashed 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 divitalise 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 adwali 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

Odontotermes obesus

Termitidae: Isoptera

Termites or white ants are another destructive pest of sugarcane, omnivorous and omnipresent. They live under ground attacking the crop, when the setts are planted in the soil and ravages continue till harvest of the crop with slight slackness during monsoon. They are mostly found in light soil. Their attack is severe in red soils and where irrigation facilities are inadequate.

The termites damage the cut ends and buds of setts affecting their germination. Setts are completely eaten away leaving only the outer hard rinds. In attacked plants, the outer leaves first show signs of drying and the attacked canes may come out easily, if pulled. The damage may range from 40-50%. Its attack results in heavy loss in yield in sugarcane and also reduction in sucrose content.

Six species of termites have so far been recorded from India, damaging sugarcane viz., *Odontotermes obesus*, *O. assumthi*, *O. taprobenes*, *Microtermes anandi*, *Eremotermes nerapololis*, and *Trinervitermes biformis*. These are morphologically different, but their habits, symptoms of damage etc are all similar.

Systematic digging up of termite mounds and destruction of queen is a permanent measure of control. Dusting methyl parathion 200 g around and leveling, deep ploughing and copious irrigation reduces infestation and drenching with chlorpyrifos 50 EC @ 10ml/l is effective.

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 effectictive 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 fully grown, they measure 3.7 to 5 cm in length. The fully 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.

COTTON APHID
Aphis gossypii
Aphididae: Hemiptera

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

Adult is small, soft, yellowish, green or greenish brown in colour. It is found in colonies of hundreds on the tender shoot and the undersurface of tender leaves. They are characterized by the presence of two tubes like structures called cornicles, on the abdomen. They are wingless normally but winged forms are often found mostly in the beginning and towards the end of season. Wings are thin, transparent and are held like a roof over the body.

They reproduce both sexually and parthenogenetically. Parthenogenetic females give rise to females ovo - viviparously.

Nymphs are light yellowish green or brownish or greenish black in colour. They colonise growing points, lower surface of leaves and tender shoots. There are four instars. Nymphal period is about 7-9 days

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

- ❖ Curled, faded and dried leaves.
- ❖ Development of black sooty mould due to honeydew excretion on infested parts.

MANAGEMENT: Same as in cotton leafhopper.

MITES

Tetranychus telarius, T. bioculatus (Tetranychidae)
Hemitarsonemus latus, (Tarsonemidae)
Eriophyes gossypii (Eriophyiidae)

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

Adult female body is oval and is variable in colour *i.e.*, red, green, amber or rusty green and with two large pigmented spots on the body. The large scale use of chlorinated hydrocarbon insecticides for the control of other pests led to the multiplication of the mites as they are less toxic to mites but more toxic to natural enemies.

It is active from March – October and passes winter as gravid female. It lays 60-80 eggs. Egg period lasts 2-6 days.

Nymph is light brown in colour and has two eye spots and four pairs of legs and quite active. Both nymphs and adults cause damage by feeding on the lower surface of the leaf underneath a web.

- ❖ On close examination of the lower leaf surface, mites smaller than a pinpoint may be seen.
- ❖ The infested leaves rapidly curl up, become hard and crisp and ultimately shed.

❖ Bolls ripen prematurely and in serious infestation shed.

Mite infestation begins in the seedling stage and extends to harvest. Nymphs grow to maturity in 2 stages within 4-9 days and adults live for 9-11 days. Total life cycle in active period takes 9-19 days.

MANAGEMENT: Foliar sprays with sulphur 50 WP 3 g/l or dicofol 5 ml/l

COTTON THRIPS

Thrips tabaci, *Scirtothrips dorsalis*

Thripidae: Thysanoptera

Cotton thrips is a highly cosmopolitan form and is found on all kinds of vegetation. Onion and garlic, amaranthus, guava, solanaceous and cucurbitaceous plants, groundnut, chilies, mango, cabbage, bhendi etc.

Nymphs and adults suck sap from leaves and flower buds. Margins of affected leaves get slightly curled up and the leaf blades show uneven surface, when attack occurs in flowering stage, the affected flowers may wither away.

It is a vector of yellow spot virus and spotted wilt virus

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.

DUSKY COTTON BUG

Oxycarenus hyalinipennis

Lygaeidae: Hemiptera

It is found in all cotton regions in India. Both nymphs and adults suck sap from immature seeds and strain the lint. The seeds do not ripen and get damaged. Seeds get lighter in weight and lose their germination capacity.

The anthocoreid bug - *Orius tantilus* is predaceous on the nymphs and dusting of methyl parathion 2D or carbaryl 10D @ 10 – 12 kg/ac is found effective.

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.

COTTON STEM WEEVIL

Pempherulus affinis

Curculionidae: Coleoptera

Cotton stem weevil is a serious pest of cotton and is known from India, Burma, Thailand and Philippines

This pest is a serious one of Cambodian cotton, particularly on summer crop. Adults generally feed on the bark of plants. Grub bores into the stem above the ground level and makes tunnels.

Attacked plants show characteristic gall like swellings on the stem. In severe cases plant may succumb during early stage of crop growth. Infestation starts on 12-15 days old cotton plants.

Removal and destruction of attacked plants., *Euderus pempheriphilla* is parasitic on grubs and foliar sprays with chlorpyrifos 2.5 ml/l or endosulfan 2.5 ml/l from three weeks after sowing were effective.

GRASSHOPPERS

Cyrtacanthacris ranacea; *Chrotogonus oxypterus*;

Catantops annexus; *Aeolopus tamulus*

Acrididae: Orthoptera

Cotton crop is often damaged in the early stage by these grasshoppers. Both nymphs and adults feed on leaves. Heavy infestation results in complete defoliation of plants.

Deep ploughing after the harvest of crop so as to expose the egg masses in the soil, dusting the bunds with methyl parathion immediately after the hoppers are noticed and check their migration and dusting the crop in the early stage with methyl parathion dust @ 10-12 kg/ac or spraying with methyl parathion 2 ml/l carbaryl 3 g/l found effective.

MEALYBUG

Phenacoccus solenopsis
Maconellicoccus hirsutus
Pseudococcidae: Hemiptera

It is a minor pest with isolated incidence. Of late the pest has been reported to infest cotton in alarming proportions sucking sap from all aerial parts of the plant. *B.t.* cotton is severely infested with *P. solenopsis*. The pest initially is restricted to a few plants. If the infestation is not checked in a few isolated spots, it spreads to all corners of the field.

Initial infestation should be checked by spot treatment with insecticides by stem application with monocrotophos / methyl demeton or imidacloprid as detailed earlier. Foliar sprays with methyl parathion / malathion / triazophos / monocrotophos each at 3 ml/l in combination with dichlorvos 1 ml/l are effective

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 JUTE

JUTE SEMILOOPER

Anomis sabulifera
Noctuidae: Lepidoptera

Moth is a medium sized, brownish in colour with dark spots and many lines on forewings.

About 150-200 eggs are laid singly on the lower surface of leaf. Egg hatches in 2-3 days.

Caterpillar is slender, green with dark green stripes and black spots on the body. In the beginning caterpillar feeds on leaves, as they grow they attack apical buds and top shoots.

Pupation takes place in the soil in rough cocoons, Some times on leaves, suspended by means of curved hooks of pupa.

- Larval parasite *Tricholiga sorbilans* suppresses the pest naturally.
- Foliar spray with carbaryl 3 g/l or endosulfan 2 ml/l or monocrotophos 1.6 ml/l

JUTE STEM WEEVIL

Apion corchori
Curculionidae: Coleoptera

Adult is a small dull black weevil with a long curved snout.

Eggs are laid singly on the stem near the base of the petiole and on seed pods. Eggs hatch in 3-5 days in to grubs.

Grubs feed inside the bark and damage the fiber. As a result of injury knots are formed on the stem and branching takes place. Larval period lasts for 8-18 days. Grub is light yellowish in colour with brown head and measures 3 mm in length when full grown.

Pupation takes place in a pupal chamber and lasts for 4 days.

MANAGEMENT

- Destruction of infested plants.
- Dusting methyl parathion 10 – 12 kg/ac as foliar spray @ 2 ml/l

JUTE STEM GIRDLER

Nupserha bicolor postbrunnae
Cerambycidae: Coleoptera

Adult female girdles stem at two levels as a pre ovipositional operation results the stem withering, drooping and finally dying above the level of the lower girdle.

Dusting methyl parathion 2D 10 – 12 kg/ac keeps the pest under control.

BIHAR HAIRY CATERPILLAR (Jute)

Spilosoma (Diacrisia) obliqua

Arctiidae: Lepidoptera

It is a polyphagous pest. Feeds on the tender portion of jute plants and defoliates.

Management for jute semi looper is also recommended against this.

PESTS OF MESTA

MESTA HAIRY CATERPILLAR

Euproctis scintillans

Lymantriidae: Lepidoptera

It also infests rose, castor, cotton, pigeonpea, mango, linseed, sunhemp, pumpkin, pomegranate apple and jute *etc.*

Moth is yellowish with a reddish line and spots on the edges.

Eggs are laid in masses on the undersurface of leaves. The egg period is 5-9 days. Eggs hatch into larvae and feed on foliage.

Larva has yellowish brown head and yellow dorsal stripe with a mid dorsal red stripe. There are tufts of black hairs dorsally on the first three abdominal segments. The early instar larvae feed gregariously on the foliage. The larval period is 29-35 days

Larva pupates in a cocoon of hairs on the leaves or leaf folds. Pupal period lasts for 10-12 days.

Timely sowing at the onset of monsoons, foliar sprays with endosulfan 2 ml/l or methyl demeton 2 ml/l were effective.

MESTA STEM WEEVIL

Alcidodes affaber

Curculionidae: Coleoptera

This insect is a common pest on malvaceous plants in India infesting bhendi, gogu, *Bombax malabaricum*, *Althae rosea* and *Ficus bengalensis* *etc.* The adult feed on leaf buds, petioles and tender terminal portion. However, serious damage is caused only by the grubs boring into stem and petioles and causing gall like swellings. Frass is found through holes made on stems. The infested plant gets stunted. Their flowers and fruiting get retarded considerably. A single plant may harbor as many as 12 grubs. This pest is active from September-December.

The grubs are parasitised by *Aphrastofracon alcidophagus* (Braconidae) and *Zoridescopus* spp (Ichneumonid). Foliar sprays of endosulfan 2 ml/l are effective in management.

MEALY BUG

Meconellicoccus hirsutus

Pseudococcidae: Hemiptera

Besides mesta, it also attacks jute, grapevine and guava. Sac-like pink coloured females are covered by milky white waxy coating. Eggs are laid in masses. Upon hatching, crawlers move to succulent parts and suck sap resulting in symptoms like swelling on stem, shortened internodes, bunchy top formation as secondary branches arise. If growing tips are infested vertical growth is suppressed. Fibre snaps at point of infestation during retting.

Release of *Cryptolaemus montronzieri* when peak infestation is noticed in sep-oct and foliar spraying with methyl demeton 2ml/l or dimethoate 1.5ml/l is effective.

LEAFHOPPERS

Amrasca biguttula biguttula
Cicadellidae: Hemiptera

APHID

Aphis gossypii
Aphididae: Hemiptera

Covered under pests of cotton

PESTS OF SUNHEMP

SUNHEMP HAIRY CATERPILLAR

Utetheisa lotrix
Argina cribraria
Arctiidae: Lepidoptera

It is the most serious and specific pest of sunhemp.

Moth of *U. pulchella* has pale white fore wing with red and black dots. *A. cribraria* has orange yellow fore wing with black spots ringed with yellow. The hind wings are orange with black spots on them.

The female moth lays about 80-100 round, smooth yellow eggs on leaves singly or in small groups. Egg stage lasts for 3-4 days.

The just hatched larva either defoliates (vegetative stage) or bores into pods (in heading stage). The larvae feed on sun hemp and defoliate the plant. The damage will be more (serious in later stages), when they bore into pods and feed on the seeds. The symptoms are defoliation of plant, bored seed capsules.

The caterpillar has yellow lines dorsally and dorsolaterally and black stripes and orange patches laterally and a brown head with long brown hairs on its body. Larval duration is 18-21 days

Full grown caterpillar pupates in the soil and pupal stage is 6-8 days. The total life cycle takes 27-31 days.

Larval parasitoid *Bracon brevicornis* suppress the population naturally. Foliar spray with endosulfan 2 ml/l or methyl parathion 2 ml /l or dusting methyl parathion 2D 10 – 12 kg/ac are effective measures.

SUNHEMP STEM BORER

Laspeyresia tricenra
Eucosmidae: Lepidoptera

The caterpillars cause small gall like swellings on shoots and stem and because of this the fiber length is affected and there is profuse branching of infested plants.

Insecticides recommended against sun hemp caterpillar are effective.

SUNHEMP FLEA BEETLES

Longitarsus belgaumensis

Chrysomelidae: Coleoptera

It is common in South India. Adult beetle bite holes on leaves. Spraying with endosulfon 1.5ml/l or monocrotophos 1.6ml/l in the evening hours is recommended.

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 determinate (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 PLUME MOTH *Exelastis atomosa; Spenarches caffer* Pterophoridae: Lepidoptera

It is a specific pest of redgram in India, AP. Assam, Bihar, Maharashtra and Tamilnadu.

Moth is slender, less than 12 mm long and are grey with long narrow wings. The forewings are divided into two parts and hindwings into three parts and provided with a fringe like border.

Minute, single eggs are laid on flower buds and pods. Egg period is 4-5 days.

Tiny caterpillar scrapes the pod surface and cuts a hole and thrusts the head into it and feeds on seed by remaining outside. The caterpillars bore into green pods and feed

on the developing seeds which are more or less completely devoured or eaten away. Also feeds on flower buds. This pest is usually found at flowering and known to cause heavy damage to redgram. Attack by this pest can cause severe bud, flower and pod drop. The larva never enters inside the pod and feeds remaining outside the pod. The damage results in the following symptoms

- ❖ Small hole on seeds.
- ❖ Dropping of flower buds and flowers in severe cases.
- ❖ Completely eaten and devoured seeds.

The full grown caterpillar is about 12 mm long greenish brown, and are fringed with short hairs and spines all over the body. Larval period is 14-30 days.

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

MANAGEMENT

- Collection of caterpillars by shaking shoots and their destruction in initial stages.
- *Apanteles* sp parasitise larvae.
- Foliar sprays should commence at 50% flowering with endosulfan 2 ml/l or quinalphos 2 ml/l or carbaryl 3 g/l

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.

STEM FLY

Ophiomyia phaseoli
Agromyzidae: Diptera

The pest attacks the crop at early stage. It is a major pest of cowpea, soybean, blackgram and greengram. Eggs are thrusts into tender part of the stem/ petiole. Maggot tunnels the stem and feeds on the internal contents. When the stem is split open the distinct tunnel can be observed along with excreta. Drooping of the first two leaves and wilting of the plants are observed due to the damage.

Growing varieties like LBG-611, LBG-402 are promising against stem fly, high seed rate, seed treatment with carbosulfan @ 40g/kg seed or thiamethoxam @ 4g/kg and foliar application of monocrotophos 1.6ml/l or acephate 1.5g/l are effective measures.

SPOTTED POD BORER

Maruca vitrata
Pyralidae: Lepidoptera

This pest is found throughout South India on pulses and beans. It webs the Dhaincha leaves

Moth is with dark brown forewings with white club shaped cross band along anterior margin and white hindwings with dark brown border.

The caterpillar with short hairs on black warts webs together the flowers and feeds on them. It also bores into pods at one end and eats up the ripening seeds. Mass excreta can be seen at the entrance of larval burrow.

Foliar spray from flower bud initiation with combination of chlorpyrifos 2.5 ml/l or quinalphos 2 ml/l or novaluron 0.75 ml/l or spinosad 0.75 ml/l or lamda cyhalothrin 1 ml/l in combination with dichlorvos 1 ml /l at weekly intervals is effective

BEAN APHIDS

Aphis craccivora

Aphididae: Hemiptera

Both nymphs and adults suck sap from tender leaves and shoots resulting in twisting of leaves, poor pod development, devitalization of plants and sooty mould. It acts as a vector of Rosette disease in groundnut and broad bean virus in pea.

It is a polyphagous pest. Redgram and other pulses, citrus etc are other host plants.

Spraying with tobacco decoction (1 kg tobacco boiled in 10 lit of water of ½ hour and make up to 30 lit + 100 g soap) and systemic insecticides like dimethoate 2 ml/l or phosphamidon 2 ml/l or malathion 2 ml/l are effective.

REDGRAM COW BUG

Oxyrhachis tarandus

Membracidae: Hemiptera

Nymphs as well as adults suck sap from green stem at all stages of the plant causing corky tissues and excrete honeydew which attracts ants like *Camponotus compressus*. Breeding takes place all the year round the limitation being only the availability of food. This species is common all over south India. It is one of the major pests of redgram.

Spraying dimethoate 2 ml/l, methyl parathion 2 ml/l or phosphamidon 2 ml/l is effective.

REDGRAM POD BUG

Cavigralla gibbosa, *Riptortus linearis*, *Anoplocnemis phasiana*

Coreidae: Hemiptera

Hundreds of nymphs and adults suck sap from the shoots and pods. Shoots fade, pods shrivel and seeds with dark patch lose germination capacity due to the feeding of bugs.

Collection of bugs and their destruction by dipping into kerosinized water and dusting or spraying with carbaryl 10D 10 kg/ac or foliar spray with dimethoate 2 ml/l or monocrotophos 1.5 ml /l are effective.

LEAFHOPPER

Empoasca kerri

Cicadellidae: Hemiptera

Small greenish yellow nymphs and adults suck sap from leaves resulting in severe case, the leaves turn brown, dry and brittle, a condition called "hopper burn".

Attacked leaflets become cup shaped and yellow at edges. Heavy attack results in the leaflets turning red-brown with subsequent defoliation and stunting.

Collection of bugs and their destruction of infested leaves, seed treatment with carbosulfan @ 30-40g/kg seed, spraying with thiamethoxam 0.4g/l or imidacloprid 0.4 ml/l have been found effective.

GREEN PLANT BUG/STINK BUG

Nezara viridula

Pentatomidae: Hemiptera

It is a polyphagous pest. Nymphs and adults suck sap from tender shoots and developing pods in large numbers, due to that shoots fade. Adults aestivate during April to June and with first rains they mate and oviposit.

Mechanical collection of nymphs and adults and destroying them and foliar spray with carbaryl 3 g/l or endosulfan 2 ml/l is recommended.

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.

BLUE BUTTERFLIES

Catochrysops cnejus, *Lampides boeticus*, *Catochrysops strabo*

Lycaenidae: Lepidoptera

It is seen on redgram, cowpea, lab lab, niger etc. The eggs are laid on flower buds. After hatching the tiny caterpillars enter into unopened flower bud and feed inside. Afterwards they may attack another flower or enter a pod and feed on the developing seeds.

Foliar spray with carbaryl 3 g/l or endosulfan 2 ml/l is effective.

RED GRAM MITE

Aceria cajani

Eriophyidae: Acarina

It infests underside of tender leaves, causing yellowing of leaves and suppression of flowering and fruiting. It transmits pigeonpea sterility mosaic virus. A single eriophyiid mite is sufficient to transmit disease. Disease can be identified from a distance as patches of bushy, pale green plants without flowers or pods. Leaves are small, show a light and dark green mosaic pattern

Destruction of perennial and volunteer pigeonpea and the ratooned growth of harvested plants provide reservoir of mite vectors and pathogens, growing tolerant

varieties like ICPL 87119, ICPL 227, Jagruthi, Bahar and foliar spray with dicofol 3 ml/l or wettable sulphur 3g/l in early stages of plant growth will control mite vector

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.

PEA STEM FLY

Melanagromyza phaseoli

Agromyzidae: Diptera

Refer under soybean stemflies.

PESTS OF SOYBEAN

STEM FLY

Ophiomyia phaseoli

Melanagromyza sojae

Agromyzidae: Diptera

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

Shiny bluish – black fly deposit eggs in punctures made by fly on young leaves. Young plants (less than 40 days) suffer more.

Yellowish maggots bore into nearest vein, reach the stem through petiole, bore down the stem and feed on cortical layers and may extend to tap root resulting in the following symptoms

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

Pupation is at ground level within the stem. Adult fly exits through a thin semi transparent window.

MANAGEMENT

- Seed treatment with imidacloprid 3 g/kg seed gives protection upto 30 days.
- Foliar spray with acephate 1.5g/l or dimethoate 2 ml/l or monocrotophos 1.6ml/l

LEAF EATING CATERPILLAR

Spodoptera exigua

Noctuidae: Lepidoptera

The caterpillar causes damage by feeding on leaves. For other details refer under millets.

SOYBEAN LEAFMINER

Aproaerema modicella

Caloptilia soyella

Important pest of soybean also attacks groundnut and some leguminous weeds. Brownish grey moth lays white eggs singly on underside of leaves close to mid rib. Young larva initially mine into leaflets and feed on mesophyll. Later as it grows web the leaflets together and feed. Severely infested field presents a symptom as if burnt when viewed from a distance. Full grown caterpillar is green with dark head and pupates within the web

Foliar spray with acephate 1.5 g/l or chlorpyrifos 2.5 ml/l or quinalphos 2 ml/l were effective measures.

WHITEFLY

Bemisia tabaci

Aleurodidae: Hemiptera

Both nymphs and adults suck sap from undersurface of leaves, excrete honeydew. Damaged leaves show uniform bronzing. For other details refer under cotton

Foliar spray with acephate 1.5 g/l or triazophos 2 ml/l or profenophos 2 ml/l were effective measures.

PESTS OF CASTOR

CASTOR SEMILOOPER

Achaea janata, *Paralellia algira*
Noctuidae: Lepidoptera

It occurs during August-January, also damages rose, citrus pomegranate, *Tridax procumbens*.

A. janata is a pale reddish brown moth, stoutly built with black hindwings having white band medially and three large white spots on the outer margins.

P. algira is also stoutly built moth. In forewings and hindwings, there are two whitish lines which are parallel and continuous lines.

A single female moth lays about 450 blue green rounded and ridged eggs singly @ 1 to 6 eggs per leaf. Egg period is 2 to 5 days

The caterpillar feeds sparingly at first and feeds voraciously during later stages leaving only mid rib and veins.

- ❖ Defoliated leaves,
- ❖ in severe cases only mid rib and veins of the leaves

Caterpillar is a semilooper, long, smooth, greyish brown in colour. The first pair of prolegs is reduced and as such a semilooper. Caterpillar possess red or whitish side stripes. Full grown larva has black head, a red spot on the black loop and red anal tubercles and measures 60-70 mm in length, larval period is 11- 15 days.

Pupation takes place in the soil or among fallen leaves. Pupal period is 10-14 days during warm weather, few months in cold weather

MANAGEMENT:

- The larvae may be handpicked and destroyed.
- *Telenomus* and *Tetrastichus* sp. Parasitize the eggs.
- Braconid parasite: *Micropletis ophiusae* acts as larval parasite whose cocoons may be seen attached to the ventral aspect of the posterior end of the host caterpillar.
- Erection of bird perches @ 10 / ha
- Application of neem oil 5 ml/l or *B.t* 1 g/l
- Foliar spray with endosulfan 2 ml/l or methyl parathion 2 ml/l or thiodicarb 1g/l or spinosad @ 0.33ml/l.

CASTOR SHOOT AND CAPSULE BORER

Conogethis punctiferalis
Pyralidae: Lepidoptera

It is a potential pest and occasionally becomes serious. It is active from September to February when crop is in flowering. It also damages ginger, cardamom, turmeric, guava, peaches, cacao, pear, mango inflorescence, sorghum earheads, soapnut tree etc.

Moth is medium sized having bright orange yellow coloured wings with numerous black dots or spots. The body length is about 10 mm while the wingspan is 22 mm.

Female moth lays pinkish oval, flat eggs singly or in groups on tender parts of plant and developing capsules. Incubation period is 6 to 7 days

Larvae bore into the shoots as well as capsules and destroy them. Occasionally the larva is found at the junction of the petiole with the lamina and rarely in thick mid rib. The symptoms are

- ❖ Frassy matter at the bored shoots
- ❖ Webbed seed capsules covered with dark excreta.

Caterpillar is brownish with pinkish tinge and fine hairs arising from warts on the body. The head and prothorax are brown. Larval period is 12- 16 days

Pupation occurs inside the damaged stem or capsule, in a thin silken cocoon. Pupal period is 7-10 days. Total life history takes 25-33 days with three generations per year.

MANAGEMENT :

- Collection of infested shoots and capsules and their destruction.
- Spraying should be commenced from the time of formation of inflorescence and again after 20 days. Insecticides like dimethoate 2 ml/l or methyl demeton 2 ml/l or monocrotophos 2 ml/l are recommended.

TOBACCO CATERPILLAR *Spodoptera litura* (Fabricius) Noctuidae: Lepidoptera

It is found through out the tropical and sub tropical parts of the world, wide 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

LEAF HOPPERS

Amrasca biguttula biguttula
Cicadellidae: Hemiptera

Light green or greenish yellow nymphs and adults suck sap from undersurface of leaf. As a result, the margins of leaf turn pale initially, later become yellowish and cause hopperburn or drying of leaves and showing brown necrotic patches in severe cases. Plants lose vigor and yield is affected. The other hosts are brinjal, mesta, cotton, bottle gourd etc.,

Seed treatment with imidacloprid 5g/kg seed or thiamethoxam 4g/kg seed, foliar spray with monocrotophos 1.6ml/l or dimethoate 2 ml/l have been found effective.

CASTOR BUTTERFLY/ SPINY CATERPILLAR

Ergolis merione
Nymphalidae: Lepidoptera

It is specific pest on castor. The larva is long green with short branching hairs in groups all over the body. The larva feeds on the upper surface of leaves and scrapes the chlorophyll content.

Collection and destruction of the larvae and foliar spray with quinalphos 2ml/l or chlorpyrifos 2.5 ml/l are effective.

CASTOR WHITEFLY

Trialeurodes rara, Trialeurodes ricini
Aleurodidae: Hemiptera

The yellowish nymphs with waxy filaments are found in large numbers on leaves. Nymphs and adults suck sap causing yellowing and drying of leaves in severe infestations.

Application of methyl demeton 2ml/l or monocrotophos 2 ml/l or triazophos 2 ml/l

CASTOR THRIPS

Retithrips syriacus, Scirtothrips dorsalis
Thripidae: Thysanoptera

Both the nymphs and adults lacerate and suck oozing out sap from the plant tissues. The plant loses its vitality. Terminal leaves turn crinkled and silvery white.

Spray application of methyl demeton 2 ml/l or dimethoate 2 ml/l.

CASTOR SLUG

Latoia (Parasa) lepida
Limacodidae: Lepidoptera

It is a sporadic pest of castor. It also attacks coconut, mango, Palmyra, citrus, wood apple etc. Larvae feed on the leaves leaving the mid rib and veins.

Foliar spray with chlorpyrifos 2 ml/l or monocrotophos 2 ml/l

MITE

Eutetranychus sp., Tetranychus telarius
Tetranychidae: Acarina

Nymphs and adults of the red spider mites suck sap from the under surface of leaves by constructing silken galleries. In severe infestations white blotches are formed on the upper surface of leaf. In severe attack, mites are also seen on upper surface of the leaves. Dusting of fine sulphur and spraying with dicofol 5 ml/l or profenophos 2 ml/l are effective.

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.

GROUNDNUT LEAF MINER

Aproaerema modicella

Gelechiidae: Lepidoptera

This is one of the major pests on groundnut especially in rainfed conditions. Bunchy variety is generally severely infested. This pest appears mostly six weeks after crop germination *i.e.*, during September-October. The other hosts are redgram, soybean *etc.*

Moth is very small with dark brown wings and small distinct white spot on forewings. Shiny and sculptured eggs are laid singly on tender leaves. Incubation period is 3 days.

The newly hatched caterpillar mines into tender leaflets or it webs together adjacent leaflets and feeds on the tissue. The leaflets get distorted and due to feeding get dried up in due course of time. Damage results in

- ❖ Mining of larvae in the upper epidermis of leaves which causes in characteristic blotches
- ❖ Folded leaves.
- ❖ Drying of affected leaves and withering of plants.
- ❖ Severly infested field looks as if burnt from a distance.

Full grown caterpillar is greenish with a small dark head. Larval period is 14 days

Pupation is inside the blotch mine and emerges as an adult in about 4 days.

MANAGEMENT:

- Regular monitoring and surveillance
- Collection and destruction of the larvae and infested plant parts.
- Crop rotation with a non leguminous crop to avoid out breaks of the pest.
- Raising soybean as trap crop.
- Setting of light traps / pheromone traps
- Foliar sprays with acephate 1 g/l or chlorpyrifos 2.5 ml/l or monocrotophos 1.6 ml/l
- Dusting or spraying with quinalphos 1.5 D @ 10 – 12 kg /ac or 2 ml /l

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 leaf lets 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.

LEAF EATING CATERPILLARS

Spodoptera litura
Helicoverpa armigera
 Noctuidae: Lepidoptera

These caterpillars feed on foliage causing extensive defoliation. Their life histories, nature of damage and their management are detailed under cotton pests.

LEAFHOPPER:

Empoasca kerri
 Cicadellidae: Hemiptera.

This species, besides groundnut, also attacks brinjal, chillies, cowpea, tomato, castor etc. Both nymphs and adults suck sap from central surface of leaves, also inject toxin causing whitening of veins and chlorotic patches at tips of leaflets in a typical 'V' – shape. There will be hopperburn in severe cases.

In presence coccinellids @ 2 or more / plant insecticidal sprays can be limited. Insecticides found effective are dimethoate 2 ml/l or methyl demeton 2 ml/l or monocrotophos 1.6 ml/l.

THRIPS

Caliothrips indicus, Scirtothrips dorsalis
 Thripidae: Thysanoptera

Both nymphs and adults suck the sap from the leaf surface. Infested leaves show pale white patches and curling of tender leaflets. It transmits peanut bud necrosis virus disease.

Foliar spray with dimethoate 2 ml/l or imidacloprid 0.50ml/l or thiamethoxam @ 0.4g/l or fipronil @ 2ml/l are effective measures.

GROUNDNUT APHID

Aphis craccivora
 Aphididae: Hemiptera

It is a polyphagous pest. The tender shoots of 2 to 2 ½ months old crop of groundnut are sometimes severely infested by this aphid. Both nymphs and adults suck sap from tender leaves and shoots of plant causing the leaves to curl and stunted growth. Flowers and pods are also affected. Excrete honeydew on which sooty mould develops which interferes with photosynthetic activity of plants. The groundnut aphid also transmits groundnut rosette virus and sometimes groundnut stunt virus diseases.

Spraying with tobacco decoction (1 kg tobacco boiled in 10 lit of water of ½ hour and make up to 30 lit + 100 g soap) and systemic insecticides like monocrotophos 1.6 ml/l or dimethoate 2 ml/l or or methyl demeton 2 ml/l are effective.

GROUNDNUT POD BUG

Elasmolomus sordidus

Lygaeidae: Hemiptera

Nymphs and adult are dark brown bugs. They suck sap from developing seeds of groundnut pods in the field. As a result, the seeds get shrivelled and become rancid and give bitter taste. The oil content and germination percentage of infested seed is also adversely affected. Besides causing damage in the field, it continues to infest the pods in threshing yard and even in storage.

Collection of bugs which on rubbish heaps in threshing floors and their destruction, application of carbaryl 10 D @ 10 – 12 kg/ac or foliar spray with malathion 2 ml/l are effective.

JEWEL BETLE

Sphenoptera perotetti

Buprestidae: Coleoptera

It is important during rainy and post rainy season. Elongated dorso ventrally flattened grub with a globular head burrows into the stem close to soil surface causing drying and death of plants. When examined grub or pupa can be seen in hollowed stem.

Application of carbofuran granules in planting row is effective.

PESTS OF SESAMUM

GINGELLY LEAF AND POD BORER

Antigastra catalaunalis

Pyralidae: Lepidoptera

This is one of the most common, important and specific pest of gingelly.

Adult is a pale brownish small moth with yellowish brown elongated wings.

The female lays about 100 to 130 shining flat eggs on the tender parts of plants. Incubation period is 4-5 days.

The larvae web together the top leaves or bore into tender shoots and capsules and feed on them. The damage results in

- ❖ Webbed leaves at top with young caterpillars
- ❖ Bored shoots, flower buds and pods

In case of severe infestation the yields are drastically reduced. The full grown larva is pale green with black head and tubercles having thin hairs on the body. It measures about 20 mm long. Larval period is 11-16 days..

Pupation is within the web. Pupal period lasts 7-10 days. Infestation starts when the crop is 15 day old, peak activity being in July – September

MANAGEMENT

- Early sowing of *kharif* crop in first week of July
- *Rabi* crop or summer crop as ID crop is recommended to escape pest and also for better quality of seed
- Collection and destruction of webbed leaves, infested pods at initial stages of infestation
- Foliar spray with endosulfan 2 ml/l or dichlorvos 1 ml/l or chlorpyrifos 2 ml/l

GALL FLY

Asphondylia sesami

Cecidomyiidae: Diptera

It is one important pest in south India and also in Rajasthan and a specific pest on gingelly.

The small mosquito like fly inserts the eggs into the ovaries of flower buds. The small whitish maggots feed on the ovary which results in

- ❖ Malformation of pod without proper setting of seeds.
- ❖ Galled buds and flowers fade and dry.

The pupation takes place inside the malformed capsule/pod. Life cycle is completed in 23 – 37 days. Activity starts at bud initiation, peak activity being in September - November.

MANAGEMENT

- Picking of galls, picking and burning shed buds as a prophylactic measure.
- Resistant variety in endemic areas is N 166 – 5
- Foliar sprays with dimethoate 2 ml/l or monocrotophos 1.6 ml/l.

SPHINX CATERPILLAR/ GINGELLY HAWK MOTH / DEATH'S HEAD MOTH

Acherontia styx

Sphingidae: Lepidoptera

The moth is very large, brownish with a characteristic skull like marking on thorax and violet and yellow bands on abdomen. Dark brown forewings are covered with yellowish, bluish and grey powdery scales. Yellowish hindwings are with two cross lines. It is known to suck honey from combs and cause annoyance to bees.

Stout green caterpillar with yellowish oblique stripes and a conspicuous yellowish curved anal horn feeds on the leaves and acts as a defoliator.

Foliar spray with carbaryl 3 g/l or endosulfan 2 ml/l or malathion 2 ml/l or phosalone 2 ml/l is recommended.

PESTS OF SAFFLOWER

SAFFLOWER APHID

Dactynotus carthami

Aphididae: Hemiptera

It is a major pest on safflower and regularly occurs in Andhra Pradesh. It also infests niger, gingelly, citrus, dhalia etc. The incidence of pest occurs a fortnight after crop germination. It completes 4-5 overlapping generations in a crop season.

Adult is a quite large aphid, black in colour with conspicuous cornicle. It appears at flowering and does not cause any severe damage.

Female produces 30 young ones by parthenogenesis

Nymphs are smaller reddish brown in colour. Nymph moults four times.

Both nymphs and adults suck sap from tender shoots and leaves, excreting honeydew

- ❖ Sooty mould develops
- ❖ Plants become stunted and weak.
- ❖ Heads of both nymphs and adults on the stem are oriented toward soil.

MANAGEMENT:

- Avoid delayed planting
- *Brumus suturalis* is predaceous on aphids
- Two sprays at 15 day interval with monocrotophos 1.6 ml/l or dimethoate 2 ml/l or chlorpyrifos 2.5 ml/l are effective.

LEAF EATING CATERPILLARS

Prospalta capensis (Safflower caterpillar)

Spodoptera exigua

Helicoverpa armigera

Noctuidae: Lepidoptera

They are polyphagous. The larvae feed on the foliage causing extensive defoliation. Their life histories damages have been detailed under cotton (*H. armigera*) and millets (*S. exigua*)

Foliar sprays with quinalphos 2 ml/l or chlorpyrifos 2.5 ml/l are recommended.

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 radish 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

Bagrada 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 quinolphos 2 ml/l or dimethoate 2 ml/l is effective.

PESTS OF SUNFLOWER

LEAF EATING CATERPILLARS

Spodoptera litura

Helicoverpa armigera

Noctuidae: Lepidoptera

They are polyphagous pests. Caterpillars eat leaves and soft portions of the stems. *H. armigera* feeds on foliage and tender flower heads and developing seeds. In severe cases there will be

❖ Plants without leaves.

Their life histories, damage and management have been detailed under cotton pests.

Dusting leaves and flower heads with methyl parathion 2D or spraying with quinalphos 2 ml/l or thiodicarb 1 g/l or acephate 1.5g/l or endosulfan 2 ml/l is effective.

(Note: Do not dust or spray during flowering period before seed set).

LEAFHOPPER

Amrasca biguttula biguttula

Cicadellidae: Hemiptera

Greenish yellow adults, pale greenish, translucent nymphs suck sap from undersurface of leaves injecting toxins which result in curling of leaves and ultimately hopper burn symptoms. Leaves dry up and drop down.

Seed treatment with imidacloprid 5 g/kg seed or foliar sprays with monocrotophos 1.6 ml/l or dimethoate 2 ml/l or endosulfan 2 ml/l are recommended.

BIHAR HAIRY CATERPILLAR

Spilarctia (= Spilosoma) obliqua

Arctiidae: Lepidoptera

It is a highly polyphagous peast. Besides sunflower, it infests millets, cotton, jute, sunhemp, castor, cauliflower, cabbage *etc*. It has been reported to feed on 96 plant species in India. The adult is dull yellow

with oblique line of black dots on hind wings. The dorsal side of the abdomen is red with dull yellow ventral side.

The larva defoliates the plants and move from one field to another. The full grown larva is darkened with yellowish brown abdomen having numerous pale white brown and black hairs and measures about 43 mm. It pupates in soil.

Collection and destruction of egg masses and gregarious larva, application of NSKE 5 % and foliar sprays particularly for grown up larva with endosulfan 2 ml/l or chlorpyrifos 2 ml/l or dichlorvos 1 ml/l are effective measures.

THRIPS

Scirtothrips dorsalis

Frankliniella dampfii

Thripidae: Thysanoptera

S. dorsalis infests lower surface of leaves which curl as a consequence, while *F. dampfii* damages capitulum and floral parts.

Seed treatment with imidacloprid 5 g/kg seed is a better option for conservation of natural enemies. Foliar sprays with monocrotophos 1.6 ml/l or imidacloprid 4 ml/10l two or three times are effective measures.

PESTS OF BRINJAL

EPILACHNA 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.

BRINJAL STEM BORER

Euzophera perticella
Pyralidae: Lepidoptera

Its damage is entirely different from that of *L. orbonalis*. It does not attack fruits and leaves. It attacks only stem of more than pencil thickness. The entry of the caterpillar is near the ground level of the stem at leaf or branch axil and covers the hole with excreta and frass. Its attack is found in older brinjal plants and not on younger plants. Branches start wilting after the attack. Plants become stunted in growth. Entire plant wilts and dries. Other hosts include chillies, potato, tomato.

Avoiding ratoon of the brinjal crop, uprooting and burning the infested plants before planting the new crop to avoid carryover of the pest to the next crop are recommended. Foliar spray with carbaryl 3 g/l or monocrotophos 1.6 ml/l is effective.

BRINJAL MEALY BUGS

Centrocooccus insolitus
Pseudococcidae: Hemiptera

Adults are brown or pinkish and are oval in shape. Body is covered with white waxy material. They are generally present on the lower surfaces of the leaves, tender shoots and stem. Colonies of nymphs and adults suck sap from leaves and shoots and stem. The affected shoots and leaves show discolouration. The damage results in stunted growth of plant. Affected branch dries up.

Removal of affected parts, foliar spray with DDVP 1 ml/l or malathion 2 ml/l are effective against mealybugs.

APHIDS

Aphis gossypii, *Myzus persicae*
Aphididae: Hemiptera

They are found in colonies on underside of tender leaves causing leaves crinkle and curled. They reproduce parthenogenetically.

Coccinellids, *Coccinella septumpunctata* and *Menochilus sexmaculata* are predaceous on aphids. *M. persicae* is parasitized by *Aphidius colemani*. Insecticidal sprays with dimethoate 2 ml/l or methyl demeton 2 ml/l are effective.

LEAF HOPPERS

Amrasca biguttula biguttula
Cixiidae: Hemiptera

Both nymphs and adults suck sap from underside of leaves, resulting in characteristic hopperburn symptom. Leaves curl downwards, crinkled and the plant is stunted.

Removal of affected parts and foliar spray with dimethoate 2ml/l or methyl demeton 2 ml/l or fipronil 2 ml/l are effective measures.

BRIJAL LACE WING BUG

Urentius hystrixellus, U. sentis
Tingidae: Hemiptera

These bugs can be identified by their lace like network of veins on the forewings and lace like embossed pattern on head and prothorax.

Both species are specific pests of brinjal. Nymphs and adults suck sap mostly from upper surface of leaves and cause yellowing of leaves in patches. Such leaves are found covered with excreta. The infested leaves shrivel, dry and drop down. Heavy infested plants dry up completely.

Foliar spray with methyl demeton 2 ml/l or dimethoate 2 ml/l or dichlorvos 1 ml/l is effective.

BRINJAL LEAF WEBBER

Psara bipunctalis
Pyralidae: Lepidoptera

Moth is straw coloured with black dot and lines on wings. The greenish caterpillar measuring about 25 mm when grown up, webs together the leaves and feeds gregariously on them. It pupates among the webbings.

The larva is parasitized by *Microbracon psarae*. The effective insecticides are malathion 2 ml/l or quinalphos 2 ml/l.

RED SPIDER MITE

Tetranychus telarius
Tetranychidae: Acarina

Red spider mites are found in large colonies on underside of leaves protected by the silk webbing constructed by the female. They are polyphagous infesting brinjal, bhendi and bean.

Leaves present a characteristic blotches which become whitish then brown patches appear. Later the entire affected leaf become discoloured and dried up. More infestation occurs. Warm and dry months are congenial.

Spraying with wettable sulphur 3-5 gm/l or dicofol 2.7 ml/l or spiromecyferan 3 ml/l or propargite 3 ml/l twice at 10 day interval are effective.

PESTS OF BHENDI

BHENDI SHOOT AND FRUIT BORER / SPOTTED FRUIT BORER

Earias vitella, *E. insulana*
Noctuidae: Lepidoptera

It is one of the important pests of bhendi throughout the country. It also infests cotton, mesta, *Abutilon etc.*,

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

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

In the early stage of the crop, the caterpillars bore into growing shoots of plants. When the fruits appear they also bore into the fruits which show holes plugged with excreta. The infested fruits are mostly shed in early stage of fruiting.

- ❖ Drooping of tender shoots
- ❖ Holes on the infested fruit and filled with excreta
- ❖ Fruits distorted and rendered unfit for human consumption.

The caterpillars of both the species have a number of black and brown spots on the body and hence the name spotted fruit borer. 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 boat shaped silken cocoon. Pupal period is about 6-25 days. Total life cycle takes 20-22 days.

MANAGEMENT

- Avoiding bhendi or cotton during off season which will serve as alternate hosts.
- Removal and destruction of affected shoots, fruits in early season help in keeping the pest under check.
- Natural enemies (enumerated under the same species in cotton) suppress the pest population.
- Foliar spray with thiodicarb 1 g/l during vegetative and at fruiting stages or carbaryl 3g/l or quinalphos 2 ml/l or profenophos 2 ml/l or endosulfan 2 ml/l twice at 10 day interval after harvest of fruits.

LEAF HOPPERS

Amrasca biguttula biguttula
Cicadellidae: Hemiptera

It is distributed throughout the country.

Both nymphs and adults suck the sap from underside of leaves injecting toxic saliva. The damage results in

- ❖ Characteristic hopperburn symptom.
- ❖ Infested leaves crinkle and show characteristic browning
- ❖ Attacked plants stunted, fail to bear fruits.

MANAGEMENT

- Removal of affected parts.
- A spider *Distina albina* and a chrysopid, *Chrysopa cymbela* are predaceous on leafhoppers. *Lymaenon empoascae* parasitizes the eggs.
- Foliar sprays with dimethoate 2ml/l or methyl demeton 2 ml/l or fipronil 2 ml/l are effective.

WHITEFLY

Bemesia tabaci
Aleurodidae: Hemiptera

Both nymphs and adults suck the sap from underside of leaves. As a result, the plant loses its luster. The adult acts as a vector for yellow vein mosaic virus disease.

Removal of affected plants, erecting yellow sticky traps, spraying with acetamiprid 0.4g/l or thiamethoxam 0.4g/l or profenophos 2ml/l were found effective

RED SPIDER MITE

Tetranychus telarius
Tetranychidae: Acarina

Refer under pests of brinjal

PESTS OF TOMATO

SERPENTINE LEAF MINER

Liriomyza trifolii
Agromyzidae: Diptera

It has been introduced into India through chrysanthemum cuttings. It is a pale yellowish fly, measuring 1.5 mm in length. The female fly punctures upper surface of leaf to lay eggs singly. The egg hatches in 4 days.

Minute orange yellow, apodous maggot feeds on chlorophyll mining in between epidermal layers. The symptoms that follow are

- ❖ Leaves with serpentine mines

- ❖ Drying dropping of leaves in severe cases

Full grown maggot measures 3 mm. Larval duration is about 7 days. Pupation is in soil. Some pupae are found in leaves. Total life cycle takes 3 weeks. Generally it does not cause economic damage.

MANAGEMENT

- ❖ Neem oil 5 ml/l or endosulfan 2 ml/l or carbaryl 3 g/l as foliar sprays are recommended, if situation warrants.

TOMATO FRUIT BORERS

Helicoverpa armigera

Spodoptera litura

Noctuidae: Lepidoptera

The larvae bore into the fruits and make them unfit for consumption and marketing.

- ❖ Bored fruits with round (*H. armigera*)/irregular holes (*S. litura*) can be readily identified.

Life histories were detailed under the pests of cotton.

Spray application of endosulfan 2 ml/l affords protection.

WHITEFLY

Bemesia tabaci

Aleurodidae: Hemiptera

Both nymphs and adults suck sap from leaves causing chlorotic spots on leaves, yellowing and drying of leaves. It has been reported as a vector of tomato leaf curl disease.

Plucking and burning leaf curl virus affected plants and spraying with systemic insecticides like dimethoate 2 ml/l or methyl demeton 2 ml/l are effective measures.

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

SNAKEGOURD SEMILOOPER

Anadevidia peponis
Noctuidae: Lepidoptera

It is a specific pest of snakegourd found throughout South India causing appreciable damage to snakegourd.

Moth is dark with a body length of 12-16 mm and wing expanse of 32 mm. Forewings have irregular light markings. Hind-wing is of lighter colour and is darker towards the edges than towards base. A sprinkling of golden sheen is discernible in close examination.

Eggs are pale green, globular, sculptured and laid singly usually on the underside of leaves. Egg period is 4-5 days.

Caterpillar is about 1.5 mm, when freshly hatched and grows to 30-35 mm. They feed on leaves causing

❖ Defoliation.

The semilooper is green with tubercles on the body from which arise thin hairs and its anal segment is humped. Only three pairs of prolegs are present. The caterpillar is often found on underside of the leaf which may also be lightly folded. Larval period is 15-20 days.

Pupation takes place in a tough, white silken cocoon in a folded leaf. Pupal period is 7-10 days.

MANAGEMENT

- Hand picking and destruction of grown up larvae and pupae.
- Larva is parasitized by *Apanteles plusiae*
- Foliar spray with quinalphos 2 ml/l or malathion 2 ml/l or endosulfan 2ml/l.

SERPENTINE LEAFMINER

Liriomyza trifolii
Agromyzidae: Diptera

Serpentine leaf miner is polyphagous pest, native of Florida and believed to be accidentally introduced into India. It is widely distributed in Andhra Pradesh, Tamil nadu, Karnataka, Maharastra causing damage to fibre crops, pulses, ornamentals, vegetables, fodder etc. It is a serious pest on tomato, cotton, ridge gourd, brinjal, cucumber, potato.

The maggot punctures the epidermal layers and scraps the chlorophyll content between the layers. In severe cases the photosynthetic activity reduced and leads to death of the plant.

Removal of affected plants, growing tomato as a trap crop and foliar spray with neem oil 5ml/l can minimize the incidence.

PUMPKIN LEAF CATERPILLAR

Diaphania indica
Pyralidae: Lepidoptera

Moth is medium with whitish wings, transparent with brown marginal patches. Elongate bright green caterpillar is seen with two narrow longitudinal white stripes dorsally. It folds the leaves and scrapes the green matter. As a result the leaves get dried up. It can also feed on ovaries of flower, sometimes bore into young developing fruits.

Hand picking grown up larvae and killing, foliar sprays with quinalphos 2 ml/l or endosulfan 2 ml/l are effective.

COCCINIA GALL FLY

Lasiptera falcata
Neolasioptera cephalandrae
Cecidomyiidae: Diptera

It infests bittergourd and coccinia etc. The maggot bore into distal shoots forming galls along distal shoots. These galls appear like elongated shoots with thickenings with more than 100 maggots inside.

Removal of affected shoots, foliar spray with neem oil 5ml/l or carbaryl 3g/l or dichorvos 1ml/l minimises the incidence.

APHIDS

Aphis gossypii
Aphis malvae
Aphididae: Hemiptera

A. gossypii infests different cucurbits while *A. malvae* infests bittergourd in south India. Both nymphs and adults suck sap from tender leaves and shoots causing the leaves to curl and growth to be stunted. Flowers and pods are also affected. Excretion of honey dew leads to sooty mould which interferes with photosynthetic activity of plants.

Spraying with tobacco decoction (1 kg tobacco boiled in 10 lit of water of 30 minutes and making up to 30 lit + 100 g soap), or systemic insecticides like dimethoate 2 ml/l or methyl demeton 2ml/l have been promising.

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.

CABBAGE BORER

Hellula undalis
Pyralidae : Lepidoptera

It infests cabbage, cauliflower, knolkhol and beetroot.

Adult is pale yellowish-brown moth having grey wavy lines on the forewing. Female moth lays yellowish shiny eggs on leaves. Eggs hatch in about 4 days.

Caterpillars web the leaves and bore into stem, stalk or leaf veins. They bore into the cabbage head also making it unfit for consumption. The damage results in

- ❖ Webbed leaves
- ❖ Holes in cabbage head with faecal matter.

The caterpillar becomes full grown in about 9 days. Full grown caterpillar is 12-15 mm, greyish yellow with seven purplish brown longitudinal stripes on the body

Full grown larva pupates in the larval burrow itself or in the soil. Pupal period is about 6 days.

Management is similar to that of DBM

CABBAGE LEAF WEBBER

Crociodolomia pavonana
Pyralidae: Lepidoptera

It infests cabbage, radish, mustard and other cruciferous plants. Adult is small with light brownish forewings. Female moth lays eggs in masses of 40-100 on underside of leaves. They hatch in 5-15 days.

Caterpillar webs together the foliage and feeds on leaves. It also feeds on flowers and pods in the case of mustard and flower heads in cabbage and cauliflower. Caterpillar bears red head with brown longitudinal stripes and rows of tubercles on the body. Larval period is 24-27 days. The damage results in

- ❖ Webbed leaves with faecal matter
- ❖ Skeletonised leaves

Pupation takes place in a cocoon within the webbed leaves. Pupal period is 14-40 days.

Management is similar to that of DBM

CABBAGE APHIDS

Brevicoryne brassicae

Lipaphis erysimi
Aphididae: Homptera

The aphids are yellowish green (*B.brassicae*) and multiply parthenogenetically. This pest infests crucifers in cold season. Both the nymphs and adults suck sap from plant causing

- ❖ Loss of vigour
- ❖ Sooty mould due to excretion of honeydew reducing the photosynthesis.

Foliar spray with malathion or dimethoate or methyl demeton each at 2.0 ml/l is effective.

PAINTED BUG

Bagrada cruciferarum
Pentatomidae: Hemiptera

Adult is yellow with black markings. Nymphs are reddish in colour. It is a serious pest of cruciferous crops and widely distributed. Both nymphs and adults suck sap from leaves, shoots and pods resulting in wilting and loss of vigour of the plant. It feeds on cabbage, caluliflower, radish *etc.*

Foliar spray with malathion or dimethoate or methyl demeton each at 2.0 ml/l is effective

TOBACCO CATERPILLAR

Spodoptera litura
Noctuidae: Lepidoptera

It is highly polyphagous pest infesting tobacco, castor, groundnut, tomato, cabbage and various other cruciferous crops. Caterpillars feed on leaves and fresh growth, active at night and cause extensive damage. The young caterpillars are gregarious in nature and skeletonise the tender leaves. Later on the broad leaves are completely eaten.

Management is detailed under cotton pests.

CABBAGE BUTTERFLY

Pieris brassicae, Pieris rapae
Pieridae: Lepidoptera

Adult is a butterfly with its forewings snow white having black distal margins. Hindwings pure white with black apical spots. The caterpillar is velvety green and measures about 4.2 cm in length. The caterpillars are gregarious initially but disperse as they grow. They skeletonise leaves and bore into heads of cabbage and cauliflower. Pupation is in damaged leaves.

Two sprays at fortnightly interval with carbaryl 3g/l are effective.

IPM IN CRUCIFEROUS VEGETABLES

Cole crops are invariably infested with diamond back moth, leaf webber, cabbage borer and cabbage butterfly; *Spodoptera litura* and *Helicoverpa armigera* also appear as head borers at times. IIHR has developed the effective IPM package mainly using mustard as a trap crop. The IPM practices are:

- Removal and destruction of crop residues to break the cycles of painted bugs as well as leaf webbers in specific localities,
- Selecting the derivatives of PI 234599 in cabbage having shiny leaves with moderate resistance to diamond back moth.
- Growing mustard as trap crop in cabbage or cauliflower fields. Mustard should be sown in paired rows (one row 15 days after planting and another 30 days after planting cabbage or cauliflower) for every 25 rows of cauliflower/cabbage.
- Application of neem seed kernel extract (5%) in synchrony with the incidence of diamond back moth/leaf webber on cabbage, which is found safer to parasitoids like *Cotesia plutellae*
- Resorting to cartap hydrochloride /*B.t* formulation applications, if head borers (*Hellula* / *Spodoptera* / *Helicoverpa*) appear.
- Opting for insecticide like dichlorvos only when situation warrants and sufficient time gap is available between spraying and harvesting.

PESTS OF TUBER CROPS

POTATO TUBER MOTH

Phthorimaea operculella
Gelechiidae: Lepidoptera

It is one of the introduced pests into our country from Italy through Bombay port and is also found feeding on brinjal, tomato and tobacco leaves.

The adult is a delicate moth with 7 mm body length and wing expanse is 20 mm. Forewings are greyish brown in colour and tapering. The hind wings are whitish in colour. Both wings are fringed with long hairs along the apical and the basal margins. Moth has conspicuously long antennae.

On emergence, the moths mate and the female begins to lay eggs within 24 hours. Each female lays 100-150 eggs in 4-5 days. Eggs are laid around the eyes or cracks of the skin of the exposed tubers. Eggs hatch in about 3-6 days.

The caterpillar acts as a leaf miner in field, boring into petiole and main shoots and at later stages attacks underground tubers. In storage, the damage ranges from 30-70% under improper storage. The damage results in

- ❖ Loss of leaf tissue, death of growing points, weakening or breaking of stems (field)
- ❖ Irregular shaped galleries with excrement near tuber eyes.

Caterpillar is white in colour with dark brown head and prothoracic shield with a few scattered short hairs on the body. Larval period is 5-16 days and the larva grows to a size of 10mm.

Pest is found active throughout the year in plains both in field and in store from April to November.

Full grown caterpillar comes out of the gallery and pupates on the outside of tubers or any other convenient place, constructing a cocoon of silk and frass material. Pupa is pale brown and pupal period is about a week. 8-9 generations are completed in one storage season.

MANAGEMENT

In field

- Frequent earthing up to cover the exposed tubers
- Collection and destruction of affected tubers
- Spraying of carbaryl 3 g/l(600g in 200l of spray fluid)

In the stores

- Storing the tubers under 3 cm thick layer of sand
- Storage bags in the godowns sprayed with malathion 3ml/l

- Fumigating the stores with carbon disulphide or carbon tetrachloride or methyl bromide

SWEET POTATO WEEVIL

Cylas formicarius
Apionidae: Coleoptera

It is a major pest of sweet potato both in field and storage.

It is a wingless, ant-like steel black weevil with a brown elongated snout and thorax.

The female bites small cavities on veins and tubers and lays about 200 eggs singly. The eggs hatch in 3-5 days.

The grub is pale yellow in colour and legless. The grubs bore into the stems of vines and also into the tubers in the field as well as in storage, feeding on the inner contents and spoiling them. The tubers become unfit for consumption. The adult weevil also feeds on leaves, vines and tubers.

❖ Their presence inside the tubers can be detected by the development of dark black patches on outside of the tuber.

The grub pupates inside larval burrow in vine or tuber. Weevil emerges after 7-10 days. Total life history takes about 4-6 weeks.

MANAGEMENT

In field

- Infested portions should be destroyed. Healthy vines should be used for planting purposes.
- Treating planting material by immersing in a solution of chlorpyrifos 2.5ml+ carbendazim 3g per litre of water.
- The cracks in the field closed by hoeing to minimize damage.
- Earthing up at 60 DAP
- Use of pheromone traps @ 1/100 sq.m.for mass trapping and destruction of males even up to 15 days after harvest.
- Crop rotation

In the stores: Management in stores is same as under potato tuber moth.

HAIRY CATERPILLAR

Euchromia polymena
Amatidae: Lepidoptera

In India it is common species infesting sweet potato. Caterpillars grow feeding on foliage. Foliar spray with chlorpyrifos 2.5 ml/l is effective.

TORTOISE BEETLES

Aspidomorpha miliaris
Chirida bipunctata

Cassida circumdata
Cassididae: Coleoptera

The beetle has its thorax and wing cases (elytra) flattened and widened to cover the head and greater part of legs like the carapace of tortoise, hence the name tortoise beetle.

The female lays eggs singly on lower side of leaves. The grubs feed by scraping the surface tissue of the leaves. They have characteristic habit of carrying on their backs, the exuviae and excrements. The damage is caused by both adults and grubs feeding on plant parts. Pupation takes place on the leaves. Total life cycle takes about 2-4 weeks.

Foliar spray with carbaryl 3 g or fenitrothion 2ml/l is effective.

PESTS OF MORINGA

MORINGA HAIRY CATERPILLAR

Eupterote mollifera
Eupterotidae: Lepidoptera

It is a specific and a common pest on drumstick.

It is a large moth with light yellowish brown wings, having faint lines. Female moth lays eggs in clusters on tender parts. Egg period is 5-7 days.

Caterpillars gather in a cluster on the stem of the plants during hot hours of day. They are active at night, defoliate the tree quickly and collect on the trunk. The larva feeds on leaves causing

❖ Defoliation

Caterpillar is dirty brown in colour with whitish hairs arising in tufts on small warts. Hairs are poisonous and irritating. Head capsule and thoracic legs are coral red in colour. Larval period lasts 20-25 days. The larva pupates in soil in earthen cocoon. Pupal period is 8-10 days.

MANAGEMENT

- The larvae in groups on tree trunks killed by a burning torch.
- Foliar spray with endosulfan 2 ml/l or quinalphos 2 ml/l against young caterpillars.

MORINGA BUDWORM

Noorda moringae
Pyralidae: Lepidoptera

Eggs are laid in groups on flower buds. Larvae bore into flower buds feeding on the inner contents and cause shedding up to 78 per cent during summer. Only one caterpillar is seen in a bud. The infested buds seldom blossom and fall to ground. Pupation takes place in soil.

Foliar spray with phosalone 2 ml/l during flower bud initiation and at fruiting, dichlorvos 1ml/l, two sprays at fortnightly interval.

PESTS OF CHILLIES

CHILLI THRIPS

Scirtothrips dorsalis
Caliothrips indicus
Frankliniella sulphurea
Thripidae: Thysanoptera

S. dorsalis is found in almost all chilly growing areas. It is a polyphagous pest. Besides chilli, it also infests brinjal, cotton, groundnut, castor, bottlegourd, guava, tea and grapevine. It is more common on un-irrigated chilli crop than irrigated one.

They are slender, tiny, straw coloured insects with fringed wings.

A female adult inserts 40-48 white, minute eggs into veins.

Both nymphs and adults lacerate the leaf tissues and suck the oozing sap, sometimes even the buds and flowers are attacked. Generally they attack tender leaves and growing shoots. Rarely the older leaves are attacked. Their damage results in

- ❖ The infested leaves curling upward, crumbling and shedding
- ❖ Infested buds turning brittle with petiole becoming brown and dropping down.
- ❖ Affected fruits showing light brown scars.

Pest infestation is severe in dry weather. The damage ranges between 30-50%.

One life cycle is completed on an average in 2- 2.5 weeks. There are about 25 generations in a year. Reproduction in thrips is generally sexual, parthenogenesis is also present.

MANAGEMENT

- Seed treatment with imidacloprid @ 3-5 g/kg of seed.
- Foliar spraying with carbaryl 3g/l or phosalone 3ml/l or acephate 1 g/l or fipronil 2 ml/l or spinosad 0.3 ml/l or diafenthiuron 1.2 g/l so as to wet the undersurface of the leaves.
- Application of fipronil 0.3G 8 kg/acre at 15 and 45 days after transplanting.

CHILLI POD BORERS

Spodoptera litura, *S. exigua*
Helicoverpa armigera; Noctuidae
Utetheisa pulchella; Arctiidae
Lepidoptera

Feeding by *S. litura*, *S. exigua* leads to irregular holes on the leaves and fruits. Affected pods turn whitish and dry up. In fruits, seeds are also eaten. Attack of *H. armigera* leads to round hole on fruits. In addition to these borers, sometimes *U. pulchella* also feeds on the pericarp leaving

the seed intact. Ladder like marks are seen on chilli pod due to *U. pulchella*. Their detailed history can be is given under pests of cotton and millets (*S. exigua*).

MANAGEMENT

1. Deep summer ploughing.
2. Monitoring with pheromone traps @ 4/acre
3. Raising trap crops like castor (*S. litura*), marigold (*H. armigera*).
4. Spraying with SNPV/HaNPV at 250LE/acre in the evening.
5. Spraying novuluron 1.0 ml/l or diflubenzuron 1.0 g/l controls just hatched larvae.
6. Foliar spraying of thiodicarb 1.0 g/l or acephate 1.5 g/l or chlorpyrifos 2.5 ml/l or spinosad 0.3ml/l or quinalphos 2 ml/l.
7. Poison baiting with rice bran 5 kg + chlorpyrifos 500 ml or carbaryl 500g + jaggery 500 g with water in the form of small balls in the evening hours.

CHILLI APHIDS

Aphis gossypii, *Myzus persicae*
Aphididae: Hemiptera

They are polyphagous pests. Cloudy weather is very favorable for multiplication of aphids. Heavy rains cause reduction in their population. Adults are found in large numbers on the undersurface of leaves and growing shoots of plants.

Both nymphs and adults suck sap and also excrete honeydew on which black sooty mould develops affecting photosynthetic activity thus it causing

- ❖ Retardation in growth and fruiting capacity of the plant.
- ❖ Sooty mould

Foliar spray with methyl demeton 1 ml/l or acephate 1.5 g/l is effective.

CHILLI MITES

Polyphagotarsonemus latus
Tarsonemus translucens
Tarsonemidae
Tetranychus cinnabarinus
Tetranychidae: Acarina

A minor pest emerged as a major pest in recent past. The infestation starts in the nursery after 40 days of germination. Severe infestation is seen in transplanted crop of 2-3 months old. The tiny white transparent mites are found in large numbers on the undersurface of leaves under fine webs. Both nymphs and adults suck sap and devitalize the plant causing 'Murda' disease of chillies. Infestation results in

- ❖ Downward curling of leaves,
- ❖ The affected leaves becoming inverted boat shaped,
- ❖ The leaves rolling down along the margin with elongation of petioles.
- ❖ Affected leaves turning dark green in certain cases.
- ❖ Younger leaves at the tip of branch clustering.

MANAGEMENT

- Foliar spraying of dicofol 5ml/l or wettable sulphur 3g/l.
- Synthetic pyrethroids not to be used.
- If both thrips and mites are noticed, spraying phosalone 3ml/l or diafenthiuron 1.5 g/l or chlorfenapyr 2 ml/l.

CHILLI BLOSSOM MIDGE

Asphondylia capsici

Cecidomyiidae: Diptera

Fly is dark reddish brown mosquito like midge that lays eggs in flower buds. Maggot is tiny pale orange colored and feeds on the floral parts leading to poor development of fruits. The ovary is distorted into gall like structure of varied shape.

Foliar spray with triazophos 2 ml/l or carbosulfan 2 ml/l followed by chlorpyrifos 2.0 ml/l one week later is found effective.

PESTS OF AMARANTHUS

AMARANTHUS LEAF EATING CATERPILLAR

Hymenia recurvalis

Pyralidae: Lepidoptera

It is widely distributed and is found throughout year also infesting beans, coleus, melon, spinach, beetroot, soybean

The moth is small having dark brown wings with broad white band in the middle. Outer margin are fringed with short hairs.

Female lays spherical snow white eggs singly in between leaf veins. Caterpillar is greenish with white lines and black crescents on thorax. The larvae initially feed on leaf epidermis, later web the leaves and feed on the green matter causing

- ❖ Webbed leaves
- ❖ Complete skeletonisation of leaves which dry up in severe infestation.

Foliar spray with malathion 2 ml/l giving 10 days waiting period before harvest

AMARANTHUS STEM WEEVIL

Hypolixus truncatulus

Curculionidae: Coleoptera

The adult is 10 – 15mm long, ashy dark grey weevil with a conspicuous snout. White, stout, apodous and curved grubs bore into the stem and cause gall like swelling. Affected stem gets weak, may split longitudinally

Removal of wild Amaranthus prevents simultaneous and offseason buildup of pest. Removal and destruction of affected plants with grubs and foliar spray with malathion 2 ml/l or dichlorvos 1 ml/l or phosalone 2 ml/l with a waiting period before harvest are 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 STEM BORER
Batocera rufomaculata
 Cerambycidae: Coleoptera

Mango stem borer is common pest in India. It is a polyphagous pest, infesting besides mango, apple, fig, mulberry, Eucalyptus, jack fruit, papaya etc.

Adult is a well built, conspicuously long, brownish grey beetle measure ring about 4.5 to 5.5 cm. It has two pink dots and lateral spines on thorax and has hard elytra and is long horned. Female deposits eggs singly under the loose bark or in wounds of the mango tree trunk. Egg hatches in 1-2 weeks.

The grub bores and tunnels through the bark of branches and stem feeding on the inner contents. As a result of feeding, the affected branches start drying up. In severe cases of attack the whole tree dies. The symptoms of damage are

- ❖ Masses of frass and sap exuding from the bore holes.
- ❖ Leaves of damaged branches dry and fall
- ❖ Branches collapse, tree succumbs in severe cases

Full grown grub is yellowish white, fleshy and about 10 cm long with dark brown head having strong jaws. It pupates inside the larval tunnel in the stem itself. Pupal period lasts for 4-6 months. Adult emerges out during May-June.

MANAGEMENT

- The affected portions with grubs and pupae removed and destroyed, if branches are affected
- The bore holes traced and opened. A swab of cotton wool soaked in chloroform or petrol 5ml or carbon disulphide or kerosene oil or dichlorvos 10ml/l inserted in to the hole and sealed with mud.

- Methyl parathion 1 ml/l poured in to the hole or tablet of aluminium phosphide inserted into the hole to kill the grub.
- When burrows are superficial, extract the grubs with stiff hooked wire and paint bordeaux paste.

MANGO NUT WEEVIL OR STONE WEEVIL

Sternochetus mangiferae
Curculionidae: Coleoptera

It is a major pest in South India. It is widely distributed in tropics. Sweet variety fruits are more liked by stone weevil. It is monophagous and is considered most serious pest of mango.

Adult weevil is about 6-8 mm in length, greyish brown in colour and stoutly built. Antennae are 10 segmented and elytra are convex. In non-fruiting season, beetles remain hidden under the bark. The mother weevil selects a place on the developing fruit, makes a boat or crescent shaped shallow depression by scooping and then lays a single egg and covers it with a transparent liquid secretion. Single female lays about 15 eggs. The egg hatches within a week.

Grub is white, thick, fleshy and legless. The newly hatched grub immediately tunnels in a zig-zag manner through pulp, endocarp and seed coat until it reaches cotyledons and the seed coat hardens afterwards. Inside the stone it feeds on the cotyledon, moults 5 times in about 5 weeks and pupates inside the stone. As a fruit develops, the tunnel gets healed up. The damage results in

- ❖ Ovipositional injuries and eggs on marble sized fruits
- ❖ Tunneled cotyledons
- ❖ Fruit dropp at marble stage

The adult emerges in about 7 days within the stone also feeds on developing seed. This hastens the maturity of infested fruit. During the life cycle of the weevil, if the infested fruit falls and decays, then adult comes out by cutting the stone. If not, adult makes its way out through pulp. Life cycle is completed in 40-50 days and only one generation is completed in a year. The infestation sometimes goes up to 100 per cent.

The pest is sensitive to temperature and low humidity and is more confined to humid areas. Due to this pest, Maryland of the USA does not allow mango imports from India.

MANAGEMENT

- Collection and destruction of infested fruits
- Ploughing orchard after fruit harvest to expose hibernating adults
- Killing adults before fruiting season by treating bark with spray of monocrotophos 1.6 ml or carbaryl 3 g or fenitrothion 1.0 ml/l at fruit set and one month after fruit set.
- Hot water treatment of fruit for specified period at 60°C kills the weevil inside the stone, but not fruit fly maggot which is within the pulp.

MANGO FRUIT FLY

Bactrocera dorsalis

Tephritidae : Diptera

It is one of the major pests of mango in India. It also infests guava, peach, citrus, ber, banana, papaya etc.

Adult fly is a brown or dark brown with hyaline wings and yellow legs.

Eggs are laid in small clusters of 2-15 just beneath the skin of the fruit. About 200 eggs are laid by a single female during a period of 1 month. Egg period is 2-3 days in March and April and prolonged up to 10 days in winter.

Damage to semi ripe fruits is caused by both maggot and the adult. The oviposition punctures made by the female serves as entry for fermenting organisms. Maggots feed on the pulp and convert the pulp into bad smelling discolored semi liquid mass, unfit for use. The fruits develop brown rotten patches on them and fall to the ground eventually. The symptoms of attack are

- ❖ Semiripe fruits with decayed spots
- ❖ Dropping of fruits

Maggots become full grown in 6-29 days depending on the season. Maggots come out of the fruits and pupate in the soil. Entire life cycle takes about 25 days in the tropics.

MANAGEMENT

- Collection and destruction of fallen, rotten fruits
- Raking under the trees to expose the pupae
- Mixing of carbaryl 10D in soil @ 50-100 g/tree
- Hanging from tree branches plastic containers with bait made of methyl eugenol 2 ml + carbofuran 3G 3 g + water one litre (200ml of bait/plastic container) to attract and kill flies
- Foliar spray with malathion 2 ml/l or acephate 1.5 g/l

Post-Harvest Control (Heat treatment techniques):

- Hot water treatment: Submerging fruits in hot water at 43 to 46.7°C for 35- 90 min.
- Double dip method: Immersion of mango fruits in water at 40°C for 20 minutes, followed by 10 minutes at 46°C to get 100 per cent mortality of *Bactrocera dorsalis* eggs.

MANGO SHOOT BORER

Chlumetia transversa

Noctuidae: Lepidoptera

This pest is active from August to October. Eggs are laid on tender leaves. Freshly hatched caterpillars bore into midribs of tender leaves and come out after a couple of days to bore into tender shoots near the growing point tunnelling downwards, throwing out the excreta out of the entry hole. Damage results in withering and drying of new terminal shoots. When the caterpillar is full grown, it come out of the shoot and pupates on dried leaves, bark, soil etc.

Clipping off and destruction of affected shoots, foliar spray with carbaryl 3 g/l or quinalphos 2 ml/l at the time new flush.

MANGO FRUIT BORER

Deanolis albizonalis

Pyralidae: Lepidoptera

Adults are brownish. Pest is active from February – May and during off season, larvae hibernate in dried twigs. The female lays eggs on the apex of the fruits. Egg period is 3-4 days. Caterpillar is brick red with white intersegmental streaks. Caterpillar bores into fruits at beak region, feeds inside reaching kernel causing secondary infection, which renders the fruit unsuitable for market or consumption. Bore holes are seen plugged with excreta. Larval period is 14-20 days. A single caterpillar can damage many fruits. Pupal period is 9-11 days and adult lives for 8-9 days. There are 2-3 overlapping generations in a year.

Castor shoot and capsule borer *Conogethes punctiferalis* is also known to bore into fruits when two fruits are seen attached together.

After fruit harvest, removal of dead wood and bark and burning, collection of damaged fruits on the tree and the ground and burning, erecting light traps, fires, spraying with NSKE 5 % at 10 days interval from fruit setting (marble size) until 15 days before harvest are recommended. Foliar sprays in the evening with dichlorvos 1.5ml/l or chlorpyrifos 1ml/l or carbaryl 3g/l or neem oil 3ml/l + chlorpyrifos 1ml/l. Avoid growing of castor in mango orchards to eliminate *C. punctiferalis* which comes as a fruit borer is recommended.

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 gauge 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.

APHID

Toxoptera odinae

Aphididae: Hemiptera

It is a brownish species infesting tender shoots and leaves by sucking sap in South India. Systemic insecticide like dimethoate 2 ml/l is effective.

MANGO LEAF WEBBER

Orthaga exvinacea

Noctuidae: Lepidoptera

Caterpillar webs terminal leaves and feeds by scraping green portion. Leaves are skeletonized, wither and drop away. Dry top shoots are conspicuous and flower stalk formation is affected.

Spraying of quinalphos 2m/l or carbaryl 3 g/l or monocrotophos 1.5ml/l during July-August is effective.

TERMITES

Odontotermes obesus

Termitidae: Isoptera

Colonies of workers feed on bark by constructing galleries and eventually tree may collapse and die.

Applying in the pit at planting time neem cake or methyl parathion 2D 100g/pit, digging termite mounds and destroying queen, drenching chlorpyrifos 10ml/l on dug termite mounds, spraying chlorpyrifos 4ml/l on tree after clearing mud galleries, applying Bordeaux paste up to 2-3 feet from base after rains cease, are some of the measures recommended.

THRIPS

Thrips hawaiiensis

Thripidae: Thysanoptera

Thrips mainly infest flowers and tender fruits. They lacerate the tissues of tender fruits and suck oozing out sap. Damage causes scab on fruits which lose their marketability.

Foliar sprays with acephate 1.5g/l or fipronil 2ml/l. when thrips are found along with mango hoppers, thiamethoxam 0.3g/l are recommended.

MANGO RED TREE ANT

Oecophylla smaragdina

Formicidae: Hymenoptera

Ants construct the nest by webbing the leaves together. Though they do not cause any direct damage, they act as carriers for scale insects, mealy bugs and also cause nuisance to the workers in the orchards. They are ferocious and workers are badly bitten.

Removal and destruction of nests mechanically and spraying chlorpyrifos 2ml/l or methyl parathion 2ml/l after disturbing the nests have been found effective.

LEAF GALL MIDGES

Amradiplosis echinogalliperda

Procontarinia matteiana

Cecidomyiidae: Diptera

Flies are mosquito like; maggots are small, yellow and apodous. Areas of ovipositional punctures on leaf develop into galls. Maggots feed within the galls.

Spraying NSKE 5% or endosulfan 2 ml/l at new flush is effective.

RED SPIDER MITE

Oligonychus mangiferus

Tetranychidae: Acarina

Tiny mites suck sap from older leaves, turning them brittle. They live under silken webs on undersurface of leaves which turn yellow. In severe infestation, leaves are shed. Foliar spray with diafenthiuran 1 g/l is recommended.

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 FRUIT SUCKING MOTHS

Eudocima materna, Eudocima fullonica, Eudocima ancilla
Noctuidae: Lepidoptera

This pest is distributed in Australia, China, Japan, Korea, Philippines, Hawaii, Thailand etc. Besides citrus, it also attacks grapes, apple, castor, ber, pomegranate, guava etc.

E. materna: The moth has brownish black forewings with a white stripe and yellowish hind wings with a circular black spot in the middle.

E. fullonica: The moth has brownish forewings and yellowish black hind wings with a half moon or kidney shaped black spot.

E. ancilla: The forewings of this moth are dark brown with a green band in the middle; hind wings are yellowish with a kidney shaped black spot.

This is the only group where the adult moths are harmful and damage the citrus fruits. Moth pierces the ripe fruit with its strong proboscis and sucks the sweet juice. The feeding injury opens way for invasion of bacteria, which makes the fruit rot around the punctures and drop prematurely

Achaea janata moth also sucks the juice from the unripe fruits. The damage results in

- ❖ Premature dropping of fruits.
- ❖ Rotting at the site of feeding injury.

Eggs are laid singly on tender parts of wild foliage. Egg period is about 3-4 days. Caterpillar is a semilooper. Larvae of *Eudocima* sp feed on foliage of other weed hosts of the family Menispermaceae. Larval period is 13-17 days. Pupation is inside the leaf fold and pupal period is 12-18 days.

MANAGEMENT

- Destruction of weeds found around orchards.
- Collection and destruction of rotten and dropped fruits.
- Adults are highly phototropic. One fluorescent light/ha one month before fruit maturation between 7.00 PM to 6.00 AM below which poison baits with sugar solution 1% + fruit pulp + Malathion 1 ml should be placed.
- Bagging of fruits with polythene or paper covers, though effective is rather expensive and not practicable on large scale.
- Creating smokes in the orchards after sunset to keep the pest away which is also rather laborious.
- Arranging poison baits during Sep – Nov and Mar – May at fruiting under lights with a solution of malathion 1ml + fruit juice with 1% sugar to attract and kill adult moths.

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.

CITRUS RUST MITE

Phyllocoptruta oleivora
Eriophyidae: Acarina

Citrus rust mite damage epidermal cells of plant leaves, fruit, and green twigs of all citrus varieties and can be found any time during the year with peak populations usually occurring during June and July in south India.

Minute worm like mites are found on the under surface of leaves and fruits. The infestation may cause

- ❖ Browning of leaves
- ❖ Pale brown and sickly fruits
- ❖ The affected fruit becomes pinkish, brown red and brittle and is locally called as “mangu” disease.
- ❖ Rust mite is known to avoid most sun exposed portion of the fruit.

MANAGEMENT:

- Foliar sprays with wettable sulphur 3g/l or dicofol 2.7ml/l or propargite 1ml/l once in a month in Sep, Oct and Nov.

BARK EATING CATERPILLARS

Indarbela tetraonis, *I. quadrinotata*
Metarbelidae: Lepidoptera

Occasionally these pests in large numbers cause severe damage especially to old trees. The freshly hatched larvae feed on the surface of tree trunks. When strong enough, they bore inside the trunks and move about inside the concealed silken gallery and feed on the bark by scraping which interrupts the translocation of cell sap adversely affecting growth and fruit setting capacity of the tree. Ribbon like or pipe like webbings on the stem near forks or angles of branches and the tree trunk is the clear indication of its damage. Only one caterpillar is seen in a gallery.

Cleaning the tree trunks by removing all the webs and placing cotton wool soaked in chloroform, kerosene, petrol and, carbon disulphide and sealing the same with mud or injecting into the hole with monocrotophos 1.6 ml/l or of dichlorvos 2 ml/l are effective.

CITRUS BLACKFLY

Aleurocanthus wogluni

Aleurodidae:Hemiptera

It is found mainly in North India. It infests during post rainy season and disappears in summer. It also infests coffee.

Adults are tiny, moth like slaty black with white markings at the edge of wings. Both the nymphs and adults suck sap resulting in loss of plant vigour and formation of sooty mould due to excretion of honey dew.

Predators like *Brumus* sp., *Scymnus* sp. And *Chrysoperla* sp suppress the pest population.

Spraying profenophos 2.0 ml /l or chlorpyrifos 2 ml/l or imidacloprid 0.5 ml/l or acephate 1.5 g/l are effective.

CITRUS RED MITE / LEAF MITE

Panonychus citri

Tetranychidae: Acarina

Citrus red mites feed on leaves, green twigs, and fruit. Visible injury is characterized by light colored, scratched areas which give the upper leaf surface a silvery appearance.

Avoiding water stress and spraying of wettable sulphur 3 g/l or dicofol 2.7 ml/l or propargite 1ml/litre of water during Sept-Nov months are effective measures.

PESTS OF GRAPEVINE

GRAPEVINE FLEA BEETLE

Scelodonta strigicollis
Chrysomelidae: Coleoptera

It is the most destructive pest of grapevine all over India.

Adult is a shiny flea beetle with a metallic bronze colour and six black patches on the elytra and is 4.5 mm long. The adults are very destructive during Sep - Nov particularly when the vines put forth new flush after pruning. The beetles feed on the sprouting buds and eat them completely without allowing them to develop. They feed on mature leaves cutting elongated holes on the leaf lamina like shot holes. The damage results in

- ❖ Complete fed sprouting buds.
- ❖ Shot holes (rectangular cuttings) on mature leaves.

Adult beetles hibernate during winter under tree bark and become active from March till November. Adults have characteristic habit of falling down and feigning death when disturbed.

The females lay eggs about one month after emergence and continue from middle of March to middle of October. Eggs are laid beneath the bark in groups of 20-40. A female lays about 220-569 eggs in 10-14 installments during its life of 8-12 months. Egg period is 4 days.

On hatching small, dirty white grubs drop down to the water basin and burrow into the soil and feed on the cortical layer of roots not causing any appreciable damage. Larval period is 6-7 weeks.

Pupation takes place in an earthen cell and the pupal period is 7-11 days. Total life history takes 52-54 days.

MANAGEMENT

- Adult beetles may be collected and killed.
- Removal of loose bark in rainy season after pruning to expose and eliminate eggs and adults found underneath
- First spraying when buds swell in early morning or evening hours to kill beetles and second spray after 10 days with monocrotophos 1.6 ml/l or carbaryl 3.0 g/l or imidachloprid 0.3 ml/l or quinalphos 2ml/l.

GRAPEVINE THRIPS

Rhipiphorothrips cruentatus
Thripidae: Thysanoptera

Most destructive pest of grapevine India. It also feeds on rose, jasmine, cashew and other fruit trees.

Adults are minute, pale, blackish brown, found on the underside of leaves. Reproduction is either with or without fertilization. Fertilized eggs give rise to female and unfertilized ones to male.

Adults appear in March and lay eggs on the underside of leaves by making slits in leaf tissue, placing one egg in each slit. About 50 eggs are laid by each female. The egg is dirty white and bean shaped. Eggs hatch in 3-8 days,

Young nymphs on hatching feed on the undersurface of leaves. Both the nymphs and adults lacerate tender foliage and suck the oozing sap. The attacked leaves appear silvery initially and later turn brown and give withered appearance, curl up and drop off the plants. Severely affected vines do not bear fruits. If fruits are attacked, they develop corky layer on the fruits and turn brown. Infestation results in

- ❖ Silvery patches on the affected leaves.
- ❖ Brown corky patches on fruits (scab)

Nymphal period is 9-20 days

Pupation on leaves and pupae possess locomotion and crawls when disturbed. Pupal period is 2-5 days.

MANAGEMENT

- Removal of weeds in and around garden.
- Cutting of infested branches and burning.
- Spraying dimethoate 2ml/l or methyl demeton 2.0 ml/l or thiamethoxam 0.25 g/l.

GRAPEVINE MEALY BUG *Maconellicoccus hirsutus* Pseudococcidae: Hemiptera

It is a serious pest on grapevine varieties having compact fruit bunches like Thompson seedless. Anab – e – shahi with loose bunches is less infested.

Clusters of mealy bugs with white mealy mass suck the sap from fruits making berries or fruits unfit for consumption. They also feed on stems and foliage resulting

- ❖ Sooty mould development that affects photosynthesis and final yield.
- ❖ Malformation of growing shoots and leaves and sooty mould are the common.

MANAGEMENT

- Clearing mealy bug clusters on stem using gunny cloth
- Releasing 8-10 *Cryptolaemus montrouzieri* (Australian lady bird beetle)/each tree.
- Removal of loose bark and paste mixture of carbaryl 6 g + Copper oxy chloride 10 g + neem oil 1ml+ gum 1ml on the stem and branches.

- Spraying of dichlorvos 2.0 ml/l or methomyl 1.0 g/l have been found effective.
- Applying sticky bands like greeze or sticky tapes around stem, stalks of branches to prevent crawlers from reaching young shoots.
- Dipping grape bunches in a solution of DDVP 1.5ml + soap 2.5g + water 1 litre for 30 seconds is also suggested.

GRAPEVINE STEM GIRDLER

Sthenias grisator

Cerambycidae: Coleoptera

Besides grapevine, this insect also infests apple, citrus, mango. It is a medium sized, stout beetle which girdles (ringing) the vine as a pre – ovipositional operation resulting in drying up of regions beyond the cut. Eggs are inserted under the bark in cuts made by the beetle on the girdled vines. 1-4 eggs are laid at one place. Egg period is 8 days. The grub tunnels in to the wood and completes its life cycle within the stem. Pupation takes place within the tunnel.

Cutting attached branches below girdling point and burning, applying dichlorvos in the holes or placing half a tablet of aluminium phosphide in to the hole and closing it with mud are recommended.

GRAPEVINE STEM BORER

Coelosterna scabrator

Cerambycidae: Coleoptera

The insect is a borer, the grub of which bores in to stem and branches and causes drying and withering of affected branches. Initially reddish sap oozes from wounds, chewed particles of wood are seen on the ground just below the site of damage

Removal of loose bark in pre monsoon period, later painting bark with lindane suspension is recommended. Applying dichlorvos in the holes and closing it with mud or placing half tablet of aluminium phosphide in to the hole and closing it.

LEAF EATING CATERPILLARS

Spodoptera litura

Spodoptera exigua

Helicoverpa armigera

Noctuidae

Euproctis sp.

Lymantriidae: Lepidoptera

Their incidence is sporadic. Caterpillars feed on grapevine leaves voraciously. Foliar sprays with carbaryl 3g/l are recommended.

WHITE GRUB OR ROOT GRUB

Holotrichia consanguinea, *H. serrata*

Scarabaeidae: Coleoptera

The pest identification, detailed biology, nature and symptoms of damage and management are detailed under pests of groundnut.

PESTS OF CASHEW

CASHEW TREE BORER

Plocaederus ferrugineus
Cerambycidae: Coleoptera

It is one of the major pests and normally found in old plantations of more than 7 years age where sanitation is poor. It is a serious pest of cashew tree in Kerala, Karnataka, Andhra Pradesh, Tamil Nadu and Maharashtra.

Adult is a medium sized, dark brown longicorn beetle.

Eggs are laid under loose bark of the stem and roots. Grub is creamy white, robust and fleshy. Grubs bore into the bark in their early stage and into the wood in their late stages making extensive tunnels within. Both young and old plants are affected. The young plants are killed immediately whereas the older plants gradually become weak and succumb. Infestation results in

- ❖ Yellowing and shedding of leaves and drying of twigs.
- ❖ Chewed up fibre, excreta and gummy secretions seen protruding from the bore holes.

Larval period is 6-7 months and full grown larva measures up to 7.6 cm. It tunnels downwards and reaches the roots where it pupates in a calcareous pupal chamber. The pupal period is 2 months. Only one life cycle is completed in a year.

MANAGEMENT

- For trees over seven years age, spraying or swabbing on tree trunks up to 3 feet from ground and exposed roots with 5%neem oil once in 4 months i.e. 3 times a year as a prophylactic measure.
- Removal of dried branches, dead trees and burn them.
- Removal of grubs, pupae and adults from damaged portion by physically chisteling and destroying them.
- Chistled trunks and roots treated with carbaryl 4 g/l.
- Removing the soil around the base of tree up to 1 foot depth and applying 300-500 g of carbaryl dust per tree and covering it with fresh soil.
- Cleaning the bore holes to insert 1-2 tablets of aluminium phosphide in each hole and plugging the holes.

CASHEW SHOOT AND BLOSSOM WEBBER

Lamida monocusalis
Pyralidae: Lepidoptera.

It is a major and regular pest and occurs all through the year. Adult is a dark brown moth with a wing expanse of 24-26 mm.

The moth lays eggs on the leaves, twigs and inflorescence stalks. Egg period is 4-7 days.

Newly hatched caterpillar is pale white and feeds on the leaves by webbing. Larva webs inflorescence at the time of flowering and feeds on the floral parts. Apples and nuts are also covered with webs with the caterpillar scraping the upper green layer of tender apples and nuts. It results in cracking of tissue and retardation in nut development. The pest incidence is severe at the time of new flush. The symptoms of damage are

❖ Webbed leaves, inflorescence, apples and nuts

Full grown larva is reddish brown with yellow lateral longitudinal bands and pinkish dorsal lines and measures up to 26 mm in length. Larval period is 16-22 days.

Pupation takes place within the webbed leaves in a silken cocoon. Pupa is dark reddish brown. Pupal period is 9-14 days. Total life history takes 29-43 days.

MANAGEMENT

- Three species of *Apanteles* (Braconidae) were observed during January and February parasitizing the larval population heavily in Guntur district of A. P.
- Spraying of carbaryl 3g/l or monocrotophos 1.6 ml/l or endosulfan 1.4 ml/l after disturbing the webs.

TEA MOSQUITO BUG

Helopeltis antonii
Miridae: Hemiptera

Major pest of cashew in Kerala, Karnataka, Goa, Maharashtra and Tamil Nadu. Besides cashew, it infests grapevine, guava, neem *etc.*

Adult is a reddish brown bug with black head, red thorax and black and white abdomen; a knobbed process arises mid-dorsally on the thorax.

Eggs are inserted into epidermis of tender shoots, axis of inflorescence and nuts. The egg is elongated and slightly curved with a pair of filaments on the operculum projecting out. Egg period is 7 days.

Nymphs and adults feed on petiole, tender shoots and leaf veins causing symptoms like

- ❖ Brownish black necrotic patches on foliage and elongate streaks and patches on shoots
- ❖ Resins exuding from the feeding punctures.

- ❖ Blossom blight and die back symptoms.

There are five nymphal instars with duration of 14.9 days. Life cycle is completed in 22.2 days on an average. Peak infestation occurs during summer months and disappears at the onset of monsoon.

MANAGEMENT

- First spray coinciding with new flush in Oct – Nov with endosulfan 2ml/l
- Second spray during emergence of inflorescence in Dec – Jan with monocrotophos 1.6ml/l or dimethoate 2 ml/l
- If damage still persists another spray at the time of fruit set in Feb with endosulfan 2ml/l

CASHEW THRIPS

Rhipiphorothrips cruentatus-Leaf thrips,
Rhynchothrips raoensis: Flower thrips
Thripidae: Thysanoptera

Incidence is severe in March-May.

Leaf thrips: Both nymphs and adults appear in colonies on the lower side of the leaf. They scrape the leaf surface and suck sap. Affected leaves turn pale green, later to pale brown with dark brown spots. Ultimately the affected leaves shrivel and drop off.

Flower thrips: Incidence is severe during December and January. Both nymphs and adults suck sap from flowers, flower stalks, apples and green nuts. This results in flower and fruit drop and development of scab on apple and green nut.

MANAGEMENT:

- Spraying chlorpyrifos 2.5 ml/l or profenophos 1ml/l.

CASHEW LEAF MINER

Acrocercops syngamma
Gracillariidae: Lepidoptera

This pest regularly occurs at the time of new flush generally during June-July and Jan-Feb. The caterpillar mines into the leaves, as a result the thin epidermal layers of the leaf swells up in the mined area and appears as whitish patches on the leaf surface of tender leaves. In older leaves big holes are formed due to the drying and crumbling of the mined areas. Generally young plants are more affected by this pest.

Spraying of carbaryl 2 g/l or monocrotophos 1.6 ml/l or endosulfan 1.4 ml/l is effective.

PESTS OF POMEGRANATE

POMEGRANATE BUTTERFLY / ANAR BUTTERFLY

Deudorix isocrates
Lycaenidae: Lepidoptera

It is the most important and destructive pest of pomegranate and distributed throughout the country, also infesting guava, annona, apple, ber, citrus, litchi, tamarind, wood apple, soap nut, etc.

Butterfly is bluish brown with an orange spot on each of the forewings and black spots on the hindwings with a tail like extension at the lower margin of hindwings. It is active in bright sun.

Eggs are laid singly on calyx of flowers or tender fruits. Egg period is 7-10 days. Caterpillar is stoutly built dirty brown in colour, with light patches, a few short hairs and measures about 16-20 mm long. Larva after hatching bores into the fruit and feeds on the seeds. Entry hole heals up. The fruit appears healthy but the caterpillar inside feeds on pulp and seeds just below the rind. It is only when the grown up caterpillar comes out, a round hole is seen through which juices come out. A single fruit may harbor half a dozen caterpillars. Feeding injury also cause rotting of the fruits. Up to 50% fruit damage is observed. Larval period is 18-47 days. The conspicuous symptoms are

- ❖ Offensive smell and excreta of caterpillar at the entry hole.
- ❖ The affected fruits ultimately falling down.

The full grown larva comes out, secures the stalk of the fruit to the stem with a silky secretion, returns to inside of fruits and pupates on fruit stalk. Pupal period 7-34 days. Total life cycle takes about 1-2 months. There may be 4 overlapping generations in a year.

MANAGEMENT:

- Destruction of fallen infested fruits checks the spread.
- Removal of flowering weeds especially of Compositae family.
- Though expensive, bagging of fruits with polythene or paper bags or cloth bags soon after the fruit set prevents the pest attack.
- During flowering and flower bud stage, endosulfan 2ml/l is recommended. After 15 – 20 days, spray application of dichlorvos @ 1 ml. /L or carbaryl 3g /l.

THRIPS

Anaphothrips oligochaetus (Flower and fruit thrips)

Rhipiphorothrips cruentatus } Leaf thrips

Scirtothrips dorsalis

Thripidae: Thysanoptera

These are found through out country. *A. oligochaetus* infests flower stalks, sepals, petals and fruits with their rasping sucking type of feeding. As a result, flowers are shed and fruits show scab like rough surface.

R. cruentatus and *S. dorsalis* lacerate the leaves and suck oozing out sap causing curling of leaves.

At flower bud initiation, foliar spray with dimethoate 2ml/l or fipronil 2ml/l is effective.

FRUIT SUCKING MOTHS

Eudocima fullonica

E. materna

Noctuidae: Lepidoptera

Moths pierce the fruits with their proboscis for feeding thus causing injury.

The detailed biology and their management have been furnished under pests of citrus. Fruits show tiny holes from which juices ooze out when pressed. Later fungi and bacteria accelerate rotting.

PESTS OF GUAVA

TEA MOSQUITO BUG

Helopeltis antonii

Miridae: Hemiptera

It is a major insect pest distributed in AP, Kerala, Karnataka, Goa, Maharashtra and TN. This pest causes damage to tea, coffee, guava, cashew, avocado, neem, cacao, cinchona, pepper, tamarind, cinnamon, apple and mahogany. Its identification and life history have been detailed under pests of cashew.

Nymphs and adults pierce the guava fruits of all sizes, tender twigs and leaves for sucking sap. Each tab (probe) on the fruit results in a brownish spot which develops into a raised pustule known as scab (gajji). A bug may tab in about 50 places on a single fruit. On tender fruits, the spots may coalesce and finally crack. Such tender fruits drop down. If the bug pierces into the twig, black, linear scars will form. If tender leaves are pierced there may be small reddish streaks and will curl up. Thus symptoms on various plant parts vary

- ❖ Scab on fruit surface
- ❖ Black linear scars on twigs
- ❖ Reddish streaks on leaves

MANAGEMENT:

- Nymphs are parasitized by the mermithid, *Agamermis paradecaudata*
- Application of recommended dose of fertilizers.
- Spray application of endosulfan 2ml/l or monocrotophos 1.6ml/l or dimethoate 2ml/l at fortnightly interval during the fruit development will manage the pest.

GUAVA MEALY BUG

Ferrisia virgata

Pseudococcidae: Hemiptera

It is otherwise called white tailed mealy bug /striped mealy bug. It is a widely distributed species in tropical and subtropical countries. It also infests bhendi,

amaranthus, coccinia, colocasia, lab lab, tomato, brinjal, cashew, anona, guava, amla, grape, tobacco, pepper, cotton, betelvine

Female bug is apterous with two long prominent waxy filaments at the posterior end and a number of waxy hairs over the body covered with waxy powder. In the posterior end of the body, the dorsum has a prominent blackish patch. It has the habit of encircling itself by secreting thin glassy threads of wax specially when its population is less. Reproduction takes place both sexually and parthenogenitically, the latter being more common. Mating takes place only once and lasts for about 12-23 minutes.

The female lays the eggs in groups which lie under its body. Fecundity ranges from 109 to 185 during oviposition period of 20-29 days. Incubation period is about 3-4 hours

Nymphs and adults remain clustering upon the terminal shoots, leaves and fruits and suck the sap which results in

- ❖ Yellowing, withering and drying of plants or shedding of fruits *etc.*
- ❖ Formation of sooty mould due to honey dew excretion.

In dry weather they may move down below ground and inhabit the roots.

Male and female nymphs moult 3 - 4 times respectively and their development period varies from 26 to 47 and 31 to 57 days. Longevity of female is 36-53 days and that of male is only 1-3 days.

MANAGEMENT:

- Pruning and destruction of the infested twigs.
- The branches that are touching the ground to be cut and destroyed
- Periodical raking of basins and application of balanced dose of fertilizers especially N.
- Arranging the polythene sheet around the stem.
- Predators *Chrysoperla carnea*, *Cryptolaemus montrouzieri*, *Pullus* sp. suppress the natural population.
- Spray dichlorvos 1.0 ml/l or acephate 1.5 g/l.

FRUIT FLY

Bactrocera dorsalis, *B. diversus*, *B. zonatus*, *B. cucurbitae*
Tephritidae: Diptera

Pest is seen all over the country. It is a pest of several fruits such as mango, guava, brinjal, chillies, loquat, apricot, plum, peach, cherry, chiku, ber, citrus *etc.* Of many species *Bactrocera*, *B. dorsalis* is the most common causes considerable loss to fruit yield. Fly lays the eggs on developing fruits. Maggots enter into the fruit and feed on the pulp. The damage leads to the formation of soft patches on the fruit and premature drop of fruits. The mature maggots come out of the fruit and fall to the ground and pupate in soil. Premature fruit drop, fruits with exit holes and soft patches are the symptoms of damage.

Collection and destruction of fruits, periodical raking of the plant basins, Incorporation of carbaryl 10D @ 50-100 g / tree manages the pupa. Poison baiting with a mixture of molasses / sugar @ 200 g and malathion 50 ml in 2litres of water kept in small earthen pots in the field attracts and kills the adults.

SPIRALLING WHITE FLY

Aleurodicus dispersus

Aleurodidae: Hemiptera

The pest is a native of America and distributed all over the world. In India this pest is mostly distributed in Kerala, Karnataka, Tamil Nadu and Andhra Pradesh. It has many cultivated and wild hosts. The host plants include trees Guava, papaya, banana, flower plants, forest trees and weeds. The pest mostly attacks old leaves during November and during April attacks tender leaves. Peak activity of pest is seen during the month of February. Adult spiralling whitefly is bigger than the other aleurodids. Eggs are laid in groups of 15-25 on the undersurface of the leaf in circular fashion, hence spiralling whitefly. Fecundity is 200 eggs. Nymphs are covered with white cottony mass and suck sap from leaves. The leaves crinkle and turn to red colour. The honeydew excretion leads to formation of sooty mould that hinders the photosynthetic activity. The vigour of the plant and fruit yields are reduced.

- Timely pruning of plants and balanced nutrition.
- *Aphelinid*, *Encarsia sp.* Are the most important in reducing the population. *Cryptolaemus montrouzieri* and *Mallada sp.* are the other natural enemies associated with this pest.
- Arranging yellow sticky traps in the gardens especially during night times for the flying adults
- Spray application of neem oil 0.5 ml /l or neem based product also reduce the damage.

PESTS OF SAPOTA

SAPOTA LEAF WEBBER

Nephoteryx eugraphella

Phycitidae (Pyralidae): Lepidoptera

This is a major pest of Sapota occurring throughout India. It also infests sapota, cured tobacco and *Mimusops elengi*. This pest is serious from July to November.

Moth is grey in colour. Female lays pale yellowish oval eggs singly or in groups of 2-3 on leaves. The number of eggs laid by a female varies considerably, the maximum being 226 in seven days. Eggs hatch in 2-5 days.

Pinkish caterpillar is with closely set longitudinal lines on dorsum. The larva constructs a tunnel of webs and frass and feed on the green matter of the tender

leaves. They also feed on buds, young shoot and tender fruits. Larval period lasts 17-32 days

- ❖ The infested trees show numerous webbed shoots, dry leaf clusters and dark brown patches on the leaves.

Pupation takes place in the leaf web itself and the pupal period is 7-11 days. The total life cycle may take about 32-45 days.

MANAGEMENT

- Collection and destruction of leaf webs with caterpillars
- Clean cultivation
- Spray application of chlorpyrifos 2 ml/l or endosulfan 2 ml/l or monocrotophos 1.6 ml/l or carbaryl 3 g/l is effective.

PARIJATHA HAIRY CATERPILLAR

Metanastria hyrtaca

Lasiocampidae: Lepidoptera

Stout greyish brown female moth is bigger than the males. Males have a white spot in the centre of a black patch on forewing. Eggs are laid in rows or group. Egg period is 9-12 days. Caterpillar is 6.5 cm long, stout with greyish hairs on the body, black head and median dorsal brownish band extending to second abdominal segment. Larval period is 45-60 days. It pupates on tree trunks in a cocoon made up of silk and body hairs. The caterpillar feeds voraciously on leaves.

Hand picking and destruction of larvae, burning the larvae with torches when they are found in groups on tree trunks and spray application of carbaryl 3 g/l or dichlorvos 1ml/l are effective during early stages.

MEALY BUG

Planococcus lilacinus and *P. citri*

Pseudococcidae: Hemiptera

Different mealy bugs cause damage to sapota. The pink coloured adults and nymphs are covered by white waxy outgrowth. Both nymphs and adults suck sap from leaves, twigs, flower buds. Flower curling and twisting of leaves is observed. Growth of the plant is affected when the shoot terminals are infested. They excrete honey dew that leads to the formation of sooty mould which affects market value. The following measures are recommended for its management.

- Pruning and destroying the affected twigs
- Maintenance of sanitation in the orchard.
- Frequent raking of plant basins and incorporation of dust formulation of endosulfan or methyl parathion in to soil.
- Releasing predators like *Chrysoperla carnea* and *Cryptolaemus montrouzieri*

- Arranging the polythene sheet around the stem
- Spraying with systemic insecticides, dichlorvos 1 ml/l or acephate 1.5 g/l

PESTS OF BER

BER FRUIT FLY

Carpomyia vesuviana

Tephritidae: Diptera

It is the most important pest of ber and has countrywide distribution. Up to 77% damage to fruits is reported from A.P.

Adult is a small black spotted fly with banded wings. Two to three generations are completed from November to April.

Eggs are laid in cavities made on the fruit with the ovipositor. Oviposition punctures made by the flies on the fruits give them rough appearance. The punctures appear as black spots in depression later on. Up to 22 eggs are laid by a female either singly or in groups of 2-4. Incubation period is 2-3 days. As many as 18 maggots may infest a single fruit.

Maggots are white tapering anteriorly. Larval period is 7-10 days. Maggots bore into the pulp forming reddish brown galleries. The damage results in

- ❖ The attacked fruits rotting and turning dark brown and smelling offensively.

The full grown maggot falls to ground to pupate in soil 5 to 7.5 cm deep for periods varying from 14 to 300 days depending upon the climate.

MANAGEMENT:

- Removal and destruction of infested fruits.
- Ploughing and continual raking of soil under the trees during summer months.
- Spray contact insecticides like carbaryl 3g/l or endosulfan 2ml/l at triweekly intervals.
- Soil application of endosulfan 4D kills maggots and pupae

BER FRUIT BORER

Meridarchis scyrodes

Carposinidae: Lepidoptera

It is distributed all over the country. Adult is a small dark brown moth. Eggs are laid on young fruits. Larvae are reddish. The larva bores into the fruit feeding on the pulp and accumulating faecal frass within. Up to 40% of the fruits are damaged during July and August. Pupation takes place in the soil.

MANAGEMENT:

- Collection and destruction of affected fruits
- Raking up of soil in tree basins in summer
- Spraying 2 – 3 times at 10 day interval from pea sized fruit stage with endosulfan 2ml/l or monocrotophos 1.6ml/l or polytrin 1ml/l

BER FRUIT WEEVIL

Aubeus himalayanus

Curculionidae: Coleoptera

Grub feeds on the seed and adult feeds on the fruit. The fruit loses its shape. Fruits become round and fruit stalk bulges. The adult also sometimes feed on the seed and comes out of the fruit.

MANAGEMENT:

Spray application of monocrotophos 1.6 ml/l or fenvalerate 1ml/l or deltamethrin 2 ml/l at 10-15 day interval from maturity of fruit till harvest.

PESTS OF BANANA

BANANA RHIZOME WEEVIL

Cosmopolites sordidus
Curculionidae: Coleoptera

It is distributed throughout India and is a serious pest of banana. This pest is also recorded on cacao. Adult is medium sized, 10-13 mm long, stout, brown initially but turns almost black after a few days. Longitudinal ridges are seen on elytra and abdomen is not covered fully. The adults also tunnel within the stem feeding on internal tissues during night.

White elongated oval eggs are laid singly in small pits made in the pseudo stem near ground level. They are elongate, oval, white and measure about 2-3 mm long. Eggs hatch in 5-8 days.

Grub is dwarf, stumpy, legless creamy white with a red head and wrinkled body. The grubs tunnel the rhizome, which is roughly circular and increases in size with the growth of the grubs. The rhizome becomes riddled with tunnels. The leaves turn yellow and dry. The tissue at the edge of the tunnel turns brown and rots. The grub also bores into the pseudo stem even up to 2-3' up. Due to the damage, the banana plants may break down when there is strong wind.

- ❖ Blackened mass of rotten tissue in which case the grub deserts the rhizome.
- ❖ The plants may show premature withering, the leaves become scarce, and the fruits become under sized.
- ❖ Very few suckers emerge from the affected plant.

Larval period 14-21 days. Pupa takes place in an oval chamber prepared just beneath the surface of the sucker. The pupal period is 5-6 days.

MANAGEMENT:

- Obtaining suckers from healthy fields for planting.
- Clean cultivation and sanitation in the orchard.
- Dipping the suckers in methyl demeton 0.1% solution before planting
- Avoiding ratooning and changing the field every year.
- Dusting the pits with carbaryl 10D 50g/ pit or 250 g neem cake/ pit before planting.
- Uprooting and destroying the affected pseudo stem and rhizome in which grubs are present.
- Applying contact insecticide during July - September at fortnightly intervals to prevent attack.
- Give temporary support to the plant.
- Application of phorate 10 G 10 g/ plant
- Spraying the pseudostem and drenching around the base of the tree with chlorpyrifos 2ml /l and after a week spraying and drenching with malathion 2 ml/ l

BANANA SKIPPER

Erionata thrax,

Hesperiidae: Lepidoptera.

Larva rolls the leaves from the edges by cutting the leaf lamina. The plant vigour is reduced as the photosynthetic area decreases.

Cutting and destroying the rolled leaves along with the larva, foliar spray with endosulfan 2 ml/l or carbaryl 3 g/l are effective measures.

BANANA APHID

Pentalonia nigronervosa

Aphididae: Hemiptera.

Adult aphid is brownish with black veins on the wings. It lives in colonies within the leaf axils or tender leaves or at the base of the culm. A single female produces 35-50 nymphs during its life span of 27-37 days. There are four instars and each instar is completed in 2-3 days. 30-40 overlapping generations are seen in a year. High humidity and moderate temperature are conducive for the population increase.

The nymphs and adults suck sap from the plant parts and in case of severe infestation progressive leaf dwarfing, leaf curling is seen. Fruit bunches become small and the fruits are distorted. These aphids also act as persistent vectors of Bunchy top of banana.

Musa AAB variety of banana is resistant to aphids and thus resistant to Bunchy top. Spray application of methyl demeton 2 ml/ l or dimethoate 2 ml/l or monocrotophos 1.6 ml/ l is effective.

BANANA PSEUDO STEM WEEVIL

Odoiporus longicollis

Curculionidae: Coleoptera

It is a serious pest of banana in North East India. Weevil is a robust reddish brown and black weevil. Adult feeds on tissues of leaf sheath from its inner surface and also on decaying tissues. Eggs are thrust singly in to the leaf sheath through oviposition slits made by rostrum. Egg period is 3-5 days in summer and 5-8 days in winter. The larva bores into the pseudostem making tunnels within and cutting holes on the outer surface. The tunnelled part decomposes and pseudostem becomes weak and easily breaks in wind. Grub is apodous, has five larval instars. Larval period is 26 to 68 days in summer and winter, respectively. Pupation occurs in stem tunnel and pupal period is 20-29 days in summer and 37-44 days in winter.

Field sanitation, uprooting and burning infested plants, foliar spray with chlorpyrifos 2.5 ml/l two to three times at three weekly intervals, injection of dichlorvos 1ml/l into the bore hole are effective measures.

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.

CODLING MOTH

Cydia pomonella
Tortricidae: Lepidoptera

The pest is distributed all over the world. Native of America and was introduced to India. It causes damages pear, peach, walnut and quince.

Adult is a small moth, greyish with chocolate brown patches near the tip of the forewings. Up to 100 eggs are laid on foliage and fruits. Eggs hatch in 4-12 days.

Caterpillar is pinkish, feeds on the leaves and then bores into fruits. Tunnels are filled with excreta. The holes are conspicuous. The infested fruits mature earlier and can be identified by their brighter colour and entry holes. The larva becomes full grown in 4-5 weeks.

The full grown larva comes out of the fruit and pupates under loose bark or on dried leaves. Pupal period lasts for 8-15 days. The third brood larva overwinters under loose bark of the host plant.

MANAGEMENT:

- Periodical removal of weeds and the debris.
- The loose bark from old trees promptly removed to prevent the hibernation of the larva.
- Collecting and destroying the fallen fruits along with the larva
- The hibernating larva collected twice or thrice and destroyed.
- Enforcing strict quarantine rules to prevent the spread of this pest.
- Indian house sparrow, *Passer domesticus indicus* is predaceous on the overwintering larva.
- *Paralitomastix varicornis* parasitizes the larva.
- Spray application of good contact insecticides up to fruit maturity.

PESTS OF CUSTARD APPLE

MEALYBUG

Ferrisia virgata

Pseudococcidae: Hemiptera

Mealy bugs are a major pest on custard apple. The life history, damage and management of *Ferrisia virgata* have been detailed under pests of guava.

PESTS OF COCONUT

COCONUT BLACK HEADED CATERPILLAR

Opisina arenosella

Cryptophasidae: Lepidoptera

It is the most important lepidopterous pests of coconut in India and Sri Lanka. It occurs more commonly along the west and east coast regions. It has been observed infesting coconut in some inland regions of Karnataka and Tamil Nadu also.

Adult is a greyish white moth measuring 10-15 mm long and 20-25 mm in wing span across outstretched wings.

The moth is straw to ash grey in colour, medium sized with uniform pale whitish upper wings. The female moth lays about 130 creamy white scale like eggs in batches along the underside of the leaflet generally near the old larval galleries. Eggs hatch in about 4-5 days.

Caterpillar is light green with red brown stripes and black head, feed gregariously on the surface tissues of the leaflets scraped out from their lower surface. The leaflets are reduced to papery tissues. The larva constructs a gallery of silk and frass and lives and feeds under it. The attacked leaflets turn brown in colour and dry up. The production of nuts gets adversely affected as photosynthetic activity of the palm is much reduced. The fronds become unsuitable for thatching and other purposes. The damage is more during hot months (April-June) and less during rainy season. The

- ❖ Folded leaflets with silken galleries and frass
- ❖ Large scale drying of leaflets
- ❖ In case of severe attack the whole plantation presenting a burnt up appearance from a distance.

The grown up larva is about 15 mm long. Larval period lasts for about 40 days. The larva pupates inside the gallery. Adult emerges after 12-14 days. Total life history occupies about 45-60 days.

MANAGEMENT:

Due to hidden nature of the caterpillars and height of the plants chemical control measures are often inadequate.

- Clipping and destroying the infested portions.
- A host of parasites attack different stages of the pest. For obtaining effective control, schedule release of a combination of these parasites should be adopted four times depending on the stage of the pest.
 - 1st release immediately when the infestation is observed.
 - 2nd – a fortnight after the first
 - 3rd – a month after the second
 - 4th – a fortnight after the third

These parasites are mass multiplied on suitable alternate hosts at four parasite breeding stations located in the important coconut growing areas of A.P.viz., Sompeta

(Srikakulam), Rajole and Ambajipet (East Godavari) and Narsapur (West Godavari) .

The parasites and their hosts are listed below

Egg parasite	<i>Trichogramma chilonis</i>
Early larval	<i>Cotesia taragamae</i>
Mid larval	<i>Bracon brevicornis</i>
Late larval	<i>Goniozus nephantidis</i>
Pre pupal	<i>Elamus nephantidis</i>
Pupal	<i>Stomatoceros sulcatiscutellum</i> <i>Trichospilus pupivora</i> <i>Brachymeria nephantidis</i> <i>Tetrastichus israeli</i>

- Bacteria like *Serratia marcescens* and *Bacillus thuringiensis* cause disease in larvae.
- Predatory carabid beetle *Parena laticincta*
- Root feeding technique: A dark brown coloured root is selected for root administration of monocrotophos to the trees. The root is given a slant cut. The cut end of the root is kept in polythene bag containing 10 ml of monocrotophos mixed in 10 ml of water for plants having 15 feet height. Allow the root to absorb the chemical for 24-48 hours. If the root does not absorb the chemical change the root.

Note: Before administering the chemical the mature nuts should be harvested. After root administration there should be a gap of at least 45 days for harvest of nuts.

RHINOCEROS BEETLE

Oryctes rhinoceros

Scarabaeidae: Coleoptera

It has a wide distribution in Asia, Australia and Pacific Islands and is reported from all regions where coconut is grown. It also attacks coconut, oil palm, date palm, sugarcane, banana, sisal, pineapple, papaya etc.

Adult is a stout beetle measuring 35-50 mm in length, shiny and black above and reddish brown and hairy ventrally. On the face, beetle has a pointed horn and hence the name, rhinoceros beetle. The cephalic horn is longer in males than in females. Adult lives for more than 200 days under favourable conditions. Beetles are attracted to light.

The beetle injures the trees by boring into the central shoots, spathes and petioles. The boring beetle chews the internal tissues and after ingesting the juicy part throws out the fibrous part which is indicative of the presence of the beetle in the crowns. The injury by the beetle is clearly.

- ❖ A series of holes on the fronds when leaf opens out and fan like cutting
- ❖ Typical 'V' shaped clipping/ cuts on mature leaves, in partly damaged crowns
- ❖ Death of the central growing primordium of both young and old plants in severe attack
- ❖ Damaged palms often becoming infected by fungal rots.

The damage caused by the beetle is more serious in young trees. The beetle breeds in decaying organic substances. White oval eggs are laid singly in rotting plant

material, especially dead palm trunks, compost heaps and rubbish dumps. A single female lays up to 140-150 eggs which hatch in 8-18 days.

Grub feeds on decaying organic matter. Full grown grub is 9-10 cm long, stout, fleshy, dirty white, curved (C- shaped) with brownish head. Tail end dark, body segments wrinkled. Larval period lasts for 99-182 days.

The mature larva first turns into a prepupa, before becoming a pupa proper. The pupation takes place in a pupal chamber in the soil or rotting plant material. Pupal period is about 10-25 days, but the adult beetle may not emerge from the cocoon immediately and the maturation period is spent within the pupal cocoon. Egg laying starts 10-60 days after emergence. Total life cycle takes about 6-12 months.

MANAGEMENT

- Periodical examination of the breeding places and destruction of eggs, grubs and pupae by raking and turning up of the manure pits.
- Treating breeding places with carbaryl 50 WP 3g/l or carbaryl c10D atleast once in three months *i.e.* January, April, July, August.
- Crownless trees and dead trees should be cut and dried to avoid breeding of the pest.
- Extraction of the beetle with a barbed iron hook or wire and filling up the holes with sand + lindane dust in equal proportions to prevent further attack or filling up holes with sevidol 8G 25g.
- Providing poisoned breeding traps made out of rotting mustard or castor cake or dung mixed with lindane to attract and kill beetles.
- The histerid beetle, *Santalus parallelus* is predaceous on the eggs and all stages of the grub while its grub is predaceous on the egg and first instar grub *Agrypnus sp.* predate on the grubs.
- The green muscardine fungus *Metarrhizium anisopliae* infects all stages except eggs.
- The bacteria *Serratia marcescens*, and *Pseudomonas sp.* attack the third instar grubs.
- Nematode, DD 136 or *Neoplectana carpocapsae* and the associated bacterium *Achromobacter nematophilus* parasitize the grub.
- Release of Baculovirus infected adults.

RED PALM WEEVIL

Rhynchophorus ferrugineus
Curculionidae: Coleoptera

It is distributed in Pakistan, India, Sri Lanka, S.E. Asia to China, Taiwan and the Solomon islands. In India it occurs in all coconut growing tracts. It also infests oil palm, date, sago and other species of Palmae

Adult is a brown weevil about 35 mm long. It has six dark spots on thorax and in the males the long snout has a tuft of hairs. The female weevil commences oviposition

1-7 days after pairing and continues it for 25-63 days. Fecundity is 276 eggs. Eggs are laid in small holes scooped out by the weevil on the soft regions of young palms of up to 7 years age, in the grown up trees the eggs are laid only in the cuts or wounds which may be present on the stem or leaf stalk. The plant sap oozing out of the wounds and cuts attract the weevil for oviposition. It prefers to oviposit in the exposed plant tissues. The infestation by rhinoceros beetle or crown rot or leaf rot diseases also attracts the weevil for egg laying and for crown infestation. The creamy white egg hatches in 2-5 days.

Grub tunnels inside and lives in any part of young palms but prefers to concentrate at or near the growing points in trees older than 5 years. A trunk may harbour 40-45 grubs. The grub feeds within the stem tissues in large numbers making tunnels. The grubs hatched from the eggs laid in crown enter in to the growing point of the crown and cause damage.

The symptoms of damage become clear at an advanced stage of infestation as follows

- ❖ Yellowing and wilting leaves of inner and middle whorls.
- ❖ Presence of circular holes on the stem with brownish black viscous fluid oozing out from the holes
- ❖ Longitudinal splitting of leaf bases and presence of cocoons or adult weevil or chewed up fibres in leaf axis or at the base of the palm.
- ❖ The sound of feeding by the grub can be heard by keeping the ear on the trunk of the tree.

Larval period ranges from 36-78 days. The full grown grub is stout, fleshy, apodous, constructs an oval cocoon with the fibres of the internal tissues and pupates within it for a period of 12-33 days. The adult female lives for 76 days and the male for 133 days.

The weevil multiplies enormously in young coconut plantations, especially in those close to the forest areas and the damage is to the extent of 5-10 % in young plantations of 5-20 years age.

MANAGEMENT:

- Disposal of felled trunks, tree stumps, dying and dead palms, dead plants due to lightning or bud rot
- Avoiding wounds, mechanical injuries and stripping of leaves
- Avoiding damage to roots and stem during cultural operation.
- Removal of rhinoceros beetle from the hole using an arrow headed rod and filling the hole with neem cake 100 g + 150 g sand to prevent weevil attack on young plants.
- Arranging bucket traps (Pheromone traps) at 1-1.5 m height on tree trunk to attract the pest and the weevils collected in the buckets destroyed or killed using poison baiting.
- The affected plant parts scraped off and swabbed with coal tar or Japan black.
- Release of sterile males to compete with the normal males to reduce the progeny.

- Chistling out the affected portions and filling with concrete mixture so that the plant can withstand strong winds.
- Earwig, *Cheliosoches moris* feeds on eggs and grubs
- Root feeding with monocrotophos 10 ml mixed with water 10 ml. (Do not harvest the nuts for the next 45 days).

SLUG CATERPILLARS

Contheyla rotunda

Macroplectra nararia

Latoia lepida

Limacodidae: Lepidoptera

It is a sporadic pest. *C. rotunda* is common in west coast, while *M. nararia* is common in Godavari district. Mango, castor, cashew, pomegranate are other hosts. The caterpillar feeds on leaves, buds, flower shoots and developing fruits.

Caterpillar is fleshy, slug like with series of tufts of spines highly irritating to touch, hence called “nettle grub”. Pupation takes place in hard shell like grayish cocoon

MANAGEMENT:

- Clipping the affected leaves along with the larvae.
- Natural parasitisation occurs with larval and pupal parasites.
- Bacterial and fungal infections on larvae and pupae are common in rainy season.
- Spray application of carbaryl 3 g/l or root feeding with monocrotophos is effective.

TERMITE

Odontotermes obesus

Termitidae: Isoptera

Termites damage the seedlings in the nursery and transplanted seedlings. Wilting of central shoot is a symptom of the attack. Up to 20% of the seedlings are destroyed by the termites in the laterite soils. Base of trunk is seen plastered with runways made of soil and fibre.

Locating termite mounds in or near the coconut nursery or garden, digging out the termitarium and destroying the queen, drenching the soil with chlorpyrifos 10 ml/l of water are effective measures.

COCONUT SCALE

Aspidiotus destructor

Diaspididae: Hemiptera

Large number of scales sucks sap from undersurface of leaflets which turn yellowish, finally wither and dry up, thus reducing vitality of plant

Root feeding with monocrotophos after harvest of nuts, spraying with carbaryl 3g/l or dimethoate 2ml/l are effective.

COCONUT ERIOPHYID MITE

Eriophyes guerreronis

Eriophyidae: Acarina

It became a threat to coconut in south India causing economic losses. The microscopic wormlike eriophyid mites are seen in thousands under inner bracts of the perianth. They also feed in colonies on lower leaf surface causing yellow speckling and chlorosis.

- ❖ Triangular pale or yellow patches close to perianth initially at the level of perianth which turn into brown patches with longitudinal fissures and splits on the husk (warting)
- ❖ Shedding of buttons
- ❖ Oozing of the gummy exudation from the affected surface.
- ❖ Reduced nut size and copra content.
- ❖ Malformed nuts with cracks and hardened husk.

MANAGEMENT:

- Application of urea 1.3 kg., super phosphate 2.0 kg and murate of potash 3.5 kg./ palm / year.
- Application of neem cake 5 kg and organic manure 50 kg / palm / year.
- Grow intercrops, banana, cacao, turmeric, vegetables in rich soils and shelter belt with casuarina all around the coconut garden to minimize the pest.
- Spraying twice at weekly interval on buttons and developing nuts on bunches with wettable sulphur 6g/l or prophano[phos 5ml/l or methyl demeton 6ml/l or triazophos 5ml/l
- Spraying azadirachtin 10000 ppm 5ml/l on fruit bunches or root feeding thrice a year with azadirachtin 10000ppm 10ml + 10 ml of water /tree.

PESTS OF TOBACCO

TOBACCO CATERPILLAR

Spodoptera litura

Noctuidae: Lepidoptera

It is found through out the tropical and sub tropical parts of the world, widespread in India. Besides tobacco, it infests 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. Hindwings 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, covered over by brown hairs. 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.

- ❖ Irregular holes on leaves initially and later skeletonisation of leaves
- ❖ Heavy defoliation, leaving veins and petioles

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.
- Setting up of pheromone traps @ 12/ha for monitoring the pest.
- 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 or acephate 1.5g/l.
- Baiting with rice bran 12kg + jaggery 2.5kg+carbaryl 50WP1kg in 7.5lt water/ha during evening hours to bait and kill the caterpillars

TOBACCO APHIDS

Myzus persicae

Aphididae: Hemiptera

It is highly polyphagous infesting tobacco, cabbage, chilli, brinjal, radish, potato, tomato, tobacco, mustard, sweet potato, *Hibiscus*, sunnhemp etc.

Adult aphid is small to medium sized about 1.25 to 2.5 mm long, usually green with a darker thorax. Antennae 2/3 as long as body. Siphunculi clavate, fairly long. They reproduce both sexually and parthenogenetically, the latter is more common.

Nymph undergoes 4-5 instars taking 4-7 days for apterous and 5-8 days for alate forms. Apterous adults produce 5 to 92 young ones / female while the alate forms produce 8 to 49 nymphs. More young ones are produced during mid winter (Jan-Feb). Longevity of adults is 15 to 27 days for alate and 10 to 25 days for apterous forms. Survival is least during late winter.

Aphids infest the crop late in the season. Both nymphs and adults feed on leaves and shoots in large numbers suck sap and devitalize the plant which results in

- ❖ Sickly appearance of plants
- ❖ Leaves curling up and fading and unfit for curing
- ❖ Sooty mould develops on honeydew excreted.
- ❖ Tobacco ring spot virus and Rosette virus disease are transmitted by this vector species

MANAGEMENT:

- Natural enemy, *Praon myzophagum* parasitizes the aphid.
- Spraying neem oil 2% or NSKE 5%
- Spray phosphamidon 2 ml/l, methyl demeton 2ml/l, Malathion 2 ml/l, Dimethoate 2ml/l, acephate 1.5g/l

WHITEFLY

Bemisia tabaci

Aleurodidae: Hemiptera

The pest is generally seen as white minute specks of flies on the underside of the leaf. It attacks both nursery and main field.

Breedings take place often parthenogenetically. The female lays up to 120 eggs. Egg period lasts for 3-5 days. Nymphal duration is 9-14 days. About 10-12 generations are completed in a year.

Nymphs and adults suck sap from leaves and devitalize the plant. It transmits the leaf curl virus disease.

- ❖ The leaves are twisted, puckered and thickened with prominent veins.
- ❖ Stunted growth and reduced yield considerably
- ❖ Sooty mould on the leaves due to honeydew excretion.

MANAGEMENT

- Removal and destruction of alternate hosts.
- Avoiding leaf curl infected tobacco seedlings for transplantations.
- Removal of leaf curl infested plants.
- Avoiding growing brinjal and sunflower in the vicinity.
- Setting up of yellow sticky traps coated with castor oil @ 12 traps / ha.
- Spray application of NSKE 5%
- Foliar spray with acephate 1.5 g and other systemic insecticides

TOBACCO STEM BORER

Scrobipalpa heliopa

Gelechiidae: Lepidoptera

Caterpillar mines into the leaf axil and then into stem. Bored stem becomes hollow, swollen and forms a gall. Destroying crop residues and monitoring the pest in nurseries are recommended.

PESTS OF COFFEE

COFFEE WHITE BORER

Xylotrechus quadripes
Cerambycidae: Coleoptera

It is the most important pest of coffee in India. Pest activity is seen from April to May. Adult is dark brown longicorn beetle having several white markings on the elytra and thorax. It measures about 8 mm. in length. They are active in bright weather and heavy rains are not suitable for egg laying.

Eggs are laid during October and November in small groups in cracks on the stem, crevices of the bark. Egg period is 8-10 days.

The grub bores into the bark and tunnels in all directions within the stem feeding on the internal tissues. The stems and branches are killed. Young bushes are more affected and older plants lose their vigour and yielding capacity. In neglected gardens, the impact is more. Damage leads to

- ❖ Presence of ridges on the stem
- ❖ Yellowing of leaves and wilting of branches

Full grown grub is 1.8 cm. in length, pale yellow in colour, stout and swollen towards the head. Larval period is 8-9 months

The larva pupates within the stem tunnel after making an exit hole. Pupal period is 25-30 days. There is one generation per year.

MANAGEMENT:

- Hand collection and destruction of the adults.
- Arranging the shade mainly April-May and October-December.
- Removing the loose bark once in every two years during April-May to reduce the egg laying.
- The wilting branches and bushes removed and destroyed.
- The grubs are parasitized by *Metapelma sp.* and *Campyloneurus sp.*
- The stems swabbed with lindane 7 ml/l at monthly interval during April-May and Oct - Dec.
- Find out the holes on the stem and plug them with cotton dipped in lindane solution.

COFFEE RED BORER

Zeuzera coffeae
Zeuzeridae: Lepidoptera

The orange red smooth caterpillar with black head, prothorax and anal shield bores into the main stem and tender branches causing wilting of branches or plants. Bore holes plugged with excreta are seen at the base of infested plant

Removal and destruction of affected branches and plants are recommended.

COFFEE GREEN SCALE

Coccus viridis
Coccidae: Hemiptera.

Green colored flat soft scale is an important pest of coffee in all the coffee growing regions. It infests the leaves and tender shoots. On leaves they are present on the undersurface. Tender branches and developing berries are also attacked. The infested plants are seen covered with sooty mould. Berries and leaves are discoloured and malformed and drop. Whole plant becomes weak.

For the destruction of hills dust formulations of quinalphos 1.5D / methyl parathion 2D / malathion 5D should be incorporated in the basins. This will encourage natural enemies of scales.

Spray application of quinalphos 120 ml or malathion 200 ml or fenitrothion 100ml in 200 litres of water on coffee and on fence against scales.

PESTS OF TEA

TEA MOSQUITO BUG

Helopeltis theivora
Miridae: Hemiptera

It is distributed in India, Sri Lanka, Vietnam and Indonesia. *H. antonii* is predominant in South India whereas *H. theivora* is common in Eastern India. It also infests guava, grapevine, cashew, mahagony, neem, cacao, cinchona, pepper, tamarind, cinnamom, apple etc.

The female bug is orange across shoulders and the male is almost black. Soon after emergence, the adults mate and the female lays 500 elongated sausage – shaped eggs within two days inserting in the tender shoots in groups of two or more and hairs from each egg project outside. The incubation period is 5-27 days.

The nymphs and adults suck sap from tender buds, leaves and stem. While feeding, the toxic saliva is injected causing

- ❖ Brownish patches and curling of leaves.
- ❖ Ultimate drying of shoots

Nymphs complete their development in about two weeks after passing through five moults. The life-cycle is completed in about a month and in a single year there may be several generations. Adults pass the winter under hibernation

MANAGEMENT:

- Collection of nymphs and adults with hand nets early in the morning or in the evening and destroying them.
- Spraying the bushes with malathion 200 ml or endosulfan 400 ml in 200 litres of water per acre.

THRIPS

Taeniothrips setiventris
Scirtothrips dorsalis
Thripidae: Thysanoptera

This is a major pest in the Assam Hills. The adult is a yellowish-brown in colour with dark-brown abdomen.

Nymphs and adults live and feed inside the buds and the young leaves. The infested leaves become deformed and curled up and the shoots stunted. Pruned tea is the worst affected.

Scirtothrips dorsalis, commonly occurs in the plains of North-East India. The damage is similar to that caused by *T. setiventris*. The life-cycle takes 13-18 days to complete during various months of the year; the peak period of incidence is in May.

Spraying the bushes with malathion 200 ml or endosulfan 400 ml in 200 litres of water per acre is recommended.

TEA MITES

Red spider mite: *Oligonychus coffeae*, Tetranychidae

Purple mite: *Calacarus carinatus*, Eriophyidae

Pink mite: *Acaphylla theae*, Eriophyidae

Scarlet mite: *Brevipalpus australis*, Tenuipalpidae

O. coffeae is brick red in colour and roundish. The mite lives in colonies in a thin web on the upper surface of mature leaf and the damaged portion turns brown. The leaf becomes bronze, dry and crumpled in case of severe attack even young leaves may be affected. Apart from tea, it also infests coffee.

C. carinatus is widespread and severely infested fields present a bronze or coppery brown or smokey discoloration of leaves. The mite is dark purple to pink in colour with characteristic white ridges running along back. It infests mostly the undersurface of mature leaves especially along the leaf margins and occasionally the upper surface and young leaves.

A. theae is the most serious pest of tea on the Anamalais as it attacks the flush. The mite is minute, not visible to naked eye, buff coloured and carrot shaped or top shaped. In the initial stages of attacks the leaf blade curls upwards and this is followed by crinkling of the leaf. The attacked leaf surface is thick and leathery whereas the under surface of leaf is glossy buff or brown in colour. It also infests coffee.

B. australis is orange red flattened obovate mite infests undersurface of mature leaves near petiole and along the margin. Infested leaves turn brownish. It also infests tea besides many other plants.

Sulphur is not recommended as it taints tea.

- Chemicals like ethion 1 ml/l, dicofol 5 ml/l, phosalone 2ml/l are effective against tea mites.
- The EPA tolerance level is 8 PPM in or on dried tea for phosalone.

PESTS OF TURMERIC AND GINGER

RHIZOME FLY

Mimegralla coeruleifrons

Micropezidae: Diptera

It is reported from Andhra Pradesh, Kerala and Maharashtra. It also infests ginger. Flies are noticed in the field during August - September. Adult flies are dark blackish. Wings are transparent with three light ashy bands. Tarsi of forelegs are white in colour

The whitish eggs are laid on the lower surface of leaves or in soil in the vicinity of plants or on exposed rhizomes. Egg period is 4 days.

Maggot is creamy white, apodous and 9 mm long. In the beginning the maggots bore into the shoot causing dead hearts. Finally they reach rhizomes and feed on them. In association with *Pythium* they cause rotting of the rhizomes. The symptoms include

- ❖ Dead hearts due to primary injury
- ❖ Wilting and drying of aerial plants
- ❖ Rotting of rhizomes due to invasion of fungus, *Pythium* sp. through feeding injuries caused by the maggot.

The larval period is completed in 17 days and pupation takes place in tunneled rhizomes or soil. Adult fly emerges in 14 days. The adult has a longevity of 18 days. The fly completes its life cycle in 38-62 days

MANAGEMENT:

- Removal of dead hearts and rotting rhizomes along with maggots after harvest.
- Treating seed material in dimethoate 2ml/l solution before planting.
- Spraying monocrotophos 1.6 ml/l or fenitrothion 2 ml/l two sprays.
- Avoiding waterlogging in the field.
- The puparia are parasitized by *Trichopria* sp.
- As soon as rotting of rhizome is noticed, application of neem cake 100 Kg/ac or carbofuran 3G 10 Kg/ac + equal quantity of sand

TURMERIC LACEWING BUG

Stephanitis typicus

Tingidae: Hemiptera.

It also infests banana, coconut, turmeric, cardamom. Bugs measure about 4 mm long with transparent, shiny reticulated wings and black body. Nymphs and adults suck sap from leaf surface causing yellowing of leaves in patches which dry and drop off. Black resinous excretion in tiny spots are seen between the damaged areas

Foliar spray with malathion 2ml/l or methyl demeton 2ml/l, or dimethoate 2 ml/l is effective.

PESTS OF BETELVINE

SHOOT BUG

Disphinctus politus

Disphinctus measarum

Miridae: Hemiptera

D. politus is the most important pest of betelvine in South India, while

D. measarum occurs in Maharashtra. The peak activity is from June to October and the least activity in December and January.

Adult is a reddish brown bug about 1.3 cm in length. Head and antennae are dark. Adults are seen taking shelter under drooping bent leaves. Eggs are laid singly within the tender plant parts with their filaments projecting out. Egg period is 8-16 days. Fecundity is 18-72 eggs.

The nymphs and adults feed on the leaves puncturing the tissues in between veins. The attacked leaves show dry spots and in severe cases the whole leaves shrivel, fade and dry up. Nymphal period is 12 – 18 days depending on season. Infestation results in

- ❖ Dry spots which later turn into shot holes in mature leaves
- ❖ Puckered appearance of leaves with leaves curling and shrivelling

MANAGEMENT:

- Foliar sprays with endosulfan 2ml/l or carbaryl 2g/l after leaf harvest are recommended at fortnightly interval.

TOBACCO CATERPILLAR
Spodoptera litura
Noctuidae: Lepidoptera

Its detailed life history is given under pests of Tobacco. The main damage on Betelvine is defoliation. Foliar sprays with neem oil 5ml/l (1 litre/ac) during Oct – Nov. after leaf harvest is recommended for its management in betelvine gardens.

PESTS OF ONION

ONION THRIPS

Thrips tabaci

Thripidae: Thysanoptera

It infests cotton, crucifers, tobacco, tomato besides onion and garlic. They are minute delicate, less than 1 mm long with fringed wings.

Female lays fertilized or unfertilized eggs in leaf epidermis on undersurface of leaves. Egg hatches in 2 – 5 days.

Nymphs are slender and yellowish. Both nymphs and adults suck sap from leaves by lacerating and sucking and causing following symptoms

- ❖ Silvery white blotches on leaves giving whitish appearance to the whole crop which become brownish and get distorted from tips downwards
- ❖ Wilting and drying of crop

Nymph passes through 4 instars and the nymphal period is about 7 days. Total life cycle takes 14 – 24 days. It completes 10 generations in a year.

MANAGEMENT:

- Variety “Spanish White” is tolerant to thrips
- Foliar sprays with dimethoate 2ml/l or fipronil 2ml/l + mancozeb 3g/l two or three times at 10 day interval.

RAGI CUT WORM

Spodoptera exigua

Noctuidae: Lepidoptera

It damages by defoliation. Its life history is detailed under pests of millets. In its management foliar sprays with carbaryl 3g/l or endosulfan 2ml/l or profenophos 2ml/l are recommended.

PESTS OF CORIANDER

CORIANDER APHID

Hyadaphis coriandri

Aphididae: Hemiptera

Adults are light green in colour but appear grey due to white powdery substance covering the body. Nymphs are yellowish green.

Both nymphs and adults infest terminal shoots and inflorescens and suck sap. They also excrete honeydew leading to sooty mould formation and making the foliage sticky. The damage results in

- ❖ Devitalization of plants
- ❖ Leaves and young shoots twisting

MANAGEMENT:

- Coccinellids and green lace wings suppress natural pest population

- Foliar sprays with dichlorvos 1ml/l or monocrotophos 1.6ml/l or methyl demeton 2ml/l or dimethoate 2ml/l after which harvesting of crop for foliage should not be done atleast for one week.

LEAF EATING CATERPILLARS

Spodoptera litura, *Helicoverpa armigera*

Noctuidae: Lepidoptera

Larvae defoliate plants heavily. Foliar spray with acephate 1.5g/l is recommended.

PESTS OF ROSE

THRIPS

Rhipiphorothrips cruentatus

Thripidae: Thysanoptera

Nymphs are reddish and adults are dark brown or black in colour. Both nymphs and adults infest leaves and flowers as a result, leaves turn sickly, crinkled and malformed and flower buds fail to open, become deformed.

Foliar spray with carbaryl 3g/l or malathion 2ml/l or monocrotophos 1.6 ml/l or phosphamidon 0.5ml/l after removing flowers including tender ones.

SCALE

Lindingaspis rossi, Aonidiella aurantii

Diaspididae: Hemiptera

Red scales completely cover the stem. Both nymphs and adults suck sap causing drying and death of plants

Rubbing off scales with cotton soaked in kerosene, diesel or methylated spirit, cutting and burning the affected branches, foliar sprays with malathion 2ml/l two rounds, at pruning and during March – April are found to be effective

ROSE LEAF CATERPILLARS

Euproctis fraterna, Porthesia scintillans: Lymantriidae

Latoia lepida: Limacodidae

Achaea janata: Noctuidae

Lepidoptera

Caterpillars defoliate the plants. Foliar spray with monocrotophos 1.6 ml/l or phosphamidon 2 ml/l or carbaryl 3 g/l after removing flowers is effective.

ROSE CHAFER BEETLE

Oxycetonia versicolor

Cetoniidae: Coleoptera

Beetles are red coloured with black markings. Adults feed on leaves, flowers during night causing irregular feeding marks on buds and flowers.

Soil drenching with lindane or some other soil insecticide around rose plants, dusting malathion 5D 15 Kg/acre in evening hours or foliar spray with endosulfan 2ml/l are effective.

PESTS OF JASMINE

JASMINE STINK BUG

Antestiopsis cruciata

Pentatomidae: Hemiptera

Nymphs and adults suck sap from flowers, tender plant portions causing heavy damage to flowers and yellowing and drying of leaves. Sometimes, they feed in large numbers on tender shoots and buds preventing flower formation.

Foliar spray with malathion 2ml/l or monocrotophos 1.6ml/l or phosphamidon 0.5ml/l after removing all flowers including very tender ones is effective.

JASMINE BUD WORM

Hendecasis duplifascialis

Pyralidae: Lepidoptera

Greenish caterpillar attacks two or three buds and buds are webbed together by silken threads. Petals are eaten away by larva resulting in buds with bore holes, webbings soiled with excreta. Pupation is in soil.

Foliar sprays with malathion 2ml/l or dimethoate 2ml/l or endosulfan 2ml/l are effective.

JASMINE GALL/ FELT MITE

Aceria jasmini

Eriophyidae: Acarina

It produces white felt like hairy outgrowth on the leaf surface, tender stems and buds leading to stunted growth and suppression of flower development

Dusting sulphur 8 – 10 Kg/ac is recommended.

PESTS OF CHRYSANTHEMUM

CHRYSANTHEMUM BLACK APHIDS

Macrosiphoniella sanborni

Aphididae: Hemiptera

Nymphs and adults infest tender shoots sucking sap and causing yellowing and drying of tender shoots, devitalization and stunted growth.

Foliar sprays with malathion 2ml/l or monocrotophos 1.6ml/l or phosphamidon 0.5ml/l are effective.

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

Internal feeders

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

External feeders

- Red flour beetle
- Saw toothed beetle
- Cigarette beetle

Soft bodied moths

Internal feeders

- Grain moth

External feeders

- Rice moth

GRAIN WEEVILS

Rice weevil: *Sitophilus oryzae*

Maize weevil: *S. zeamais*

Granary weevil: *S. granarius*
(Curculionidae: Coleoptera)

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

LESSER GRAIN BORER

Rhizopertha dominica

Bostrichidae: Coleoptera

This pest is original inhabitant of India, now spread to rest of world. It is a pest of unhusked paddy. It also causes damage to wheat, maize, sorghum, barley, dried potato, millets, tamarind, pumpkin seed, biscuits as well as broken pulses.

Brown to blackish beetles. The head is deflexed downwards to such an extent that it is almost hidden in a dorsal view. There is a prominent constriction between prothorax and elytra. These are good fliers and migratory, spoiling more than they eat.

Flour produced serves as feed for young grubs till they enter the grain. Antenna has a large loose three segmented club. Adults come out from the grain after some days leaving irregular hole. Males live for longer periods.

Eggs are glued on the surface or interstices (gaps) of cereal grains singly or in clusters. Single female lays up to 300–400 eggs. Egg period is 5–9 days.

After hatching, grubs feed on flour produced by the adults. Later burrows in to the slightly damaged grain. Both grubs and adults are destructive, feeding inside the grains. The free living larvae normally enter the grain after 3rd instar for pupation. Infestation is indicated by

- ❖ Irregular messy waste flour spots in bagged storage
- ❖ Heating
- ❖ Kernels reduced to mere shells

The damaged kernels remain engulfed in a film of waste flour. Localised infestation is almost a rule.

Full grown grub is 3 mm long, dirty white with light brown head, constricted elongate body. Grub period is 44 days. Pupation is inside the grain. Pupal period is 7–8 days. Entire life cycle takes 25 days under optimum conditions. 5–6 generations per 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.

GROUNDNUT BRUCHID

Caryedon serratus

Bruchidae: Coleoptera

It is of Asian origin, but has become distributed to many tropical and subtropical regions of the world. It is a large robust bruchid which is associated with groundnut when stored in their shells; it is also a pest of tamarind pods.

The beetle has a reddish-brown cuticle densely clothed with grey-brown setae and with dark irregular markings on the elytra. The pygidium in the female is fully visible from above.

Eggs are glued on to groundnut pods or kernels, and infestation can take place as soon as the groundnut is harvested and left to dry. The larvae bore into the groundnut shell and feed on the seed. They usually leave the pod to pupate; each larva spins a paper-like pupal cocoon which it usually attaches to the outside of a pod. Severe infestations are usually restricted to the outer layer of groundnuts. The optimum conditions for development are 30-33°C and 70-90% R.H., under which development period is 41-42 days. Infestation of groundnut by the beetle is revealed by

- ❖ Larval exit holes and presence of cocoons outside the pods
- ❖ Damage to the seeds seen when pods are split open.

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

SAW TOOTHED BEETLE

Oryzaephilus surinamensis

O. mercator

Silvanidae: Coleoptera

The beetles are narrow, flattened measuring 2.5 to 3.0 mm long with thorax with six teeth like serrations on each side. Adult longevity is 6 – 10 months. Eggs are laid loosely in grain / flour/ cracks of receptacle / godown @ 300 per female. Grub is slender, pale creamy with two slightly darker patches on each segment. It moves freely in grain. Maximum length is 3mm. Grub period is for 14-20 days. Adults and larvae cause

❖ Roughening of grain surface producing off odour

❖ Heating of grain

Grains with higher percentage of brokens and foreign matter attract heavy infestation, which leads to heating of grain. Full grown larva makes protective cocoon like covering with sticky secretion. Prepupal and pupal period lasts for 7-21 days. Multiplication is quick in rainy season and in coastal areas.

CIGARETTE BEETLE

Lasioderma serricorne

Anobiidae: Coleoptera

It is cosmopolitan pest, also feeds on seeds, dried plant products, such as black and red pepper. It is a round beetle, light brown in colour. Head and prothorax bent down to give humped nature. Eggs are laid in and about the substance on which it feeds.

Both grubs and adults bore holes into tobacco products like cigarettes, cheroots (cigars) and chewing tobacco. It also damages stuffing furniture. Grubs are yellowish with light brown head. Pupation is in silken cocoon covered with bits of food.

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 flop. 3-4 generations are seen in a year.

RICE MOTH

Corcyra cephalonica
Galleriidae: Lepidoptera

It is distributed in Asia, N. America and Europe, pest on rice, gram, sorghum, maize, groundnut, cotton seed. Moth is pale buff brown coloured. Wing expanse is 25 mm, forewings with dark veins. It is bigger than other grain moths. Adult longevity is one week. Eggs are laid singly or in groups of 3 – 5 each on the grain. Egg period is 4 -7 days.

Caterpillar alone is responsible for damage. It prefers partially damaged grains and feeds. It pollutes food grains with frass, moults and dense webbing. In case of whole grains, kernels are bound into lumps up to 2 kg with the following

- ❖ Grain converted to webbed mass
- ❖ Damaged grain / flour with bad odour unfit for consumption.

Larval period is 21 – 41 days. Pupa is in a silken cocoon. Pupal period is 9 – 14 days. Six generations per year are completed.

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.

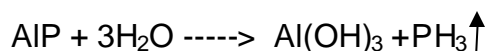
- For shed fumigation – 21 tablets each weighing 3g / 28 m³
- Period of fumigation – 5 days

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 feed.

S.No	Common name	Taxonomic position
1	Rice leaf mite	<i>Oligonychus oryzae</i> , Tetranychidae: Acarina.
2	Rice panicle mite:	<i>Steneotarsonemus spiniki</i> , Tarsonemidae: Acarina.
3	Jowar mite:	<i>Oligonychus indicus</i> , <i>Shizotetranychus andropogoni</i> , Tetranychidae: Acarina
4	Cotton leaf mite:	<i>Tetranychus telarius</i> , <i>T. bimaculatus</i> , Tetranychidae: Acarina
5	Woolly mite of cotton:	<i>Aceria gossypii</i> , Eriophyidae: Acarina.
6	Red gram mite:	<i>Aceria cajani</i> , Eriophyidae: Acarina.
7	Chilli mites	<i>Polyphagotarsonemus latus</i> , <i>Tarsonemus translucens</i> Tarsonemidae: Acarina
7	Citrus rust mite:	<i>Phyllocoptruta oleivora</i> , Eriophyidae: Acarina.
8	Coconut eriophyid mite	<i>Eriophyes gurreronis</i> Acarina: Tetranychidae
9	Mites on vegetables	<i>Tetranychus telarius</i> , <i>T. bimaculatus</i> , Tetranychidae: Acarina
10	Tea mites Red spider mite: Purple mite: Pink mite: Scarlet mite:	<i>Oligonychus coffeae</i> , Tetranychidae <i>Calacarus carinatus</i> , Eriophyidae <i>Acaphylla theae</i> , Eriophyidae <i>Brevipalpus australis</i> , Tenuipalpidae

MITES

The general biology, nature and symptoms of damage and their management of the mite pests have been covered in the respective crop pests. However general management aspects of mites are covered here under.

MANAGEMENT OF MITES

Cultural

- Avoiding monoculture
- Intercropping with non - host crops
- Destroying mite damaged parts in case of Erinium patches and malformations
- Adopting clean cultivation

Biological

Predatory mites

- *Amblyseius longispinosus*
- *A. cucumerus*

Coccinellids:

- *Brumus suturalis*
- *Scymnus gracilis*
- *Stethourus pauperculus*

Thrips: *Scolothrips indicus*

Lygaeids: *Geocoris* sp.

Chemicals:

Chemicals which kill ticks and mites are called Acaricides

★ Specific acaricides

- Dicofol (KELTHANE)
- Tetradifon (TIDEON)
- Aryl alkyl sulphide (ARAMITE)
- Barium polysulphide (SOLBAR)

★ Insecticides with acaricidal properties

- Phosphamidon
- Dimethoate
- Methyl demeton
- Formothion
- Phosalone
- Monocrotophos
- Ethion
- Phorate granules
- Disulfoton granules

NEMATODES

Nematodes are minute worm – like animals without true body cavity and with unsegmented, bilaterally symmetrical and externally cuticularised body. In plants, they are either endoparasites or ectoparasites. Economically important plant parasitic nematodes, their damages and management are explained in this section.

WHITE TIP NEMATODE OF RICE/ SPRING DWARF NEMATODE *Aphelenchoides besseyi*

It is widely distributed in Tamil Nadu. Remain alive as pre adult, beneath the hull of paddy seed for two years. When seed are sown, immature forms become active and move up the plant along a thin film of moisture and feed on foliage as ectoparasites. Adults lay eggs on foliage. Larvae move to panicle when it is formed and enter grains. The symptoms are

- ❖ Leaf tips (2-5 cm) turn yellow, brown and finally turn white, dry up and hang down.
- ❖ Tips of developing leaves become twisted and crinkled.
- ❖ Kernels distorted and in severe cases it become chaffy.

MANAGEMENT:

- Treatment of paddy seeds with hot water at 52– 55°C for 15 minutes.
- Seed treatment with N – 244 @ 3 ml a.i. for every litre gives 100 % control

WHEAT GALL NEMATODE/ EAR COCKLE NEMATODE: *Anguina tritici*

It is a problematic pest in all wheat growing areas of world. Second instar larva inside seed gall gets activated when sown under favourable moisture conditions and come out of the seed. Larva crawls up the plant through a thin film of moisture. It feeds on tender foliage as ectoparasite. It enters young green grain and converting it into a gall, grow and reproduce in the gall. Each female inside the gall lays hundreds of eggs, hatched out larvae remain in seed and will be viable in dry seeds for years. When those seeds are sown the cycle is repeated. The following symptoms can be seen.

- ❖ Affected plant stunted with wrinkled and twisted leaves.
- ❖ Infested grains ripen slowly, smaller in size with irregular contour.
- ❖ Whole or part of the grain converted into galls, cockles or pepper galls

Nematode infestation is associated with “Tundu disease” or “yellow slime” disease caused by a bacterium, *Corynebacterium tritici* causing rotting of spikelet with oozing of yellow slime (yellow slime disease). This results in

- ❖ Twisting of leaves
- ❖ Distortion of ear heads
- ❖ Rotting of spikelets with profuse oozing of yellow slimy liquid.

MANAGEMENT

- Seeds for sowing should be immersed in salt solution by dissolving 10 kg of common salt in 60 litres of water. The floating seeds should be rejected.

(or)

Seeds pre soaked in water about 2 h and after rejecting seeds that float, (light and chaffy seeds) the remaining seeds are kept in hot water at 50° C for 2 h. Seeds treated by either of the above methods should be shade dried by spreading on floor in a thin layer

- Resistant variety is Kanred (USA)

WHEAT CYST NEMATODE

Heterodera avenae

It infests wheat and oats. Female encysted with tough resistant leathery wall is called a cyst. This encysted female is resistant to chemicals, adverse environmental conditions and will remain alive in soil even in the absence of host for years. Second stage larva enters root near tip and feeds on tissues resulting in

- ❖ Shallow root system.
- ❖ Stunted plants with chlorotic leaves.

MANAGEMENT

- Soil fumigation with DD @ 500 l / ha
- Application of carbofuran 3G @ 4 kg a.i./ha

ROOT KNOT NEMATODE

Meloidogyne spp.

M. incognita and *M. javanica* infest all vegetables, other crops like cotton, sugarcane, chillies, wheat, barley, tea. *M. incognita* infests brinjal, chillies, tomato and bhendi while *M. arenaria* infests chillies and tomato. Infections by this nematode lead to the invasion of pathogens like *Fusarium*, *Rhizoctonia*

Female lays 200-500 eggs in a gelatinous sac surrounding the posterior tip of female. Egg mass is seen protruding out of the galled roots. Second stage larva is

slender, long and cylindrical. After entering the roots, female larva swells up at each moult. Adult female is spherical, flask shaped. Males are slender. As a result of feeding by nematode, infested roots show

- ❖ Knot-like galls on roots.
- ❖ Stunted plants with chlorotic leaves.

MANAGEMENT

- Fallowing field in summer after 2 or 3 deep ploughings and drying
- Keeping the field in flooded condition for a few days, wherever possible.
- Ploughing nursery area and spreading paddy husk uniformly @ 20 kg/m² (about 15 cm thickness), burning it and ploughing back facilitates production of nematode free seedlings.
- Crop rotation with mustard
- Application of chopped leaves of Pongamia and Crotalaria reduces disease severity.
- Preplant soil fumigation with DD mixture.
- Nursery treatment with carbofuran 3G @ 65 g/m² and in main field carbofuran 3G @ 4 kg a.i./ha is effective.
- Resistant varieties in tomato are
 - Nematox
 - SL 120
 - NTR – 1
 - Nemared
 - Ronita
 - Pelican

CITRUS NEMATODE *Tylenchulus semipenetrans*

It infests many species of citrus and related genera, in all citrus growing areas. Females are swollen, sac like, remain attached to roots with head region buried in tissues. Damage results in

- ❖ Drying of apical leaves, buds, twigs downward- known as die back.
- ❖ Trees show reduced vigour, gradual reduction in yield.

MANAGEMENT

- Selection of planting material from nematode free nurseries.
- Application of neem or castor cake @ 15 kg / tree
- Application of carbofuran 3G @ 50 g / tree and watering.
- Avoiding brinjal, tomato and tobacco as intercrops in citrus gardens which are nematode prone.
- Preplant soil fumigation with DD mixture and using clean nursery stocks.
- In infested orchards, soil drenching with DBCP (Dibromo chloro propane) is found to be effective.

BANANA BURROWING NEMATODE

Radopholus similis

It infests banana, coconut, rice, sweet potato, tomato, citrus, coffee, pepper, grasses and weeds.

Nematode enters root at any point, feeds on cell contents, and migrates through root tissues. Females leave numerous eggs in their trail. Cell walls dissolved and destroyed and roots are severed from plant. It is an endoparasite responsible for panama wilt of banana caused by *Fusarium oxysporum*, *F. cubens*. Nematode infections give way to pathogenic fungi, bacteria, which hasten destruction of infested root tissues. Infestation results in

- ❖ Characteristic reddish brown lesions throughout cortex.
- ❖ Reduced root system with few short stubs.
- ❖ Affected plants getting toppled.

MANAGEMENT

- Crop rotation
- Deep summer ploughing
- Selection of suckers from nematode free areas.
- Planting suckers only after trimming all the roots.
- In endemic areas, trimming rhizome and dipping in clay slurry and applying 40 g carbofuran 3G on clay slurry before planting gives effective protection.
- Application of carbofuran 3G @ 20 – 40 g/plant at the base at a depth and covering it with soil and water.

RODENTS

Rodents are vertebrate pests which belong to class Mammalia and have an external covering of hairs. Its order Rodentia includes a large number of animals ranging in size from the smallest mice to as large as porcupine, squirrel and beaver etc. Rodents are easily distinguished from other mammals by the characteristic arrangement and form of their teeth. They have only one pair of chisel shaped incisors in both the lower and upper jaws and no canines. The rodent incisors grow continuously throughout the life @ 12.5 cms/year. About 2.5% losses are caused due to rodents in storage annually. Rodents not only feed on grains but also contaminate 20 times more than what they consume with their droppings, urine, hair and even some times with their own dead bodies. Some of the important rodents species found in field and storage are discussed in this section.

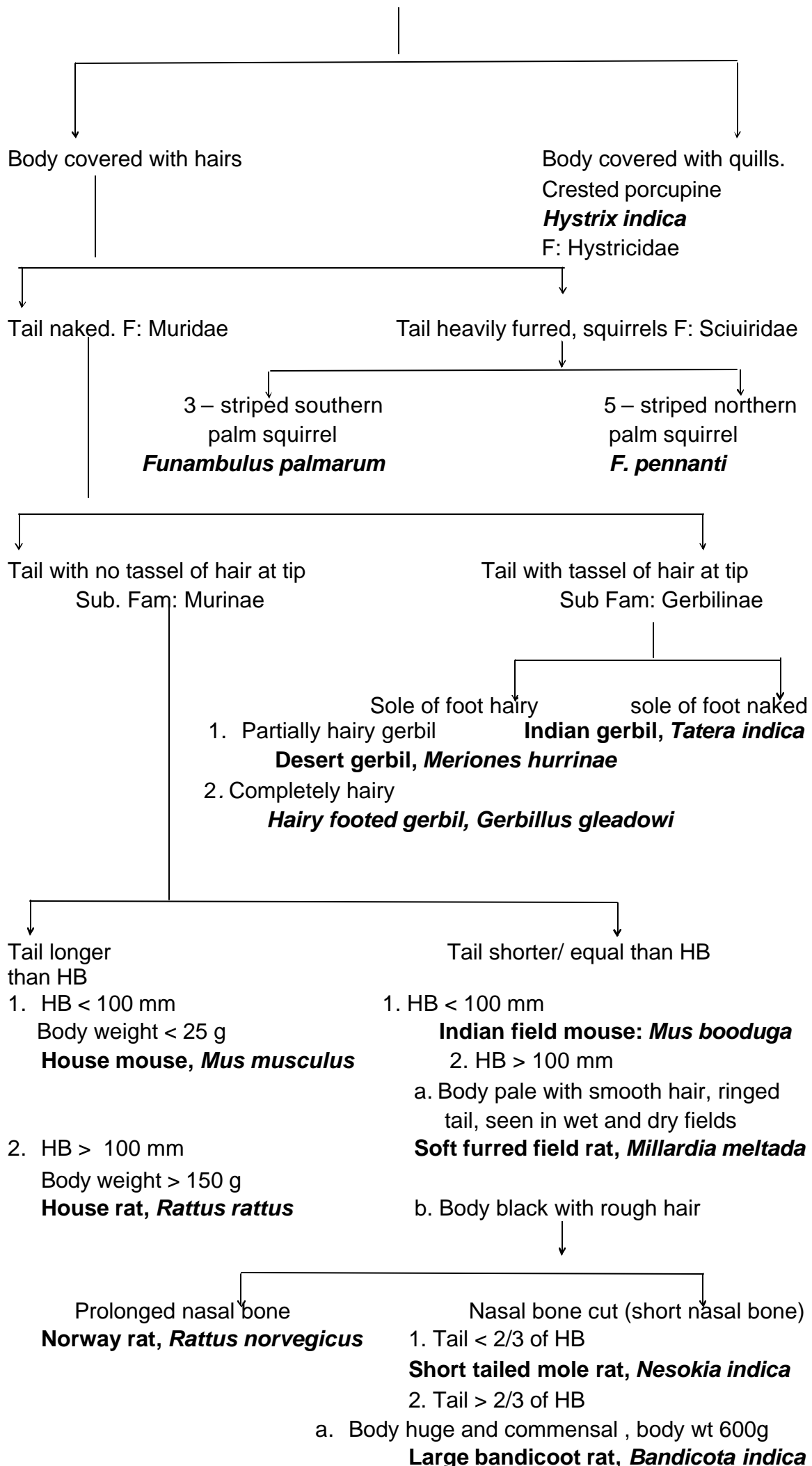
FIELD RODENTS

Indian mole rat / lesser bandicoot	<i>Bandicota bengalensis</i>
Soft furred field rat / grass rat	<i>Rattus (Millardia) meltada</i>
Indian gerbil rat / antelope rat	<i>Tatera indica</i>
Indian field mouse	<i>Mus booduga</i>
Brown spiny mouse	<i>Mus platythrix</i>
Coconut rat	<i>Rattus rattus wroughtoni</i>

RODENTS IN STORES

House mouse	<i>Mus musculus</i>
House rat / common rat	<i>Rattus rattus rufescens</i>
Larger Bandicoot / Bandicoot rat	<i>Bandicota indica</i>
Brown rat / Norway rat / sewer rat	<i>Rattus norvegicus</i>

**KEY FOR IDENTIFICATION OF COMMON INDIAN RODENTS
(Rodentia)**



b. Body medium and field rodent , body wt 300g
Lesser bandicoot rat, *B. bengalensis*
MANAGEMENT OF RODENTS

FIELD RODENTS

Three basic components of IPM as in any other pest are

1. Prevention
2. Observatrion
3. Intervention

Prevention:

Food and habitat manipulation is the key in preventing rodents in the field to pose any threat to field crops

- Summer ploughing
- Keep the field bunds free from weeds
- Trimming the field bunds and reducing the number of bunds as far as possible.
- Selecting uniform maturing varieties
- Uniform planting, avoiding staggered sowings / plantings
- Monitoring rodent population build up particularly after floods / natural calamities.
- Avoiding hay stacks near fileld to eliminate harbourages.
- Encouraging natural enemies (snakes, birds *etc.*,)

Observation:

- Identifying species can be made by
 - Visual observation of species
 - Their burrowing pattern.
- Assessment of rodent population by burrow count is handy because single adult whether male or female, inhabits a burrow.
- ETLs 2% tiller damage
(Rice) 15 % affected hills

Intervention:

- Setting of indegenous traps
 - Bow traps @ 20 – 25 / ha
- Smoking burrows with burrow fumigator (originally designed at APRII, Maruteru, AP)
- Baiting on a community approach over a large area. Rats are colour blind and can not vomit. This character is exploited in baiting.

1. Acute poison:

- i. Zinc phosphide 2 %.
- ii. Pre baiting should be done 2 – 3 days before.
- iii. Baiting: Broken rice (local food) – 96 parts
 - Edible oil – 2 parts
 - Zinc phosphide – 2 parts
- iv. 10 bait stations / ac

- v. Followed by baiting, fumigation with aluminium phosphide after enumeration of burrows @ 2 pellets (1.2 g) / burrow.

* Zinc phosphide burrowing can be done only once during the season.

2. Single dose Anticoagulants

- i. Bromadiolone 0.25 CB at same ratio.
- ii. Bait can be used at any number of times at 10 – 15 days interval during crop season.

3. Sustained baiting with Bromadiolone bait throughout crop period at bait stations, each provided with 15 – 20 g of freshly prepared bait.

Coconut rats

Bandicota indica (Burrowing rat) damages transplanted seedlings by uprooting them.

Rattus rattus wroughtoni enters crowns, burrows into immature nuts. Attacked nuts are shed. Damage is more in closely planted gardens.

Management of coconut rats involve

- Nailing tin hat / tin sheets around trunk of grown up trees.
- Avoid close planting.
- Placing bromadiolone cake @ 2 pieces or 33 g per tree in crown at opposite directions.
- Inserting Aluminium phosphide tablets in holes made in bole.
- Use of traps, burrow smoking.

MANAGEMENT OF RODENTS IN STORES

- Killing by sticks
- Using traps
 - Snap neck trap
 - Live catch trap
 - Wonder trap
- Encouraging predators like cats, dogs, owls and hawks.
- Use of chronic anti coagulants
 - **Rodafarin 'C' (solid bait)**
 1. Rodafarin 'C' – one part
 2. Sugar – one part
 3. Vegetable oil – one part
 4. Crushed grain /corn meal – 17 parts
 - **Rodafarin 'S' (liquid bait)**
 1. Rodafarin 'S' – one part
 2. Water – 19 parts
 3. Effective in stores as there is lack of water in stores
 - Death of rats is observed after 2.5 day of continuous feeding.

- Bromadiolone (ROBAN, MOOSH MOOSH): Single dose anticoagulant new generation rodenticide.
 - Bromadiolone 0.005% RB (Ready Bait)
 - One piece should be kept at hiding place / runways *etc.*,
- Coumatetralyl (RACUMIN): new group of anticoagulant is available as loose bait or tracking powder.

BIRDS

Birds belong to the class Aves. Their body is covered with feathers. They have a unique characteristic of forelimbs modified as wings. Mouth is continued to form a beak and are homoethermous and grainivorous. About 0.85% losses are caused due to birds in storage. The damage done by birds to food grains in fields and stores is appreciable both quantitatively and qualitatively. Average consumption by birds ranges from 8 to 25 gm per day. Besides eating grain in the fields and godowns, they are also responsible for spoilage, contamination with excreta, feathers and dead bodies. Some of them are responsible for spreading diseases. They also create nuisance and unhygienic conditions in warehouses.

Some of the important birds of agricultural importance are described here below.

S.No	Common name	Scientific name	
1	Common pigeon, Blue rock –pigeon	<i>Columba livia</i>	Grainivorous, eat foodgrains in grain mandies, godowns
2	House Sparrow	<i>Passer domesticus</i>	Principally grainivorous; lives or enters house and warehouses, eat grains in open / bag storage
3	House Crow	<i>Corvus splendens</i>	Omnivorous feeding on kitchen waste to dead animals and hence considered as the best scavenger.
4	Rose ringed parakeet	<i>Psittacula krameri</i>	Normally frugivorous, attacks ripening cereal crops and foodgrains in open storage.
5	Common mynah	<i>Acridotheres tristis</i>	Damages food grains in fields and mandies but seldom enters ware-houses.
6	Baya/Weever bird	<i>Ploceus philippinus</i>	Pest of paddy grains
7	Spotted Munia	<i>Lonchura punctuata</i>	Feed on ripening paddy grains, other grass seed.

MANAGEMENT

- Habitat manipulation: trimming trees, removal of shrubs on borders reduces roosting place where birds perch/settle/sleep.
- Netting: arrangement of traps and nets for catching the birds.
- Scaring by
 - Beating empty drums
 - Mechanical bird scarers
 - Metallic ribbons
 - Pyrotechniques (art of making fire works)
 - Bioacoustics - making distress calls
- Firing blanks with gun

- Throwing missiles
 - Catapulting (to shoot from a hurl)
- Destruction of eggs and nests
- Use of non toxic and sticky material like “ Lassa”
- Growing bird resistant varieties like
 - Ganga 3 in maize
 - Red sorghum
- Use of repellents like cupric oxide, methiocarb.
- Use of chemosterilants like mestranol, ornitrol, avitrol.
- Fumigation of holes
- Use of stupefying substances, immobilizers, narcotizers (Alfachloralose 1 – 2 % in bait.)

ANNEXURE

LIST OF COMMONLY USED INSECTICIDES ACARICIDES IN PLANT PROTECTION (in alphabetical order)

Common name of the insecticide and its formulation	Trade names / Proprietary names
Abamectin 1.8 EC	VERTIMEC
Acephate 75SP	TAMARON, LUCID, DHANRAJ, ACEFEX, TWINGUARD, LANCER, PACE, ASATAF
Acetamiprid 20 SP	DHANPREET, PRIDE, REKORD, POLAR, PERMIT, MANIK
Alphamethrin 10 EC	FARSA, SHERALP, NUMETHRIN, ALPHAGUARD , TATA ALPHA,
BPMC 50 EC	BIPVIN, MERLIN
Beta-cyfluthrin2.5SC	BULLDOCK
Buprofezin	FLOTISH, CHEMISTAR, BLAZE, APPLAUD.
Carbaryl 50 WP	SEVIN
Carbofuran 3 G	LEGEND, DANFURON, DIAFURAN, TATAFURAN
Cartap hydrochloride 4G,50 SP	PRATAP, CALDAN, BEACON, DHAAL, SANVEX
Chlorantraniliprole 0.4G	FERTERRA
Chlorantraniliprole 18.5 SC	CORAGEN
Chlorpyriphos 20 EC	DURMET, CLASSIC, DHANVAN , DURSBAN, TRICEL, CHLOROGUARD, RADAR, FORCE
Chlorpyriphos 50 EC	PREDATOR, ECOGUARD
Clorfenapyr 10SC	INTREPID, LAPIDO
Clothianidin 50 WDG	DANTOP
Cypermethrin 10 EC	RIPCORD, BILCYP, SHAKTI, CYPERGUARD , LACER, SURAKSHA, USTAAD
Cypermethrin 25 EC	BASATHRIN, CYBIL, SHAKTI, CYPERGUARD EC, TROFY, COLT CYMBUSH,CYRUX
Dichlorovos 76SL	LUVON, DIVAP, NUVAN, DOOM
Deltamethrin 2.8EC	DECIS, DECAGUARD
Dicofol 18.5 EC	KELTHANE, COLONEL-S, TIKTOK
Diafenthiuron 50 WP	PEGASUS, POLO
Diflubenzuron 25WP	DIMILIN
Dimethoate 30 EC	NOVAGOR, ROGOR
Emamectin benzoate 5 SG	EM-1, SPOLIT, PRABHAAV, PROCLAIM
Endosulfan 35 EC	THIODAN, LUSUPHAN, SPEED, ENDODHAN, ENDOTAF
Ethion 50 EC	LAZOR, DHANUMIT, FOSMITE,
Ethofenprox 10EC	PRIMO, NUKIL
Fenazaquin 10 EC	MAGISTER
Fenpropathrin 30EC	DANITOL, MEOTHRIN
Fenpyroximate 5EC	MITIGATE
Fenthoate 50EC	DELGAN
Fipronil 0.3G	REGENT GR
Fipronil 5 SC	REGENT SC
Flubendiamide 20WG	TAKUMI, FAME
Fenvalerate 0.4 D	FENVAL DUST

Fenvalerate 20 EC	LUFEN, NEWFEN , FENVAL, SUMICIDIN
Imidacloprid 17.8 SL	CONFIDOR, CHEMIDA, MEDIA, IMIDAGOLD, IMIDACEL, MAHARAJA , ATOM, ADMIT
Imidacloprid 70WS	GAUCHO, TATAMIDA
Indoxacarb 14.5SC	DHAWA, AVAUNT, KINGDOXA, DAKSH, FEGO
Lamda cyhalothrin 2.5 EC	DEVA, WARRIOR, REEVA, KUNGFU
Lamda cyhalothrin 5 EC	AGENTPLUS, WARRIOR+, REEVA 5, KARATE
Lindane20EC	KANODANE
Lufenuron 5.4 EC	CIGNA, MATCH
Malathion 50EC	FYFANON, MALATHION
Methomyl 40SP	DUNET, LANNATE
Methyl parathion50EC	METACID
Monocrotophos 36WSC	LEPHOS, MONODHAN , NUVACRON, MONOCIL
Novaluron 10EC	CAESAR, RIMON, TATANOVA, PEDESTAL
Phenthoate 50EC	DHANUSAN, CIDL
Phorate 10 G	FORATOX, VOLPHOR, THIMET
Phosalone 35EC	ZOLONE
Phosphamidon 40 SL	KINADON, DIMECRON
Phosphamidon 85EC	DIMECRON
Profenophos 50EC	AURIFOS, PRODHAN, CELCRON, PROFEX, CARINA, PRABAL, CURACRON
Propargite 57EC	OMITE
Pyridalyl 10EC	RISE
Quinalphos 25 EC	BAYRASIL, VAZRA, DHANULUX, QUINGUARD, FLASH, EKALUX
Spinosad 45SC	SPINTOR, TRACER
Thiacloprid 21.7SC	CALYPSO
Thiamethoxam 25WG	MAXIMA, ANANT, ACTARA, RENOVA
Thiamethoxam 70 WS	CRUISER
Thiodicarb 75 WP	LARVIN, SPIRO
Triazophos 40 EC	HOSTATHION, TRIFOS, GHATAK , TRIKON ,
Zetamethrin 10EC	TOLSTAR, FURY

- ❖ The doses of insecticides (ml/l or g/l) recommended in the text for each pest hold good for an average instar of the pest in high volume sprays which may be enhanced three times in low volume sprays. Effective monitoring before interventions is a prerequisite.