ENTO.311
pests of crops and stored grains and their management 3(2+1)

POLYPHAGOUS PESTS

There are many **polyphagous** pests which damage a number of crops and cause substantial losses. Important polyphagous pests are as follows :

1. **Desert locust-(*Schistocerca gregaria),* Bombay locust- *(Patanga succincta* Linnaeus), Migratory locust- (*Locusta migratoria*** Linnaeus).

Order-Ortoptera , family- **Acrididae**

2. ***Rice grasshopper Hieroglyphus banian*** **(Fabricius) and *H. nigrorepletus* Bolivar , order-Orthoptera: Family;Acrididae**

3. **White grub-(*Holotrichia consanguinea* blanch),**

Order- Coleoptera family- Scarabaeidae

4. **Red hairy caterpillar- *Amsacta moorei* (Lepidoptera: Arctiidae)**

5. **Termite - *Odontotermus obesus* and *Microtermus obesi* , (isoptera : termitidae)**

LOCUSTS

- **The larger grasshoppers which form swarms are called locusts and there are three species of the family - Acrididae found in India.**

  (i) Desert locust, *Schistocerca gregaria* (Forskal)

  (ii) Bombay-*locust, Patanga succincta* Linnaeus

  (iii) Migratory locust, *Locusta migratoria*(Linnaeus).

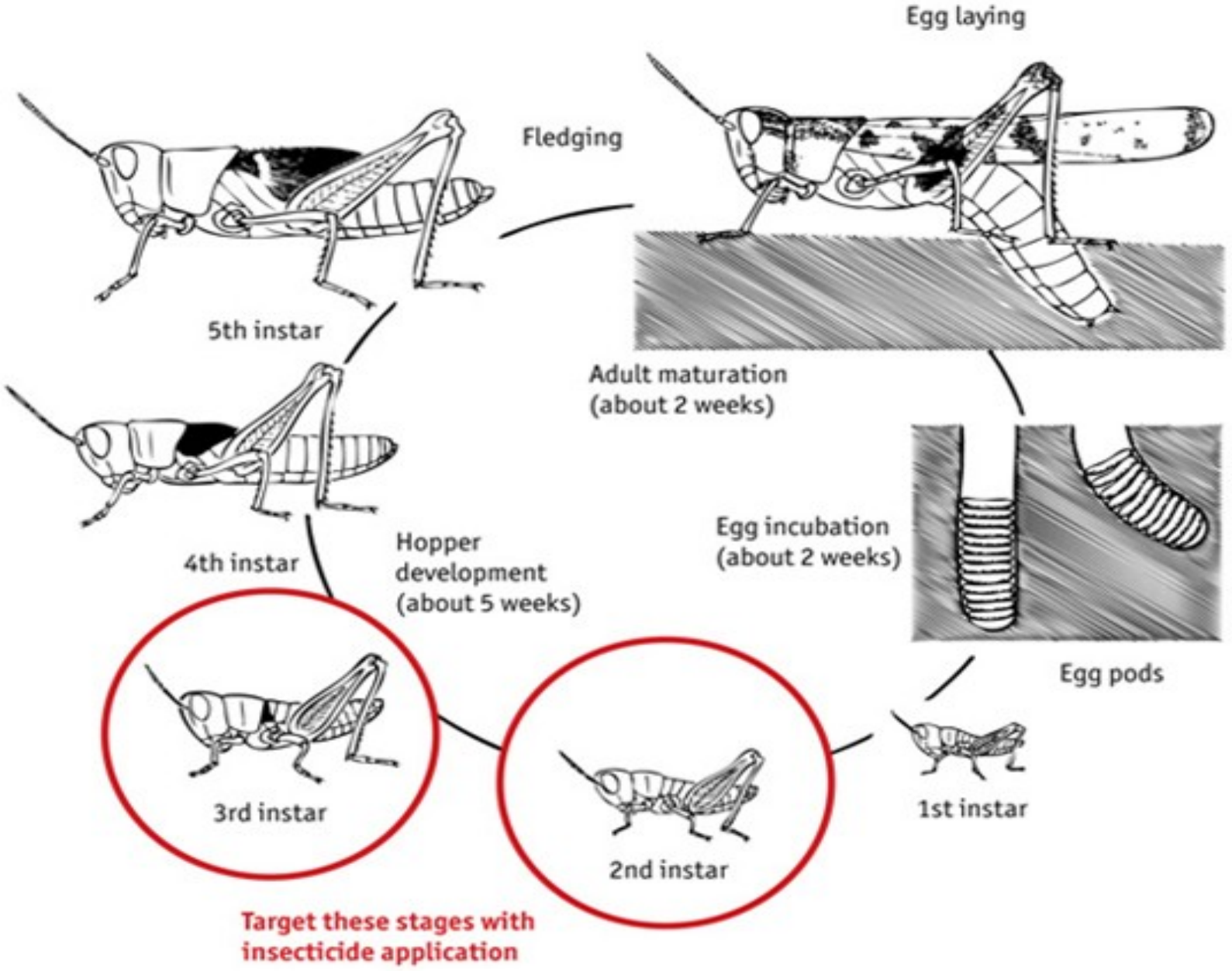
- **Of these, the desert locust is the most important**. There are very few records of swarms involving other locusts, particularly of the migratory locusts. The first and second species are important in **Maharashtra, Gujarat and Rajasthan** but the **desert locust is of all India importance.** In fact, it is an **international pest** and efforts are being made constantly to control it through the International Locust Control Organization of the Food and Agriculture Organization.

Desert locust, *Schistocerca gregaria* (Forskal) (Orthoptera : Acrididae)

The desert locust is found in two phases i.e. the solitary phase and the gregarious phase. Individuals having characteristics in between the two are often placed under the transient phase.

Mark of identification: The nymphs of the gregarious phase are yellow or pink, with distinct black markings, whereas the color of the solitary hoppers varies according to the color of the surrounding vegetation.

The gregarious adults are pink on emergence, gradually turning grey and ultimately yellow, when sexually mature. The adults of the solitary phase remain greenish grey throughout their life.


Egg laying
Fledging
5th instar
Adult maturation
(about 2 weeks)
4th instar
Hopper
development
(about 5 weeks)
Egg incubation
(about 2 weeks)
Egg pods
3rd instar
2nd instar
1st instar
Target these stages with
insecticide application

Life cycle:

A single female may lay up to **11 egg-pods**, each pod containing up to **120 eggs**. A female normally lays **500 eggs in about 5 pods**. Before egg laying the female, with the help of her ovipositor, bores a hole into the loose sandy soil, **5-10 cm deep**. Having laid a pod, she **secretes a frothy material over**. The eggs, which hardens on drying and makes the pod water-proof while laying eggs, the females may be sitting very close to one another and as many as 5,000 eggs may be laid one square meter. The **egg, resembling grain of rice**, is lightly curved and 79 mm long. The duration of the egg stage depends upon the soil conditions, temperature and moisture. **The eggs laid in February and March hatch in 3-4 weeks and those laid 1n May-September hatch in 12-15 days.** The nymphs, at the time of emerging, break the egg-shell and creep out of the holes. **The duration of the nymphal (hopper) stage lasts 6-8 weeks in spring and 3-4 weeks in summer.**

Damage:

The locust is harmful in both the hopper and the adult stages. These gregarious and voracious feeders eat almost any vegetation, except a few plant species such as vegetation, **except a few** plant species such as **ak (Calotropis procera), dharek (Melia azedarch), neem (Azadirachta indica), dhatura (Datum stramonium),** etc. When in swarms, they can consume all the green vegetation and cause a famine. In addition to the damage to **crops, orchards, forests**, etc., the locust can be **nuisance in houses, as these creatures climb over the walls, invade kitchens, storerooms and even enter into the beds.** They **fall into wells** by the million and thus **make water unfit for drinking** If an army of hoppers or **adults marches on to the railway lines, all trafiic is suspended because the crushed hoppers cause slippery rails.**

Management: Management operation can be carried out against all stages of the locust, the most practicable and effective measures are against the nymphs.

Eggs. If **eggs are laid in a well-defined area**, a trench may be dug around it, so that the young nymphs on emerging drop into it and can be buried alive, filling the ditch with soil. If these **trenches are heavily dusted with lindane**, it may not be necessary to bury the nymphs.

Nymphs. The hopper stage is the most vulnerable and control measures are most effective before the second moult. The nymphs may be destroyed either with chemicals or by using mechanical methods: (i) The principal mechanical method of control lies in **digging trenches in front of the moving army of nymphs** and driving them into these trenches, with brooms or with twigs of trees and then, buried alive. The nymphs can also be guided to the trenches along metal or canvas barriers 45 cm high. Two barriers, one, on each side of the army of the marching hoppers are so fixed that they converge on a narrow gap that leads to a trench in which they drop. The trench should be deep enough to accommodate a large number of hoppers most of which would then die under the weight of their own fellow creatures. Later, the trench can be filled with earth. In the early stages, a trench 30-45 cm wide and 60 cm deep, 18 sufficient but when the hoppers are older, the width should be 57 cm and the depth more than 60 cm. (ii) **At night** when the **hoppers rest on bushes**, they can be **burnt with flame-throwers**.

(iii) **Lindane (2%), in an oil medium**, is also effective _ when sprayed with an aeroplane on top of a flying swarm. Lindane 20 EC 1n water suspension can also be sprayed on locusts, on the ground.

Anti-Locust Organization. The Anti-Locust Organisation in India consists of (a) The Central AntiLocust Organization, and (b) the State AntiLocust Organizations.

(a) Central AntiLocust Organization. **This organization is handled by the Plant Protection Adviser to the Government of India, who is also the Director of Locust Control, having his headquarters at Faridabad (Haryana). The Directorate is required to**:

- Record the weekly density of locusts per unit area in the breeding areas located 1n India and to carry out control operations there.
- Interpret the records and pass on the information on locust movements to the various State Locust Control and Warning Officers and to the revenue authorities of the concerned districts before the locust reaches there so that arrangements for control can be made in advance. •**Keep watch on the coming swarms** of extra-Indian origin, their direction and size. * Give technical and material assistance to the various States.
- **Coordinate the Antilocustwork 1n India** by issuing a fortnightly bulletin on the locust situation both in India and in foreign countries.

In India, the work of this organization extends both to the scheduled desert areas where locusts breed and to the cultivated areas where they do the damage.

In the scheduled desert areas, (a) the Central Anti-Locust **Organization operates over an area of 2,05,785 square kilometers** in the States of **Rajasthan, Haryana, Maharashtra and Gujarat.** This area is **divided into 10 zones** which are grouped into **4 circles with headquarters** at **Bikaner, Jodhpur, Barmer and Palanpur (Gujarat)**. The responsibility of the control work is entrusted to the Locust Entomologist in charge of the circle.

(b) State Anti-Locust Organization In the scheduled area of the desert as well as in the adjoining States where locusts cause damage; there are State Anti-Locust Organizations to take suitable measures against the swarms. The State organization is headed by the Locust Control and Warning Officer, who 1s well connected with the local revenue authorities, from the Deputy Commissioner to the Tehsildar and Patwari. When the latter official receives information from district headquarters warning him of a 16cust invasion; he alerts the villagers to be ready with machines and insecticides, kerosene, flamethrowers, spades, etc. When the swarm actually arrives, the farmers try to kill it as well as they can and then the Patwari intimates the Locust Control Officer and his own Deputy Commissioner of the extent of success achieved. In case the swarm settles down to lay eggs, the Locust Control Officer or his staff visits the place to devise suitable control measures.

White grub : *Holotrichia consanguinea*

Order : Coleoptera : Family: Scarabaeidae

Hindi name : Safed gidar

other species:

H. serrata fabr.

Anomala bengalensis blanch.

Host plants.

White grub is a **polyphagous** pest and feeds on almost all the kharif crops like, jowar, bajara, maize, groundnut, sesamum, sunflower, chillies, cotton, sugarcane, tobacco, brinjal, cucurbits, and bhindi.

Distribution : This is a **cosmopolitan** pest and attained a status of **major pest** in the states like **Rajasthan, Gujarat, Maharashtra, Karnataka, Tamilnadu, Bihar, U.P. and Orissa.**

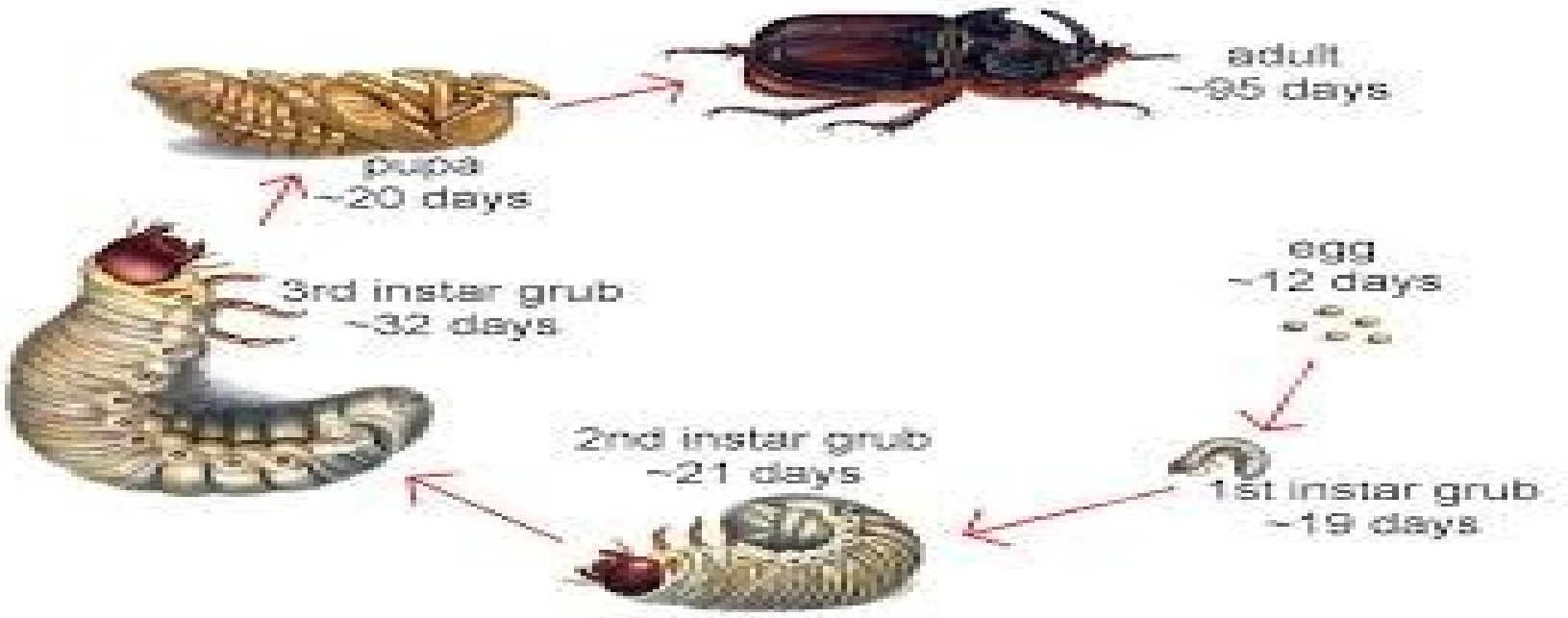
Mark of identification :

The insect appear as a pest of groundnut in 1957 in the Gujarat state. The adult beetls are **dull brown ,couper coloured** and measure about **18 mm** in length and **7 mm in width.** The fully grown **grub** is curved **C-shaped and dirty white in colour**. Its posterior abdomen is shiny black devoid of folds through which intestinal contents are visible. The **head is dark brown with strong mandibles and prominent thoracic legs**.

Life history

The life cycle of this pest passes through the following four stages viz, **egg, grub, pupa, and adult**. With the **onset of monsoon** the **beetles emerge from the soil at dusk (7.30 to 8.00).** The eggs are generally laid singly in **loose soil** or in an earthen cell inside the soil up to the depth of **10 cm**. the eggs are oval, creamy white when fresh and later turn to brown in colour. The number of laid by a female may vary from **30-120**. The **hatching** period varies from **7-10 days**. The **newly hatched grub is creamy white** and they feed on organic matter. There are **three larval instar** of this pest. The fully grown grub is curved **C-shaped and dirty white in colour**. Its posterior abdomen is shiny black devoid of folds through which intestinal contents are visible.

The **head is dark brown with strong mandibles and prominent thoracic legs**. The **total larval** period varies from **8-10 weeks.** The grub construct an earthen cell in which it passes a quiescent **pre pupal** stage which lasts for **one to 6 weeks**. The **freshly formed pupa** is **light yellow** and extremely tender, but as it grows **older** it **turn brown**. It is of execrate pupa i.e. the appendages are free from the body. The **pupal duration ranges from 14 day**. The freshly formed beetle is **cream coloured** but **mature beetle has brown colour** and elytra gets hardened. Generally the adults male are smaller than the females. The adult beetles remain in soil until the next years of summer rains. The **total life cycle is completed from 90-108 days** and all the known species in india have **one generation in a year**.



RED HAIRY CATERPILLARS

- **Red hairy caterpillar, *Amsacta moorei* (Lepidoptera: Arctiidae)**
- **Bihar hairy caterpillar, Spilarctia obliqua Walker (Lepidoptera: Arctiidae)**

- The red hairy caterpillar or **katra is** widely distributed in the Orient, including India. It is a *polyphagous* insect and **feeds on all kinds of vegetation growing during the Kharif** season. Its attack is particularly serious on **sunhemp, maize, sorghum, glwra, mung, math and sesamum**.
- The moths are **stoutly built** and have **white wings with black spots**. **The outer margins of the fore wings, the anterior margin of the thorax and the entire abdomen are scarlet red.There are black bands and dots on the abdomen**. The full grown **caterpillars are reddish-amber to olive green** and the **body is covered with numerous long hairs arising from the fleshy tubercles.**

Life cycle

The female moths lay light-yellow spherical eggs in clusters of 700-850 each on the under surface of the leaves of host plants. A single female may lay up to **1,500 eggs**, **which hatch in 2-3 days**. The young caterpillars **feed gregariously** and, as they grow older, they march in bands destroying field after field of various kharif crops. The caterpillars grow through **six stages** and **complete their development in 15-23 days**. They enter the soil, shed their hair and make earthen cocoons at a depth of about 23 cm. **Here they pupate and remain in this stage for many months till they emerge next year from the cocoons**. In a given population, probably **more than one generation is completed in a year**.

Caterpillar

April-June

June-July

July-Aug.

Aug.-April

Egg Mass

Pupa

Adult

Damage. The young katra caterpillars prefer to eat the growing points of plants. The older ones have no such discrimination and they **feed voraciously on all vegetation resulting in disaster**. **Field after field is devastated by the moving army of caterpillars**.

Management. (i) The moths are strongly **attracted to artificial light**. Therefore, **light traps** of electric or **petromax lamps** placed just above a broad flat basin full of **kerosenized water**, should be put on the night following the first shower of the monsoon and continued throughout the period of emergence for about one month. (ii) Young larvae can be destroyed by pulling out the infested plants and burying them under-ground. (iii) The grown up caterpillars may be **destroyed by crushing them under feet** or **picking and putting them into kerosenoized water. (iv) In case of serious attack, spray 1.25 litres of endosulfan 35EC or quinalphos 25EC or 500 ml of dichlorvos 76EC in 500 litres of water per ha or dust 35 kg of trichlorphon 5% cent dust per ha.**

RICE GRASSHOPPERS

***Hieroglyphus banian* (Fabricius) and *H. nigrorepletus* Bolivar , Orthoptera: Acrididae) ,**

Distribution. Rice grasshoppers are **sporadic pests of rice** distributed throughout India.

Host plants. They are polyphagous and feed on leaves of **rice, maize, mil-lets, sugarcane, grasses, sunhemp, arhar.**

Identification. *H. banian* and *H. nigrorepletus* are somewhat like locusts but are smaller. The adults are **40-50 mm long** and **are shining greenish yellow, having three black lines running across the pronotum. Nymphs are yellowish, with many reddish brown spots in the early stages, but become greenish as they grow older.**

Life-history.*Hieroglyphus spp*. have one generation in a year and pass the winter and dry part of summer in the egg stage. The **eggs** are found **on bunds** in the **soil during October-November** and they **hatch** in **June or** in early **July (Hatching period 9-10 month), a few days after the first shower, of the monsoon.** On emergence, the **nymphs** start feeding actively and **complete** their development in seven stages, **within 10-14 weeks**. The adults are seen feeding voraciously during August and September. When they are two months old, they mate. The female starts **laying eggs** by inserting her abdomen **in the soil**. The eggs are laid 5-8 cm deep, in pods, each containing 30-40 eggs. The **egg-laying continues from September to November** and the **adults die soon after, sometime in the winter**.

Damage.The greatest amount of damage .is caused during August-September When both adults and nymphs feed on paddy and other crops, causing defoliation. In certain years, they cause extensive damage, moving from field to field over large areas.

Management. Trim the bunds **Dust carbaryl 10 per cent or Malathion 5 percent @ 25 kg per,quinalphos 1.5% ha, and malathion 50 EC 500-800 ml per ha.**

TERMITES: *Odontotermes obesus,Microtermes sp, Isoptera: Termitidae*

The termites, commonly called **white ants**, belonging to the **order Isoptera**. They live in underground nests . They make small **earthen mounds** that are visible above the ground. On opening a portion of an earthen mounds, **grayish white**; **Wingless insects** are seen moving towards or away from the center of their nest, where the queen of the colony resides. They belong to many families and their nesting behavior is characteristic of every group.

The following **four families** of the order are, (i) **Kalotermitidae** (ii) **Hodotermitidae** (iii) **Rhinotermitidae** (iv) **Termitidae** (largest and economically most important, both under and above ground dwellers, e.g. ***Odontotermes, Microtermes,*** Hypotermes, Nasutitermes).

The termites are **social insects** and their colony organization is **based on on the labour system.** In a colony, there are numerous **workers,** lots of **soldiers**, one **queen**, a **king** and a good number of **complementary or the colonizing** forms of true but immature males and females. The various castes and their duties **are described as under.**

A. Productive Castes

1. **Colonizing individuals**. These are **winged individuals of both sexes** and are produced in large numbers during the **rainy season**. When the temperature and moisture conditions are optimum, they **hover over street** lamps early in the evening, usually after a shower of rain. The wings are meant for the **nuptial flight** only and when they have mated, the **wings usually drop** off. Most of the **winged insects are eaten up by frogs, lizards and snakes**. A pair that happens to escape may start a **new colony** in a crevice in the soil as the queen and the king of a colony.

2. **Queen.** This is the only **perfectly developed female in the colony**. She develops either from colonizing individuals described above or from the Wingless forms (complementals) present in an established colony. **She is a phenomenal "egg-laying machine", laying one egg per second or 70,000-80,000 eggs in 24 hours. There is only one queen in a colony and normally she lives from 5 to 10 years. The queen is fed by the workers on the choicest food, and is housed in a special area referred to as the 'royal chamber' which is situated in the centre of the nest, at depth of about**

3. **King. A king develops from an unfertilized egg**. He is the **father of the colony** and is a constant companion of the queen, living with her in the '**royal chamber**'. He is much **smaller than the queen** and is slightly bigger than the colonizing individuals. He **mates with the queen** from time to time and, thus, aids her in laying fertilized eggs from which the colonizing forms and workers develop. The **king's life is much shorter** than that of the queen and, when he dies, he is replaced by a new one.

4. **Complementary castes**. They are **short-winged or Wingless creatures of both sexes** and lead a subterranean life. In the event of the **untimely death of the king or queen in a colony, the complementary castes replace them**.

B. Sterile Castes

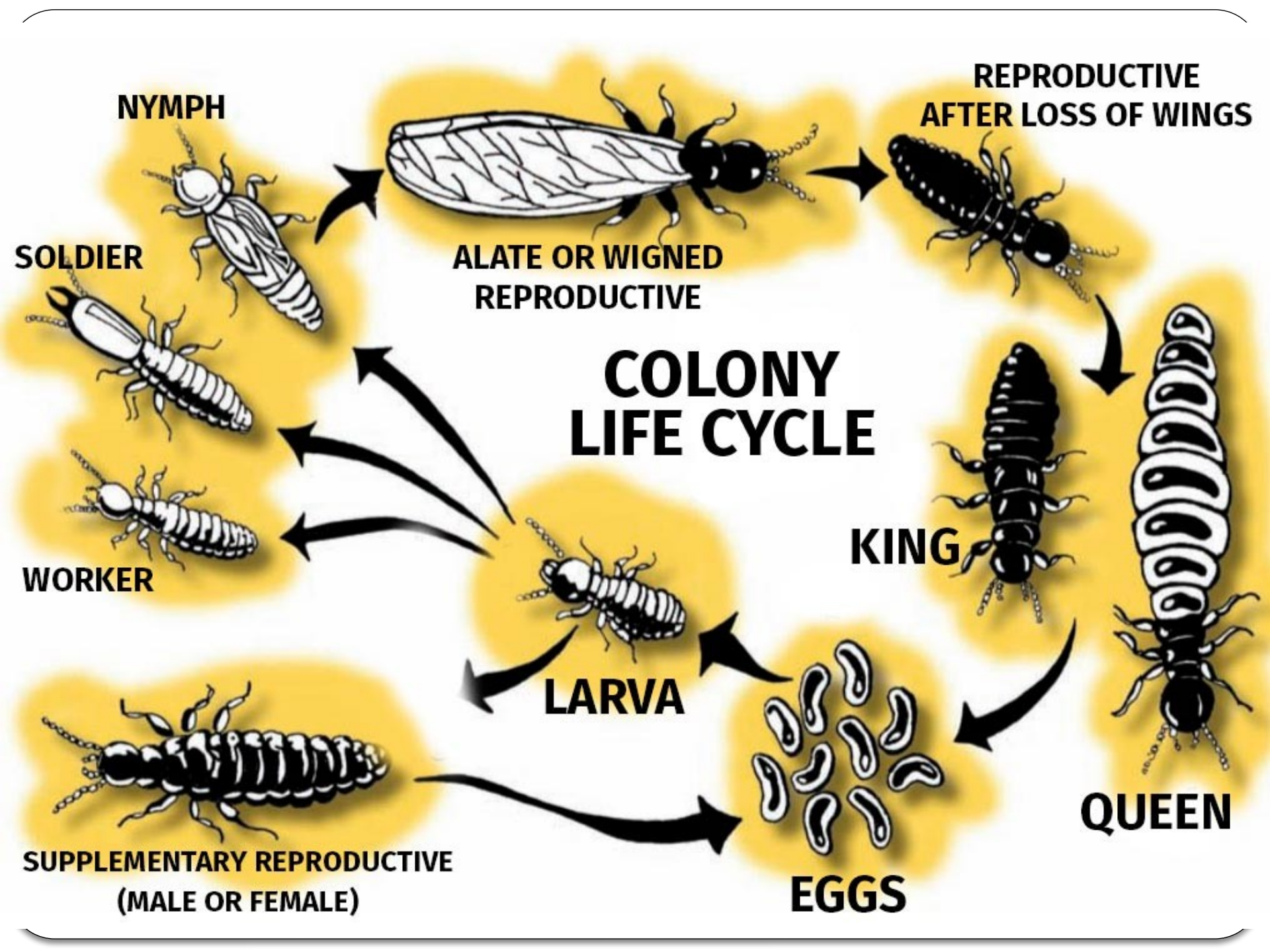
5. Workers. The **workers develop from the fertilized eggs** but **remain stunted as they are reared on ordinary food**. Numerically, **they are the most abundant in a colony** but are smaller than the soldiers. Except for the reproduction and defense of the community, practically **all other duties are performed by the workers they take care of the eggs and the young ones and remove them to safe places at the time of danger. They also tend and feed the queen, collect food and cultivate a fungus food (ambrosia) in underground gardens.**

When a new colony is established, the earlier broods of workers construct a hemispherical chamber for the queen and it is connected with innumerable galleries. **In certain species, the workers also construct a high mound above the ground, which is known as the termitarium.** Since the workers have to collect all provisions for the colony, they are notoriously destructive.

6. **Soldiers.** The soldiers develop from **unfertilized eggsand remain comparatively underdeveloped.** They are the most specialized members of the community and can be readily recognized by the large head and strongly **characterised sickle-shaped mandibles.**

Life-cycle. In the rainy season when atmospheric conditions are favorable, the **colonizing forms leave their parent colony**. As they are weak fliers, they do not travel a long distance unless aided by wind. As a rule, a particular species_ swarms at about the same time of season. The members of the swarm comprise individuals of both sexes. They are **attracted to light** where they mix with individuals of the neighboring swarms. A great majority of them fall prey to many types of predators and only a few individuals survive in the end. Sooner or later the survivors fall down and cast their wings and mate before or after shedding them. Both the male and female participate in the early operations of forming a nest by excavating small burrows or galleries or the nuptial chambers. In the beginning only a few eggs are laid and are looked after by them and the newly hatched nymphs are fed by the parents themselves. They develop into Workers and then take over all the brooding. During the first season, the reproductive castes are usually not produced. Gradually, the queen grows in size and the number of eggs laid increases.

The eggs hatch after one week during the summer and within 6 weeks the larvae develop to form soldiers or workers, as the case may be. **The reproductive castes when produced, mature in 1-2 years. The queen** is capable of laying many millions of eggs during her life, which is very difficult to estimate, **but probably 6-9 years is the approximate span**. The nests of many termites grow fungus gardens in the center, near about the 'royal chamber'. The fungus grows into a comb like structure and is fed to the royal pair and the larvae.


NYMPH
ALATE OR WIGNED REPRODUCTIVE
REPRODUCTIVE AFTER LOSS OF WINGS
SOLDIER
COLONY LIFE CYCLE
KING
WORKER
LARVA
QUEEN
SUPPLEMENTARY REPRODUCTIVE (MALE OR FEMALE)
EGGS

Damage. The **termites live on cellulose** which they obtain from dead and living vegetable matter to obtain their food, they destroy **wood-work, household articles, fences and wooden poles** that come into contact with the soil. They also damage **fruit and shade-trees, crops** such as sugarcane, chilies, wheat and peas.

Management of Termites

1. When a colony is established, it is not so easy to eradicate the pest. The only sure method is to reach the center of the nest and kill the queen and the complementary forms. **Since the termite tunnels run for hundreds of meters**, it the wood and in the crevices is the only remedy. For a lasting relief the nests should be located in the vicinity and **destroyed by flooding them with the insecticide emulsions.**

2. To avoid the attack of white-ants in cultivated fields, care should be taken not to **use green manure or raw farmyard manure.**

3. Insecticidal control

(a) Fruit trees

(1) In new plantations, **the pits should be treated with 0.2 per cent lindane** emulsion or crude-oil emulsion before planting the trees. This is done by thoroughly mixing 0.25 kg of crude-oil emulsion and a little arsenic in about 4 baskets of subsoil taken from the pit. The treated soil is returned to the pit.

(2) To protect the tree trunks, spraying them with **1 per cent lindane** is effective.

(3) To protect the roots, **0.5 per cent chlorpyriphos** or **lindane** or 3 per cent sanitary fluid in the irrigation basin should be applied.

(b) Field crops

(i) (ii) Soaking the emulsion in furrows at the time of planting, sav**sugarcane setts in 0.5 per cent lindane/chlorpyriphos suspension or 0.25 per cent lindane/chlorpyriphos**es them from termite attack.

(iii), Wheat seed treatment before sowing, with **160 ml emulsion of chlorpyriphos in one liter of water spraying on thinly spread out 40 kg seeds with a water emulsion of chlorpyriphos 20EC** remains effective for the crop season. Termite damage in standing wheat crop can be minimized by application of **5 liters of lindane 20EC per hectare into irrigation water or field spreading of one liter of lindane 20EC** .mixed with sand or soil, followed by light irrigation.

(3) Buildings

(i) A **galvanized sheet of iron** with its outer edge turned downwards when placed just above the damp-proof layer makes the house white-ant-proof. Wooden structures such as **doorframes should not directly touch the ground and should be raised on a cement layer.**

(ii) **An insecticidal barrier between the ground and woodwork in building should be made by treating the soil beneath the building and around foundations with 0.5 per cent chlorpyriphos or lindane. The solution should be applied at the rate of 5 liters per m2.**

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4. **To protect wood-work, paint it with solignum.** The cupboards, almirahs, shelves, etc. should be sprayed with lindane or chlorpyriphos frequently. The place from where the galleries originate in the house should be **either sprinkled over or injected with 0.5 per cent lindane or chlorpyriphos suspension in water.** If wooden structures have already been attacked the injection of 0.5 per cent lindane or chlorpyriphos emulsions with a hypodermic needle into the wood and in the cervices is the only remedy.

5. **Mounds of termite, if any, in the area should be treated with 0.5 per cent chlorpyriphos or lindane after breaking open the earthen structure, and making holes with an iron bar**. The insecticidal emulsion should be used at the rate of 4 liters per m of the mound

Pest of Cucurbitaceae

S.No	Pest	Scientific name	Order	Family
	Melon Fruit-fly	***Bactrocera cucurbitae***	***Diptera***	***Tephritidae***
	Red Pumpkin-beetle	***Aulacophora foveicollis***	***Coleoptera***	***Chrysomelidae***
	Red vegetable mite	***Tetranychus telarius***	***Acarina***	**Tetranychidae**

Melon Fruit-fly

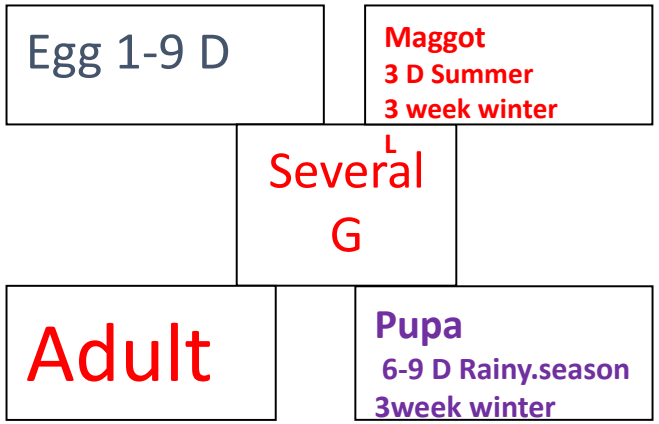
Melon Fruit-fly, *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae)

- This is the commonest and **most destructive fruit-fly of musk melon** and other cucurbits.
- **Host Plant: Tomato, chillies, guava, citrus, pear, fig, cauliflower**, etc.In north-western India, it is very common on **late-sown melons** that ripen after the monsoon rains begin. **Two other allied species** common in India are ***Dacus ciliatis*** Loew and ***Bactrocera dorsalis*** (Hendel).
- **Marks of identification:**
- **Larva**:Maggots are legless and appear as headless, dirty-white wriggling creatures, thicker at one end and tapering to a point at the other. A full-grown maggot is 9-10 mm long and 2 mm broad in the middle. **Adult** : The adult flies are reddish brown with lemon-yellow markings on the thorax and have fuscous areas on the outer margins of their wings.

➢**Life-cycle:**

This pest is active throughout the year, but the **life cycle is prolonged during winter.** The adult **flies emerge from pupae in the morning hours** and **mate at dusk**. It takes a few days for the eggs to mature inside the body of a female which starts laying them within 14 days. During winter, the pre-oviposition period is prolonged. They oviposit in comparatively soft fruits avoiding those with hard rind. The selection of a suitable site and the actual laying of eggs take about 6-8 minutes. A cavity is made by the sharp ovipositor and about a 12 **white cylindrical eggs are laid, mostly in the evening hours.**

After laying the eggs, the female releases a gummy secretion on eggs which cements the tissues surrounding the puncture and makes the entrance water proof. The **secretion solidifies to form a shiny brown resinous material**. The **female, on all average, lays 58-95 eggs in** 14-54 days.



The **eggs hatch in 1-9 days** and the maggots bore into the pulp, forming galleries. The attacked **fruits decay because of secondary bacterial infection.** The **larvae are full-grown in 3 days during summer and 3 weeks during winter.** The mature **larvae come out of the rotten fruits and jumps in soil**. these are made possible by folding and unfolding the two ends of the elongated body. They **bury** themselves **about 5 mm deep in the soil** and pupate. The **pupa are barrel-shaped,** light brown and they transform themselves into winged **adults in 6- 9 days** in the **rainy season** and **3- 4 weeks** in the winter. There are several generations in a year.

Pupae are parasitized by ***Opius fletcheri*** Silvestri, ***O. compensatus*** Silvestri and ***O. insisus*** Silv. (Braconidae), *Spalangia philippinensis* Full. and *Pachycepoideus debrius* (Pteromalidae), *Dirhinus giffardi* Silvestri and *D.Izonensis* Rohw. (Chalcididae)

Damage:

The maggots pollute and **destroy fruits by feeding on the pulp**.

The damage caused by this fruit-fly is most serious in melons and after the first **shower of the monsoon, the infestation often reaches 100 per cent. Other cucurbitaceous fruits** may also be infested up to

Management:

The regular **removal and destruction of the infested fruits** helps in the suppression of this pest. **Frequent raking of the soil** under the vine or **ploughing the infested field** after the crop is harvested can help in killing the pupae.

Apply the bait spray containing 50 ml of malathion 50 EC + 0.5 kg of gur /sugar in 50 litres of water per ha. When the attack is serious, it should be repeated at weekly intervals.

Spraying the bait on the lower surface of the leaves of maize plants grown at distance of 8- 10 cm as trap crop has been found to be effective as the flies have the habit of resting on such tall plants.

Red Pumpkin-beetle

Aulacophora intermedia

Raphidopalpa foveicollis

Red Pumpkin-beetle, *Aulacophora foveicollis* (Lucas) (Coleoptera: Chrysomelidae)

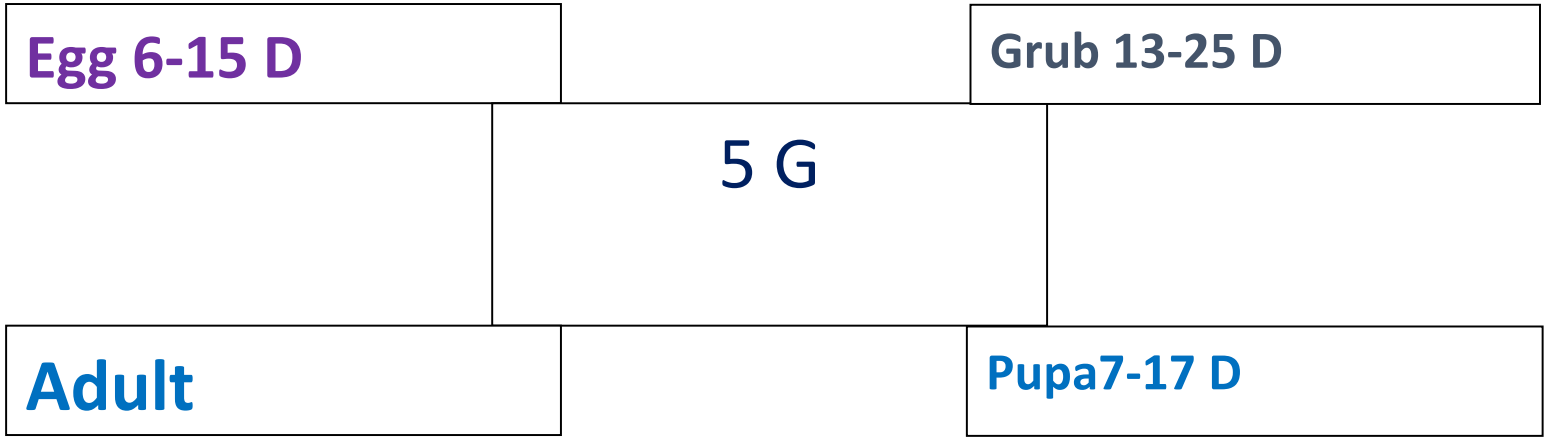
- The two species, red pumpkin-beetle, ***A .foveicollis*** and blue pumpkin-beetle, ***A. atripennis*** Fabricius are common in North-western India, the former being more important. Damage is caused by grubs as well as by beetles.
- **Marks of identification:**
- **Larva**: The **grubs lead a subterranean life** and when full-grown, they measure about **12 mm** in length and **3.5 mm across** the mesothorax. They are **creamy white,** with a slightly darker oval **shield at the back**.
- **Adult** The **beetles feed** on those parts of the plant which **are above the ground**. They are oblong and **5-8 mm long**. Their dorsal body surface is brilliant **orange red** and **ventral surface is black,** being clothed in short white hair.

Life-cycle:

The **beetles are found concealed in groups under dry weeds, bushes and plant remains or in the crevices of soil**. They resume activity as soon as the season warms up and in their **life span of 60-85 days**, they lay **about 300 oval yellow eggs singly or in batches of 8-9 in moist soil, near the base of the plants.**

The eggs **hatch in 6-15 days** and the grubs remainbelow the soil surface **feeding on roots, underground stems** of creepers and on **fruits lying in contact with the soil**. They are full-grown in **l3- 25 days** and **pupate in thick-walled earthen chambers in the soil,** at a depth of about **20-25 cm.**

The **pupal stage lasts 7-17 days** and the beetles, on emergence, begin to feed and breed. The life-cycle is completed in 26-37 days and the pest **breeds five times from March to October.**



Damage:

The beetles are very **destructive** to cucurbitaceous vegetables, particularly during **March-April when the creepers are very young.**

The **grubs damage the plants by boring into the roots,** underground stems and sometime into the fruits touching the soil.

The beetles **injure the cotyledons, flowers and foliage by biting holes into them.** The **early sown cucurbits are so severely damaged** that they have to be resown.

Management:

After harvesting the infested fields, **plough deep to kill the grubs in the soil**.

Sow the crop in November to avoid damage by this pest.

Apply 7.0 kg of carbofuran 3G per ha 3-4 cm deep in the soil near the base of the plants just after germination and irrigate or spray 375 g of carbaryl 50 WP in 250 litres of water per ha.

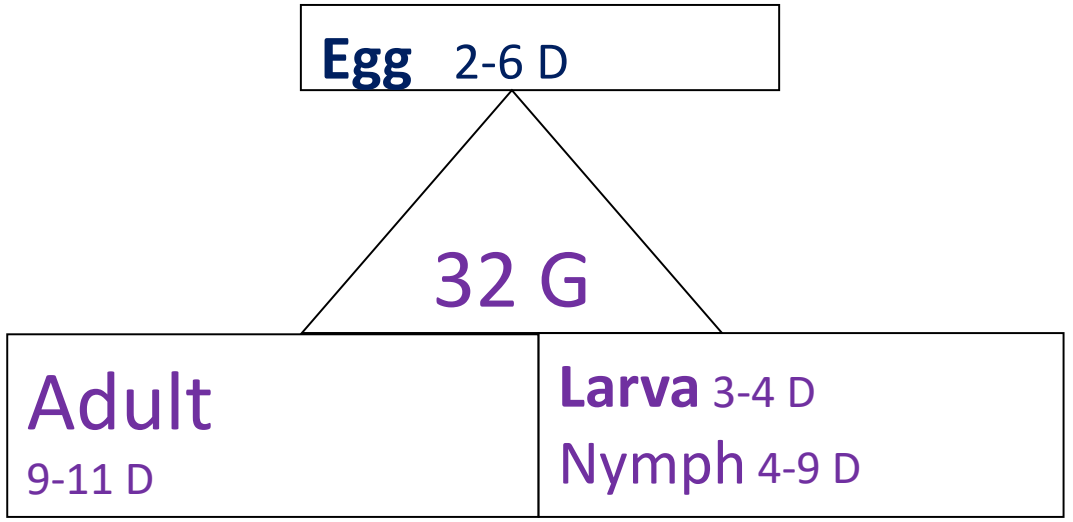
Red Vegetable Mite, *Tetranychus telarius* Linnaeus (Acari: Tetranychidae)

- The **red vegetable mite**, also called the **two-spotted spider mite**, is world-wide. The large scale use of chlorinated hydrocarbon insecticides for the control of various other pests leads to the **multiplication of mites**, since they are less toxic to mites and especially since they kill large number of the natural enemies of mites.
- **Host plants:** The mite is a **polyphagous pest** and is known to feed on **183 species** of plants including **cucurbits, brinjal and okra** on which it is occasionally very serious.
- **Marks of identification: Nymph**: A fully developed **nymph** is **microscopic and measures about 0.33 mm in length**. It is light brown and **has two eye-spots**, **four pairs of legs** and is quite active.
- **Adult**: The **adult** malemeasures about 0**.52 mm** in length and **0.30 mm** in **breadth**. The body of the female is **oval, pyriform and variable in colour**. It may be **ferruginous red, greenish amber or rusty green**. **Two large pigmented Spots are present on the body.**

Red Vegetable Mite

Life-cycle:

The **mite is active** from **March to October** and passes the winter as a gravid female. As the season warms up in March, it **spins webs on the undersurface of leaves** of various host plants and **lays 60-80 eggs**. The eggs are **spherical and hatch in 2-6 days**. The emerging **larvae are light brown** and have **three pairs of legs**. They feed underneath the **webs** and, within **3-4 days, change into nymphs** which have **four pairs of legs**. The nymphs grow to maturity in **two stages within 4-9 days** and the **adults live for 9-11 days**. The life-cycle during the active period is completed in 9-19 days. In Punjab, this mite is believed to complete 32 generations in a year.



Damage:

The **damage is caused both by the nymphs and adults.**

All the active stages usually **feed on the underside of the leaves by sucking cell sap.**

Gradually, the infested leaves dry up and the webbing interferes with plant growth. There is a poor setting of the fruits and the yield is considerably reduced.

Management. Spray 625 ml of **dimethoate 30EC** or **oxydemeton methyl 25EC** in 250 litres of water per ha and repeat spray at 10-day interval.

Pests of Mango (*Mangifera indica* : family : anacardiacea)

- Mango is considered to be the **king of all fruits** in south Asia. India is the largest producer and exporter of mango in the world. Mango is rich source of vitamin A and vitamin C. There are a number of insect pests of this fruit and over **175 species** of insects have been reported damaging mango tree but the most abundant and destructive at the flowering stage are the mango hoppers.Important pests of mango are as follows;
- **1.Mango-hopers, *Idioscopus clypealis, Amritodus atkinsoni and Idioscopus niveosparus* : Hemiptera : cicadellidae.**
- **2.Mango mealybug, *Drosicha mangiferae* (Hemiptera) : Margarodidae**
- **3. Mango stem borer, *Batocera rufomaculata* (Coleoptera : Cerambycidae) , *Batocera rubus* (Coleoptera : Cerambycidae)**

4.Mangofruit fly, *Bactrocera dorsalis* (Diptera : Tephritidae)
5.Mango stone weevil, *Sternochetus mangiferae* (coleopteran : curculionidae)
6. Mango shoot borer, *Chlumetia transversa* (Lepidoptera : Noctuidae)
7.Mango gall psyllid *Apsylla cistella* (hemiptera : psyllidae)
8.Mango bud mite, *Acerya mangiferae* (Acarina : Eriophidae)
9.Bark eating caterpillar, *Inderbella quadrinotata* (Lepidoptera : Meterbelidae)
10.Red tree ant, *Oecophylla smaragdina*, (Hymenoptera : formicidae)
11.Mango scale, *Chloropulvinaria psidi*, (Hemiptera : Coccidae)
12.Mango leaf mining weevil, *Rhynchaenus mangiferae*, (coleopteran : Curculionidae)

Mango hoppers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Mango leaf hoppers

1.Mango-hopers, *Idioscopus clypealis, Amritodus atkinsoni and Idioscopus niveosparus* : Hemiptera : cicadellidae.

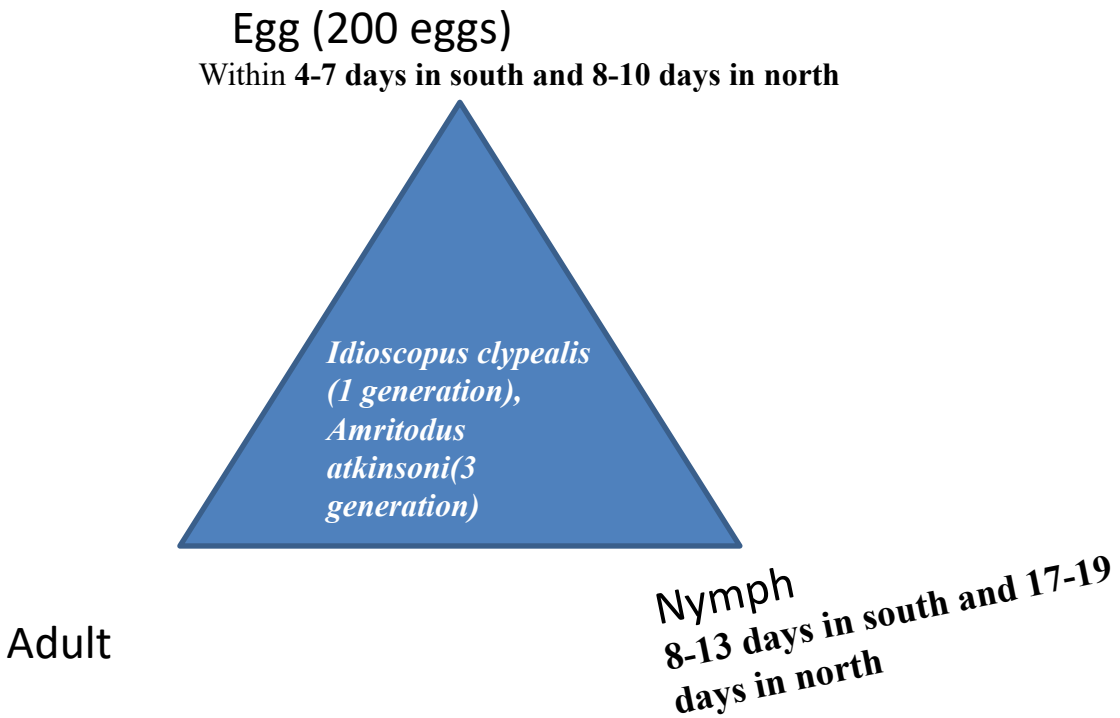
- **Mark of identification** : The newly hatched **nymph are yellow** and become active in the beginning of February. The **nymphs of *I. clypealis* are dull yellow or dust yellow**, whereas those of ***A. atkinsoni* are pale yellow**, elongated and more active.
- This insect is **triangular** in shape being **broader at anterior end narrower towards the posterior**. Adults of the larger mango hopper ***I. clypealis* measure 6.3 mm** length are **grayish**.
- Freshly hatched nymphs are wedge shaped and whitish in colour with two small red eyes.
- Gradually with each moulting, the colour changes to yellow, yellowish green, green and ultimately greenish brown.
- *A. atkinsoni* adult is about 5.1 mm long. It differ from the larger species by the absence of a central longitudinal dark streak on the scutellum.
- **Adults of mango hoppers are light greenish-brown with black and yellow markings.**

Life-cycle. This pest is **active** practically **throughout the year** but during the hot months of May-June and the cold month of October-January, only the adults are found sitting in thousands on the bark of trunk, branches etc.

The adult surviving winter **emerge in February from underneath the bark of tree and other places of shelter.** They **cluster on the floral buds and start sucking the cell- sap** .

When the **infloresence appears, they start laying eggs in them** in the **second or third week of February** and continue to do so for some weeks. The eggs are **deposited singly** and since they are **embedded in plant tissues**, it is extremely difficult to observe them under natural conditions. They commence feeding on inflorescence, quickly suck the cell sap and **excrete honeydew** ,which serve as a medium for the development of **shooty mould, *Chaetothyrium mangiferae***.

This gives **dull blackish look to the mango trees.** The **smoky black appearance persists for many months** until the fruits are mature and the crop is almost over. The full fed nymph then moult and give rise to winged hoppers.



A female deposits on an average,**200 eggs**. Within **4-7 days in south and 8-10 days in north, the egg hatch**. The **nymphal period lasts 8-13 days in south and 17-19 days in north**.

The **life cycle is complicated in 15-19 days** during the flowering season, ***Idioscopus clypealis (1 generation), Amritodus atkinsoni(3 generation)*** per year.

Damage: Mango hoppers are the **most destructive pests** of fruit tree. Injury to the inflorescence and young shoots is caused by egg laying and feeding.

The voracious feeding **nymphs are particularly harmful**. They cause the **inflorescence to wither** and **turn brown**. Even if the flowers are fertilized, the subsequent development and **fruit setting may ceases**.

A **sooty mould develops on patches of honey dew exuded by the nymphs**. As the wind blows, the young fruits and **dried inflorescence break of the axil and fall to the ground**. The growth of the young trees is much retard and the older tree does not bear much fruits. Damage to mango crop may be as high as **60 per cent.**

Management : (1) **do not go for high density planting** as it provides favourable habitat for hopper multiplication.

(2) **do not give regular irrigation** and split doses of nitrogenous fertilizers.

(3) **Avoid water logged** and or damp condition.

(4) **Pruning of branches** may be done in the **winter** to have better light interception.

(5) spray **2 liters of malathion** 50 EC or **Carbaryl 50 WP 2.5 kg** in 1250 liters of water.

Mango mealybug

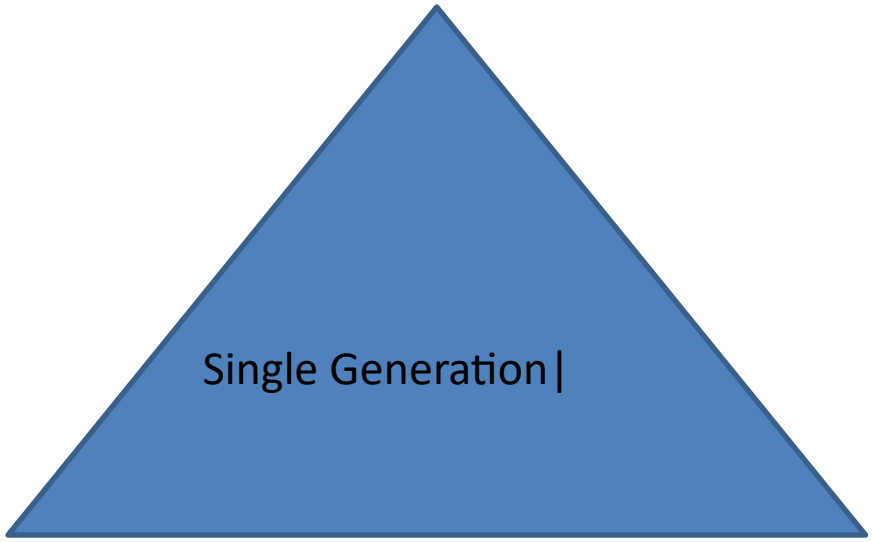
Mango mealybug, *Drosicha mangiferae* (Hemiptera) : Margarodidae.

- The mango mealybug , besides mango, attacks **62 other plants**, including such trees as **jack-fruit, the banyan, guava, citrus spp. and jamun.**

- **Mark of identification**: The **wingless females are oval, flattened and have body covered with a white mealy power.** The **male** have **one pair of black wings and are crimson red in coolur.**

- **Life cycle:** The eggs are generally **deposited in April-May in soil up to 15 cm within silken pures**. The **dead body of the female is often found sticking to them.** They **hatch at the end of December or in January (hatching period 7-9 month)** and, in a given locality continue to hatch for about one month. Thus, the nymph appears before the fresh growth of flowers on mango trees and nymphal period of female lasts for 15-35 days with 3 instars and male nymphal period lasts for 1 Week with 4 instar and a pupal period as well. The adult duration is 22-47 days.

Egg 7-9 months



Adult (22-47 D)

Nymphs
15-35 days(Females)
1 Week (Males)

The young **nymphs assend and congregate on the panicles** where they **feed on cell-sap** and pass through **three stages**. At the time of moulting the young nymphs wander away from the original feeding places in search if suitable shelters such as cracks and crevices in trunk .

After moulting, they again seek suitable feeding-sites. The third stage nymphs, however, stick to their original feeding places and destined to be females, continue feeding. The mating takes place soon after emergence of the males at a time when the females are not fully developed. The males fly about large numbers, apparently in search of their mates. They have a very strong sex instinct and during the life span of about one week they mate frequently. The **female** mature after **15-35 days** and lay eggs for 22-47 days during April-May.

Damage: The **nymphs and adult females are destructive** and they **suck plant juice**, causing **tender shoots and flowers to dry up.** The young fruits also become juiceless and drop off. The pest is responsible for causing considerable loss to the mango growers and when there is a serious attack, the **tree retains no fruit at all.**

Management:

(1) **Remove weeds** from orchards which acts as additional hosts for mealybug

(2) **Ploughing of orchards** during summer exposes eggs to natural enemies and extreme sun heat.

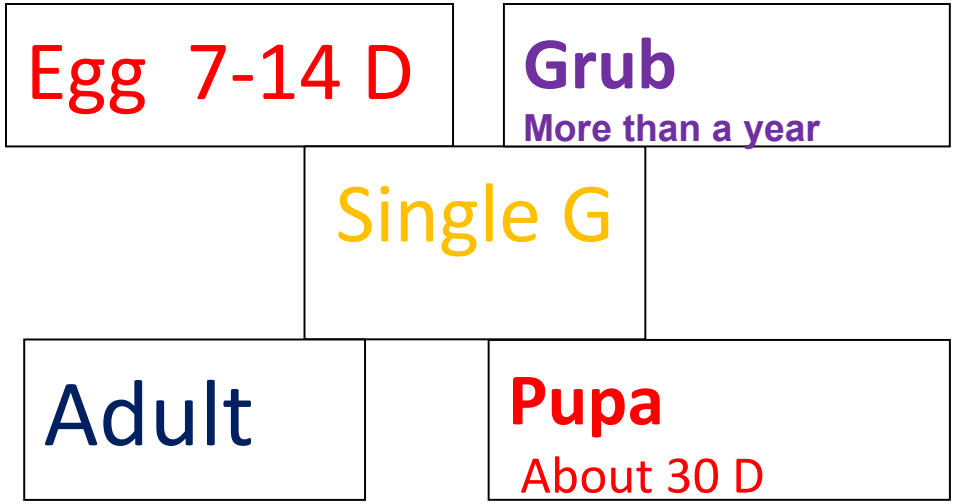
(3) Nymphs should be prevented from crawling up the tree by appling **8 cm wide sticky bands with alkthene or plastic sheets** around the trunk about 1 meter above the ground level during second week of December .

(4) The nymphs found **congregating below the lower edges of alkathene band should be killed mechanically or by spraying them with 500 ml of methyl parathion 50 EC in 1250 l of water per ha.**

Mango stem borer:

Mango stem borer, *Batocera rufomaculata, Batocera rubus* (Coleoptera : Cerambycidae)

- Host Plant: Mango stem bore is a pest of mango, fig and other tree in north – western part of the India.
- **Mark of identification** : The adults are **5 cm long and 2 cm breath, yellowish brown** longicorn beetles, well built, and large. The beetle is provided with long legs and antennae and a dirty white band, extending from the head to tip of the body on each side. A number of **dirty yellowish spots are present on the elytra**. The full grown larva is a **stout, yellowish- white, fleshy grub, measuring about 6cm in length.**
- **Life cycle** : The adult deposit eggs under the loose bark in a wounded or diseased portion of the trunk or branch. The **eggs hatch in7-14 days**. The grub are equipped with strong biting mouth parts and they penetrate into the stem or even the roots, feeding on woody tissues. Winter is passed in the grub stage in that very burrow. They make large galleries for feeding. The full grown larva then hollow out a cell for pupation. The **larval stage probably lasts more than a year and the pupal stage last about one month**. The **life cycle** may be completed **in 1-2 year.**


Egg 7-14 D
Grub
More than a year
Single G
Adult
Pupa
About 30 D

Mango wilting due to infestation by stem borer

Damage : Although the borer is not very common, yet whenever it appears in the **main trunk or a branch,** it invariably kill the host. Though the external symptoms of attack are not always visible, the site can be located from the **sap or frass that come out of the hole.**

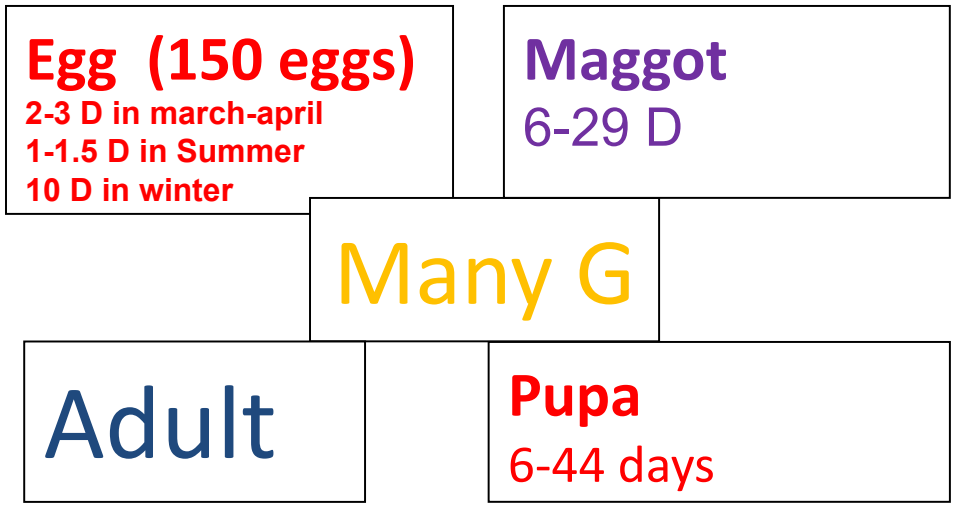
Management :

(1) **Cut and destroy** the infested branches with grub and pupa within.
(2) **Remove frass near** the hole on main stem and inject 4 ml of methyl parathion 50 EC mixed in one litre of water into the hole and plug it with mud.

Fruit fly

Mango fruit fly, *Bactrocera dorsalis* (Diptera : Tephritidae)

- The mango fruit fly or **Oriental fruit-fly** is the most serious of all fruit flies, it attacks on mango,guava, peach, apricot, cherry, pear, chiku, ber, citrus and other more than 250 plants.
- **Mark of identification** : The adult fly is stout, a little larger than the housefly, is **brown or dark brown** fly and has **transparent or hyaline wings and yellow legs**. The legless maggots are **yellow and opaque**.The other fruit flies damaging mango fruits are ***Dacus zonatus, D. correctus, D. diversus*** **and** ***D. hageni*****. Which, though less common than** ***D. dorsalis*****,** cause similar damage.



Life cycle : The adult flies **emerge in April** and start laying eggs under the rind of the ripening fruits and vegetables of the season such as guava, laquat, apricot, plum, brinjal, and later shift to mango. They lays 2-15 eggs at a time in clusters. A female lays on an average, **50 eggs** but under favourable conditions, 150 eggs are laid in one monththe **eggs hatch in 2-3 days in March April and 1-1.5 days in the summer and 10 days in winter**. As the maggot develop they pass through **3 stages** in the ripening pulp and are full grown in **6-29 days**. They leave the fruit and move away by jumping in little hope. On reaching a suitable place, they burry themselves into the soil and pupate 8-13 cm below the soil surface. In 6-44 days, they emerge as flies and reach the ripe fruit for

Damage. The damage is caused **by both maggot and adults**. The adults feed on exudation of ripe fruits and honeydew of various insects. The punctures for egg laying made by the females attract fermenting microorganisms. The maggot destroy the pulp making it **foul smelling** and **discoloured.** The fruit develop brown rotten patches on them and **fall to the ground** ultimately. The infested fruits become **unmarketable** and at times almost all of them contain maggots.

Management : (1) Avoid infestation of fruit flies **by early harvesting** of mature fruits.

(2) To prevent the carryover of the pests, **collect and destroy all fallen infested fruits** twice in a week.

(3) **Plough round the tree** during winter to expose and kill the pupae.

(4) Monitor the fruit fly population in orchards by using **methyl eugenol traps.**

(5) Spray **1.25 litres of malathion 50 EC + 12.5 kg gur or sugar in 1250 litres of water** per ha and repeat spray at 7-10 days intervals if infestation continues.

(6) After harvest dip the fruit in 5 per cent sodium chloride solution for 60 minutes to kill the eggs, if any and also to decontaminate them of insecticide residue if at all present.

Pest of Guava (*Psidium guajava)* (Family : Myrtaceae)

Guava fruit fly, *Bactrocera dorsalis* (Diptera : Tephritidae)

- The guava fruits are attacked by five species of flies, viz., ***Bactrocera dorsalis, B. diversus, B.curcubitae, B. nigrotibialis and B. zonata,*** however, among these, the former two are most common and serious pests of guava.
- **Mark of identification** : The **adult is stout**, a little larger than the housefly, is **brown or dark brown** fly and has **transparent or hyaline wings and yellow legs**. The **legless maggots** are **yellow and opaque.**The other fruit flies damaging mango fruits are ***Dacus zonatus, D. correctus, D. diversus*** **and** ***D. hageni*****.Which, though less common than** ***D. dorsalis*****,** cause similar damage.

Life cycle : The adult flies **emerge in April** and start laying **eggs under the rind of the ripening fruits** and vegetables of the season such as **guava, laquat, apricot, plum, brinjal, and later shift to mango.** They **lays 2-15 eggs** at a time in clusters. A female lays on an average, **50 eggs** but under favourable conditions, **150 eggs** are laid in one monththe **eggs hatch in 2-3 days in march april and 1-1.5 days in the summer and 10 days in winter**. As the maggot develop they they pass through **3 stages** in the ripening pulp and are full grown in **6-29 days**. They leave the fruit and move away by jumping in little hope. On reacing a suitable place, they burry themselves into the soil and pupate 8-13 cm below the soil surface. In **(Pupa)6-44 days,** they emerge as flies and reach the ripe fruit for further multiplication. The **life cycle** is completed in **2-13 weeks** and **many generations** are complicated in a year.

- **Damage**. The damage is caused **both by maggot and adults**. The **adults feed on exudation of ripe fruits and honeydew of various insects**. The punctures for egg laying made by the females **attract fermenting microorganisms.** The **maggot destroy the pulp making it foul smelling** and **discoloured.** The fruit develop brown rotten patches on them and **fall to the ground** ultimately. The infested fruits become **unmarketable** and at times almost all of them contain maggots.
- **Management :** (1) a thorough **clean cultivation/ sanitationof orchard** is essential in reducing the **pests infested fruits and bury them in at least 60 cm deep pit.** The pit may be covered with clay after every 2-3 days and should not be allowed uncovered for a longer period.

(2) **Avoid taking rainy season crop** which may get heavily infested by the pest.

(3)**Plough** and **stir the soil well before june- july** to expose and **kill pupae**.

(4) **harvest the fruit** when **slightly hard and green** in colour.

(5) **Fix methyl eugenol based PAU fruit fly traps @ 40/ ha** in the **first week of july** and recharge the same if required.

(6) in orchards spray **3.15 liters of fenvalrate 20 EC in 1250 litres of water/ ha at weekly intervals** on ripening fruits from july onwards till the rainy season crop is over, **fruit should be harvested** at least **after 7 days of spray.**

Pests of Citrus (Citrus spp) (family: Rutaceae)

Citrus psylla, *Diaphorina citri* (Hemiptera: Aphalaridae)

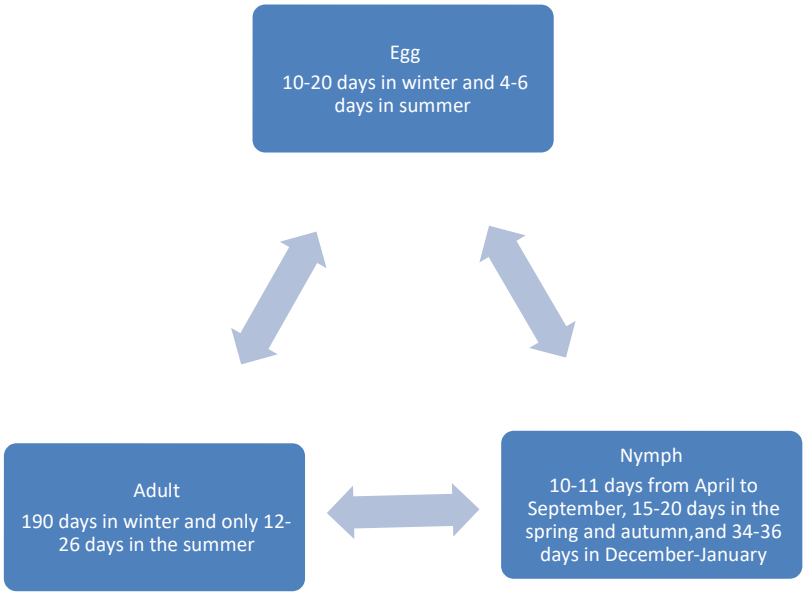
Appearance:The insect is brown with its head lighter brown and pointed. The wings are membranous, semitransparent; with a brown band in the apical half of the fore wings.The hind wings are shorter and thinner than the fore wing. The nymphs are flat, louse like, orange yellow creatures, and are seen congregated in large number on the young leaves and buds in February –March. The adult tail end body being turned upward.

Host plant: On all species of citrus and a number of other plant of the family Rutaceae. It is the most destructive pests of all the citrus pests.

Active period:Winter, February –March.

Citrus psylla

life cycle: The female lay ,on an average 500 almond- shaped, orange and stalked egg on tender leaves and shoots of citrus tree. The eggs hatch in 10-20 days in winter and 4-6 days in summer. There are five nymphal stsges and the development is complited in 10-11 days from April to September, 15-20 days in the spring and autumn,and 34-36 days in December-January. The female live longer than the males, and the duration may be as long as 190 days in winter and only 12-26 days in the summer. There are 8-9 overlapping generation in a year.

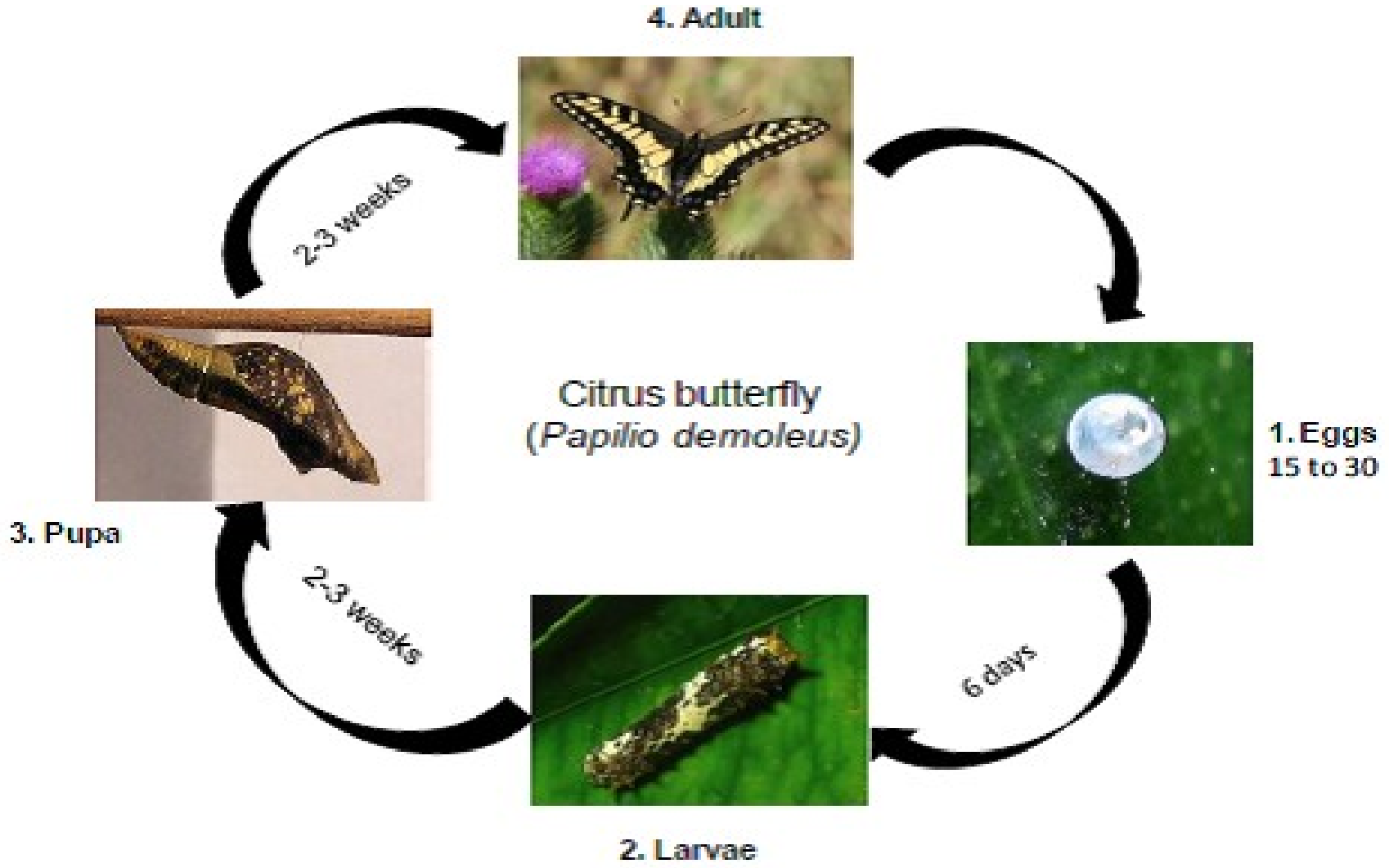


Damage: Damage is caused by nymph and adult. With the help of their sharp, piercing mouth parts, they suck the cell-sap in millions. The vitality of the plants deteriorates, and the young leaves and twigs stop growing further. The leaf-buds, flower, buds and leaves may wilt and die. The fruit formed in the spring fall off prematurely. Moreover, the nymph secrete drop of a sweet thick fluid On which a black fungus develops, adversely affecting photosynthesis. It is also thought that the insects produces a toxic substance in the plants as a result of which the fruit remain undersized and poor in juice and insipid din taste. This insect is also responsible for spreading the greening virus.

Management: (1) Tetrastichus radiates (Eulophidae) is an important parasitoid of nymphs. A number of lady bird beetles , viz. *Coccinella septeumpunctata, C.transversalis, Menochil chilus sexmaculatus, , Brumoides suturalis and Chrysoperla carnea* larvae also feeds on nymphs.

(2) Spray 1.70 liters of dimethoate 30 EC or 1.50 liters of monocrotophos 36 SL in1250liters of water per ha during February- March (Spring flush) May- June (before rainy season) and July- August (after rainy season).

Citrus Butterfly



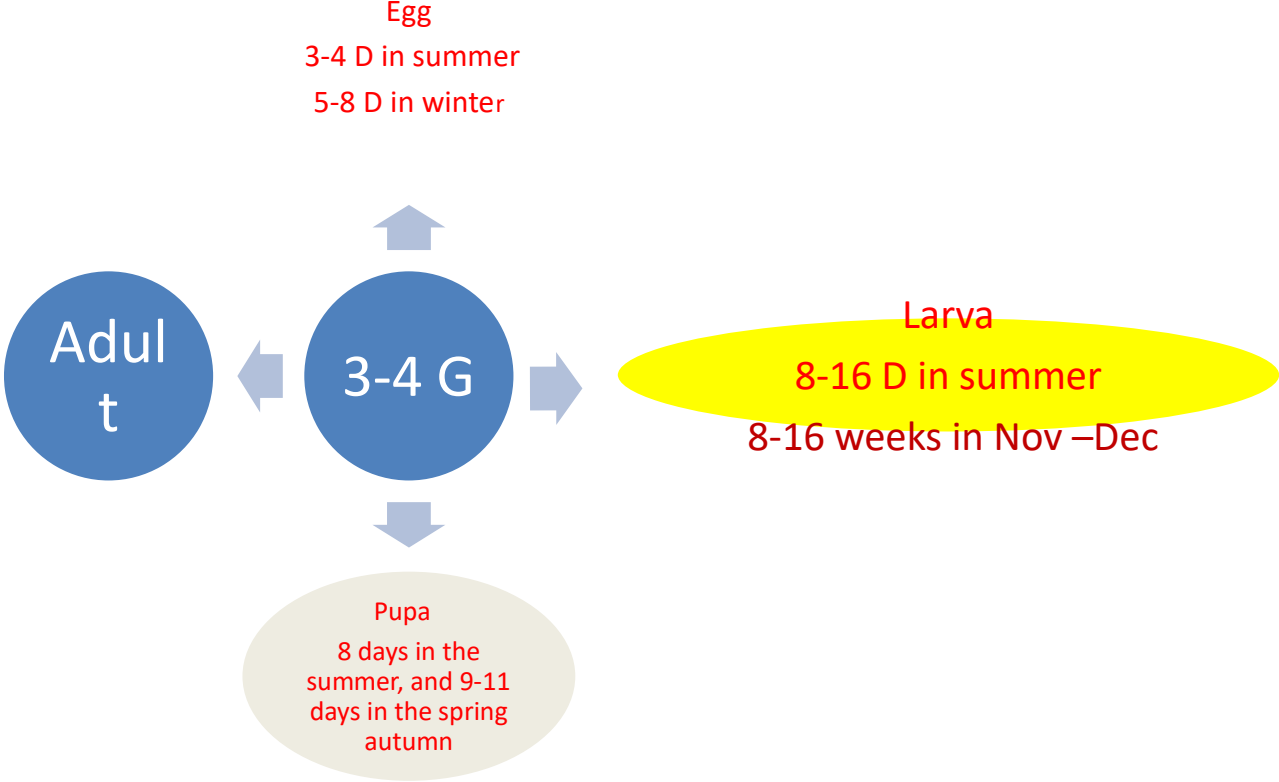
Citrus caterpillar, *Papillio demolleus* (Lepidoptera:papilionidae)

Appearance: Caterpillar is yellowish green, horn like structure in the dorsal side of the last body segment (40 mm L and 6.5mm W). the adult is a large beautiful butterfly with black and yellow marking on the fore wing, there being a creamy- yellow colouration on the under side of the abdomen.

Host plant: Feed and breed on all varieties of cultivated or wild citrus and various other species of family Rutaaceae.

Active period: This pest is most active in September and October.

Life cycle: The butterfly appears in March and lays egg in tender shoots and fresh leaves mostly on the undersurface. The eggs are placed singly or in group of 2-5. The eggs are glued firmly on to the surface of the leaf and are pale or greenish yellow in colour. They hatch in 3-4 days during summer and 5-8 days in winter. The larval life lasts 8-16 days in the summer and about 8-16 weeks during November –December. The black or brown and white markings make the larvae look like bird droppings. The pupal stage lasts about 8 days in the summer, and 9-11 days in the spring autumn. The pests posses 3-4 generation in a year. Since there is an over lapping generation in a year, all the stages of the pests are found throughout the year.



Damage: The young larvae feed only on fresh leaves and the terminal shoots. Habitually, they feed from the margin inwards to the midrib in later stages, they feed on mature leaves and sometimes the entire plant may be defoliated. This pest particularly devastating in nurseries and its damage to foliage seems to synchronize with fresh growth of citrus plants in April and August- September. Heavily attacked plants bear no fruit.

Management:

(1)The egg parasitoids associated with this pests are *Trichogramma evanescens* and *Telenomus sp* while the larvae is parasitized by *Brachymerria sp.*

(2) hand picking of various stages of the pest in nurseries and field and their destruction will suppress their population.

(3) Spray Bacillus thuringiensis , DD-136 and neem seedextract (3%) give effective control.

(4) spray following insecticide%

(a) quinalfps 25 EC @ 2.0 liters

(b) Indoxacarb 1 ml/lit of water should be sprayed.

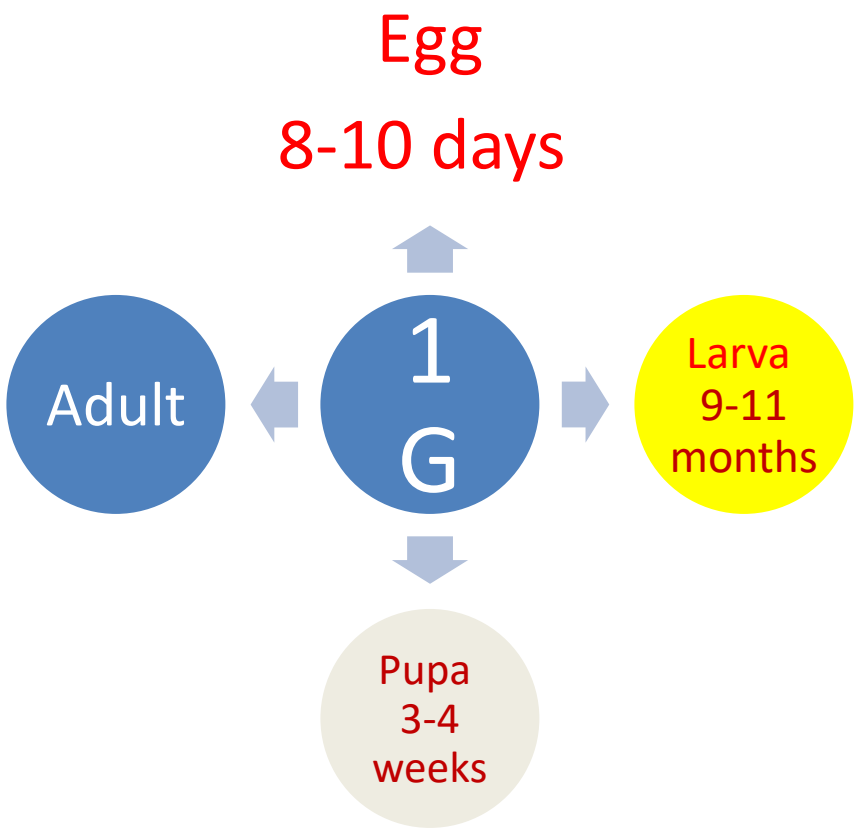
Bark eating caterpillar

Bark eating caterpillar, *Indarbela quadrinotata*, Lepidoptera : Metarbelidae.

Host Plant: The bark-eating caterpillars feeds on a number of forest and ornamental trees. It also feed on citrus, mango, guava , jamun, laquat, mulberry, pomegranate, ber, drumstick, litchi, amla, rose

Mark of identification: The adults are pale brown moths with rufous head and thorx. The fore wings are pale rufous with numerous dark rufous bands. Their hind wings are fuscous. The freshly larvae are dirty brown while the full grown caterpillars (50-60mm) have pale brown body with dark brown heads.

Life cycle: The female lays eggs in cluster of 15-25 eggs each, under the loose bark of the trees. As many as 2000 eggs may be laid by a single female. The egg hatch in 8-10 days and the freshly hatched larvae nibble at the bark and after 2-3 days bore inside. The larvae have the habit of making webs along the feeding galleries and the webs above them have a zig-zag shape and contain wooden frass and excreta. The larvae take as many as 9-11 months to complete development.When full grown, they make hole into the wood and pupate inside. The pupal stage lasts 3-4 weeks. The moth emerges in summer and they are short lived. Only one generation is completed in a year.



Damage: Thick ribbon like, silken webs are seen running on the bark of the main stem especially near the forks. The larva also make holes as many as 16 may be seen in a tree, one caterpillar occupying each hole. A severe infestation may result in the death of the attacked stem but not of the main trunk. There may be interference with the translocation of cell sap and thus arrestation of growth of the tree is noticed with the resultant reduction in its fruting capacity.

Management: (1)Clean cultivation is essential to prevent infestation of these borers.

(2)As soon as infestation is noticed, kill the caterpillars mechanically by inserting an iron spike into the holes made by these caterpillars.

(3) During February –March insert into the borer holes insecticides-soaked cotton sweb or plugs (with the help of metallic spike) and plaster on the outside with mud.

(4) The insecticides for 10 litres of water are 2 ml dichlorvos 76 EC or 5 ml methyl parathion or 10 ml monocrotofos 36 SL . These chemicals should be applied after removing webbings.

(5) Treat all alternate host plants in the vicinity of the orchard.

Pest of Pomegranate

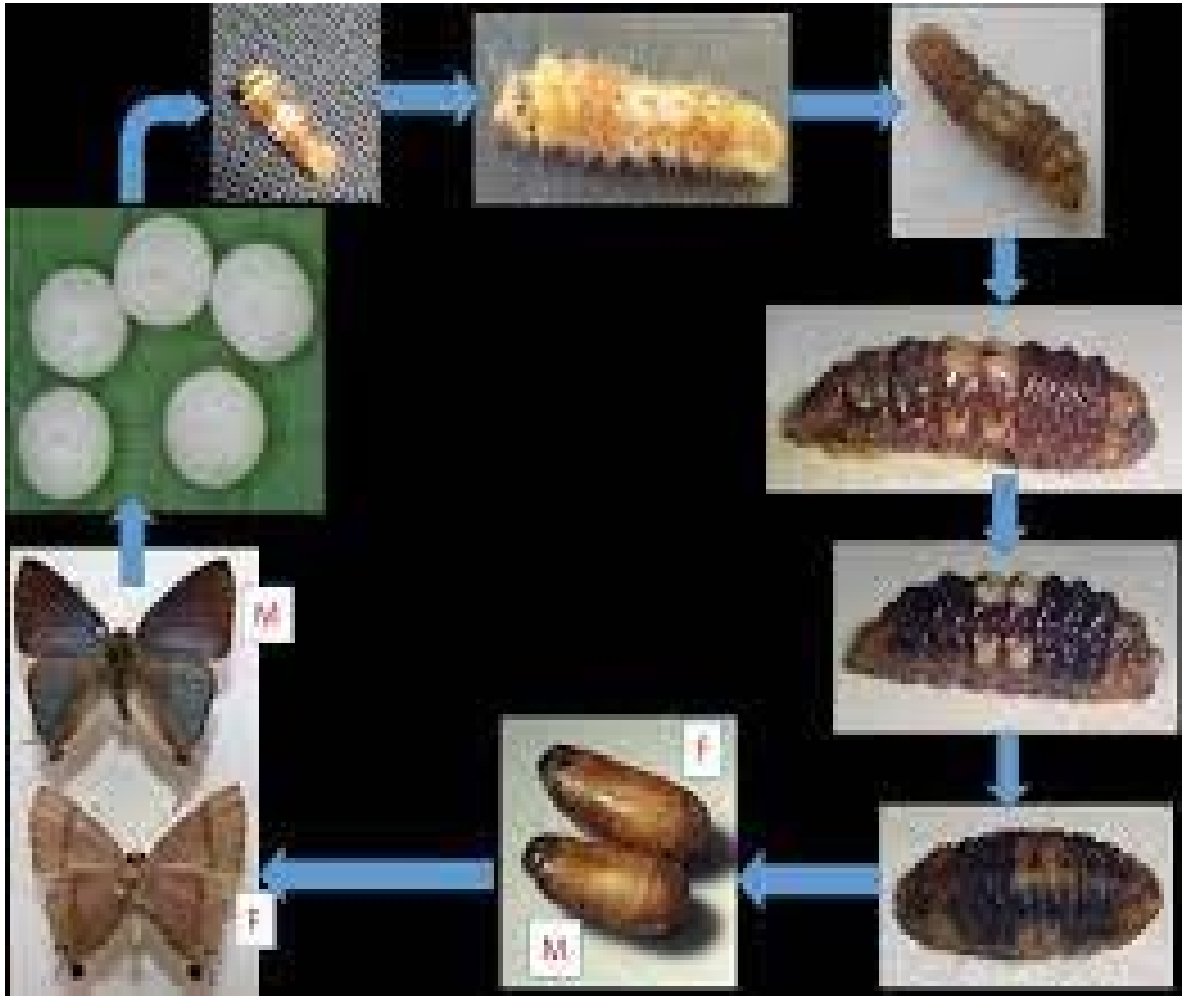
Anar Butterfly, *Virachola Isocrates* or *Deudorix Isocrates* (Lepidoptera: lycaenidae)

- **Appearance**: Butterfly: Male is **bluish-vilot** while , Female is **brownish violet**, with an **orange patch** on fore wings .
- Host Plant: Apple, ber, citrus,guava, litchi,loquat,mulberry, peach, pear, plum, sapata, tamarind.
- Caterpillar, **dark brown** and have short hair and **whitish patches** all over the body.

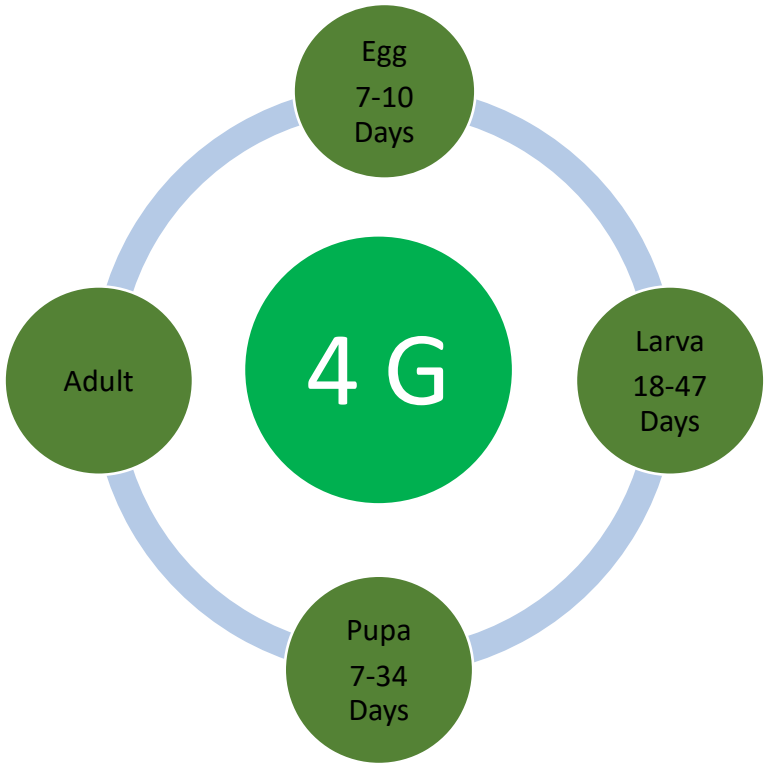
This is a polyphagous pest.

Anar Butterfly

Damaging Symptoms



- **Life cycle:** The female butterfly lays shiny white oval shaped eggs on the calyx of flower and on small fruits.
- The eggs hatch in 7-10 days. The larval period lasts for 18-47 days
- They pupate inside the fruit but occasionally may pupate outside even attaching themselves to the stalk of the fruit.
- The pupal period lasts 7-34 days.
- There are 4 over lapping generations in a year.



Damage: The caterpillar damage the fruit by feeding inside and riddling through the ripening seeds of pomegranate. As many as eight caterpillars may be found in a single fruit.

The infested fruits are also attacked by bacteria and fungi which cause the fruit to rot.

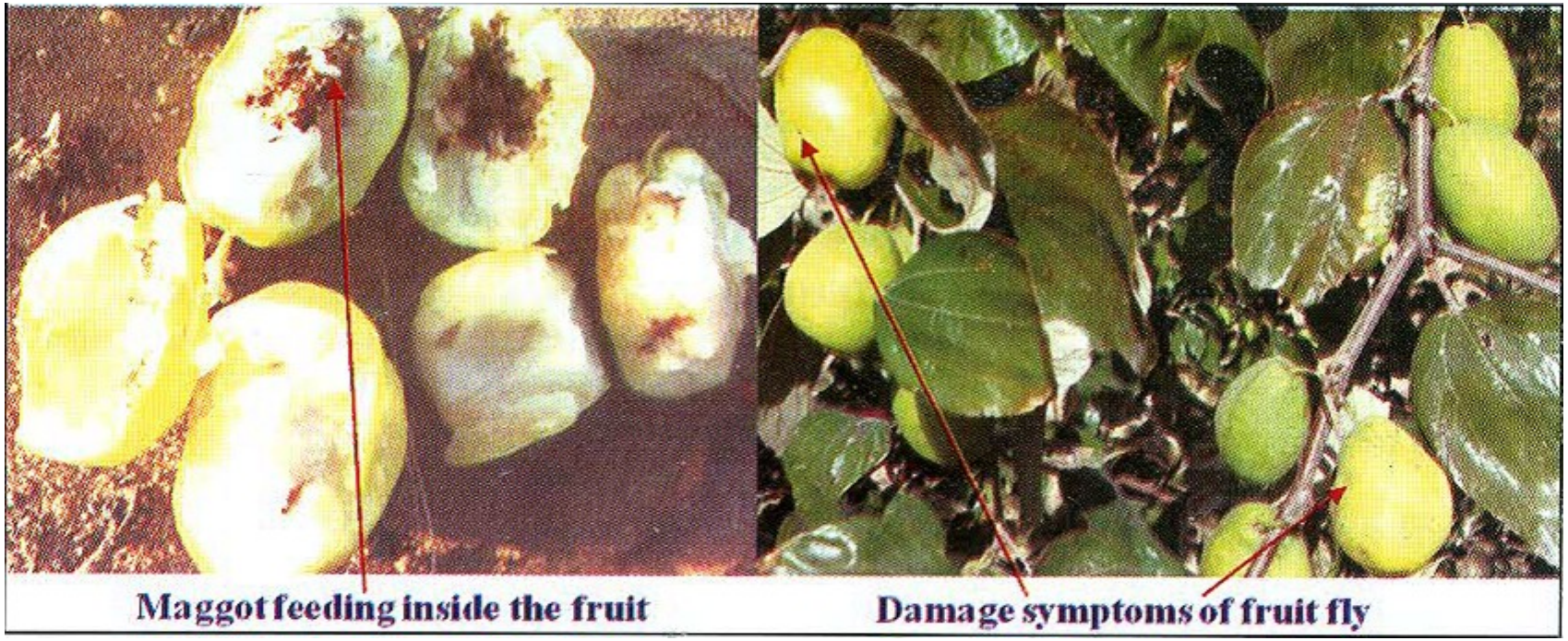
The affected fruits ultimately fall off and give an offensive smell. This pest causes 40 to 90 per cent damage.

Management:(1) Bagging of fruits before maturity will help in checking damage.
(2) Collection and destruction of fallen infested fruits prevent build up of the pest.
(3) Remove flowering weeds especially of compositae family.
Spray young fruits with 1.75 liters of qunalphos 25 EC in 1250 liters of water per ha during May-June at 15 days interval. 2-3 sprays are enough.

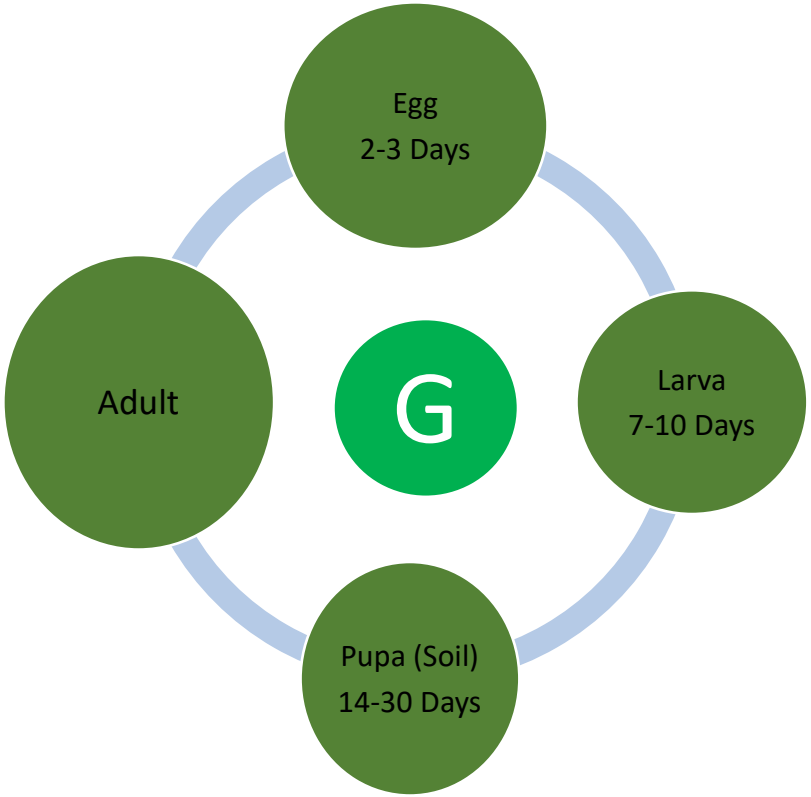
Pests of Ber (*Zizyphus mauritiana*, family: Rhamnaceae)
Ber fruitfly, *Carpomyia visuviana* (Diptera: Tephritidiae)

Appearance: Adult fly: **Brownish yellow**, with **brown longitudinal stripes on the thorax** surrounded by black spots on the side and back of the body.
Greyish brown spots on the wings and **bristly hairs on the tip of the abdomen.**
Larvae: Creamy white and slightly smaller than the other fruit flies.
Host plant: *Zizyphus mauritiana,Z. jujube and Z. sativa*.
Active period: August to mid November.

Ber fruitfly



Life cycle: The flies lays eggs in skin of fruit. The egg hatch in 2-3 days .The larval period lasts for **7-10 days**. The **pupal stage** lasts for **14-30 days**.There are **2 to 3 brood** in a year. The pest is active in winter and hibernate in the soil from April to August in the pupal stage in the soil.



Damage: The fly make **cavities in the skin of fruit.**

The **maggots feeds on the flesh** of the fruit, making **galleries toward the center.**

Such fruits **rot near the stone.** There are as many as **18 maggots** have been recorded in a fruit.

The **fruit become deformed** and there is **no further growth of the fruit** in the vicinity of this puncture.

Fleshy varieties of ber are more seriously damaged than the less fleshy ones.

The attacked fruits are **rotten near the stones and emit a strong smell.**

Management:

(1) Collect and destroy the fallen infested fruits at alternate days.

(2) Rake the soil around the trees during the summer to expose the pupas to heat and natural enemies.

(3) To escape egg laying on fruits, do not allow the fruits to ripe on the tree, harvest at green and firm stage.

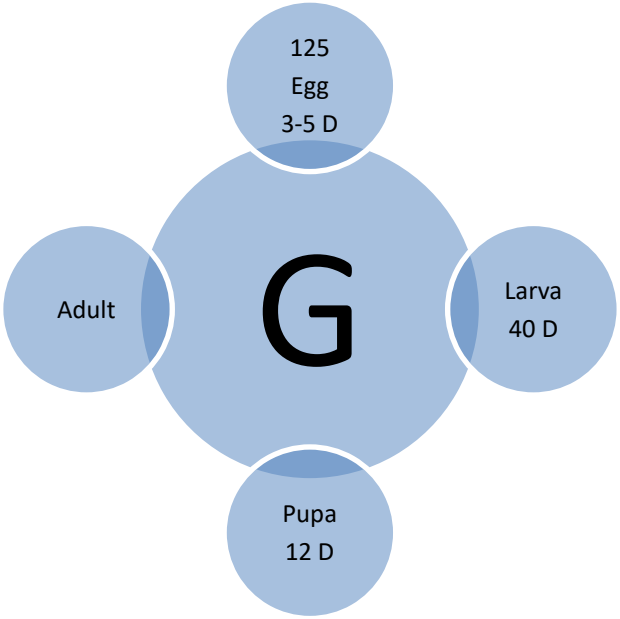
(4) Spray 1.25 liters of dimethoate 30EC in 750 liters of water ha^{1} during pea fruit stage.

Pests of coconut

Black-headed caterpillar, *Opisina arenosella*, Lepidoptera : xyloryctidae.

This is one of the most important pests of coconut palm. The moth is **ash grey coloured**. It is medium sized, measuring **10-15 mm,** with wing expance of **20-25 mm.**

Life cycle.A female moth lays **125 scale like eggs** in small batches on the **underside of tip of old leaves.** Freshly lays eggs are **creamy white and turn pink** on completion of embryonic development. The **incubation period** lasts about **3-5 days** in summer and **10 days in winter**. The larvaa feedson green matter and simultaneously construct silken galleries in which it feeds and voids frass. When full grown in about **40 days**, the larva transformed itself into a brownish pupa inside the gallery. Within about **12 days**, a whitish moth emerges and starts the life cycle all over again. The caterpillar is paracitized by ***Apanteles taragammae***, **Bracon brevicornis**,and ***Elasmus nephantidis***. Inundative release of native parasitoids, ***Goniozus nephantidis*** *and* ***Bracon brevicornis*** at 3000 and 4500 per ha respectively have given encouraging results for management of black head caterpillar.



- **Damage:**As a result of the **numerous galleries** made by the feeding caterpillars, the foliage dries up. infested tree can be located or recognize from the **dried up patches in the fronds**. In cases of severe attack due to large scale drying of leaflets, the whole plantation presents a **burnt up appearance** from a distance, results in a considerable reduction in yield.
- **Management:** apply **2.5 liters of chloropyrifos** 20 EC in 625 litres of water per ha.

Pests of apple

San jose scale, *Quadraspidiotus perniciosus*

(Hemiptera : Diaspididae)

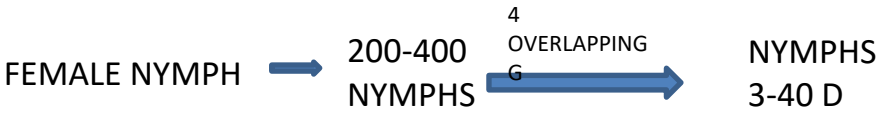
Appearance: The scale which forms a covering on the body of the insect is black or brown. Underneath, a lemon-yellow insect is visible when the covering is lifted.

Host plant: Prefer Rosaceae family plants such as plum, pear, current, willow, hawthorn and rose.

Active period: March to December

San José scale damage on apple fruit (left). San José scale black cap stage (center), female (upper right) and male (lower right). *[Photos courtesy of Greg Krawczyk (Penn State University), E. Beers (Washington State University) and S. Schoof (North Carolina State University).]*

Life cycle: The San jose scale gives birth to young ones, each female may give birth to 200-400 nymphs. They become full- grown in 3-40 days and the females again start giving birth to young ones within the next 10-14 days. The gravid mothers live for about 50-53 says. The male hardly live for 24-32 hours. Four over lapping generations are completed in a year.



Damage: The nymph find a suitable place on the host, they insert their mouth parts in to the plant tissue and benign to feed by sucking the cell-sap. All the parts of the plant above the ground are attacked and the injury is due to loss of the cell-sap . At first, the growth of the infested plant is checked, when the scale increases in number, the infested plant may die.

Management: (1) Sanitation of orchard, infested pruned material should be collected and brunt.

(2) The parasite *Encarsia perniciosi* and *Aphytis sp*. Proclia may be released to checke the overwintering on the wild host plant.

(3) To check the plant in nursery, apply carbofuran granules @ 0.75- 1.0 g a.i. per plant.

(4) Spray 625 ml of methyl parathion 25EC in 500 liters of water.

(5) Spray diesel oil emulsion+Bordeaux mixture (diesel oil 68 ltrs+ copper sulphate 15 kg +unslacked lime 3.37 kg) to be emulsified and diluted 5-6 times before spraying.

Woolly apple aphid

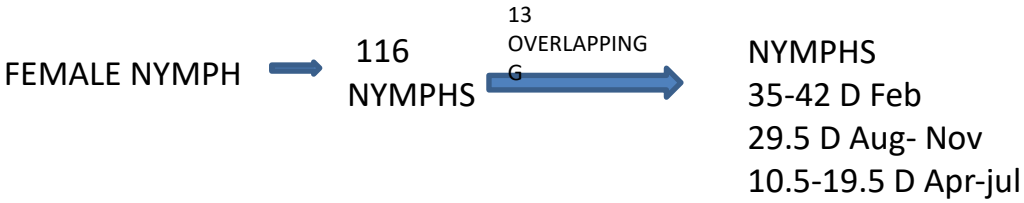
Damaging symptoms

Winged Adult

Woolly apple aphid, *Eriosoma lanigerum*
(Hemiptera : Aphididae)

- **Appearance**: Purplish aphid covered with white cottony mass.
- **Host plant**: Apple, pear, crab-apple, howthorn and mountain ash etc
- **Active period**: March to December.

Life cycle: The aphids reproduce parthenogenetically and the progeny thus produced, consists of females only. Each female may produced up to 116 young ones in her life time . There are four nymphal instar and the duration of each varies according to the season. The total duration of nymphal period is 35-42 days in February, 29.5days in August-November, and 10.5-19.5 days in April-july. There may be 13 generations in a year. There is a partial migration from aerial parts to the roots of infested plants (**December**)and the reverse migration from the roots to the aerial parts takes place in(**May**).



Damage: Both **nymphs and adults suck the cell-sap from the bark of the twigs,** fruit stalk, calyx and from the roots underground. **Swelling or knots appear on the roots** which hinder the normal plant functions. Owing to the loss of cell-sap, the twigs also shrivel and the young nursery plants may die quickly.

Management: (1) Use of resistant root stock like **Golden Delicious and Northern Spy.**

(2) Release specific parasitoid ***Aphelinus mali*** which attacks the 4^{th} and 5^{fth} stage nymph.

(3) Select healthy plants from nursery and treat them with **chloropyriphos 0.5 %** before planting.

(4) During **leaf fall** stage spray the plants with **methyl parathion 3.0** ltrs in 1250 ltrs of water per ha,spray **oxydemeton methyl 25 EC 3.0 ltrs in 1250** ltrs of water for **controlling root forms**. Spray the plants **with malathion 50 EC 2** ltrs in 1250 ltre of water during **summer.**

(5) Carry out fumigation against root forms with **paradichlorobenzene granules** in 15 cm deep trench dug around the infested tree,about 2 meters from it.

Pests of ornamental crops

- Rose is an important ornamental crop grown throughout India in open and greenhouse conditions. The crop is attacked by a large number of pests. In the present lecture students will be taught about the host range, identification, nature of damage, life cycle and management of different pests attacking this crop.

1. **Rose aphid, *Macrosiphum rosaeformis* (Aphididae: Hemiptera)**

- **Distribution:** In India this aphid has been reported on rose in Punjab, Delhi, Karnataka, Mysore, Andhra Pradesh and Nilgiri hills
- **Host**: **Rose**
- **Mark of Identification:** Small (about 2.5 to 2.6 mm long) wingless aphids having elongated body, **large red eyes, black cornicles and a yellowish green tip of abdomen.**

- **Damage:**The aphids **suck the sap from the tender parts** Particularly to leaves,tender buds, and twigs, resulting in the disfigurement and withering of flowers. Each aphid makes several punctures producing wounds.A black fungus also develops on the honey dew giving ugly appearance to the plant. **Deteriorates** the market value of the produce.

- **Life cycle:**The pest is **active from November to April** in North India. **Nymphal development** of **non winged is complted** in 11-14 days and of **winged forms in14-19 days**. The growth is quickest in March. Population starts increasing from November and is highest during March. There is an **increase in winged forms from December on wards with peak in March (90% winged).**The **pest multiplies most rapidly in late spring but can not withstsnd the summer heat** and with the **increasing in temperature its population declines.**
- Management: The **pest can be controlled** by spraying the crop with **oxy-demeton methyl (0.025%) or phosphamidon (0.03%) or malathion (0.05%)** as soon as the attack is noticed.Natural enemies like **coccinellids, syrphids, chrysopids,** etc. also take care of these aphids.Avoid application of insecticides when these natural enemies are active.

2.Hollyhock tingid bug, Urentius euonymus (Hemiptera :Tingidae)

- **Hosts**: Garden *hollyhock, Althcea rosea, Abutilon indicum, Sida cordifolia* and *Chrozophora rottleri*.
- **Mark of Identification:** The bugs are about 5-6 mm in length having densely reticulate body and wings . The nymphs are spiny in appearance.

- **Damage**: Both nymphs and adults suck the cell sap from the under surface of leaves. The infested leaves become pale yellow then turn brown and ultimately dry up after shriveling.

- **Life cycle:**
  - ✓ This pest appears from March to June Adult females lay eggs on the upper surface of leaves
  - ✓ The incubation period is 8-10 days
  - ✓ There are five nymphal instars
  - ✓ nymph period is 15-27 days
  - ✓ The full developmental life cycle is completed on a single leaf.
  - ✓ The pest over winters in egg stage.
- Management: Spray dimethoate @ 0.05% and Oxy de meton methyl 0.03%. (500-600ml insecticide /ha)

3. Jasmine budworm *(Hendecasis duplifascialis)*

- Mark of Identification of the pest:

  Larva is yellowish green in colour with pale body hairs and black head. Adult - small white moth with black wavy lines on hind wings and abdomen.

- Symptoms of damage :

  Caterpillar makes hole on the flower bud and feeds on the inner content. The larva feeds voraciously on the corolla leaving only the corolla tube in mature buds. In case of younger buds, the larva remain outside the buds and feed in the inner floral whorl through a small hole in the corolla tube. The infested flower turns violet and eventually dries out. A single larva may damage 6 flower bud. During heavy infestation, the adjacent buds along the inflorescence are webbed together by silken thread. buds. Larva attacks 2 -3 buds Petals are eaten by the larvae.

Life cycle: The freshly laid eggs are round, creamy and glued to flower buds. The eggs hatch in 2.6 to 3.5 days and the larvae passes through five instar. The total larval duration varies from 11.5 to 17.0 days depending up on the jasmine species. The pupal stage lasts 6.5 to 9.0 days and the life cycle is completed in 21 to 29 days.

- **Management**
  - ✓ Collect and destroy the damaged buds with larvae
  - ✓ Use light trap to attract and kill the adult moths
  - ✓ Spray NSKE 5% or malathion 50EC 2ml/lit
  - ✓ Spray 500 ml of Dimethoate 30 EC or cypermethrin 25EC in 500lt of water/ hac.
  - ✓ Proper pruning and hygienic maintenance of bushes

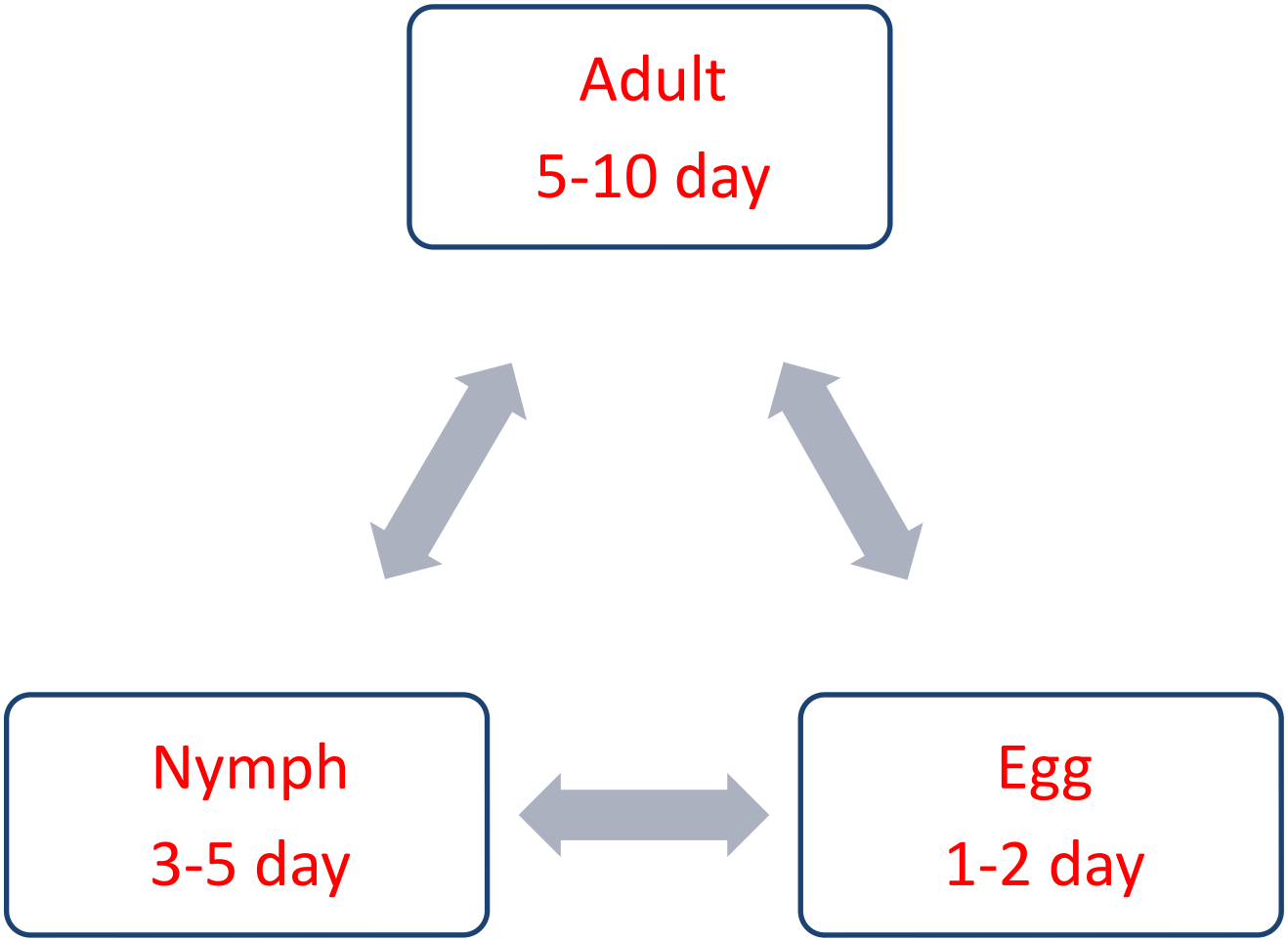
Pest of spices and condiments

- India is the home of spices, is the largest producer and consumer of spices. During 2012-13, spices were grown in 3.08 million ha and production was 5.74 million tonnes
- Since spices come from different parts of plants, belonging to a number of families, the pests that have adopted themselves to feeding on these aromatic plants are also of different types. Apart from the field pests of the Spice plants, a number of insect pests of stored products also damage spices in storage.

1. Fennel aphid *Hyadaphis coriandri* Das. (Hemiptera: Aphididae)

- Mark of identification: The first instar nymphs are dull white and became light green in the second instar. The third instar nymphs and adults turned green. Adult: Adults are yellow-green in color, dusted with greyish wax.
- Biology:
- Egg: The females produce wingless off spring which are mated by the males and then lay hard-shelled eggs on the branches. The eggs initially are greenish, but soon turn black. In this form the aphids survive the winter. In Spring the eggs hatch to wingless females which produce winged off spring by parthenogenesis.
- Nymph: There were three nymphal instars. The first instar nymphs were dull white and became light green in the second instar. The third instar nymphs and adults turned green. Adult: Adults are yellow-green in color, dusted with greyish wax. They have short, dusky, slightly swollen, siphunculi (or cornicles) that are about twice as long as wide.

Life cycle



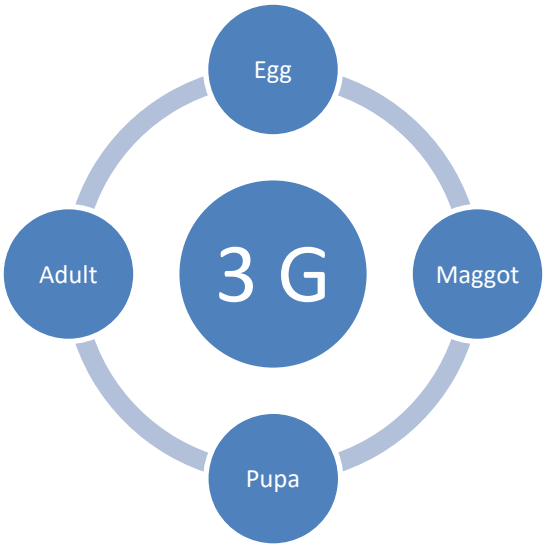
- Damage symptoms:
- Direct damage: Aphids damage plants by puncturing them and sucking their juices. They damage the young and soft parts of plants, such as new leaves and shoots. Signs of damage are leaves not opening properly and being smaller in size. Severe infestation can cause shoots to wilt and dry out.
- Indirect damage: Aphids have wings and can move from plant to plant spreading viral diseases, picked up from infected plants. Aphids secrete a sugary liquid that stimulates black sooty mold growth. It can cover the surface of leaves which affects the way they absorb sunlight.

- Natural enemies of aphid:
  - ✓ Parasitoids: *Lysiphlebus sp, Diaeretiella sp*, Aphelinus sp, *Aphidius colemani* etc.
  - ✓ Predators: Ladybird beetle, lacewing, spiders, hover fly etc.
- Cultural control:
  - Spray pressurized water
  - Use yellow and blue sticky traps @ 4-5 traps/acre for aphid and thrips, respectively, before flowering.
- Biological control: • Release *Coccinella septumpunctata* @ 2000 beetles/ acre (2 releases at 15 days interval)
- Chemical control: Spray systemic insecticide.

Seed Midge, *Dasyneura leguminicola* (Lint.) (Diptera: Cecidomyiidae)

- This is a tiny, delicate, mosquito like fly that has a bright-red abdomen. It lays eggs on or near the flower heads of clover crops, principally red clover. The newly hatched larvae wriggle into the unopened flowers. They suck the sap from the ovaries and keep the ovules from undeveloping.
- The seed crop may be heavily damaged or destroyed.

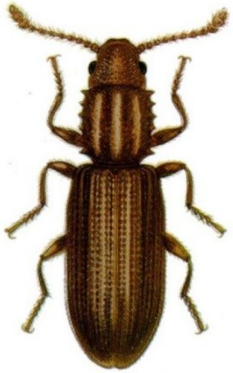
- **Life cycle:** Development of the clover midge is closely correlated with weather and is particularly dependent on rainfall. Three generations are produced each year in the Northwest. The seed crop is grown from May to August; it is the summer generation of midges that damages it.

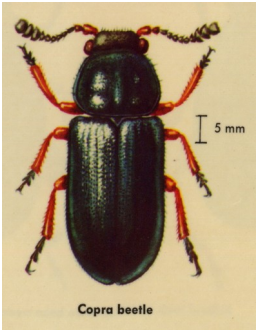


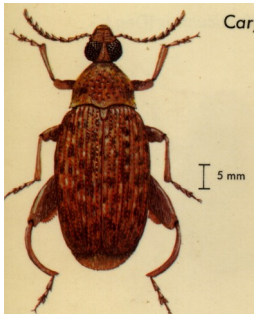
Control is effected by timing the appearance of the flower heads so that the midges find few suitable heads on which to lay their eggs. Pasturing the field in the fall after the seed crop is harvested or in the spring before the seed growth is started will prevent most midges of the fall or spring generations from finding suitable flower heads. In consequence, the summer generation of midges will be small, and little damage will be done to the seed crop

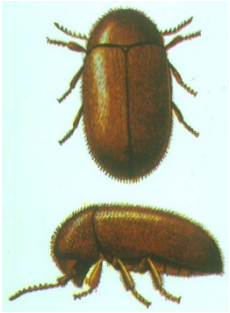
- Clipping the spring hay growth for mulch about May 20 times the seed growth so that neither the spring nor summer generation midges find suitable flower heads. If a hay crop is raised first, cutting and removing it promptly from the field in early June will kill most of the mature spring-generation larvae in the crop as well as time the blooming of the seed crop so that most summer generation midges will have disappeared before the flowers become attractive for midge oviposition.
- It is important to remove the hay promptly because the mature spring-generation midge larvae, needing the moisture to move, will leave the flower heads for the soil and develop into adults if enough rain falls on the hay

Ex.No.18.
STUDY OF COLEOPTERAN, LEPIDOPTERAN AND OTHER STORED GRAIN PESTS







Define storage insect pests.

- Insects like beetles, moths attack and destroy the grain products in storage bins, mills, warehouses and stores, such insects are commonly called as insect pests of storage.
- They may be grouped as Primary storage pests: and Secondary storage pests.
- Primary storage pests: The primary storage pests can attack the **sound grains only**.

•Secondary storage pests: It can attack either the **broken grains or the grain already damaged** by primary storage pests.

•They may be grouped as internal feeders and external feeders.

- Internal feeders: The larvae of these pests feed entirely **within the kernels or grain** of stored materials ex, Rice weevil (*Sitophilus oryzae*), Lesser grain borer (*Rhyzopertha dominica*), Gram dhora (*Callosobruchus chinensis*), Mung dhora(*Callosobruchus analis*), Angoumois grain moth(*Sitotroga cerealella*).
- External feeder: The larvae and adults feed on the grain from outside,ex Red rust floor beetle(*Tribolium castaneum*), Khapra beetle(*Trogoderma granarium*), Rice moth(*Corcyra cephalonica*), Almond moth(*Ephestia cautella*), Indian meal moth(*Plodia interpunctella*).

- Storage insects belong to **generally two orders namely coleoptera (beetle pests) and lepidoptera (moth pests).**
- In storage, insects cause damage by feeding on grains causing weight loss and loss in quality as they deplete the nutrients.
- They contaminate the grains with their dead bodies, cast skins, excreta and with their webbings.
-
- The grains and grain products get bad colour, odour and taste.
- Under severe infestation, grains become unfit for consumption.
- Some of the storage insects are known to infest the grains in the field itself. eg. Weevils, Bruchids, Angoumois grain moth, etc).

A.COLEOPTERAN PESTS

1. Rice weevil: *Sitophilus oryzae* Linn. (Curculionidae: Coleoptera)

Rice weevil: Sitophilus oryzae:

Coleoptera: Curculionidae.

Host: wheat, Rice, Maize, Jower.

Egg: Translucent white, singly, plug the hole with gelatinous secretion.

Grub: White, brown head, apodus, curved, remain within the grain.

Pupa: Pupate inside the grain.

Adult: Redish brown to chocolate coloured, Snout is present.

Other species: Sitophilus granarius.

Adult

Egg

Grub

Pupa

Life cycle and Damage

This is the **most destructive pest of stored grains** throughout the world.

Both adult and grub causes damage.

The rice weevil may be found in the field as well.

The rice weevil **breeds from April to October**,and hibernate as adult in winter.

The female **lays eggs on the grain** by making depression by their maindible.

A single female lay 400 eggs, the **egg hatch in 6-7 days.**

The young **grub bore into the grain** (25-35 days)where they feed and grow to maturity .

They **pupate in side the grain** the **pupal stage last 6-14 days .**

On emergence, the adult weevil cuts its way out of the grain and **live fore 4-5 months.**

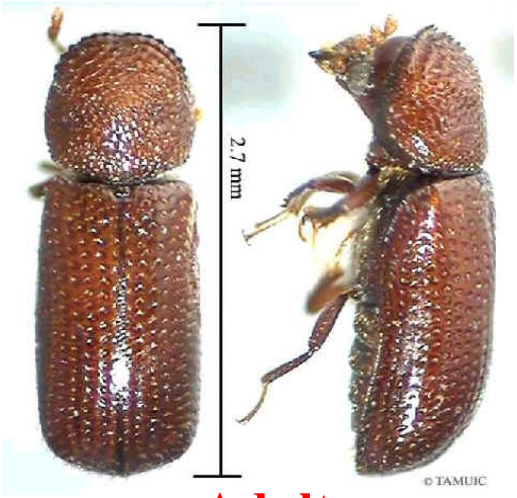
3-4 generations are completed in a year.

Sitophilus granaries this is the allied species of Rice weevil.

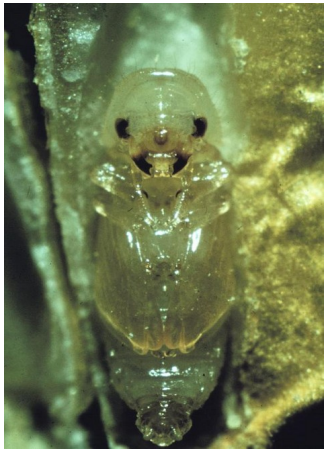
Damage

2. Lesser grain borer: *Rhizopertha dominica* (Fabr.) (Bostrychidae: Coleoptera)

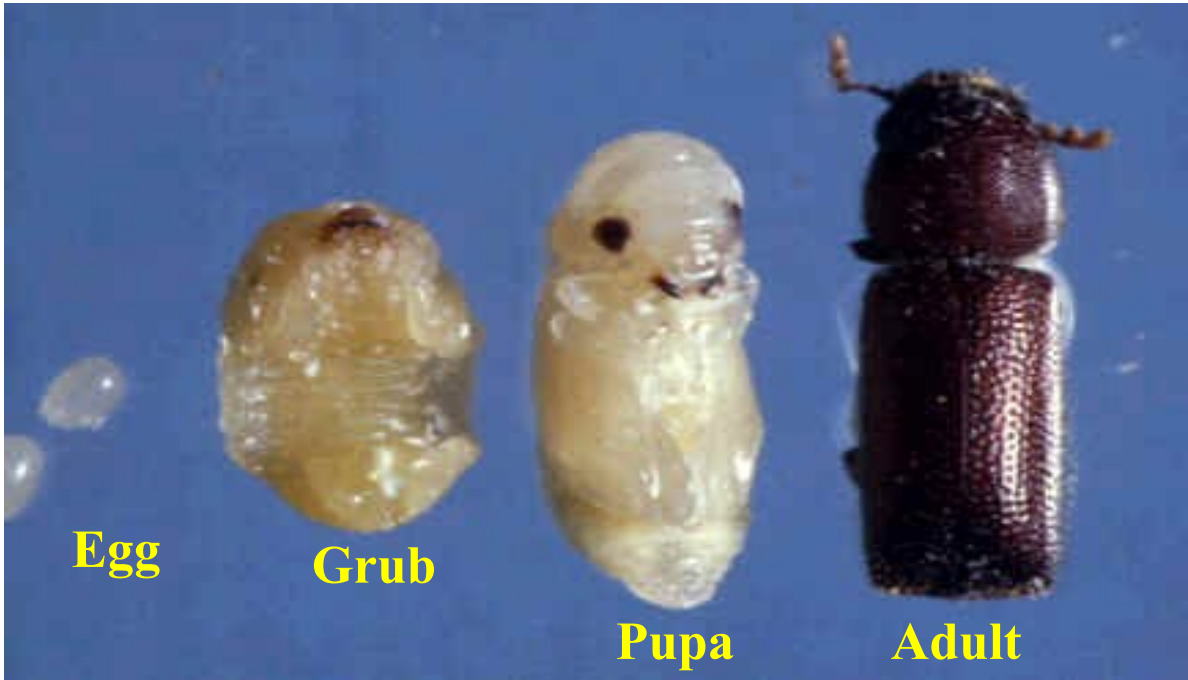
- The beetle is dark brown or black, measures 3 mm long with a cylindrical body.
- The head is bent under the thorax.
- Antenna is 3-segmented serrate, grub small and white in colour with bent body.
- Both adults and grubs bore into the cereal grain and feed inside making irregular holes.
- It is a serious pest of cereals including paddy.



Adult


Pupa


Larva



Lesser grain borer: *Rhizopertha dominica*: Coleoptera: Bostrychidae.

Active period: March to November

Host: **Paddy, Rice,Wheat, Maize.**

Egg: **On surface of grain, white, cylindrical, Singly or Cluster, 300-400 eggs (H.P. = 4-9 days at different tem.)**

Grub: **White, Brown head, Apodus (3 Instars 23-52 days at different tem.).**

Pupa: **Grub enters the grain after 3rd instar for pupation in Grain, 3-6 days.**

Adult: **Brown to blakish beetle, 39-87 days at different temperature.**

Nature of damage: **Grub+adult, holes,both feed inside the grain, Powder.**

Damage

3. Red Rust flour beetle: *Tribolium castaneum* (Herbst); *Tribolium confucium* (Tenebrionidae: Coleoptera)

- Beetles are small, elongate rust red coloured measuring 3-4 mm in length.
- Grub is flat, dull yellowish and body covered with setae.
- Both adults and grubs are external feeders, feeding on broken grains, oilseeds, oil cakes, dried fruits, nuts and processed products like flours, soji, atta, maida etc.
- It also imparts bad smell to the commodity.
- The two species occur together and they can be distinguished based on the antennae.

Egg

A

Grub

Red Rust Flour Beetle: *Tribolium castaneum, T. confusum* :

Coleoptera: Tenebrionidae.

Host: Broken grain, flour,Maida and sujji.

Active period: April to October

Egg: White, translucent, sticky, slender (327-956 eggs) H.P =4-10 days.

Grub: Whitish, cream coloured, worm like 6-7 moults ,22-25days.

Pupa: pupation in the grain lying in grain or naked p.p.=5-9 days.

Adult: Brown in colour, Secondary pest.

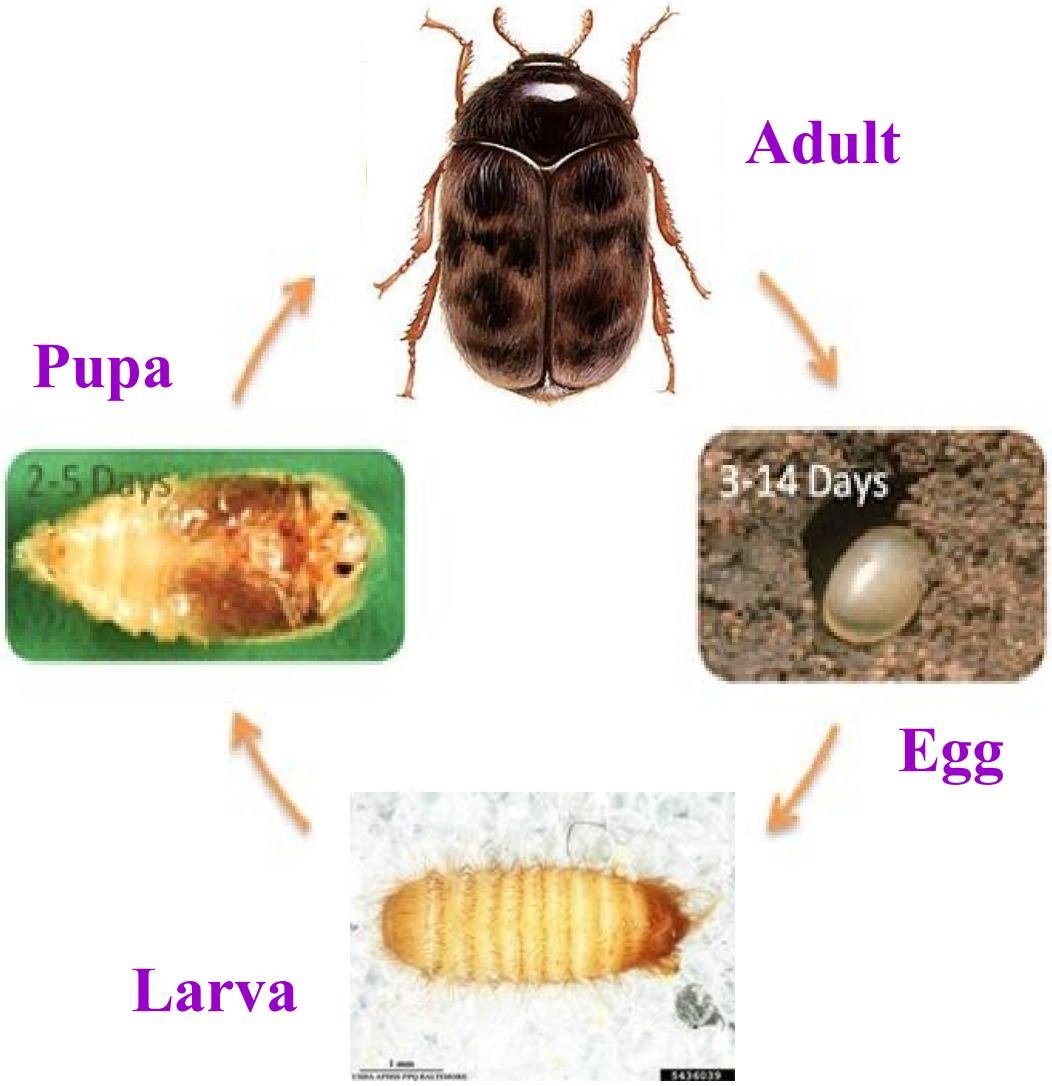
Nature of damage: Grub: incapable of feeding on sound grain. Flour turn Greyish, mouldy and gives pungent odour, making unfit for human consumption. Larvae are negative phototactic and are found hidden in food.

Damage

Ljósm. Erling Ólafsson

5. Khapra beetle: *Trogoderma granarium* (Everts.) (Dermestidae: Coleoptera)

- Beetle is reddish brown to black; oval shaped measuring 1.5-3.0 mm with clubbed antennae.
- Larva campodeiform yellowish white covered with long brown hairs.
- Larva (yellowish-white) is the damaging stage, feeds on many kinds of grains wheat and other grains like sorghum, barley ,rice.
- The damaging stage is grub only.
- The attacked wheat loose their commercial value and ultimately become unfit for human consumption.



Life cycle *Trogoderma granarium*, Khapra Beetle

Khapra beetle: *Trogoderma granarium* (Everts.) (Dermestidae: Coleoptera)

- This is a major pest of stored wheat.
- Damage is caused by only Larval stage.
- The grub attacks embryo points first.
- Germination point of grain is greatly destroyed.
- Infestation occurs in superficial layer upper 50 cm.
- They can survive for 4 years, living for the greater part of it even without food.
- Egg, larva and adult stages are susceptible to oxygen.

Khapra beetle *Trogoderma granarium* : (coleoptera: Dermestidae)

- Larvae: 4 mm, yellowish-white,and brownish head at young stage. Yellowish-brown transverse bands across the body, long hairy bristle on the body.

- The adult is small dark brown beetle,2-3 mm long. The entire body is clothed in fine hairs.

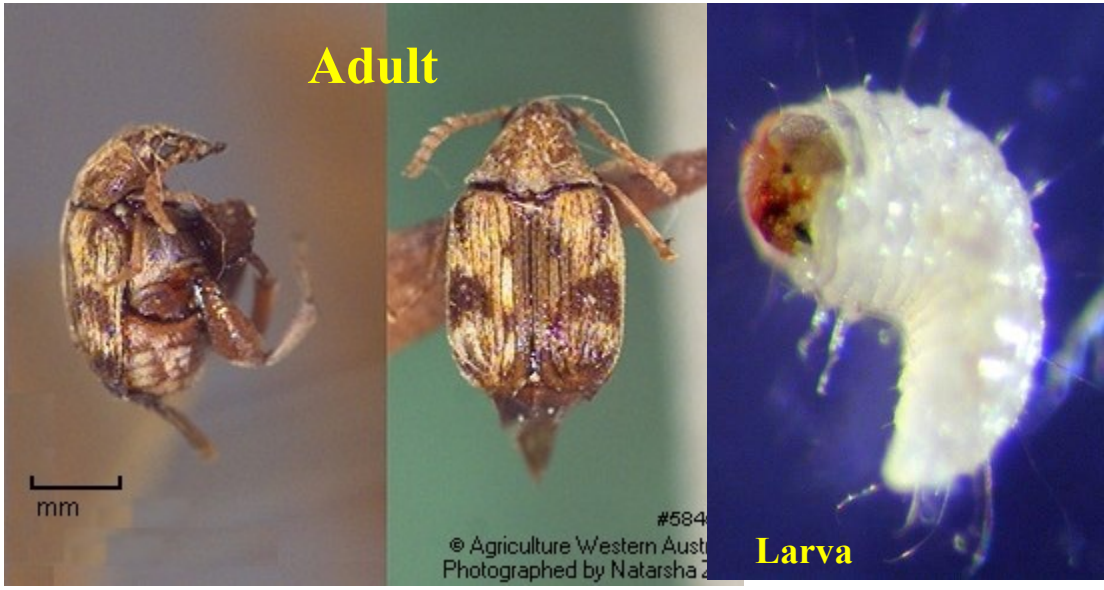
- The insect breed from April to October.
- The female lay white translucent eggs in the grain singly or in cluster of 2-5.
- A female may lay 13-35 eggs which hatch in 3-5 days in June and 6-10 days in October.
- The male larvae complete its development in 20-30 days while female larvae in 24-40 days.
- The pupal stage lasts 4-6 days in the male 4-5 &

Damage

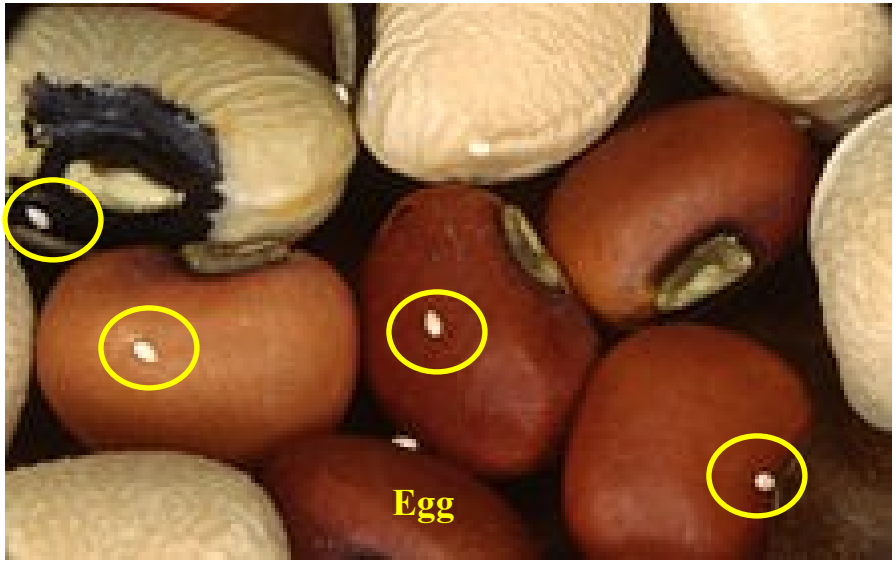
- The greatest damage is done in Summer from July to October.
- The grub eat the grain near the embryo. They confined themselves to the upper 50 cm layer of the grain.
- In severe infestation the grain is reduced to mere frass.
- Since the larvae are positative thermotactic, they can be collected by merely placing gunny bags on a heap of grain.

Damage

6. Pulse beetle: *Collosobruchus chinensis* (Linn.) (Bruchidae: Coleoptera)



- These beetles exclusively feed on stored whole pulses like red gram, black gram, green gram, horse gram, cowpea etc.
- White eggs are visible on grains.
- Adults don't feed, grubs bore into the grain feeding on the internal content.
- Affected grains show circular emergence holes.
- Adults are stout bodied beetles with serrate or pectinate antennae.
- Wings short and exposing the tip of the abdomen uncovered (Pygidium).



Pulse beetle: *Callosobruchus chinensis*,Coleoptera: Bruchidae

Host: Whole pulses Beans and Gram

Eggs: Orange cream in colour and turn grayish white, singly, surface of pod or grain TotalEgg=34-113 H.P.= 7-14 days in April. 4-6 days in September and 8-16 days in November.

Grub: Creamy white with black mouth parts, curved and fleshy 10-12 Aug-Sept 26-38 days in Nov, .

Pupa: Under seed coat , in pupal cell P. P.= 4-28 days.

Adult: Brownish grey coloured. Ivory spot on middle of dorsal surface. Adult is harmless A.P.=5-20 days.

Pygidum: Elytera dose not cover the abdomen.

Nature of damage: Grubs eat the grain by making cavity adult come out by making exit hole. The other species *callosobruchus maculates*.

Damage

2. Angoumois grain moth: *Sitotroga cerealella* Oliv. (Gelechiidae: Lepidoptera)


Adult

- This is a small moth; yellowish-brown or straw colour with a wing expanse of 1 cm.
- Wings are narrow pointed and fringed long hairs along the posterior margin.
- It is an internal feeder.
- Larva is the damaging stage, which bores into a number of cereals like wheat maize sorghum, barley oat.
- Neat emergence holes are seen on grains.


Larva

Pupa

Angoumois Grain Moth: *Sitotroga cerealella*: Lepidoptera: Gelechiidae.

Host: Paddy, Maize, Jowar, Barley, Wheat.

Egg: White eggs, **singly or in batches Surface of grain, Store or Field, become Red later, 150 eggs H.P.=4-8 days .**

Larva: white with yellow head **L.P. 21 days.**

Pupa: Pupate in cocoon inside the grain P.S 9-12 days.

Adult: Yellowish Brown **(dirty) wing, wins are narrow pointed and completely folded over back in sloping manner. Several generation is completed in a year.**

Nature of damage: Caterpillar, feed inside the grain and remain in a single grain only. Infestation remain to upper 30 cm depth only.

Grain mite: *Acarus siro*: Acarina:

- **Grain mite: *Acarus siro*: Acarina**:
- **Host: Cereals, grain, flour etc.**
- **Adult:** Pale straw coloured to dark Redish Brown.

MANAGEMENT OF STORED GRAIN PESTS

Hundreds of species of are associated with stored grains. Only 50 of these species are considered as injurious to food grains in terms of quality and quantity of food grains.

A) Preventive or prophylactic measures

B) Curative measures

A) Preventive measures

i.Hygiene or sanitation

a)Threshing floor/ yard should be clean, free from insect infestation and away from the variety of village/granaries.

b)Clean the harvesting and threshing machines before their use.

c)Trucks, trolleys or bullock carts which are used for transportation of food grains should be made free form insect infestation.

a)Storage structures/godowons should be kept clean. Maintenance of hygiene and sanitation in the store. Cracks and crevices and other holes in store house should be properly sealed and plastered. Food grains should be kept in stores which are rat and moisture proof.

b)Whitewash the store rooms before storage of food grains.

c)Proper stacking of the grain bags should be done with provision of dunnage materials leaving gangways or alleyway of 0.75 – 1.0 m all around for aeration, **inspection, prevention of moisture seepage and for fumigation and sprayings.**

Disinfestation of stores/receptacles

a) Before the use, the receptacles (gunny bags)/store rooms/godown should be disinfested with approved insecticides, *viz.* Malathion 50 EC @ 10 ml/l or Dichlorvos 76 WSC @ 7 ml/l and apply @ 3 lit/100 m2.

Chemical control measures

a)If produce is meant for seed purpose, mix 1 kg of activated kaolin or malathion 5 %D @250 gm for every 100 kg of seed and store in gunny or polythene bags.

b)If produce is meant for grain purpose, For Cereals mix 1 kg of activiated kaolin or 1 kg neem seed kernels for every 100 kg of grain and store in gunny or polythene bags. For Pulse grains – mix 1 kg of activated kaolin or 1 kg edible oil or 1 kg *Acorus calamus* (Bhaje) powder for every 100 kg of grain. (groundnut, sesamum or mustard oil @ 0.25 to 0.50% can protect pulse from pulse beetle, upto 6 months).

Legal method

* Entry of an insect which is not found in the particular area can be prevented by the impositionof Destructive Insect Pests Act 1914.

B. Curative measures:

The infestation of stored grain insect pests can be controlled by the following methods.

1)Non-chemical control measures

Ecological control measures The infestation of stored grains from insect pests largely depends on the proper management of three factors *viz.*

i)Temperature

ii) Moisture content of grain

iii)Availability of oxygen

All these factors are required for normal rapid development and multiplication of insects. Hence, they have to be properly manipulated through design and construction of storage structures/godwons and storage practices so as to create ecological conditions unfavourable for attack by insects

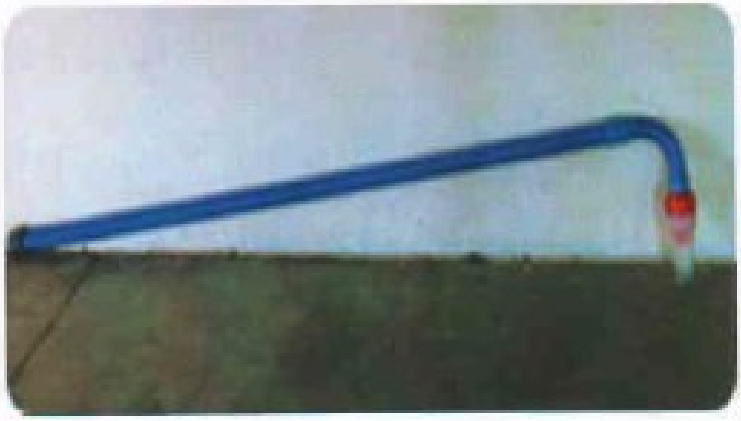
Traps used for management of dermestid beetle

a) Probe trap

b) Pit fall trap

c) Light trap

d) Stack probe trap

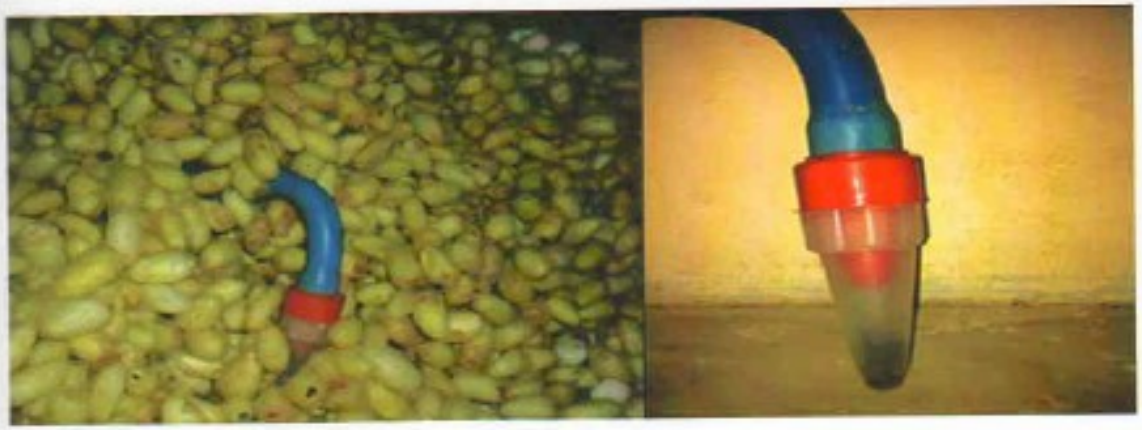


Installation of traps in pierced cocoon room

a) Probe trap

b) Pit fall trap

b) Pit fall trap



d) Stack probe trap

c) Light trap

Stored Grain Insect Management Kit

Food grains are stored for varying periods to ensure proper and balanced **public distribution throughout the year.**

Among the biotic and abiotic factors which affects grains /seeds in storage, insect plays a major role in the deterioration of grains / seeds causing both qualitative and quantitative losses.

Often the presence of insects in store houses are felt only when they are hovering and flying around, by which time enormous loss and population build up of insects might have occurred.

Hence, timely detection of the stored grain insects will help to prevent heavy losses.

Probe Trap

Pitfall Trap

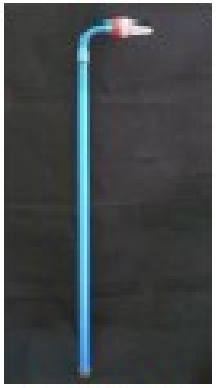
Indicator Device

Egg Removal Device

Two in One Model trap

Automatic Insect Removal Bin

UV Light Trap



Stack Trap (Warehouse trap)

Kit Box

- **TNAU is one of the pioneering institutes in India in the development of detection devices for stored grain insects.**

- **These devices exploit the wandering behaviour of the insects and help in timely detection of insects in stored produce leading to timely control.**

- **These include TNAU probe trap, TNAU pit fall trap, two in one model trap, indicator device, Automatic insect removal bin, UV-light trap technology, Egg removal device and Stack Trap.**

- **These devices have been widely used in many places and have received State and National recognitions.**

- **Hence, the Department of Agricultural Entomology, Centre for Plant Protection Studies, TNAU, Coimbatore has developed a "KIT" named as TNAU-Stored Grain Insect Pest Management Kit containing prototypes of all the devices along with a CD-Rom about the** devices and how to use them.

- **This kit will be of great use in popularization of the technologies across the country.**

- **The kit will be an ideal "hands – on training" tool for Education, Extension centers (KVK, Plant clinic, save grain centers) and also for private warehousing.**

Thanking you

C. OTHER STORED GRAIN PESTS

I) RODENTS: Rodents include rats, bandicoots, gerbils, Squirrels and Porcupines.

Bandicoot Rat

A) Rats:

- Some of them occur in houses and others in fields and stores.
- Some of them burrow the land, floors, feed on grains, cause spillage of grains and collapse of stacks.
- In the field, they are serious pests on many cereals and oilseed crops.
- They contaminate the food stuffs with urine, hairs and their excreta.

1. The house mouse: *Mus musculus* L.

- It can live indoors in close association with the house rat.
- It is the smallest measuring 2-3 inches.
- It destroys clothes, sacs, paper etc. and feeds on food materials.

***Mus musculus* L.**

2. House rat: *Rattus rattus* L.

- It is the commonest house rat distributed all over India and the world.
- It weighs 150-300 g with slightly longer tail.
- It can occur in fields of coconut and other crops.
- It cannot burrow but can make nest in the trees.

3. Brown or Norway rat: *Rattus norvegicus* W.

- It is found mainly at ports in tropical countries.
- As compared to *R. rattus*, it has blunt muzzle, smaller ears and tail.
- It is also found in Sewers.

Rattus norvegicus

White rat *Rattus norvegicus*

4. Common field rat: *Rattus meltada* Gray

- It has rounded earlobes and soft fur.
- It is found in irrigated fields, bunds, hedges and grasslands.

5. Common Indian field mouse: *Mus booduga* Gray.

- It dwells in shallow burrows.

6. Indian mole rat: *Bandicota bengalensis* Gray.

- It is found all-over India.
- It measures 6-9 inches and weighs 300 g.
- Live in extensive burrow.
- It destroys many crops.

B) Bandicoot: *Bandicota indica* L.

- Largest in size.

C) Gerbils: *Tatera indica* Hardw.

- They differ from rats in having their tails clothed in fur and ending in tassel.
- Live in unplanned burrows.

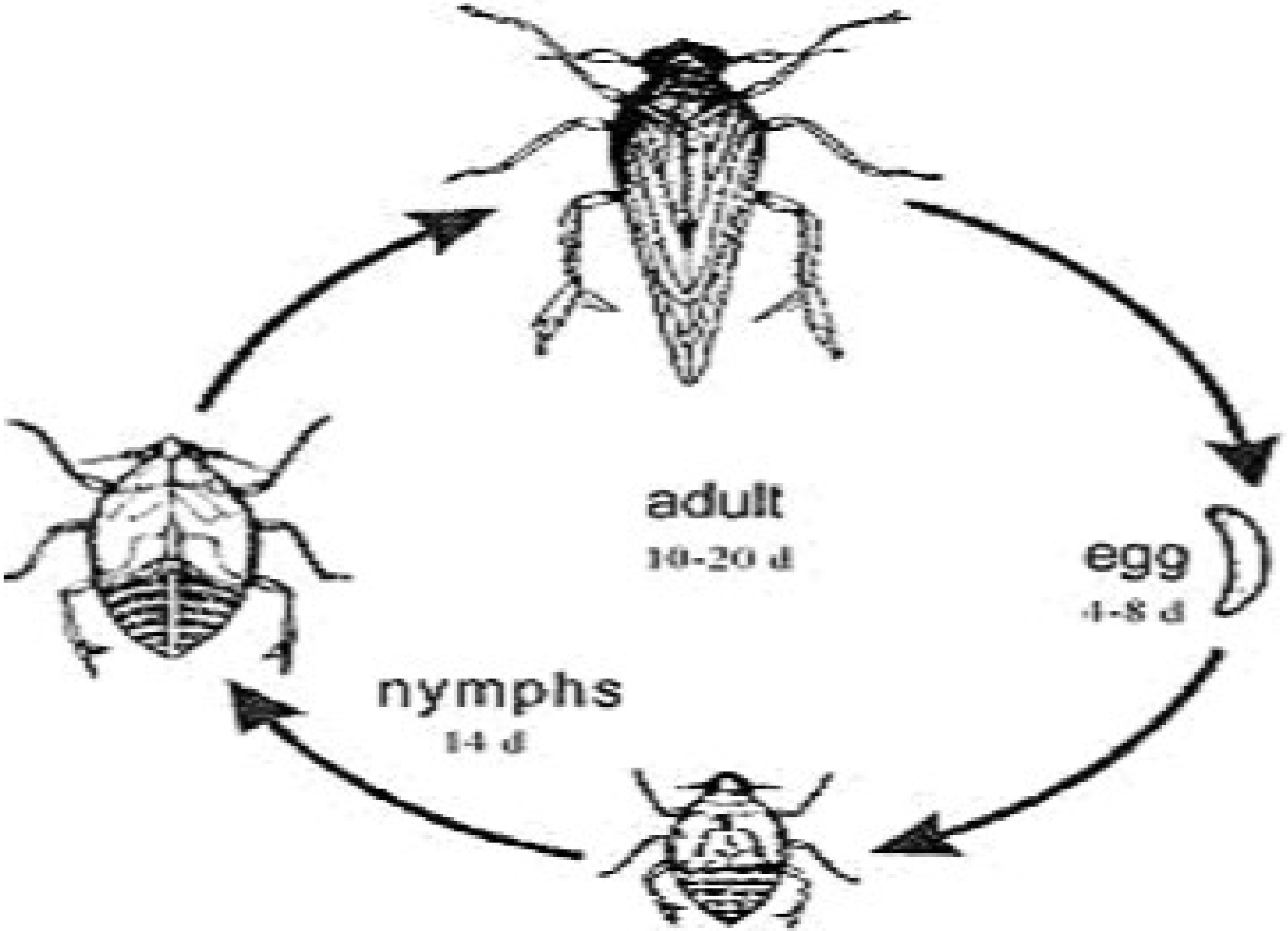
Insect Pest of Rice(*Oryza sativa*, Family: Gramineae)

More than **100 insect** species are associated with the rice crop at one stage or the other and 20 of these are pests of major economic significance. The following are the pests of rice crop.

1. Brown plant hopper, (*Nilaparvata lugens*) (Hemiptera: Delphacidae)
2. Yellow stem borer (*Scirpophaga incertulas*) (Lepidoptera; Family - Pyralidae)
3. Rice hispa, (*Dicladispa armigera*) (Coleoptera:Chrysomelidae)
4. Pink borer(*Sesamia inferens*) (Lepidoptera : Noctuidae)
5.Rice leaf-folder (*Cnaphalocrocis medinalis*) (Lepidoptera: Pyralidae)
6. Rice gall midge, (*Orceolia oryzae*) (Diptera: Cecidomyiidae)
7. Whitebacked planthopper, (*Sogatella furcifera*) (Hemiptera : Delphacidae)
8. Green leafhoppers, (*Nephotettix nigropictus*) and (*N. virescens*)(Hemiptera: Cicadellidae)
9. Paddy root weevil (*Echinocnemus oryzae*) (Coleoptera : Curculionidae)
10. Rice bug (*Leptocorisa acuta*) (Hemiptera : Coreidae)

1. Brown plant hopper, (*Nilaparvata lugens*) (Hemiptera: Delphacidae)

- The brown plant hopper is the most destructive pest of rice of **high-yielding varieties** of paddy in India. Both adults and nymphs feed on paddy, sugarcanes and grasses by sucking the cell sap. The brownish adults with brown eyes are 3.5-4.5 mm in length. The **nymphs are brownish-black** in colour and have **greyish-blue eyes.**
- **Life cycle**
- The females start laying eggs within 3-10 days of their emergence and deposit eggs in masses, by **lacerating the parenchymal tissue**. The number of eggs per mass varies from 2 to 11 and a female lays, on an average, **121 egg-masses.**
- The eggs are somewhat **dark and cylindrical**, having two **distinct spots**. The **incubation period ranges between 4 to 8 days**. The nymphs, on emergence, start feeding on young leaves and after **moulting 5 times**, become adults **in 2-3 weeks.** The total cycle is completed in **18-24 days.**


adult
10-20 d
egg
4-8 d
nymphs
14 d

Damage: **Both the nymphs and adults** cause damage by **sucking cell sap from the leaves** which **turn yellow.** If the insect **attacks** during the **early stages of growth**, the **entire plantmay dry up**. **The population increases very rapidly and the rice fields start drying up in patches known as 'hopperburn'. T**he **loss in yield** may range from **10 to 70 per** cent. This insect is known to transmit the **grassy stunt virus** disease of rice.

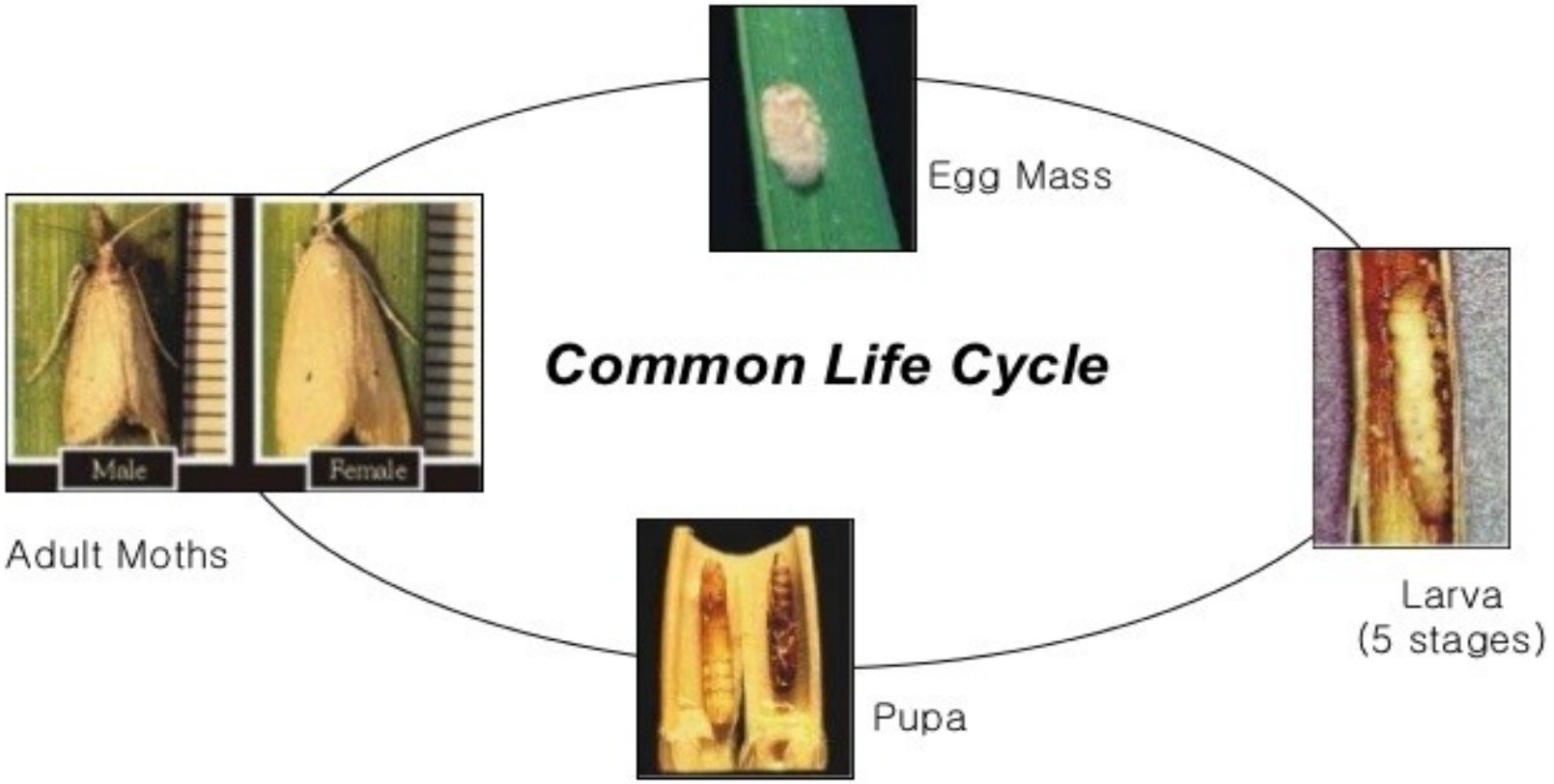
Management: (i) **Closer spacing of 15 x 10 cm creates favourable** microclimate in field for rapid development of hopper population. Hence, a spacing of **20 x 15 cm should be followed.**(ii) **Alternate drying and wetting** the field during peak infestation, and **draining out the standingwater** from the field **2-3 times** checks the population of the hopper to a large extent. (iii) Three rleases of **mirid bug, *Cyrtorhinus lividipennis*** Reuter **@100 bugs or 50-75 eggs/square meter at 10 day intervals have been found effective** for the control of brown planthopper. (iv) **Spray at economic threshold level of 5-10 insects per hill,** 100 ml of **imidacloprid 200SL,** or 2.0 litres of **quinalphos 25ECor 2.5 litres of chloropyriphos 20EC** or **1.4 litres monocrotophos 36SL in 250 litres of water per ha**. Repeat application if hopper population persists beyond a week after application. **While spraying, nozzle should be directed at the basal portion of the plants.**

2. Yellow stem borer (*Scirpophaga incertulas*) (Lepidoptera; Family - Pyralidae)

- The yellow stem borer is a specific pest of rice and is common in all the Asian countries. The caterpillars alone are destructive and, when full-grown, they measure about 20 mm and are dirty white or greenish yellow, having brown head and pronotum. The adults have a wing expanse of 25-45 mm and are yellowish white with orange yellow front wings. The females have a prominent tuft of brownish yellow silken hair at the tip of their abdomen. The female moth is bigger than the male moth and has a centrally situated black spot on each of the forewings.
-

Life-cycle : This pest is active from April to October and hibernates from November to March as a full-grown larva in rice stubble. The moths lay about 120-150 eggs on the underside of the leaves in 2-5 clusters of 60-100 eggs each. The eggs are covered with yellowish brown hair of the female tuft. They hatch in 6-7 days and the tiny black-headed caterpillars soon bore into the stem from the growing points downwards. The **larva** grows in **6 stages** and is full fed in **16-27 days**. It then **constructs an emergence hole which is always located above the water level and pupates inside the attacked plant**. Within **9-12 days(pupa)**, it emerges as a moth. The **life cycle** is completed in **31-46 days.** There are **3 broods in Bengal, 2 in Orissa, 4-5 in Punjab, Andhra Pradesh and Tamil Nadu.**

Ecology of Pests and Diseases



Life Cycle of rice yellow stem borer (*Scirpophaga incertulas*)

- **Damage**:The larva feeds inside the **stem causing drying of the central shoot or 'deadheart' in** young plant and drying of the **panicle or 'white ear' in older plant. Basmati varieties suffer heavy** damage than coarse varieties.
- **Management**: The **removal and destruction of stubbles** at the time of the **first ploughing after harvesting** the crop . (2.) **Ploughing and flooding** the field is also effective in **killing the larvae**. (3.) Since the **eggs** of stem borer are **laid near the tip of leaf,clipping of tips of seedlings before transplanting** can reduce the carryover of eggs to the field. (4.) **Inundative releases of *Trichogramma japonicum*** Ashmead **@ 150,000 ha. during egg laying period** (5.) The fields showing more than **5 per cent deadhearts** should be sprayed with **875 ml of triazophos40EC** or **2 litres of quinalphos** 20AF or **1.4 litres of monocrotophos 36SL**or 2**.5 litres of chlorpyriphos 2OEC in 250 litres of water per ha**. Same chemical should not used repeatedly.

3.Rice hispa, *Dicladispa armigera*, Coleoptera : Chrysomelidae

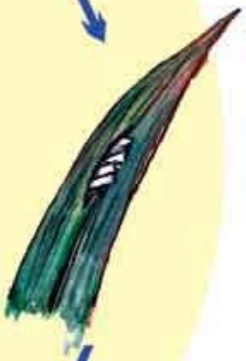
- Rice hispa is distributed throughout India but often **serious on young rice crop.** The **adult is a small bluish black beetle measuring 5 mm in length** and is recognized by **numerous short spines on the body**. The **legless, creamy-white larvae are not easily seen, because they are concealed inside the leaf tissue.**
- **Life-cycle**: The **eggs are embedded in the leaf tissue towards the tip H. P.(3-5 Days)**. On hatching, the young **grubs feed as leaf-miners, between the upper and lower epidermis (grub period 15 days)**. The attacked **leaves turn membranous, showing characteristic blisters or blotches.** Later on, the **attacked leaves wither and die**. When the larvae are full-grown, they pupate inside(**Pupal Period 3-5 days**) and finally emerge as black beetles. The insect passes through about **six generations in a year.**

Rice Hispa

(May - October)

Adult Beetle
6-10 Days

Eggs
3 - 5 Days



Grub
15 Days

Pupa
3 - 5 Days

Damage

Mined & Scrapped leaves

➢**Damage**: Apart from the damage caused by **larvae as leaf-miners**, **the adults also feed on green matter and produce parallel whitish streaks on the leaves**. The damage starts in **nurseries and spreads to the rice fields**. The **infestation** varies from **6 to 65 per cent.**

➢**Management**

i. The pest is suppressed if the **infested leaf tips are clipped off and destroyed, while transplanting**.

ii. If the **nursery beds are flooded, the beetles float and can be swept together with brooms and then destroyed**.

iii. Spray at **economic threshold level (1 adult or1-2 damaged leaves per hill)** with **300 ml of methyl parathion 50 EC** or **625 ml of fenitrothion 50EC** or **chlorpyriphos 20EC or 2.5 litres of lindane 20EC in 250 litres of waterper ha**. If the attack continues, repeat spray after two weeks.

II) BIRD PESTS:

- Birds are important pests in fields and cause severe damage to the crops at milky stage, sometimes the damage being very severe in crops like sunflower, jowar, pulses and also in fruits.
- They also feed on stored grains in store houses and threshing yards.
- Some birds feed on crop pests and are thus beneficial (eg. Myna).

1. Common house crow, *Corvus splendens* L.

2. Rose ringed parakeet, *Psittacula krameri* Scopoli

3. House sparrow, *Passer domesticus* L

4. Common myna, *Acridotheres tristis* L

5. Pigeon, *Columba livia* Gmelin.

6. Peacock, *Pavo cristatus* L.

Storage structures and methods of grain storage

- **Grain storage**
- **Parameters :** The store must satisfy the following parameters as far as possible:

(a) The grain must be kept dry;

(b) The grain should be kept at a uniform temperature;

(c) The grain should be protected from insect attack;

(d) Rodents and birds should be excluded. It is evident from previous sections that, in many cases, facilities for drying and storage are found in one and the same structure.

Combining these functions is economical and allows further conditioning at later stages if required.

- For example, if a hot spot develops in a storage bin, it can easily be ventilated again. It may also be possible to provide some low-volume ventilation in an otherwise pure storage system.
- However, there are situations where storage is considered quite separately from drying, ranging from the storage of naturally dried crops to the storage of grain from a continuous-flow or batch dryer.
- The size and type of a storage facility is likely to be dictated by:
  i. total volume of crop/produce to be stored;
  ii. the storage requirements for the crop/produce to be stored;
  iii. the unit cost of various types of storage;
  iv. the form in which the crop/produce is stored, i.e. cob maize versus shelled maize, or bagged wheat versus bulk wheat.

- The volume of the store required can be estimated from the expected yield and the land area.
- A comparison between different forms of storage is normally made by calculating costs per tonne of capacity.
- The form of storage depends not only on how the crop is harvested, the volume and the way it is delivered to the market, but also on the overall cost.
- Where drying is a problem, bag storage has the advantage of allowing a higher moisture content than bulk storage.
- For maize, the requirement for safe storage is a maximum of 15 per cent and 12 percent moisture content respectively. In general terms, the respective advantages and disadvantages of bag and bulk storage are:

bag	bulk
Flexibility of storage	Inflexible storage
Partly mechanizable	Mechanizable
Slow handling	Rapid handling
Considerable spillage	Little spillage
Low capital costs	High capital
costs High operating costs	Low operating costs
Easy inspection	Inspection more difficult

Grain storage structures

Grain is generally stored either in bags or in bulk. A combined system of bag-cum-bulk storage is also practiced in some parts of the country. In villages the bulk storage system is more common than the storage in bags which is considered to be a practicable method of storing grain in the government godowns as well as in trade. There main following three types of storage structures for storage of grains.

- Traditional storage structures
- Improved storage structures
- Modern storage structures
- Farm Silos

1.Traditional Storage Structures

In this types of storage structures the grain is generally stored in bulk. This types of storage structures having generally capacities between 1 to 50 tonnes. The storage of grain is generally done in one of the following storage structures in the different rural and urban regions of India in bulk as well as in bag storage.

i. Morai type storage structures
ii. Bukhari type storage structures
iii. Kothar type storage structure
iv. Mud Kothi type storage structure
v. Muda type storage structure
vi. Kanaj type storage structure
vii. Kuthla type storage structure
viii. Metal/ Steel bin type storage structure
ix. Bag type storage structure

2 Improved Storage Structures

Improved storage structures are the storage structures for storage of food grains.

In this type of storage structures there are some improvements made in traditional storage structures.

This type of storage structures having a higher storage capacity and long term storage of food grains than traditional storage structures.

Improved type of storage structures having capacities is generally 1.5 to 150 tonnes.

The storage of grain is generally done in one of the following storage structures in the different rural and urban regions of India in bulk, bag as well as bag and bulk storage.

1 Pusa bin

Pusa bin is like other traditional storage structures made of mud. To make the storage structure moisture proof a plastic film is used in all the inner sides of the bin.

2 Brick and cement bin

These type of storage structures are very strong and effect of seasons on these is minimum.

3 Bunker Storage

These type of storage structure is used for long term storage and a larger volume of grains storage.

4 'CAP' Storage structures

The word 'CAP' is used for cover and plinth, plinth from the bottom and cover from the top.

This type of open storage is considered as transit storage and serves the purpose of storage of food grains in bags for short period.

Pusa bin

- This ia a rectangular structure of 1.7 m x 1.2 m x 7 cm thick.
- This design consists of two bricks walls of 10 cm thick each using sun dried brickswith polythene sheet sandwitch in between. The structure is condtructed on a brick masonary plateform plastered with cement mortar. A mud slab is provided as top on wooden frame structure.the polythene sheet is also provided at the top qnd the base to make the structure completely moisture proof and air gtight.
- When the structure is filled with grain the main hole is finally sealed with a square piece of polythene film.

Bulk storage installations.

- In bulk storage structure , large scale storage instalations with adequate storage and mechanical grain handling facilities are used by grain handling authorities in the countries like Food Corporation of India, Marketing Cooperative Federations, central and state wherehousing corporations etc.
- The storage bins or silo have a capacity of 10,000 each and provide for bulk storage of grain. The elevators are provided with mechanical operations for receving and issuing out grain with the help of a mechanical system on scientific lines.

Domestic metal bins

- Several types of domestic designs of metal bins have been developed, the capacity of which range from 3 to 27.5 quintals. These are indore bins and may be kept in room or varandaqh under a roof. The bins are made from galvanized iron sheets and are moisture, rodent and insect proof. These are found suitable for storage of wheat, paddy,maize, pulse and seed grains.

3 Modern Storage Structures

In India, for larger volume of food grains are to be stored in bulk is 'silo' and conventional godowns (Shed) designed for bagged storage.

The godowns side walls are of brick or stone masonry and sloped roofing in asbestos or Corrugated Galvanized Iron (CGI) sheets over steel trusses.

Silos are constructed from steel or reinforced concrete. There are a cluster of adjoining silos in any modern large/ capacity processing plant.

The modern permanent storage system should be selected for the safe keeping of stored grains and other products.

The modern storage structures should be selected on the basis of first on quality and then on cost considerations. There are following types of modern storage structures.

1 Silo type of storage structures

Silos/bins are classified into two groups depending upon the relative dimensions of the container. These are classified as,

(1) deep bins and

(2) shallow bins.

1.1 Shallow bins

Squat silos are comes under shallow bins. A squat silo has a wall height to diameter ratio 0.5 or even less. Squat silo can compete with sheds for low-cost quality storage.

1.2 Deep bins

Vertical Silos are comes under this type of storage structures. There are two types of vertical silos a) Flat bottom vertical silo and b) Hopper bottom vertical silo.

2 Shed

Generally, a horizontal sheds have been used to provide low-cost, large volume storage. For storing grains and other products a very large volume sheds have also been constructed by Central Warehousing Corporation.

4 Farm Silos

Farm silos is a farm structure used to store and protect the animal fodder so that it is preserved in an ideal condition for farm animals. Animal fodder is cut and packed in the air tight silo to allow a partial fermentation to occur. The storage fodder is known as silage. There are two types of farm silos i) Tower silos and ii) Horizontal silos.

4.1 Tower silos

Cylindrical Shpe and made of masonary, wood or metal Cost of construction is comparatively much higher than that of horizontal type. Loading of animal fodder is difficult. Mechanical loader or a large capacity of blower is essential. This type of storage structures are not recommended under Indian conditions.

4.2 Horizontal silos:

In horizontal silos pit type, bunker type and trench or stake type of storage structures used for storage of animal fodder. There are surface as well as below ground (underground) types of storage structures used on most of dairy farms as temporary and permanent storage structures for silage. The spoilage of silage and dry matter losses of these silos ranges between 20 to 30 percent.

4.2.1 Pit Silos

- Permanent pit silo is a circular deep well which is lined all around the side, and sealed from bottom, so that water may not rise in to it.
- Made in areas where the soil is deep and the water table is very low.
- Made of bricks, stones or concrete, and either cement or lime can be used as a binding material.
- A 22.5 cm thick wall will be used satisfactory up to 15 meter depth.
- The entire surface which is coming in contact with the silage should be plastered to make it smooth, air tight and water tight.
- Simple roof is made over the silo to protect the silage from sun and rain.
- Corrugated metal sheet dome or half pitch roof with ample overhang on all the sides are most economical and provide more space for filling.
- Stairs may be built along with wall for removing silage from the silo.
- The diameter of a silo is usually limited to 6 m and its depth is kept 2 to 3 times that of diameter.
- When the silo is opened for removing the silage, nobody should enter till the gases are removed.

4.2.2 Trench Silos

- Unlined trench silo can be made easily without involving any investment on building materials such as brick, cement and sand.
- Unlined silos give more spoilage and are likely to have caved side walls due to excessive rain and tend to become muddy at the bottom. So, lined trench silos are therefore become popular.
- The walls of the trench silos can be lined with brick, concrete or cement plaster with reinforcing wire mesh.
- If possible the silo should be roofed.
- Drains should be made around trench to intercept surface water.
- To facilitate drainage it is desirable to locate the trench silo on slopping ground.
- Capacity is depends on size of herd and number of day the silage is fed in a year.
- It is always economical to construct only one trench silo, even if it is quite larger.
- Sidewalls are given generally 33 per cent slope.

Principles of stored grains pest management

A. Preventive measures

- Remove all debris –cracks, crevices and corners
- Threshing floor or yards free from insect infestation
- Clean the machines, harvester and thresher
- Truck, trolleys or bullock carts free from infestation
- Clean the godown or storage structure before storing
- Metal sheet –25 cm height –bottom of the wood in doors
- Fix up wire meshes –windows, ventilators, gutters, drains etc –rats, birds, and squirrels control
- Remove dirt, rubbish, sweepings and webbings from the godown
- Close rat burrows -a mixture of broken glass pieces and mud and plaster with cement

- Plaster the cracks, crevices, holes and floors with cement
- Dunnage leaving gangway or alleyway –0.75 to 1 m all around
- Use rat and moisture proof storage structures
- Disinfection of storage structure –Malathion 50 EC@ 3lit –100 m

B. Curative methods

I. Ecological methods

- Temperature above 42 0 C and below 15 0 C –retards reproduction and development
- Moisture content below 10 %
- Dry the storage bags, bins etc., -sun light –kill the pests biostages
- Reduce oxygen content –1% -increase the CO2 –the stages of insects

II.Physical methods

- Super heating system by infrared heaters –flour mills and food processing plants –55 –600 C –10 to 20 min –insect ’s die
- Modification of storage atmosphere
- low oxygen (2.4%) and high carbon dioxide (9.0-9.5) – adding CO2 –control the insects Seed purpose
- Activated kaolin 1 kg or malathion 5 % D 250gm/ 100 kg of seeds Grain purpose
- Activated kaolin 1 kg/100 kg of grain Pulse grain: Activated kaolin 1 kg/100 kg of grains or edible oil 1 kg / 100 kg of grain or Neem seed kernel 1 kg/100 kg of grain
- Do not mix synthetic pyrethroids

III.Cultural methods

- Store the food grains in airtight containers
- Split and store pulse grains –pulse beetle

IV.Mechanical methods

- Sieve and remove all broken grains
- Stitch all torn out bags

VI.Chemical methods

- Treat the walls, dunnage materials and ceilings –malathion 50 EC 10 ml / lit or DDVP 76 WSC 7 ml / lit @ 3 lit spray fluid / 10 sq.m
- Alleyways and gangways -malathion 50 EC 10 ml / lit or DDVP 76 WSC 7 ml / lit (1 lit of spray fluid/ 270M3)
- Malathion 50 EC 10 ml / lit @ 3 lit of spray fluid / 100M2 over the bags
- Do not spray insecticides directly on food grains
- Knock down chemicals –lindane or pyrethrum –kill the flying insects

- Seed protectants-Carbary ldust or pyrethrum dust
- Shed fumigation –intensity of infestation
- EDB ampoules @ 3 ml/ quintal-wheat and pulses ; 5 ml / quintal –rice and paddy
- Do not recommend EDB –oil seeds and moist grains
- Large scale storage-EDCT @ 30 –40 lit / 100 cubic meter
- Small scale storage –EDCT @ 55 ml / quintal, Aluminium phosphide(ALP) @ 1-2 tablets / tonne–food grains lot

➢ Cover fumigation

- 1 tablets of ALP 3 g/ tonne of grains

➢ Shed fumigation

21 tablets of ALP 3g/28 cubic meters (exposer period :5 days)

SORGHUM (*Sorghum bicolor*,Famly:Gramineae)

More than **150 species** of insects have been reported to damage sorghum. However, over a dozen species are very serious and constitute a major constraint in sorghum production.

1. **Sorghum shoot fly (*Atherigona soccata*) (Diptera : Muscidae)**
2. **Sorghum earhead bug, (*Calocoris angustatus*) (Hemiptera:Miridae)**
3. **Sorghum shoot bug, (*Peregrinus maidis)* (Hemiptera : Delphacidae)**
4. **sorghum midge, *Contarina sorghicola* (Diptera : cecidomyidae)**
5. **Stem borer, *Chilo partellus* (Lepidoptera : pyralidae)**
6. **Pink borer,(*Sesamia inferens*) (Lepidoptera : Noctuidae)**
7. **aphid, *Rhopalosiphum maidis*, (Hemiptera : Aphididae)**
8. **Leaf hopper, *Pyrilla perpusilla* (Hemiptera : Lophopidae)**
9. **Hairy caterpillar, *Amsacta moorei* (Lepidoptera : Arctiidae)**
10. **white grub, *Holotrichae consanguinea* (Coleoptera : scarabaeidae)**
11. **whitefly, *Neomaskelliia bergii* (Hemiptera : Aleyrodidae)**

1. Sorghum shoot fly (*Atherigona soccata*)(Diptera : Muscidae)

- The sorghum shoot fly, **also known** as the **sorghum stem fly**, is a widely distributed pest in Europe, Africa and Asia. In India, it is more serious in southern parts.Besides **sorghum**, it infests **maize, wheat, broom corn, small millets** (*Panicum spp.*) and **grasses.**
- **Life-cycle**: The female fly lays approximately **40 eggs singly on the underside of the leaves** during its life span of about one month. The **eggs hatch in 1-2days** and the tiny maggots creep out and reach in between the sheath and the axis, and bore into the stem.
- They feed **(maggot)** inside the main shoot for **6-10 days** and, when full grown, they may **pupate** either **inside the stem** or come out and pupatein the **soil**. The **pupal period** in the **summer** lasts **about 7 days**. **Several generations** are completed in a year. In northern India, the **pest over-winters in the pupal stage**.

➢**Damage**

The insect attacks the young crop when it is in the **six-leaf stage**. As the maggots feed on the main shoot, the growing point is destroyed and by the time they pupate, the plant is almost dead. The young plants show typical **dead-heart** symptoms. When the attacked plants are somewhat older, tillers are produced, which mature later than the main crop. The total loss in yield is sometimes as high as **60 per cent**.

➢**Management**

i. Seed coating with imidacloprid 600 FS @ 15 ml per kg seed or isofenphos 5G @ 30 g per 100 g seed provides protect on against shoot fly upto 2 weeks.

ii. In case seed treatment has not been done; apply12.5 kg of carbofuran 3G, 10 kg of phorate 10G/ha, in furrow before sowing(iii) spray 1.25 litres of malathion 50 EC or 2.0 kg cararyl 50 WP in 500 liters of water/ha.

MAIZE (*Zea mays*, Family : Gramineae)

- More than **130 insects** have been recorded causing damage to maize in India. Among these, about **half a dozen** pests are of economic importance.

1. Maize borer, (*Chilo partellus*) (Lepidoptera: Pyralidae)

- It is the **most destructive** pest of maize and sorghum in Sri Lanka, India, Pakistan, Afghanistan, Uganda, Central and East Africa. It is found throughout India. This insect has also been recorded on ***bajra***(*Pennisetun typhoides*), **sugarcane,** Sudangrass, *baru* (*Sorghum halepense*), ***sarkanda*** (*Saccharum munja*) and some other **grasses.**
- The grown up **caterpillars** are about **20-25mm** long and **dirty greyish white**, with **blackhead** and **four brownish longitudinal stripes on the back**. The adults are **yellowish grey moths**, about **25 mm across the wings** when spread.
- **Life-cycle**: The **eggs** are laid in **overlapping clusters of** in rows on the **undersurface of the leaves** during **April-May**. A female lays over **300eggs** during its life-span of **2-12 days** and the eggs hatch in **4-5 days** in **summer**. The young **larvae first feed on the leaves**, making a **few shot holes** and **then bore their way downwardthrough the central whorl as it opens**

The larva becomes full-fed in 14-28 days, passing through six stages and after making a hole in the stem pupates inside it. The **life-cycle** is completed in about **3 weeks** and there are probably **5 generations** in a year. The full-grown **caterpillars of the last generation hibernate in stubble, stalks**, etc., and **remain there till the next spring.**

Damage

The **damage** is done by the **caterpillars** by **feeding inside the stem** and producing **'deadhearts'**. About **25-50 per cent of the plants are destroyed**.

Management

i. The potential for carry over may be reduced by **destroying the stubble,weeds and other alternate hosts of the stem borer by ploughing the field after harvest.**

ii. **Removal and destruction of dead-hearts** and destruction of **infested plants** showing **earlyp in-hole damage** has been found to be successful practice in reducing the pest incidence.

iii. **Destruction** of crop residues and chopping of stems **harbouring diapausing larvae can be** very effective in reducing borer population.

iv. **Release** laboratory bred adult populationsof ***Trichogramma spp***. at the first sight of egg masses of maize borer and synchronize the release of ***Apanteles sp***. or ***Microbracon sp.*** **adults** with the larval

(a) **Spray** the crop **2-3 weeks after sowing** or as soon as borer injury to the leaves is noticed with any of the following synthetic pyrethroids using 300 litres of water per ha. **fenvalerate 20EC@ 100 ml/ha, cypermethrin 10EC 100 ml/ha or deltamethrin 2.8EC @200 ml/ha.** Usually, no additional spray or granular application is required after the spray with pyrethroids.
(b) Alternatively, the crop should be sprayed with any of the following insecticides:, **monocrotophos 36SL @ 275 ml/ha, or carbaryl 50WP @ 250 g/ha.**
(c) After this spray, apply twice at 7-10 days intervals any of the following insecticides in the whorls of only infested plants that show fresh borer injury in the central leaves: **fenitrothion or trichlorphon 5 D or trichlorphon 4G**. In case of dust, mix it with equal quantity of moist soil before application. Apply a pinch of this mixture to the whorl of plants. Usually1.5-2.5 kg of the insecticide would be required per ha for one application. **Apply granules to the whorl of plants@0.5-1.25 kg/ha per** application through a bottle with a few holes in its cap.

SUGARCANE INSECT PESTS

- In India, sugarcane is produced in both **tropical** and **subtropical** regions. The major
- Sugarcane growing districts **Kurukshetra, Yamunanagar, Karnal, Sonipat, Rohtak, Faridabadand Panipat** in which farming of this crop is done. Besides sugar, cane juice possesses severalvitamins and minerals that provide immense health benefits for people suffering from variety of conditions. Among various limiting factors for low yield of pulse crops, the incidence of insect pests assumes high significance. These are describing as below:

i. ***Early Shoot Borer (Chilo infescatellus)***
ii. ***Internode Borer (Chilo Saccharifagus Indicus)***
iii. ***Top Borer (ScirpophagaExcerptalis)***
iv. ***Scale Insect (MelanaspisGlomerata)***
v. ***Pyrilla (Pyrilla purpusilla Walker)***
vi. ***Termites (Odontotermes assmuthi)***
vii. ***Whitefly (Aleurolobus barodensis Mask)***
viii. **Leaf hopper, *Pyrilla perpusilla* (Hemiptera : Lophopidae)**

1. Early shoot borer , *Chilo infescatellus*, Lepidoptera,Pyralidae

Host Plant: Sugarcane, Maize, Bajara, Sarkanda,Baru and other grasses.

Identification:

caterpillar is 20-25 mm in length and dirty white in colour and have five light-violet longitudinal stripes on the body . Adult moth is straw colour fore wings and witish hind wing

Life cycle:Moth lay eggs in the clusters of **11-36 eggs** on the **under surface of the leaves** by the side of the mid rib. The **eggs** are **creamy-white** in colourand has **scale like appearance**. The larvae are **dull white in colour** with a number of **brownish-red longitudinal stripes on the back** and they bore a number of times, either in the same stalkor in the neighboring ones.Moth lays **300-400eggs on lower surface of leaves**. Which **hatch in 4-5 days.** The larval period lasts for **about 3-4 (21-28 days) weeks**, the **pupal period is 6-7 days** after which the larvae pupates in the tunnel within the sugarcane stalk where they had been feeding before. Total 4-5 generation in a year.

Damage Symptoms:

Shoot borer **infestation is high during pre-monsoon period** (April-June) when ambient temperature remains usually high with low relative humidity. Borer attacks the cropduring the **early part of cane growth, before internode formation**.

SUGARCANE EARLY SHOOT BORER

Larva

pupa

Egg

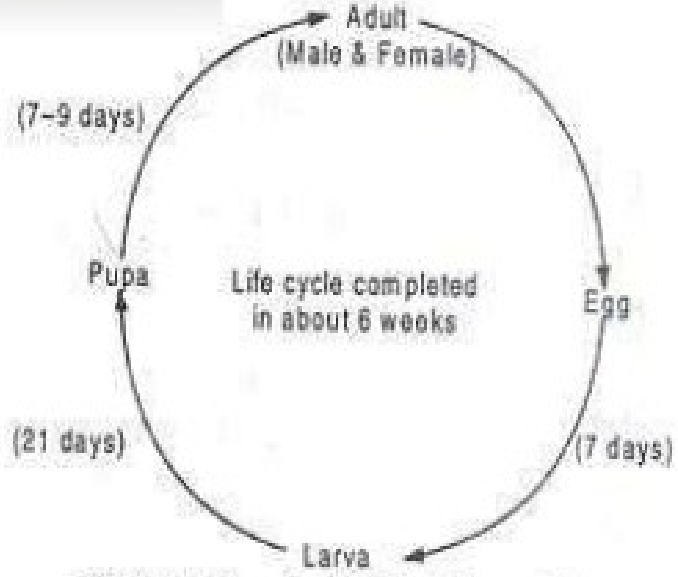


Fig. 66. Life cycle of *Chilo infuscatellus*.

adult

Larvae enter the cane internally through one or more holes in the stalks (shoot) just above the ground level and bores **downwards as well as upwards killing the growing point** this leads to gaps in the field. Thus,it cuts of the central leaf spindle, which eventually dries forming a '**dead heart'**. Dead heart **in1-3 month old crop**, whichcan be easily pulled out, **dead heart emits an offensive odour**. Asingle caterpillar may destroy **three or four shoots** before it pupate. Borer activity decreases appreciably with the onset of monsoon.

Management:

(1) February – March: At the time of sowing Setts are treated with 2.5 L **chlorpyriphos 20 EC** or 600 ml **fipronil 5 EC** (Reagent) (for sandy soil 700 ml) in 600-1000 Lwater per acre. Spray on the furrow with the help of knapsack sprayer or use 150 **ml imidachloprid 200 SL in 250-300 L water** or 8 kg Dursban 10G / 10 kg **fipronil 0**.3 G / **7.5 kgSevidol 4G per acre.**

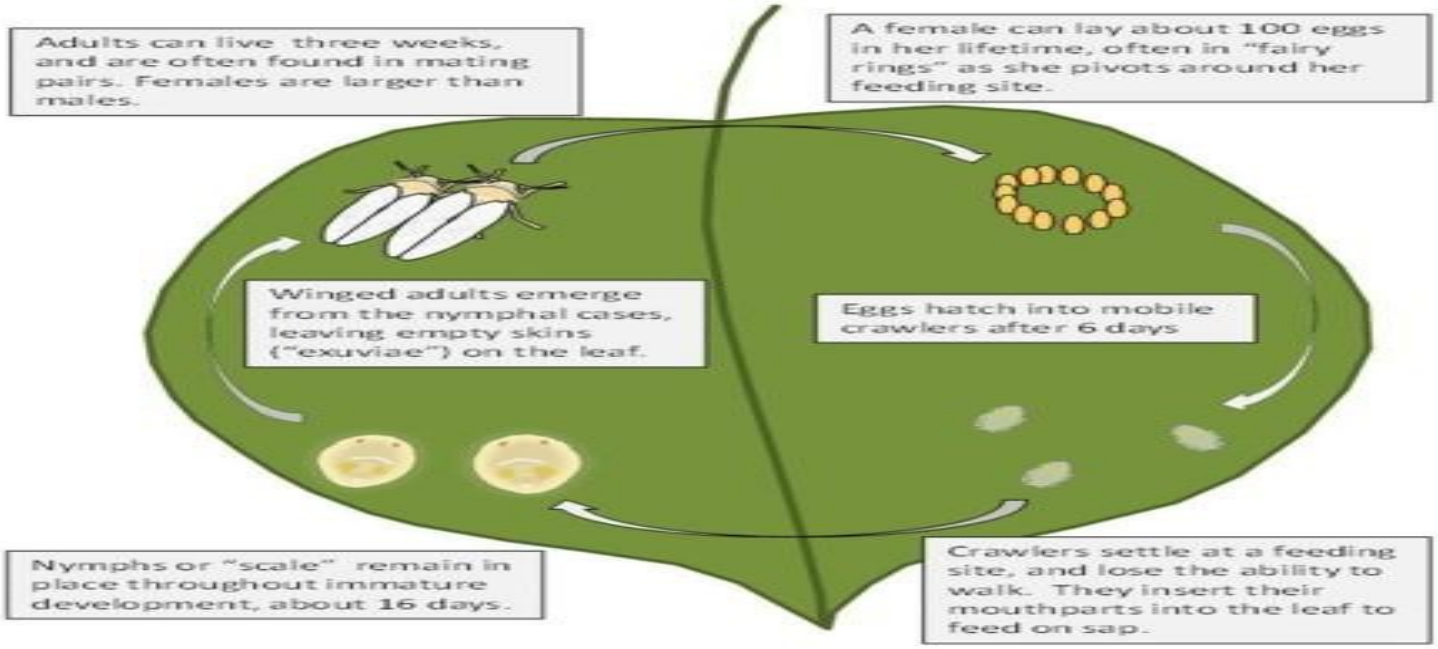
(2) April- June: When the soil testing is not done at the time of sowing treat the setts withabove any one insecticide. In May-June giving irrigation at 10 days intervals to protect thecrop

SUGARCANE Whitefly (Aleurolobus barodensis, Hemiptera, Aleyrodidae*)*

- **Identification:**

Nymph of the whitefly is 3mm long **oval, scale like in form and black in color and has a silvery grey waxy coating on the body.** **The adults are small delicate, pale yellow and their wings have a white mealy appearance, molted with black dots.** They move about briskly, but they are not easily noticed in the field.

- **Symptoms: The only nymphs of whiteflies suck the sap from the under surface of leaves which turn yellow and pinkish in severe cases and gradually dry up. Honey dew=black mould= photosynthesis= poor yield and fodder. Poor quality of gur causes reduced sugar recovery by 25 %.** **Waterlogging** and **nitrogen starvation** cause severe outbreak of whiteflies.**Varieties with broad and long leaves** are more **susceptible** to this pest.



. **Heavy infested leaves are covered by the sooty mould caused by the fungus, which adversely affects photosynthesis. The whitefly infestation retards cane growth and reduces sugar content.**

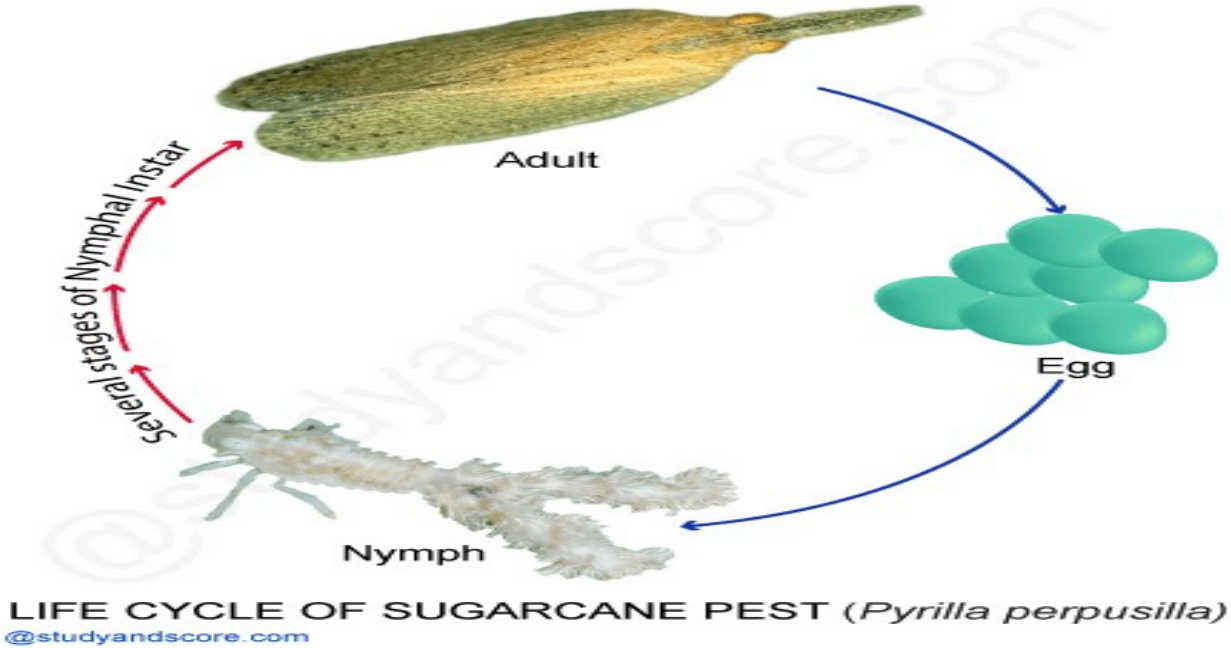
Management:

July-November:- Use **800ml of malathion 50 EC or methyl demeton 25 EC(Metasystox) or 600 ml dimethoate 30 EC for spray in 400 ml water per acre**. In this solution use 10 Kg urea for spray due to this leaves become green frequently

SUGARCANE Pyrilla *(Pyrilla purpusilla Walker* Hemiptera: Lophopidae*)*

- **Host plant: wheat, barlrey, oats, maize, sorghum, baru, guinea grass, swank and sudan grass.**
- **Identification:**
- The leaf hopper is very **agile,20 mm long** and jumps around in large numbers, making a **faint noise** when a person walks through a heavily infested field. The adult equally active, has a **straw colored body with dark patches or spots on the wings. At the front end it has a snoutlike prolongation and prominent red eyes. Nymphs are pale yellow, 10-15 mm long and has two white prominent feather like filaments at the tail end of the body.**
- **Damage**
- Pyrilla **adults and nymphs both suck the cell sap from the lower side of sugarcane leaves**. Due to continuous de-sapping by large number of hoppers top leaves in the affected canes dry up and lateral buds germinate. The hoppers **exude a sweet sticky fluid known as honeydew,** which promotes quick and luxuriant growth of the fungus and as a result the leaves are completely covered by the **sooty mould**. This affects **photosynthesis** activity of the plant and growth of the plant is affected adversely. Affected canes when planted give **poor germination** and **low yield.Heavy rainfall followed by 75-80% humidity,intermittent drought periods, high temperature (26-30°C) and wind movement favors rapidbuildup of pyrilla.** Other factors favoring pyrilla buildup are **dense and luxuriant crop**, **excess nitrogen** application, **water logging,** lodging of cane and varieties with broad and succulentleaves.
-

Life cycle:Eggs:300-536 cluster on the under surface of leaf. Egg cluster are covered with fluffy material.
Hatching Period: 8-10 days in summer 3-4 week during winter, Nymph: 8 weeks in summerand 18-20 weeks in winter. Adult: 27-52 days in summer and 18-20 weeks in winter. 3-4 generation in a year.



Management:

1.Collect and destroy all trashes after harvest.

(1) Sometimes leafhopper will be attacked in April to June. Spray 1000 ml **mlmalathion 50 EC** in 400 L water per acre.

(2) *Epiricania melanoleuca* and *Epipyrops melanoleuca,@4000-5000 cocoons or 4-6 lakh eggs/ha.* biological agent control the Pyrilla

spray with Malathion 50 EC in 800- 1000 ml /ha in 400 liter of water

Pests of pulses

Gram pod borer,*Helicoverpa armigera* Lepidoptera: Noctuidae)

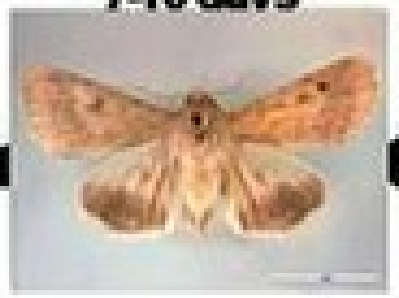
The gram pod-borer or the gram caterpillar is **cosmopolitan** and is serious pest of **chickpea, pigeon pea, mungbean, urdbean, lentil soybean and cowpea.** The insect has also been found damaging **cotton, sorghum, okra, maize, tomato, berseem, sunflower and wheat also.**

Identification:

The moth is **stoutly built** and is **yellowish brown**. **The forewings are marked with greyish wavy lines and black spots of varying size on the upper side and a black kidney shaped mark and a round spot on the underside. The hind wings are whitish and lighter in colour with a broad blackish band along the outer margin. The caterpillars when full-grown, are 3.5 cm in length, being greenish with dark broken grey lines along the sides of the body.**

Pod borer, *Helicoverpa armigera*

4. Adult
7-10 days



1. Eggs

2. Larva

3. Pupa

2-4 days

18-25 days

7-15 days

- **Life-cycle**.

The females lay **eggs singly** on **tender parts of the plants**. A single female may lay as many as **741 eggs in 4 days**. The eggs are **shining greenish yellow** and are **round.** They hatch in **2-4 days in April to October and 6 days in February** and the **young larvae feed on the foliage** for some time and later here into **the pods and feed** on the developing grains, **with their bodies hanging outside**. They move from pod to pod and are full-fed in **13-19 days** and measure 35 mm in the last instar. The full-grown larvae come out of the pod and **pupate in the soil**. In the active season, the **pupal periodlasts 8-15 days**, but in winter the duration is prolonged, particularly in northern India. Some of the **pupae** remain in a facultative **diapause** during **November** April in northern India. There may be as many as **8 overlapping generations in a year.**

- ***Campoletis chlorideae*** **Uchida (Ichneumonidae) is a larval parasite** of major importance. it may parasitize 50-60 per cent of *H. armigera larvae.*

Damage. Although they prefer food plants like gram and red gram, the larvae are **polyphagous.** They feed on the **foliage, when young**, and on the seed in later stages, and thus reduce yield. A single larva may **destroy30-40 pods before it reaches maturity.**

Management.

i. **Timely sowing**, i.e. up to mid October or growing early maturing cultivars which complete podding by first week of March in northern region helps in escaping peak activity period of *H. armigera.*

ii. Use of Helicoverpa-tolerant varieties like JG 315 and JG 74 for central zone and ICCV 7 for southern zone is recommended.

iii. **Mixed intercropping with non-preferred host** plants like **barley, wheat, mustard and linseed** should be preferred over sole crop.

iv. **Hand picking** of the older larvae during early hours of the day is helpful 35 these are less susceptible to insecticides.

v. **Apply nuclear polyhedrosis virus (NPV) @ 250-500 larval equivalents/ha** alone or alongwith half dose of endosulfan 35EC (1.25 litrBS/ ha). Spraying should be carried out in the evening hours.

vi. The pod borer can be managed by spraying the insecticides at the **economic threshold level of one larva per five plants** at at pod initiation stage. The recommended insecticides are **250 ml of fenvalerate 20EC or 200 ml of cypermethrin 25EC or 400 ml of deltamethrin 2.8EC in 625 liters of water per ha** at the start of pod formation and repeat after two weeks, if necessary Alternatively. **Apply fenvalerate 0.4 per cent dust @ 20 kg/ha or Malathion 5 per cent Dust @ 25 kg/ha or endosulfan @ 25 kg/ha.** For consuming any part of the raw gram plant observe waiting period of 20 days after application of the insecticide.

Gram cutworm: *Agrotis ipsilon* & *Ochropleura flammatra* (Lepidoptera: Noctuidae)

- The **term cutworm or surface caterpillar is applied to the larvae of several species of noctuid moths which have, in common, the habit of biting through the stems of seedlings at ground level and eating the leaves or the entire seedlings.**
- **Host Plant: It feesds on Chickpea or gram. It is a polyphagous pest** besides **gram,** it feeds on the seedlings of **many vegetables** and other plants such as **potato, cucurbits, peas, okra, wheat, tobacco, opium, poppy, etc.**

Mark of identification. The **adult is a heavy bodied, grayish-brown or wheat-colored insect characteristic markings and smoky patches which measures 5.0-6.2 cm in wing expanse.Its fore wings have. The caterpillars are dark grey or dull green and their skin is smooth and greasy.**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The female **moths lay yellowish-white eggs on the under surface of leaves, shoots, stems, or in the soil**. A female lays up to **980 eggs** in its life time. The **eggs hatch in 4-7 days during summer and 10-14 days during winter. The larvae remain hidden in soil during the daytime and feed at night on young shoots or underground tubers.** They are **full grown in 4-7 weeks** and then **make earthen cells in the soil for pupation. The pupal stage lasts 12-15 days but during winter it extends up to 5 weeks. The life cycle is completed in 7 -11 weeks and there are generally two generations in a year.**

Hatching Period: 4-7 days in summer 10-14 days in winter

Larval Period: 4-7 week

Pupal Period: 12-15 days in winter, extend up to 5 weeks in winter,

No of Generation: 2 Generation

Damage.

This **cutworm is a sporadic pest of major importance**. In some years, 50 per cent of the gram crop may be destroyed. **The caterpillars spend the day hiding near and about the plant bases. They remain in the top 5-10 cm of the soil near the plants that might have been cut the night before. At night, they come out and become active, cutting down the young plants of gram, potato, vegetable seedlings, etc. just above or slightly below the surface of the soil they seem to be very voracious eaters and they cut more plants than they can consume.**

Management.

The **pest can be controlled with fenvalerate .4D @ 25 kg per ha or spray 80ml fenvalerate 20 EC or 50 m1 cypermethrin 25 EC or 150 ml decamethrin 2.8EC in 100 litres of water per ha.**

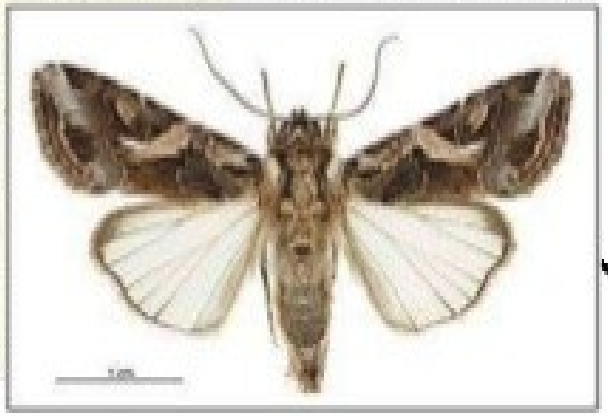
Tobacco caterpillar, *Spodoptera litura* (lepidoptera: Noctuidae)

- **Distribution** : **Tropical** and **sub-tropical** part of the world.
- **Host plant** : Pulses, Tobacco, Castor, Groundnut, Tomato, Sunflower, Cabbage and Cruciferous plants.
- **Mark of identification** : **Caterpillar** is **35-40 mm** in length and they are **velvety black with yellowish-green dorsal stripes and lateral white bands.**
- **Moth** is **22 mm long** and measure **40 mm across the spread wings**. The **fore wings** have beautiful **golden and greyish brown pattern**.

Life cycle :

- This a **polyphagous pests breeds throughout the year.** The female are **active at night** and lay **300 eggs** in cluster. The **eggs cluster** are covered by **brown hairs**.
- They **hatch in 3-5 days**. They pass through **six stage** and become fully develop in **15-30 days.**
- The **larva enter** the **soil where they pupate**. The **pupal stage** lasts for **7-15 days**. The moth live for 7-10 days.
- The life **cycle is completed in 32-60 days** and the pest complete **8 generation** in a year.
- The natural enemies ,***Compoletis*** **and** ***Eriborus*** **and** ***Rogus sp*** are associated with larvae.

Moth Longevity is 7-10 days



LIFE CYCLE

pupa

Period is 2 weeks

eggs

Hatches in 3-5 days

4-5 larval stages

Larval instars – it lasts for 2-3 weeks

P.Ramya

Damage:

- The **damaging stage** of this pest is **caterpillar.**
- The larvae **feed gregariously** for the first few days and then **dispers** to feed individually.
- The larvae **feeds on leaves and fresh growth**.
- They are mostly **active at night** and causes extensive damage, particularly in tobacco nurseries.

Management :

- **Remove the egg masses** and **cluster of larvae** and destroy them.
- Spray **1 litre of quinalphos 25** EC or **trichlorphon** 50 EC, **625 ml of diazinon**, or **250 ml of fenvalrate** 20 EC in **300 litres of water** per ha. Repeat sprays after **15 days** intervals.

Pest of oil seed crop

Among the principal commercial crops grown in India, the oilseeds occupy a prominent place with a production of 25.1 million tonnes from an area of 23.4 million ha in 2003-04. These crops are damaged by a number of pests, of which **mustard aphid, mustard sawfly and the painted bug** are more serious.

1. **Mustard aphid, *Lipaphis erysimi* (Kaltenbach) (Hemiptera : Aphididae)**
2. **Mustard sawfly, *Athalia lugens* (Klug) (Hymenoptera: Tenthredinidae)**
3. **Painted bug, *Bagrada hilaris (*Burmeister) (Hemiptera : Pentatomidae)**
4. **Groundnut aphid, *Aphis craccivora* Koch (Hemiptera: Aphididae)**
5. **Soyabeen,Girdle beetle *Obereopsis brevis* , Coleoptera : Cerambycidae**
6. **Castor semilooper, *Achaea janata* (Linnaeus) (Lepidoptera: Noctuidae)**
7. **Castor capsule borer, *Conogethes puntiferalis* (Lepidoptera : pyralidae)**
8. **Til leaf and pod caterpillar, *Antigastra catalaunalis* (Lepidoptera: Pyralidae)**

BRASSICA CROPS (Brassica spp.; Family : Cruciferae)

1. Mustard aphid, *Lipaphis erysimi* (Kaltenbach) (Hemiptera : Aphididae)

- The mustard aphid is worldwide and is a **serious pest of cruciferous oilseeds** like **toria,sarson, raya, taramira and Brassica vegetables like cabbage, cauliflower,knol-khol**,etc.
- **Mark of Identification**
- The aphids are **minute, soft-bodied and light green** insects having a **pair of short tubes called cornicles on the postero-dorsal region of the abdomen.**
- Life cycle.

The insect **breeds parthenogenetically** and the **females give birth to 26-133 nymphs**. They grow very fast and are full-fed in **7-10 days**. About **45 generations** are completed in a year. The **winged forms are produced in autumn and spring**, and they spread from field to field and from locality to locality.

➢**Damage.**

Both the **nymphs and adults suck cell-sap from leaves, stems, inflorescence or the developing pods**. Due to the very high population of the pest, the **vitality of plants is greatly reduced**. The **leaves acquire a curly appearance**, the flowers fail to form pods and the developing pods do not produce healthy seeds. The **honey dew excreted** by the aphids provides congenial conditions for the growth of **sooty mould** on the plant. In case of severe infestation the crop yield may be reduced by even **80 per cent** or more.

➢**Management.**

Early sowing reduces the incidence of mustard aphid at many locations in India. Three rounds of manual **removal (clipping) of aphid infested twigs at 15 day intervals** starting with the first appearance of the post has been found effective if cheap labour is available. ***Menochilus sexmaculatus*** **is a preadator of this aphid.**Apply any one of the following insecticides **when the population of the pest reaches 50-60 aphids per 10 cm terminal portion of the central shoot or when an average 0.5-1 cm terminal portion of central shoot is covered by aphids or when plants infested by aphids reach 40-50 per cent**: (i) Foliar sprays. 625-1000ml of **oxydemeton methyl** 25EC, **dimethonte** 30EC, quinalphos 25EC, formathion 25EC, **malathion** 50EC; 940-1500 ml of **chlorpyriphos** 20EC in 200-315 litres of water per ha depending on the stage of the crop. (ii) Granular insecticides. 10 kg of phorate 10G, 33 kg of carbofuran 3G per ha followed by a light irrigation.

2. Mustard sawfly, *Athalia lugens* (Klug) (Hymenoptera: Tenthredinidae)

- **Host Plant:** It **feeds on various cruciferous plants like mustard, toria, rapeseed, cabbage, cauliflower, knol-khol, turnip, radish**, etc.

Mark of Identification: The **larvae are dark green** and have **8 pairs of abdominal prolegs**. A full-grown larva measures **16-18 mm in length**. The adults are small **orange yellow insects with black markings on the body and have smoky wings with black veins.**

- **Life-cycle:** The adults lay **30-35 eggs singly,in slits made** with **saw like ovipositors** along the **underside of the leaf margins**. The eggs **hatch in 4-8 days** and the larvae feed exposed in groups of 3-6 on the leaves during morning and evening. They pass through **seven stages** and are **full-grown in 16-35 days**. The full-fed l**arvae descend** the plant and **enter the soil to a depth of 25-30 mm.**

➢There, they **pupate** in water proof oval **cocoons made of silk** and emerge from them as adults in **11-31 days.** Thus, the **life-cycle** is completed in **31-34 days**. The pest completes **2-3 generations from October to March**.

➢**Damage.**

It is a **serious pest** of all **crucifers at the seedling stage**. The grubs alone are destructive. They **bite holes into leaves preferring the young growth and skeletonize the leaves completely**. The **older plants**, when attacked, **do not bear seed.**

➢**Management.**

Clean cultivation and **quick threshing of harvested crop** helps in lowering the incidence of the pest. Spray one litre of **malathion** 50EC or or **quinalphos 25EC in 150-200 litres of water per ha** once in **October** and again in **March-April.**

3.Painted bug, *Bagrada hilaris (*Burmeister) (Hemiptera : Pentatomidae)

- The painted bug is a **serious pest of cruciferous crops** and is widely distributed in Myanmar, Sri Lanka, India, Iraq, Arabia and East Africa. Besides cruciferous crops, it has also been observed **feeding on rice, sugarcane, indigo and coffee**.
- **Mark of identification**
- The full-grown nymphs are about **4 mm long and 2.66 mm broad**. **Nymph** are **black with a number of brown markings.** The adult bugs are **3.71 mm long and 3.33 mm broad. Adult Bug** are sub-**ovate, black and have a number of orange or brownish spots.**
- Life-cycle: These bugs lay **oval, pale-yellow eggs singly or in groups of 3-8 on leaves stalks, pods and sometimes on the soil.** A female bug may lay **37-102 eggs** in its life-span of 3-4 weeks. The eggs **hatch in 3-5 days during summer and 20 days during December**. The nymphs develop fully in live stages and transform themselves into adults in **16-22 days during the summer and 25-34 days during the winter**. The entire lifecycle is completed in **19-54 day,** and it passes through **9 generations** in a year**.**

- **Damage.**

The painted bug appears at two stages of crop growth, i.e. **seedling and maturity** and many times infestation is carried even to threshing floor. Both **nymphs and adults suck cell sap from the leaves and developing pods, which gradually wilt and dry up. Severe attack at seedling stage may even kill the plants. The nymphs and adult bugs also excrete a sort of resinous material which spoils the pods.**

- **Management:**

Clean cultivation and quick threshing of harvested crop helps in lowering the incidence of the pest. Spray one litre of **malathion 50EC or quinalphos 25EC in 150-200 litres of water per ha** once in October and again in March-April.

GROUNDNUT (*Arachis hypogaea* L: Family: Leguminosae)

4. Groundnut aphid, *Aphis craccivora* Koch (Hemiptera: Aphididae)

- This is one of the most **serious pests of groundnut**. It also attacks **peas, beans, pulses, safflower and some weeds**.
- **Mark of identification**
- **Nymphs are brownish and** The **winged adults are soft-bodied insects with black wings and** they reach the freshly germinated groundnut plants after overwintering on collateral host plants.
- **Life cycle.**

Even without fertilization the females may produce **8-20 young** ones in a **life span of 10-12 days**.

The young nymphs are **brownish and they pass through four moults to become adults in 5-8 days.** The **apterous females** start producing brood within **24 hours of attaining that stage.** Breeding occurs almost throughout the year and **both alatae and apterae are present**.

The coccinellid beetle, ***Menochilus sexmaculatus*** (Fabricius) (Coleoptera: Coccinellidae) and ***Ischiodon javana*** (Wiedemann) (Diptera: Syrphidae) are the main predators of this aphid pest.

➢Damage.

The **nymphs and adults suck the sap,** usually from the **underside of leaves**. Infestation in the early stages causes stunting of the plants as well as **reducing their vigour**. When the attack occurs at the time of flowering and pod formation, the yield is reduced considerably. Infestation on the groundnut crop usually occurs **4-6 weeks after sowing**. The aphid is also **vector of rossette disease of groundnut.**

➢Management.

As soon as the pest appears on growing points, spray 625 ml of **malathion 50EC** or 425 ml of **dimethoate 3OEC** or 425 ml of **oxydemeton methyl 25EC** in 200 litres of water per ha.

5.SOYBEEN GIRDLE BEETLE *Obereopsis brevis* (Gahan) (Coleoptera :Cerambycidae)

- **Identification.** The adult is a small **black beetle** with hard shell-like exterior and rather on antennae. The freshly emerged **adult is yellow, red, brown on the head thorax and bases of elytra. The larva is white, soft-bodied worm with a dark head.**
- **Host plants.** This is an important **pest of soybean** and **also attacks cowpea and lablab.**
- **Life-history.** The ovipositing female beetle **girdles the stem twice and makes it 3 punctures Just above the lower ring before inserting a single egg through the largest whole into the pith. This results in dropping of the upper part of the stem.** A female beetle lays **7 -13 eggs** and they hatch in **4-5 days.** The **larva tunnels upwards and downwards within the stem** and a single larva can destroy the whole plant.

•The **larval period lasts 34-47 days**. Over-wintering takes place as the full-grown larva within the feeding tunnel in a gall-like chamber near the base of the plant in the girdled portion of the stem which has fallen out or under plant debris. The **Pupal period is 8-11 days**.

Damage. The **attack** of this insect begins initially in the **last week of July to fortnight of August**. The female of this insect feeds on the **xylem of the stem.** The **larvae further and fill these with excreta**. The **leaves and the growing point get damaged. The grub tunnel the stem and plants dry up. In later stages, the plant is cut at about 15-25 cm above the ground and broken stems can be seen in the field.**

Management. Trizophos 0.05% quinalphos0.05%, Monocrotophos @ 2ml/ lit of water, Imidacloprid @ 0.3 ml / lit of water Acetamiprid @ 0.5 gm / lit of water etc .

6.Castor semilooper, *Achaea janata* (Linnaeus) (Lepidoptera: Noctuidae)

This is a **serious pest of castor** in all parts of India and Pakistan and has also been reported from Sri Lanka and Thailand.

Mark of identification:

The adult of ***A. janata*** is a **pale reddish brown moth** with a wing expanse of **6-7 cm**. The wings are decorated with **broad zig-zag markings**, a **large pale area and dark brown patches. The full grown larva is dark and is marked with prominent blue-black, yellow and reddish stripes.**

➢**Life cycle.**

A female lays up to **450 eggs** during its life span. The **egg,** being about **1 mm in length, is fairly large and also has on its surface a few ridges and furrows which radiate from the circular depression at the apex.** The **larva emerges** by **cutting a hole in the egg-shell** in **2-5 days** and **devours it immediately**. The larva feeds and **moults 4-5 times** and becomes full-**grown in 15-20 days**

➢**The grown-up larva prepares a loose cocoon of coarse silk and some soil particles, and pupates under the fallen leaves on the soil, usually at the edge of the field.** In some cases, **pupation also takes** place **within the folded leaves** on the plant itself. The **pupal stage lasts 10-15 days** and the moths, on emergence, feed on the soft fruits of **citrus, mango,** etc. There are **5-6 generations** in a year.

➢**Damage.**

The **caterpillars feed voraciously on castor leaves, starting from the edges inwards and leaving behind only the midribs and the stalks**. With the excessive loss of foliage, the **Seed yield is reduced** considerably.

➢Management.

Apply 1.5 litres of monocrotophos or 1000 ml of quinalphos 25EC In 625 litres of water per ha.

7. Castor capsule borer, *Conogethes puntiferalis* (Lepidoptera : pyralidae)

- This bore is distributed throught India wherever castor is grown such as **Utter Pradesh, Bihar, Orissa, Maharastra, Gujarat, Karnataka, Andhra Pradesh and Tamil Nadu**.

- **Mark of identification**
- The full- grown **caterpillar measures 25-30 mm in length**, is **radish brown, with black blotches all over the body and a pale stripes on the lateral side.** The **moth** are **orange yellow with black markings on both the wings.**

- **Life cycle.**

The moth lays **eggs on leaves and other soft parts of the plant**.

The eggs hatch in **about a week (7days)**.

The larvae passes through **4-5 instars** and are full fed in **2-3 weeks**. **Pupation** takes place **inside the seed or some times in the frass**.

The **pupal stage** **lasts about a (7 days) week.**

The **life cycle** is completed **in 4-5 week and** **3 generation** are completed in a year.

- **Damage.**

The attack by this borer is recognized from a distance by the **webbed capsule heads**. The **yield is reduced** considerably since the capsules and **seeds** within **are damaged.**

- **Management.**

(1) it is advisable that the **infested shoots and capsules may be collected** and **destroyed**.

(2) **Apply 1.5 litres of monocrotophos or 1000 ml of quinalphos 25EC In 625 litres of water per ha.**

SESAME (*Sesamum indicum* L.; Family : Pedialiaceae)

8.Til leaf and pod caterpillar: *Antigastra catalaunalis* (Duponchel) (Lepidoptera: Pyralidae)

- The sesame **leaf and pod caterpillar is a serious and regular pest of til (S. indicum)** and is also distributed throughout India. This species has also been reported from Europe, Africa, Cyprus, Malta, Indonesia and South-east Africa.

Mark of Identification:

- The **caterpillars are pale yellow, when young, but gradually become green and develop black dots all over the body**. The full-grown **larva** measures **14-17 mm**. The **moth is a small** insect with a **wing span of about 2 cm** having **dark brown markings on the wing-tips.**

- **Life cycle.**

Females lay up to **140 eggs singly on the tender portions of plants at night**. The eggs are **shiny, pale-green and they hatch in 2-7 days,** depending upon the season. On emerging, the young **larva**, which measures **about 2 mm in length**, **feeds for a little while on the leaf epidermis or within the leaf tissue**. Soon after, **it binds together the tender leaves of the growing shoot with the help of silken threads and continues to feed in the webbed mass**.

- The size of this rolled mass increases gradually as the caterpillar grows older. It becomes full-grown in about **10 days in summer, but the period may be prolonged to 33 days in winter**.

- The grown-up **larvae creep to the ground and pupate in silken cocoons in soil.**
- **Sometimes, pupation also takes place in the plant itself**. Pupal development is completed in **4-20 days**, depending upon the season.
- In summer, **a generation is completed in about 23 days but in the winter it takes about 67 days.**

- Damage.

Young **caterpillars feed on leaves**. They also **bore into the shoots, flowers, buds and pods**. An **early attack kills the whole plant,** but infestation of the shoots at a later Stage hampers further growth and flowering.

- Management.

Spray the crop twice (first at pest appearance and then at flowering stage) with **250 ml of fenvalerate 20EC or 375 ml of deltamethrin 2.8 EC or, thrice with 500 ml of cypermethrin 10EC at pest appearance, flowering and pod formation in 250 liters of Water per ha.**

- **COTTON (Gossypium spp.: Family :Malvaceae)**

Although **India occupies the largest area** in the world under cotton, it ranks **third in production**.

More than 1326 species of insects have been reported attacking cotton in the World However, **in India, only 162 species have been recorded**, among which only **15 species may be called as major pests** due to their occurrence in serious proportions almost every year.

1. Pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera - Gelechiidae)
2. Spotted bollworms, *Earias insulana* (Boisduval) and *E. Vittella* (Fabricius) (Lepidoptera: Noctuidae)
3. American bollworm, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae)
4. Cotton leafhopper, *Amrasca biguttula biguttula* (lshida) (Hemiptera Cicadellidae)
5. Cotton whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera : Aleyrodidae
6. Cotton aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae)

7. MEALYBUG,*Phenacocus solenopsis* Tinsley (Cotton mealy bug, Hemiptera: Pseudococcidae
8. Red cotton bug, *Dysdercus koennigii* (Hemiptera: Pyrrhocoridae)
9.Dusky cotton bug, *Oxycarenus laetus* Hemiptera : Lygaedae
10.Cotton leaf roller, *Sylepta derogate*, Lepidoptera : Pyrallidae
11.Bud moth,*Phycitia infusella*, Lepidoptera : Pyrallidae
12.Cotton semi looper, *Tarache notabilis*, Lepidoptera : Noctuidae
13.Green semi-looper, *Anomis flava*, Lepidoptera : Noctuidae
14.Cotton grey weevil, *Myllocerus undecimpustulatus*, Coleoptera : Curculionidae
15.Cotton stem weevil, *Pempherulus affinis*, Coleoptera : Curculionidae

1. Cotton leafhopper(Jassid),***Amrasca biguttula biguttula*** **(**lshida) (Hemiptera Cicadellidae)

The cotton leafhopper is widely distributed in India and is the **most destructive pest of American cotton** in the north-western regions. Besides cotton, it also feeds on **okra, potato brinjal** and some wild plants, like **hollyhock, kangi buti**, etc. Adults are about **3 mm long** and **greenish yellow during the summer, acquiring a reddish tinge in the winter.**

Life cycle. The females lay about **15 yellowish eggs on the underside of the leaves**, **embedding them into the leaf veins**. The **eggs hatch in 4-11days** and give rise to nymphs which are **wedge-shaped** and are very active. They **suck cell-sap from the underside of the leaves** and pass through **six stages of growth in 7-21 days**. On transformation into winged **adults**, they live for **5-7 weeks**, feeding constantly on the plant juice. The pest **completes seven generations** in a year.

Damage.Injury to plants is caused **both by the nymphs and the adultswhich suck sap from the foliage and probably also due to the injection of toxins into the plant tissues. The attacked leaves turn pale and then rust-red. With change in appearance, the leaves also turn downwards, dry up and fall to the ground. Owing to the loss of plant vitality, the cotton bolls also drop off, causing upto 35 per cent reduction in yield.**

Management. Grow American cotton varieties which are **resistant or tolerant** to leafhopper attack. In Punjab, recommended varieties are F1861, F1378, F846, LH1556 and hybrid LH144, all of which are moderately resistant or tolerant to leafhopper attack.

Spray against leafhopper should be done only at **economic threshold level of 1-2 nymphs per leaf or when second grade injury symptoms (yellowing and curling at margins of leaves) appear in 50 per cent of the plants**. Any one of the following insecticides can be used in **250 litres of water per ha: 750 ml of formothion 25EC or oxydemeton methyl 25EC, 625 ml of dimethoate 30EC, 100 m1 of imidacloprid 200 SL, 50g of acatamiprid 20SP, 100g of thiamethoxam 25WG. At the time of sowing, smear the cotton seed with imidacloprid 75WS@ 5g/kg seed.**

2. Cotton whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera : Aleyrodidae)

- This pest is distributed throughout the northern and western regions of the Indian Subcontinent and is a very serious pest of American cotton, particularly in the dry areas. Apart from cotton, this insect also **feeds on** various other plants such as **cabbage, cauliflower, sarson, toria, melon, potato, brinjal, okra and some weeds.**
- In the winged stage, they are **1.0-1.5 mmlong** and their **yellowish bodies are slightly dusted with a white waxy powder.They have two pairs of pure white wings and have prominent long hind wings.**
- **Life-cycle** : Females lay **stalked eggs singly on the underside of the leaves**, averaging **119 eggs per female**. The eggs **hatch in 3-5 days during summer, 5-33 days in winter.** The nymphs **feed on cell-sap** and grow into **three stages** to form the **pupae within 9-14 days in summer and in 17-81 days in winter**. In **2-8 days, the pupae change into whiteflies.** The total **life-cycle is completed in 14-122 days** and **11 generations** are completed in a year.

Damage.

The damage is caused by both the **nymphs and the adults** by **sucking the sap from the leaves**. Insects **exude honeydew which attracts sooty mould**. Therefore, in severe infestation, the **plants** not only become weak, but the mould **interferes** with the normal **photosynthesis** resulting in poor growth and yield of cotton. B. tabaci is known to transmit number of virus diseases including the **cotton leaf curl, the leaf curl disease of tobacco, the vein clearing disease of okra and the leaf curl of sesame.**

Management.

Grow American cotton varieties which are **resistant or tolerant** to leafhopper attack. In Punjab, recommended varieties are F1861, F1378, F846, LH1556 and hybrid LH144, all of which are moderately resistant or tolerant to leafhopper attack.

3. Red cotton bug, *Dysdercus koennigii* (Hemiptera: Pyrrhocoridae)

- This insect is widely distributed in India and is a **minorpest of cotton** in the Punjab and UP. Apart from **cotton** it feeds on **okra, maize, pearmillet,etc**. The bugs are **elongated slender insect crimson red with white bands across the abdomen. The membraneous portion of their fore wings, antennae and scutillum is black**. Both **adults** and their **nymphs feed** on the **cell-sap of cotton**, hollyhock, wheat, maize, pearl-millet, clovers etc.
- **Life cycle :** This insect is active throughout the year and **passes winter in the adult stage**. In spring the bugs becomes active and lays, egg on an average , **100-130 eggs in moist soils or in crevices in the ground**. The eggs are **spherical , bright yellow** and are laid in the in cluster or in loose irregular masses of 70-80 eggs each. They **hatch in 7-8 days** and the young nymphs have flabby abdomens, but as they grow older, they become more slender and develop black markings on the body. There are **five nymphal stages** and the development is completed in **49-89 days**. In summer, the life of an adult is very varaible, but in winter, it may live up to three months .The predacious bugs like ***Antilochus cocqueberti*** and ***Harpactor costalis*****feed on nymph and adults**.

- Damage : the insect **sucks the cell-sap from the leaves and green bolls of cotton**. Heavily attacked **bolls open badly** and the **lint is of poorer quality**. The **seeds** produced may also have **low germination** and **less oil**. The bugs **stain the lint with their excreta or body juice as they are crushed in the ginning factories**. The staining of lint by the **growth of certainbacteria** inside the bolls is also believed to be initiated by these bugs.
- **Management.** Any one of the following insecticides can be used in **250 litres of water per ha: 750 ml of formothion 25EC or oxydemeton methyl 25EC, 625 ml of dimethoate 30EC, 100 m1 of imidacloprid 200 SL, 50g of acatamiprid 20SP, 100g of thiamethoxam 25WG. At the time of sowing, smear the cotton seed with imidacloprid 75WS@ 5g/kg seed.**

5. Pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera - Gelechiidae)

- The pink bollworm is one of the **most destructive pests** 0f Cotton and is found in America, Africa, Australia and Asia. It is highly destructive in India and Pakistan.
- The **adult is a deep brown moth, measuring 8-9 mm across the spread wings. There are blackish Spots on the fore wings, and the margins of the hind wings are deeply fringed.**
- **Life-cycle.** The females **lay whitish, flat eggs singly on the underside of the young**, **new shoots, flower buds and the young green bolls**. The **eggs hatch in one week** and the caterpillars, on emergence, are **white and turn pink as they grow older**. Soon after emergence, the larvae enter the flower-buds, the flowers or the bolls. The **holes of entry close down**, but the larvae continue feeding **inside the seed kernels**. They become full-grown (8-10 mm) in about **two weeks** and come out of the holes for **pupation on the ground, among fallen leaves**, **debris**, etc. Within **one week, the moths emerge** to start the life-cycle all over again By **October-November, 4-6 generations are completed.**

- Full-grown larvae of the **last generationdo not, however, pupate**. Just a few of them reach the ground, but the great **majority keep feeding inside the bolls and connecting to produce what are known as the 'double seeds'**. The hibernating larvae lie curled in double seeds for many months and after passing the winter, they emerge as moths. **The last life-cycle is very long covering 5-10 months**, although during the active season, the life cycle is short, taking only 3-4 weeks. The pest passes through several broods during its active period.
- **Damage.** There is **excessive shedding of the fruiting bodies. The attacked squares, buds, flowers (called rosetted flowers) and young bolls fall off pre-maturely and those which do mature do not open properly. The damaged seed-cotton is difficult to pick, discoloured and gives a lower ginning percentage, lower oil extraction and inferior spinning quality. The infestation ranges from 40 to 85 per cent.**

Management.

(i) **Cultural and mechanical control**. The carryover and multiplication of this pest can be appreciably reduced by the following **cultural and mechanical control measures**:

1. **Pick the seed cotton completely**. Partially unpicked locule (burs) should not be left on the plants.

2. After the last picking, **sheep, goats and other animals should be let into the cotton fields to feed on the plant debris and unopened boll**s. Goats are most effective as they can browse even on the standing plants.

3. The **leftover, unopened and partially picked bolls should be dislodged b**y beating against the ground or by plucking them. The burs and bolls so collected should be burnt immediately.

4. **Cut the cotton sticks 5-6 cm below ground level to prevent their re-growth.**

5. **Do not keep the cotton sticks in the fields**. Stack them in the Village premises. This would reduce the number of focal points from which initial infestation spreads to the fields.

6. **Plough the cotton fields deep by the end of February**, preferably with a furrow-turning plough.

7. **Crushing of cotton seed** should be completed before sowing of cotton begins in the area and seed left uncrushed should be sun-dried in thin layers for three consecutive days in the middle of April or fumigated to kill the diapausing larvae of the pink bollworm. For fumigation one 3-g aluminium phosphide (Celphos) tablet should be used per cubic meter of space giving an exposure period of 48 hours or 2 tablets per cubic meter of space with an exposure of 24 hours.

8. **The seed should be acid-delinted or fumigated before sowing.**

9. Replace the cotton seed by seed-cake for feeding the animals.

10. The damage of the pest can be reduced **by sowing short-duration varieties** and by early termination of last irrigation to the crop.

- (iii) Chemical control. In case the bollworm damage exceeds 5 per cent, the crop should e Sprayed immediately and thereafter at 10 day interval with any of the following insecticides in 315-375 litres of water per ha.
- (a) Organochlorine. 2. 5 litres of endosulfan 35EC. (b) Organophosphates. **2. 0 litres of fenitrothion 50EC, 2.0 litres of quinalphos 25EC, 1. 25 litres of monocrotophos 36SL, 1.0 liters of phenthoate 50EC, 5.0 litres of chlorpyriphos 20EC, 2. 0 litres of quinalphos 25EC,1.25liters of quinalphos 20EC 1.25 litres of fenitrothion 82.5EC, 1.5 litres of triazophos 40EC, 2.0 litres of ethion 50EC, 2.0 kg of acephate 75SP, 1.25 litres of profenophos 50EC. (c) Carbamctes 2.5 kg of carbaryl 50WP, 3.125 kg of carbaryl 40LV, 1. 5 kg of carbaryl 58, 3.0 litres of carbaryl 42F (d) Synthetic pyrethroids. 500 ml of cypermethrin 10EC, 200 ml of cypermethrin 25EC 400 ml of deltamethrin 2.8EC, 275 ml of deltamethrin 4EC, 250 ml of fenvalerate 20EC 300 ml of Fluvalinate 25EC, 250 ml of alphamethrin I0EC or asymethrin 5EC. (e) 150 ml of spinosad 48 SC.**
- (iv) At **least 5-6 sprays are required for effective control of bollworms**. **Same insecticide should not be sprayed repeatedly** to avoid the development of pesticide resistance and appearance of secondary pests. Also, avoid using insecticides of the same group in more than three sprays.

(ii) Biological control. **The releases of Trichogramma spp. @ 1,50,000 parasitized eggs** ha at weekly intervals have proved promising for bollworm control.

6. Spotted bollworms, *Earias insulana* (Boisduval) and E. Vittella (Fabricius) (Lepidoptera: Noctuidae)

- These **two species** of bollworms are widely distributed in North Africa, India, Pakistan and other countries and are serious pests of cotton. The full-grown **dull-green caterpillars are 20 mm long having tiny stout bristles and a series of longitudinal black spots on the body. The moths are yellow green and measure about 25 mm across the wings. E. vittella moths are of the same size and have a narrow light longitudinal green band in the middle of the forewing.**
- **Life cycle.** The female moths **lay 200- 400 eggs** at night, **singly on flower buds, brackets and tender leaves of okra or cotton plants**. The **eggs hatch in 3-4 days** and the **caterpillars passthrough 6 stages**, becoming full-grown in **10-16 days**. They **pupate** either on the **plants** or **on the ground** (during November December) among **fallen leaves** and the **moths emerge in 8-14 daysin summer and 18-23 days in winter**. The **life cycle** is completed (usually August to October) **in 17-29days**. **Several overlapping generations** are completed in a year.

- **Damage**. When cotton plants are young, the **larvae bore into the terminal portions of the shoots, which wither away and dry up**. Later on, they cause **shedding of the fruiting bodies.** The **green bolls attacked by spotted bollworm are often infected by fungi which causes bolls to rot and dry up without opening. The infested bolls called aborted bolls open prematurely and produce poor lint, resulting in lower market value.**
- **Management.**
- (i) The pest can be suppressed **with clean cultivation and the destruction of alternative food plants** (Abutilon indicum Sweet, Malvastrum tricuspidatum A. Gray, Sida spp) particularly when cotton or okra is not growing in that locality.
- (ii) The **withering tops** of the plants damaged by the spotted bollworm during June-July should be removed and destroyed to check the multiplication of the pest in the initial stage.
- (iii) Chemical control measures are same as in case of pink bollworm. The economic threshold level is **10 percent incidence** in shoots or reproductive parts.
- (iv)**Trichogramma chilonis** and *Trichogramma brasilience* are the egg parasitoid against spotted boll worm.

7. American bollworm, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae)

Mark of Identification:-The moth is **stoutly built** and is **yellowish brown** with a **V shaped speck on fore wing**. **Hind wings** are **whitish and lighter in color** with **broad blackish band along outer margin**.

Caterpillar :- greenish with dark broken grey lines along the side of the body (35 cm long).

Damage:-Small puncture may be seen on bolls .Larva seen feeding on the bolls by thrusting the head in boll and **half body hanging outside**. The **larvae** first **feed** on the **leaves than on the bolls.**

Life cycle:-

Moth **lays eggs on tender parts of plant**

They **pupate in soil**

ETL 5 % damage in fruiting bodies or **3-4 male moth / pheromone trap/ week 2-3 times**

Management:-

i. Avoid **mono and continuous cropping**

ii. Deep summer ploughing

iii. Avoid mono cropping by growing 0f less preferred crops like**greengram, blackgram, castor, soyabean**along with cotton as inter crops, border crop or alternate crop.

iv. Remove and destroy crop residue to avoid the carryover of the pest

v. Avoid the excessive use of nitrogen fertilizers

vi. Water management to prevent excessive vegetative growth and larval harborage

vii. Monitoring the pest through **light and pheromone** traps Inundative release of **egg parasites Trichogrammaspp @1.5 lac/ha**

viii. Destroy the larvae by hand collection

ix. 10-12 thousand chrysoperla/ Bigha, Apply **NPV @ 0.75ml/l** of water

x. Neem insecticide 300 ppm/5.0ml/lit water

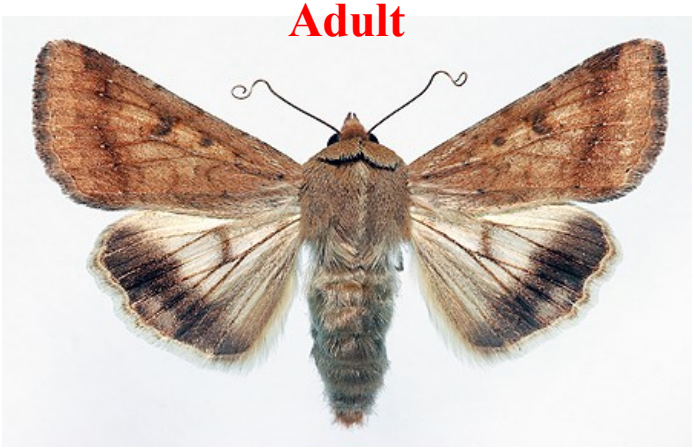
xi. Spray following Insecticides for control

Quinolphos 25 EC – 2 ml/lit, Malathion 50 EC – 2 ml/lit, Deltamethrin 2.8 EC 1.0 ml/lit, Thiodicarb75 SP – 1.75 gm/lit, Ethion 50 EC – 3.0 ml/ lit, Indaxocarb 14.5 SC 1 ml/lit, Spinosad 45 SC –.33 ml/lit

Alphamethrin 10 EC - 0.5 ml/ lit, Chlozopyriphos 20EC - 5 ml/lit

Tomato Fruit Borer

Adult



Pupa

Tomato Fruit Borer, *Helicoverpa armigera* (Hubner) (Lepldoptera: Noctuidae)

The tomato fruit borer is **cosmopolitan** and is serious pest of **Peas, tomato, cotton, maize, tobacco, safflower, groundnut, chillies,chickpea, pigeon pea, mungbean, urdbean, lentil soybean and cowpea.** The insect has also been found damaging **sorghum, okra, maize, berseem, sunflower and wheat also.**

Identification:

The moth is **stoutly built** and is **yellowish brown**. **The forewings are marked with greyish wavy lines and black spots of varying size on the upper side and a black kidney shaped mark and a round spot on the underside. The hind wings are whitish and lighter in colour with a broad blackish band along the outer margin. The caterpillars when full-grown, are 3.5 cm in length, being greenish with dark broken grey lines along the sides of the body.**

- **Life-cycle**.

The females lay **eggs singly** on **tender parts of the plants**. A single female may lay as many as **741 eggs in 4 days**. The eggs are **shining greenish yellow** and are **round.**

They hatch in **2-4 days in April to October and 6 days in February** and the **young larvae feed on the foliage** for some time and later on to **the tomato fruit.**, **with their bodies hanging outside**. They move from fruit to fruit and are full-fed in **13-19 days** and measure 35 mm in the last instar.

The full-grown larvae come out of the fruit and **pupate in the soil**. In the active season, the **pupal periodlasts 8-15 days**, but in winter the duration is prolonged, particularly in northern India. Some of the **pupae** remain in a facultative **diapause** during **November** April in northern India. There may be as many as **8 overlapping generations in a year.**

- ***Campoletis chlorideae*** **Uchida (Ichneumonidae) is a larval parasite** of major importance. it may parasitize 50-60 per cent of *H. armigera larvae.*

Damage. Although they prefer food plants like gram and red gram, the larvae are **polyphagous.** They feed on the **foliage, when young**, and on the seed in later stages, and thus reduce yield. A single larva may **destroy some fruit before it reaches maturity.**

Management.

i. **Timely Transplanting of tomato**, i.e. up to mid October or growing early maturing cultivars.

ii. Use of Helicoverpa-tolerant varieties.

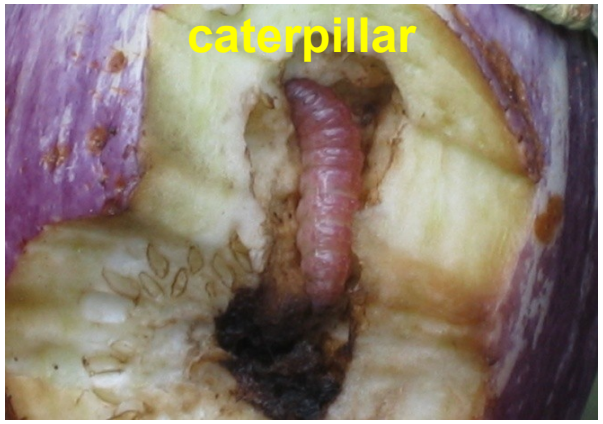
iii. **Mixed intercropping with non-preferred host** plants like **barley, wheat, mustard and linseed** should be preferred over sole crop.

iv. **Hand picking** of the older larvae during early hours of the day is helpful 35 these are less susceptible to insecticides.

v. **Apply nuclear polyhedrosis virus (NPV) @ 250-500 larval equivalents/ha** alone or alongwith half dose of endosulfan 35EC (1.25 litrBS/ ha). Spraying should be carried out in the evening hours.

vi. The fruit borer can be managed by spraying the insecticides at the **economic threshold level.** The recommended insecticides are **250 ml of fenvalerate 20EC or 200 ml of cypermethrin 25EC or 400 ml of deltamethrin 2.8EC in 625 liters of water per ha** at the start of pod formation and repeat after two weeks, if necessary Alternatively. **Apply fenvalerate 0.4 per cent dust @ 20 kg/ha or Malathion 5 per cent Dust @ 25 kg/ha or endosulfan @ 25 kg/ha.** For consuming any part of the raw gram plant observe waiting period of 20 days after application of the insecticide.

Brinjal Shoot and fruit borer



1.**Brinjal fruit and shoot**Borer :***Leucinodes orbonalis***
(lepdoptera : Pyralidae)

Appearance: Moth , **white** but has **pale brown or black spot** on the dorsum of the thorax and abdomen (20-22mm).

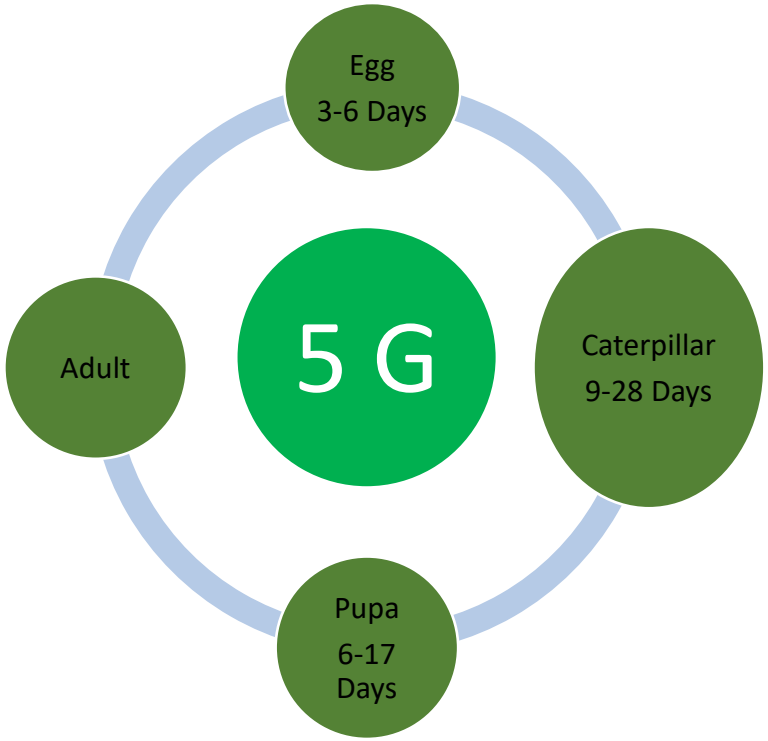
Wings : White with a pinkish or bluish tinge and have small hairs along the apical and anal margin.

Caterpillar: Creamy white when young, but **light pink** when full grown.

Host plant: Solanaceous plants and green pods of pea also.

Active period: March-April.

➢**Life cycle: Egg,creamy white egg** on **under surface of leaves, stem,flower buds and calyces of fruit**. **Hatching period 3-6days**. **Larval period 9-28 days. Pupal stage in the fallen leaves 6-17 days**. 5 **over laping generation.**



➢**Damage**:The young caterpillar **bore into the tender shoot** near the growing point into **flower buds and into the fruits.** The **growing point of the plant killed**. Later on it bore into the fruit. **One caterpillar** may destroy as many as **4-6 fruits**. The damage to fruit particularly in autumn , is very severe.

➢**Management**:

(1) **Remove and destroy the infested fruit.**

(2) **Avoid continuous cropping** of brinjal crop.

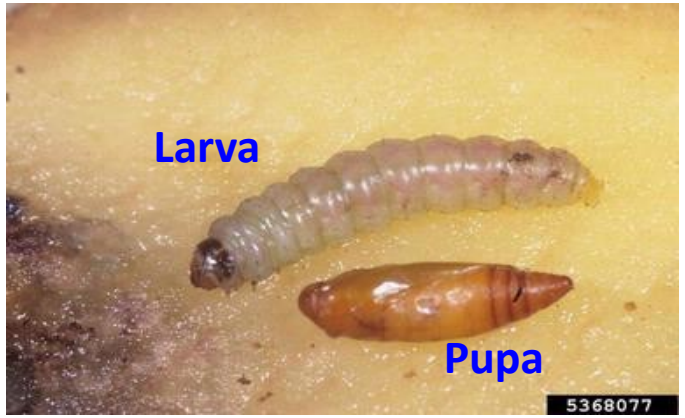
(3) **do not ratoon the brinjal crop**.

(4) spray **carbaryl 50 wp @ 4 gm or formathion 50 EC @ 1 ml or Acephate 50 EC @ 0.5 gm quinalphos 25 EC, trizophos 40 EC and monocrotophos 36 SL @ 2 ml per litres of water.**

Pest of POTATO (*Solanum tuberosum*) **Family**: Solanaceae

Potato Tuber Moth

adult



- **Potato Tuber Moth, *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae)**

This pest occurs especially in **hot** and **dry** climates. It is destructive to **potato** and also attacks **tobacco, tomato, brinjal and solanaceous weeds**. It is particularly **serious on potato in Himachal Pradesh**.

The **adult** is **very small narrow-winged nocturnal** moth, about **13 mm** across the wings when spread, It is **greyish brown with mottling of dark brown**.

The **larvae** cause the damage and are recognized as **pinkish-white or greenish caterpillars, with dark-brown heads**. They are about **20 mm** in length.

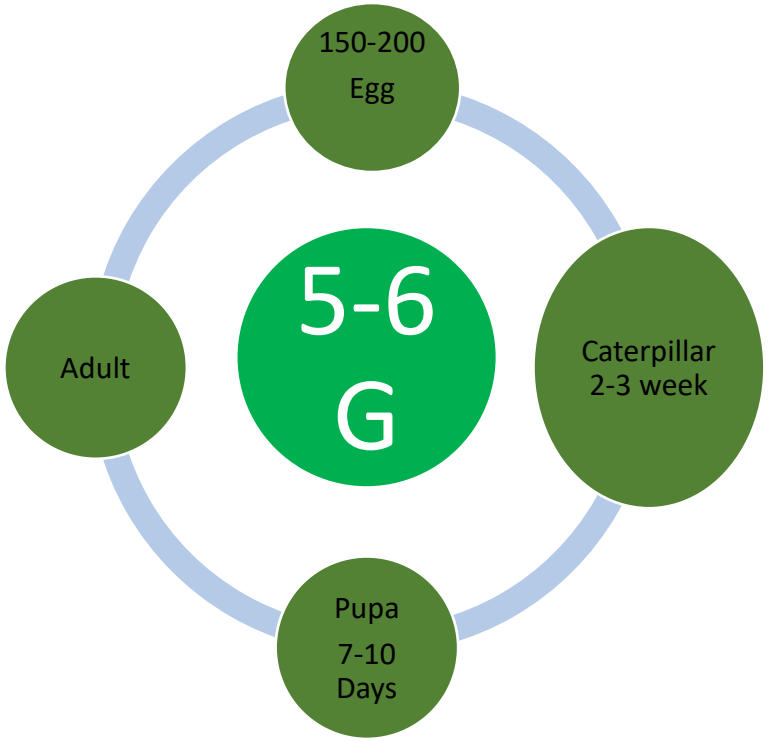
Another species of tuber moth attacking potato is ***P. heliopa*** (Lower)

Life-cycle: This pest may **breed throughout the year**. In **cold weather**, the life-cycle is much **prolonged**.

Early in the **spring,** the **moths escape** from **store-houses** and **start breeding in fields**. A female, on an average, **lays 150-200 eggs singly on the underside of leaves or on exposed tubers**. H. P. is 2-6 days.

The larvae first produce **blotch mines on leaves but subsequently, they work their way into the stems**. The **larval stage in summer lasts 2-3 weeks** and the **mature larva pupates in a grayish silken dirt-covered cocoon,** which is about 13 mm in length. The **moths emerge in 7-10 (Pupa) days**. They complete their life-cycle about **one month and there are usually 5-6 generations in a year.**

Damage: In **warm dry climates extensive damage** may be done to the crop; but the **potato tubers kept in cold stores escape damage.** Later generations in the field infest the **tubers** also. The grubs bore into the tender vines and tubers making the later unfit for marketing and consumption. At the **time of digging, the moths may lay eggs on tubers**. **The larvae, on hatching, may work their way just under the skin and, later, may make tunnels through the flesh, causing damage to the tubers. 30 to 70 % damage in storage.**


150-200
Egg
Caterpillar
2-3 week
Pupa
7-10
Days
Adult
5-6
G

Management:

All the **infested tubers should be removed** and destroyed.

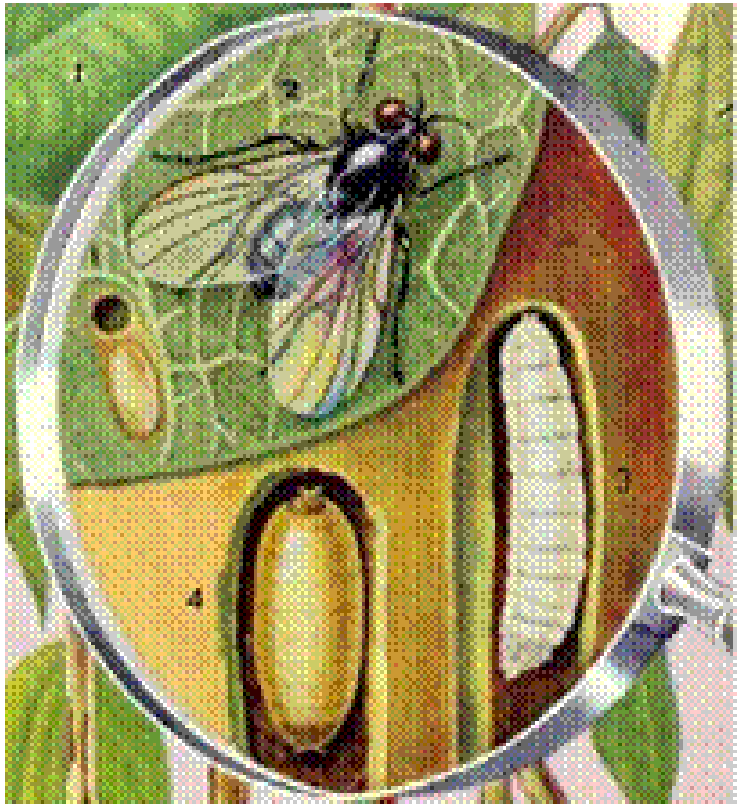
Cold storage of tubers also helps in suppressing the pest.

The pest can be checked by spraying **2.5 kg of carbaryl 50 WP in 625 litres** of water per ha or **by dusting seed potato with 150 g of malathion 2 per cent per 100 kg**.

Repeat Spraying 2-3 times at fortnightly intervals and do not dust the edible potatoes.

If **potato tubersi n the stores get infested**, fumigation with **carbon di sulphide @ 2-3 litres per 100 m^3should be done.**

Pea Stem Fly, *Ophiomyia phaseoli* (Tryon) (Diptera: Agromyzidae)



Pea Stem Fly, *Ophiomyia phaseoli* (Tryon) (Diptera: Agromyzidae)

It is sporadic pest.

Hosts: Peas, *Phaseolus mungo* L., *Phaseolus aconitifolius* Jacq., soybean, *Glycine max* Mer., cowpeas, *Vigna catjans* Walp. and *Lablab niger* L.

Marks of identification:

Larva : **Yellowish maggots and are leaf-and stem-miners.**

Adult : **The adult flies are metallic black.**

Life-cycle: The flies are active in summer and mate 2-6 days after emergence. The female **lays 14-64 elongate, oval and white eggs into the leaf tissue** with the help of its elongated ovipositor.

The **eggs hatch in 2-4 days** and the **maggots on emergence feed on leaf tissue** at first but later on move to the **terminal stems**.

They pass through **three instars** and **the larval development is completed in 6-7 days in March-April and 9-12 days in November and December**.

The **larva pupates within its gallery and the pupal period lasts 5-9 days in March and April, and 18-19 days in November and December**.

The female flies live for 8-22 days and the males for 11 days. The pest **completes 8-9 generations** from July to April and shifts from one host plant to the other in various seasons.

It passes winter as larva or as pupa.


14-64
Egg
2-4 Days
Caterpillar
6-7 D(Mar-April)
9-12 D(Nov. –Dec.)
Pupa
5-9 D(Mar- April)
18-19 D(Nov. –Dec.)
Adult
8-9
G

Damage: The **maggots bore into the stem thereby causing withering and ultimate drying of the affected shoots, thus reducing the bearing capacity of the host plants.**

The **adults also cause damage by puncturing the leaves, and the injured parts turn yellow. The damage is more severe on seedlings than on the grown up plants.**

Management:

Avoid sowing of the crop earlier than mid-October to check the attack of the pest.

Sow the crop in the second fortnight of October to escape the damage of the pest.

Remove and destroy all the affected branches during the initial stages of attack.

Apply **7.5 kg of phorate 10G or 25 kg of carbofuran 3 G per ha in furrows at the time of sowing.**

On the crop, spray three times 750 ml of **oxydemeton methyl 25EC in 250 litres of water per ha. The first application should be just after germination and the other two at an interval of 2 weeks each.**

Onion

Botanical name : *Allium cepa* L.
Family: *Alliaceae*

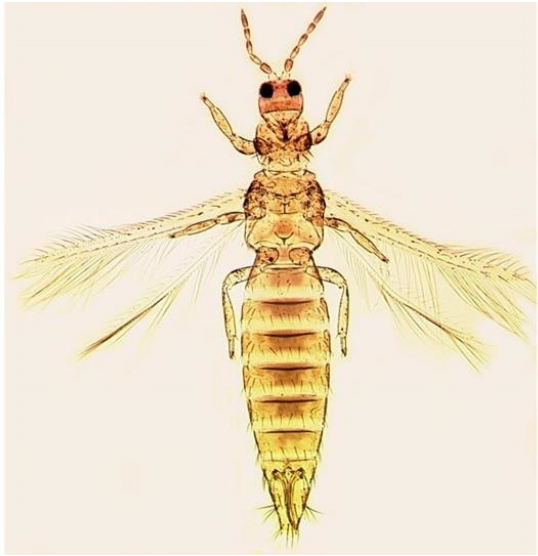
S.No	Pest	Scientific name	Order	Family
1. .	Onion Thrips	*Thrips tabaci*	Thysanoptera	Thripidae

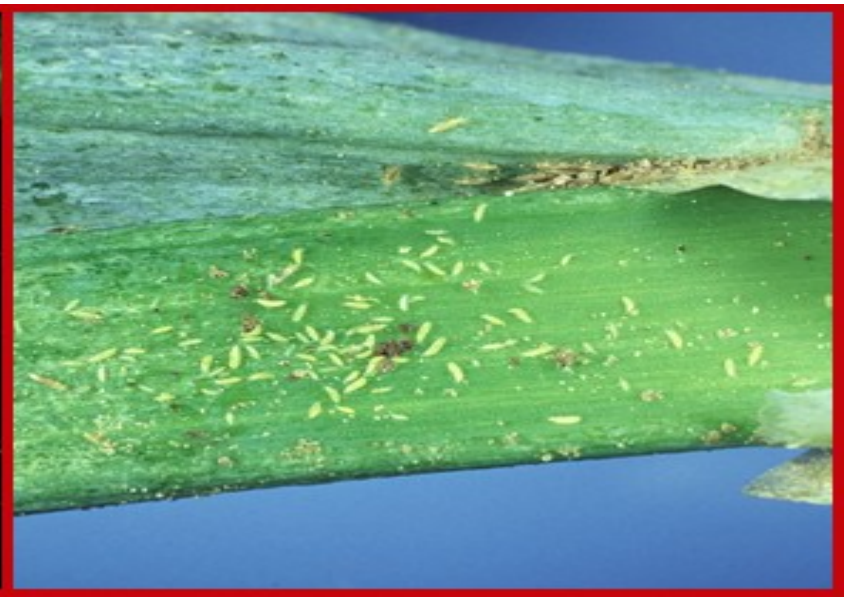
1. Onion Thrips, *Thrips tabaci* Lindeman (Thysanoptera: Thripidae)

Onion thrips is world-wide and is found throughout India as a **major pest of onion and garlic.**

Other Hosts: Cotton, cabbage, cauliflower, potato, tobacco, tomato, cucumber etc.

Onion Thrips





brown and measure about 1 mm in length. The **males are wingless** whereas the **females have long, narrow strap-like wings**, which are furnished with long hair along the hind margins. **Nymph:** The nymphs resemble the adults but are wingless and slightly smaller. They move briskly on the flowers and leaves of onion and garlic plants.

➢**Life-cycle:** This pest is active throughout the year and **breeds on onion and garlic from November to May** when it migrates to cotton and other summer host plants and breeds there till September. In **October**, it is found on **cabbage and cauliflower.** The adult female lives for 2-4 weeks and lays **50-60 kidney-shaped eggs singly in slits which are made in leaf tissue with its sharp ovipositors. It reproduces parthenogenetically.** The **eggs hatch in 4-9 days** and the **nymphs start feeding on plant juices** by **lacerating the leaf tissues**. **On onion and garlic, they are usually congregated at the base of a leaf or in the flower**. On cotton, cabbage and cauliflower, they generally feed on the lower surface of leaves. The **nymphs pass through four stages and are full-fed in 4-6 days**, after which they descend to the ground and **pupate at a depth of about 25 mm.** The

8-9
G

➢**Damage: Damage** is done by **adults as well as by nymph by congregate at the base of leaf or in the flower. The nymph and adult lacerate and suck the sap from the leaves. The puncture produces silvery white blotches leading to distortion, wilting, curling, wrinkling and drying of leaves from tip downward. The seedling show retard growth. The bulb remain undersized and appear distorted in shape.**

In Hawaii, ***T. tabaci*** **is known to act as a vector of streak -virus disease of peas and yellow-spot of pineapple.**

➢**Management:**

➢**Grow resistant varieties sweet Spanish, white Persian and Grano.**

➢**Use neem coated urea which reduces the infestation of pest.**

➢**Set up sky blue sticky traps which attracts more adult than yellow colour traps**

Spray 625 ml of Malathion 50 EC in 250 litres of water per ha as soon as the pest appears. A waiting period of 7 days should be observed before harvest.

Chilli thrips: *Scirtothrip dorsalis Thripidae:* Thysanoptera

- **Host Plant:** Chilli, Citrus, corn, cotton, eggplant, melon, rose, tobacco, tomato.
- **Mark of Identification:** Small size, yellow coloration, dark antennae and dark striping on the lower abdomen.
- **Biology:** The insect reproduce **sexually as well as parthenogenetically.** The female thrips **insert eggs into the veins of leave** and a female may lay **40-80 eggs.** The female **lay kidney shaped** egg. Egg will hatch in 2-7 days. There will be two nymphal stage. The nymph feed for 8-10 days before entering into **pupal stage that lasts for 2-3 days.** The life cycle is completed in **10-20days.**
- Damage: The nymph and adult infest tender leaves and feed on the sap causing curling of leaves which may leads to stunting of the crop. Buds and flower are damaged. The yield loss may range to 25-50%. **Chilli thrip is a vector of chilli leaf curl virus,tobacco streak virus.**
- **Management:** Dusting Quinalphos 1.5 % or spray application of Dimethoate .03% malathion 0.1% quinalphos 0.05% or cypermethrin0.025%. Spray these insecticide four times at monthly intervals.

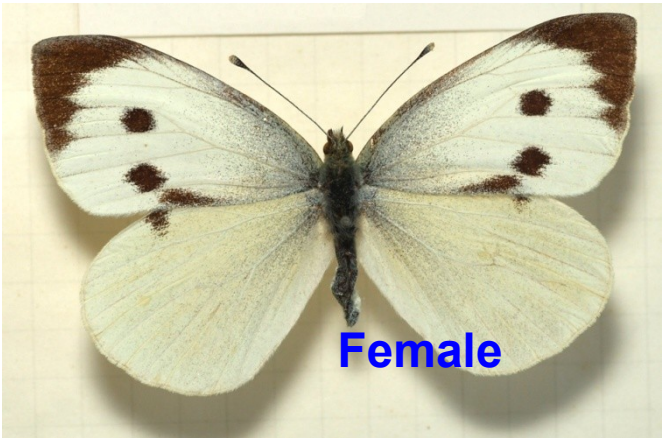
Pest of Cruciferous vegetable

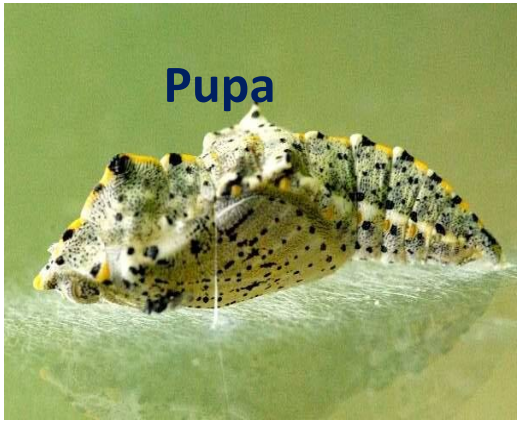
Cabbage (***Brassica oleracea var.capitata*** L.); Cauliflower (***Brassica oleracea var. botrytis*** L.); Knol-khol (***Brassica oleracea var. gongylodes***); and Radish (***Raphanus sativus*** L.)

Family : Brassicae

S.No	Pest	Scientific name	Order	Family
	Cabbage Caterpillar	*Pieris brassicae*	Lepidoptera	Pieridae
	Diamond-back Moth	***Plutella xylostella***	**Lepidoptera**	**Yponomeutidae**
	Cabbage Semi-looper	***Thysanopulsia orichalcea*** **and** ***Autographa nigrisigna***	**Lepidoptera**	**Noctuidae**
	Tobacco Caterpillar	***Spodoptera litura***	**Lepidoptera**	**Noctuidae**
	Crucifer Leaf-webber	***Crocidolomia binotalis***	**Lepidoptera**	**Pyralidae**
	Cabbage Borer	***Hellula undalis***	**Lepidoptera**	**Pyralidae**
	Cabbage Flea Beetles	***Phyllotreta cruciferae, P. chotanica, P. birmanica, P.oncera, P. downesi***	**Coleoptera**	**Chrysomelidae**

Cabbage Butterfly: *Pieris brassicae,* Lepidoptera:Pieridae





Cabbage Caterpillar, *Pieris brassicae* (Linnaeus) (Lepidoptera: Pieridae)

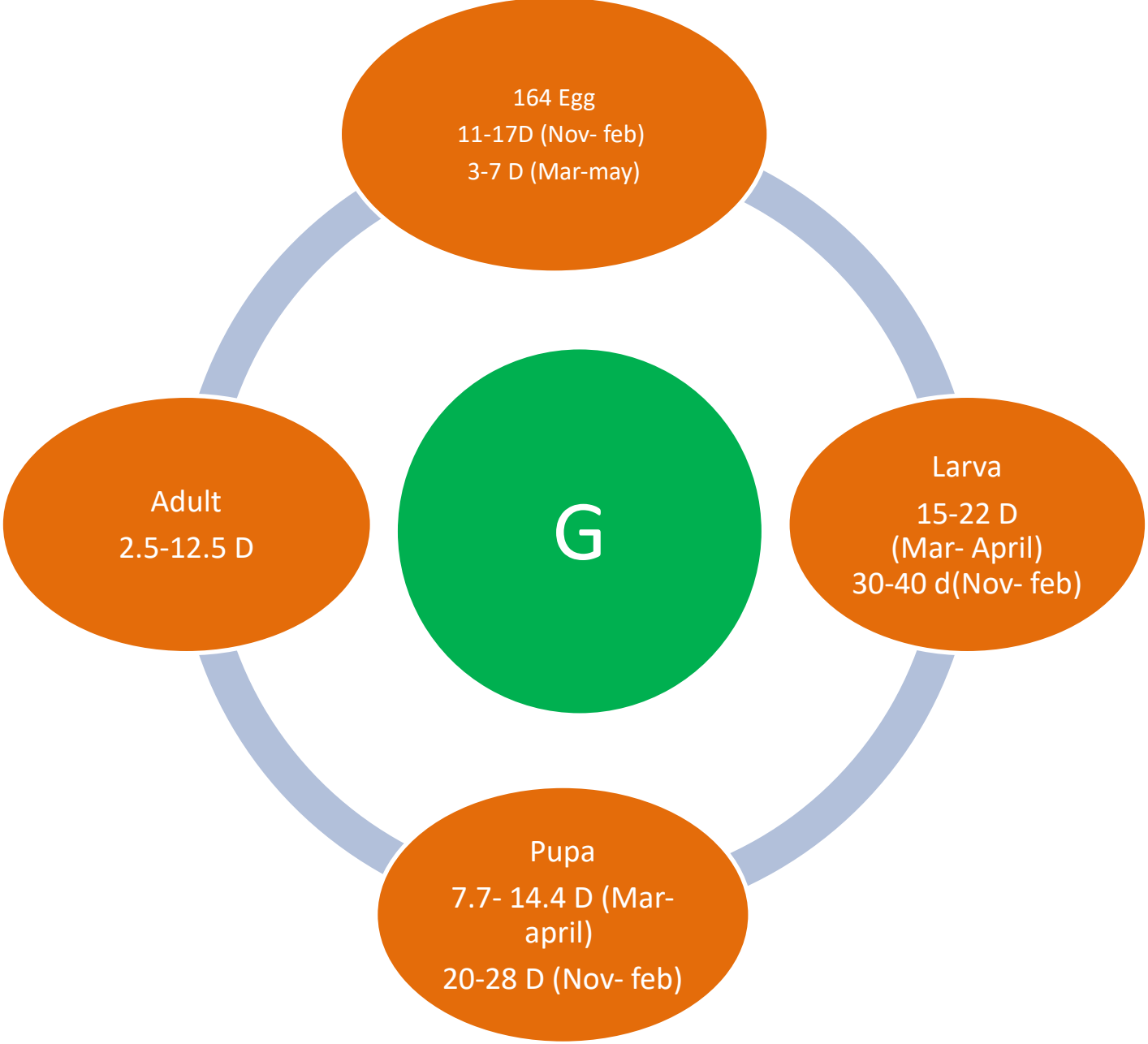
- **Hosts:** It is a serious pest of **cabbage, cauliflower, knol-khol** and it may also attack **turnip, radish, *sarson*, *toria*and other cruciferous plants.**
- **Marks of identification:**
- **Larva:** The full-grown **larva** measure **40-50 mm** in length. The young **larvae are pale yellow, and become greenish yellow later on. The head is black and the dorsum is marked with black spots. The body is decorated with short hair.**
- **Adult:** The **butterflies are pale white** and have a **smoky shade on the dorsal side of the body**. The wings are **pale white, with a black patch on the apical angle of each fore wing and a black spot on the costal margin of each hind wing**. The **females measure 6.5 cm across** the spread wings and have two conspicuous black circular dots on the dorsal side of each fore wing. **Males are smaller than the females** and have **black spots on the underside of each fore wing.**

Life-cycle:

This pest apper in **October and remains active up to the end of April**.

The female lay, on an average, **164 yellowish conical eggs in clusters of 50-90 on the upper or the lower side of a leaf**. The **eggs hatch in 11-17 days in November-February** and **3-7 days in March-May**. The **caterpillars feed gregariously during the early instars and disperse as they approach maturity**. They **pass through five stages and are full-fed in (larval period) 15-22 days during March-April and 30-40 days during November-February**. **The larvae pupate in barns or on trees. The pupal stage lasts 7.7-l4.4 days in March- April and 20-28 days in November-February**. The butterflies live for 25-125 days and the pest breeds four times during October-April.

The **larvae** of this insect are **parasitized by *Apanteles glomeratus*** (Braconidae) in the natural populations.


164 Egg
11-17D (Nov- feb)
3-7 D (Mar-may)
Larva
15-22 D
(Mar- April)
30-40 d(Nov- feb)
Pupa
7.7- 14.4 D (Mar-april)
20-28 D (Nov- feb)
Adult
2.5-12.5 D
G

Damage:

The **caterpillars alone cause damage.**

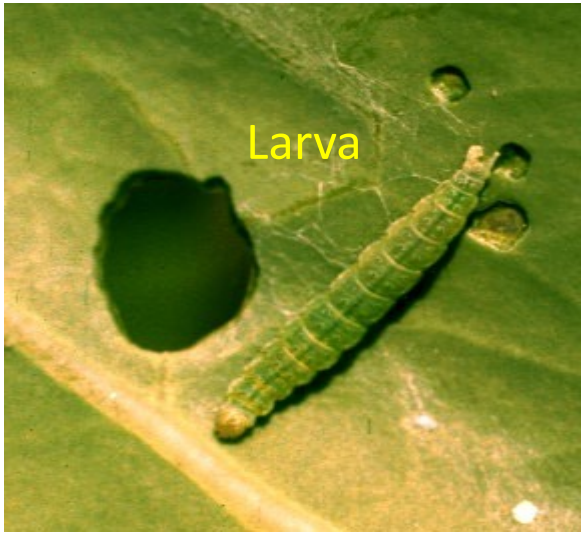
The **first instar caterpillars just scrape the leaf surface, whereas the subsequent instars eat up leaves from the margins inwards, leaving intact the main veins. Often, entire plants are eaten up.**

Management:-

Hand picking and mechanical destruction of caterpillars during early stage of attack can reduce infestation.

Spray one litre of **Malathion 5OEC** or 925 ml of **quinalphos 25EC** in 250 litres of water per ha. Repeat spraying at 10 day interval s if necessary. Do not spray the crop at least one week before the harvest.

Diamond-back Moth :*Plutella xylostella*



Diamond-back Moth, *Plutella xylostella* (Linnaeus) (Lepidoptera: Yponomeutidae)

This world-wide moth is a **serious pest of cauliflower and cabbage, but also feeds on many other cruciferous, solanaceous and liliaceous plants**, all over India.

Marks of identification: Larva: When full-grown, the **larvae measure about 8 mm in length and are pale yellowish green with fine black hair scattered all over the body.**

Adult: The **moths measure about 8-12 mm in length and are brown or grey, with conspicuous white spots on the fore wings, which appear like diamond patterns when the wings lie flat over the body.**

Life-cycle:

This insect is **active throughout the year**. **Yellowish eggs** of the size of pin heads are **laid singly or in batches of 2-40 on the underside of leaves**. A female may lay **18-356 eggs** in her life-time. The **eggs hatch in 3-6 days.**

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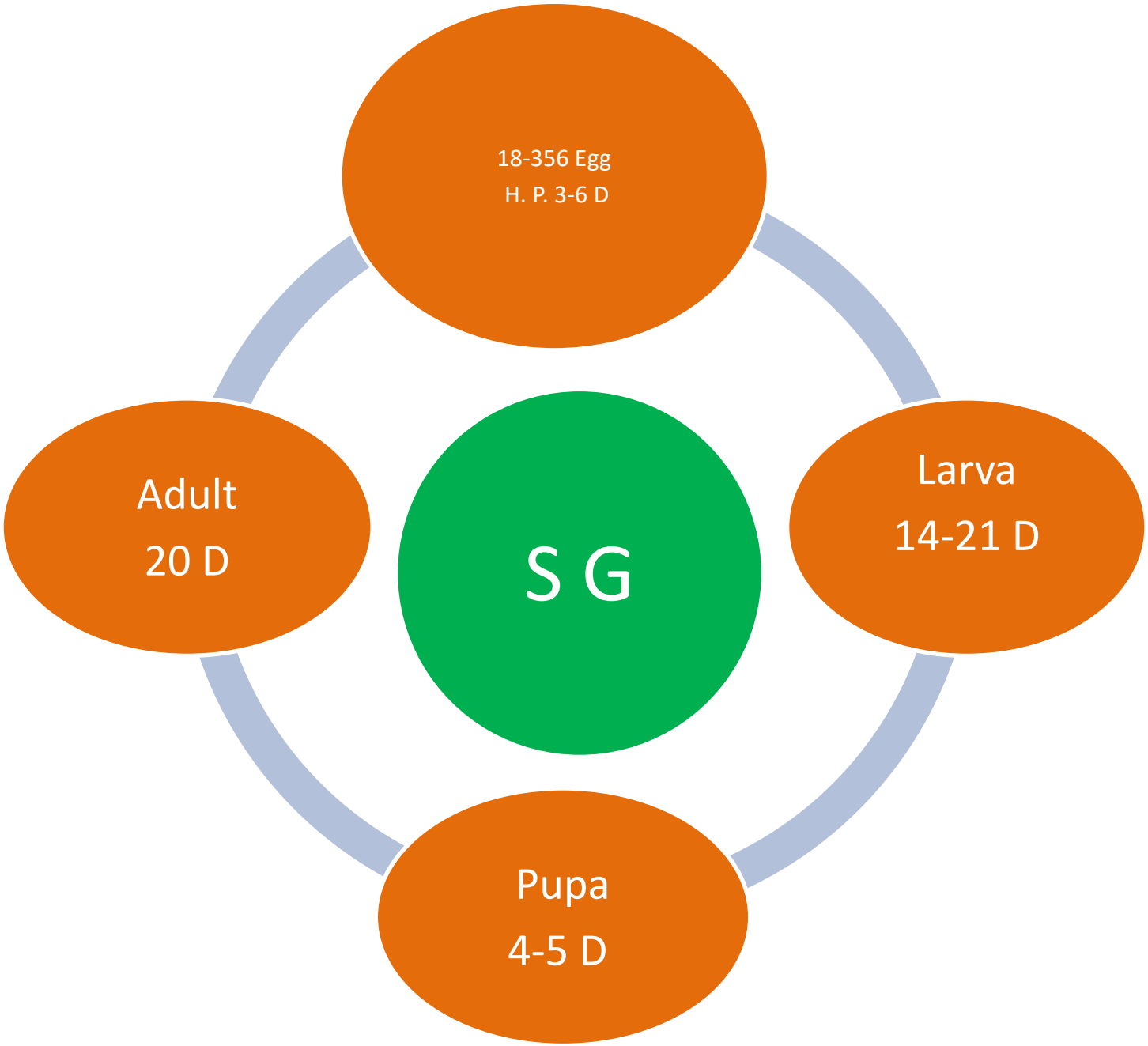
- The **newly hatched caterpillars bore into the tissue from the underside of leaves and feed in these tunnels.** At first, **their presence is detected only from the blackish excreta** The **larvae are very sensitive to touch, wind or other physical disturbances** and readily feign death. **They become full-grown in 14-21days**. **Before pupating, the larva constructs a barrel-shaped silken cocoon which is open at both ends and is attached to the leaf surface.** The **pupa stage lasts 4-5 days and the moths may live for as long as 20 days**. The **life-cycle is completed in 15-18 days** during September-October and there are **several generations in a year.**


18-356 Egg
H. P. 3-6 D
Larva
14-21 D
Pupa
4-5 D
Adult
20 D
S G

***Apanteles plutellae* (Kurdyumov) effectively checks the population of diamondback moth** on cabbage in Gujarat and Karnataka under favourable environmental conditions.

Damage:-

Damage is caused by the caterpillars which, in the earlier stages, feed in mines on are lower side of cabbage leaves and, in the later stages, feed exposed on the leaves.

Caterpillars damage the leaves of cauliflower, cabbage and rape-seed particularly in the heart of the first two.

Central leaves of cabbage or cauliflower may be riddled and the vegetables rendered unfit for human consumption.

The pest is most serious when it appears on the early crop in August-September.

Management:-

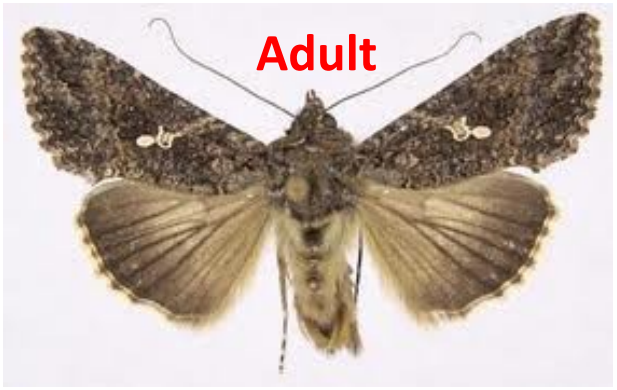
Remove and destroy all the remnants, stubble, debris, etc. after the harvest of the crop and plough the fields.

Tomato, when intercropped with cabbage, inhibits or reduces egg laying by diamond-back moth.

Indian mustard, which attracts 80-90 per cent diamond-back moths for colonisation, can be used as a trap crop.

Spray 625 ml of diazinon 20EC or 1.0 litre or quinalphos 35EC or trichlorphon 50EC or 250 ml of fenvalerate 20EC in 250 litres of water per ha. Repeat sprays at one week intervals.

Cabbage Semi-looper



Cabbage Semi-looper, *Thysanopulsia orichalcea* (Fabricius) and *Autographa nigrisigna* (Walker) (Lepidoptera: Noctuidae)

- **Hosts** : This is **polyphagous** pest.: **Cabbage, cauliflower and other winter vegetables, groundnut and sunflower** are the host plant.
- **Marks of identification:**
- **Larva:**The **caterpillars are plump and palish green**. They **cause damage by biting round holes into cabbage leaves. On walking, they form characteristic half-loops and are often seen mixed with cabbage caterpillars.**
- **Adult:**The **adults of *T. orichalcea* are light palish brown with a large golden patch on fore wing. They measure about 42 mm across the spread wings. The adults of *A. nigrisigna* arc darker and have dark brown and dirty-white patches on the fore wings.**

- **Life-cycle:**
- These insects are active during the winter and it is not known how they survive the heat of summer. During the active period, they lay eggs on leaves of host plants and the caterpillars feed individually, biting holes of varying size according to the stage of their active development. When full-grown, they pupate in the debris lying on the ground. The moths are very active at dusk on flowers in gardens and public parks, where they are seen in hundreds during the spring season.
- **Management:** Same as in case of cabbage caterpillar.

Tobacco Caterpillar

Damaging symptoms

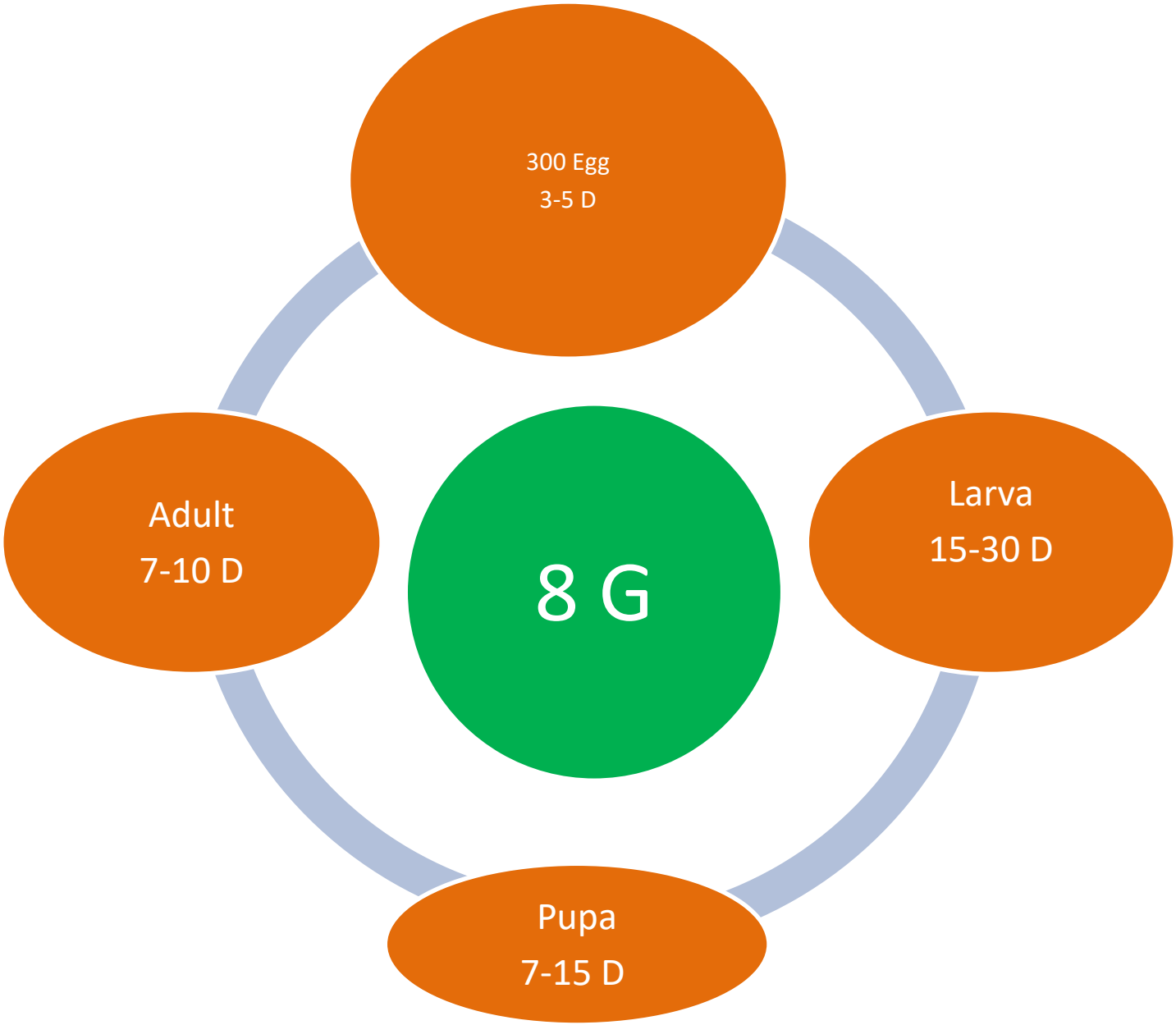
Tobacco Caterpillar, *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae)

Hosts: Besides tobacco, feeds on **castor, groundnut, tomato, sunflower, cabbage** and various other cruciferous crops.

Marks of identification:- **Larva :** **Larva** measure **35- 40 mm** in length, at maturity. They are **velvety black** with **yellowish-green dorsal stripes and lateral white bands.**

Adult : The **moth** are about **22 mm long** and measure **40 mm across the spread wings**. The fore wings have beautiful **golden and greyish brown patterns**.

Life-cycle: This pest breeds throughout the year, although its development is considerably **retarded during winter.** The moths are active at night when they mate and the female lays about **300 eggs** in **clusters.** These clusters are covered over by brown hair and **they hatch in about 3-5 days**. The larvae feed gregariously for the first few days and then disperse to feed individually. They pass through 6 stages and are full-fed in 15-30 days. The full-grown larvae enter the **soil** where they **pupate**. The **pupal stage lasts 7- 15 days** and the **moths**, on emergence, live for **7-10 days.** The **life cycle is completed in 32-60 days** and the pest completes **eight generations** in a year.


300 Egg
3-5 D
Larva
15-30 D
Pupa
7-15 D
Adult
7-10 D
8 G

The natural enemies, ***Compoletis* sp., *Eriborus* sp., *Rogas* sp. (Braconidae)** and *Strobliomiyia orbata* W. (Anthomyiidae) are associated with larvae of this pest.

Damage:

The **damage** is done only by the **caterpillars.**

The **larvae feed on leaves and fresh growth**. They are mostly active at night and cause extensive damage, particularly in tobacco nurseries.

Management:

Remove the egg masses and clusters of larvae and destroy them.

(ii)Spray 625 ml of diazinon 20EC or 1.0 litre or endosulfan 35EC or quinalphos 35EC or trichlorphon 50EC or 250 ml of fenvalerate 20EC in 250 litres of water per ha. Repeat sprays at one week intervals.

PESTS OF COTTON

❑ COTTON (Gossypium spp.: Family :Malvaceae)

Although **India occupies the largest area** in the world under cotton, it ranks **third in production**.

More than 1326 species of insects have been reported attacking cotton in the World However, **in India, only 162 species have been recorded**, among which only **15 species may be called as major pests** due to their occurrence in serious proportions almost every year.

1. Pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera - Gelechiidae)
2. Spotted bollworms, *Earias insulana* (Boisduval) and *E. Vittella* (Lepidoptera: Noctuidae)
3. American bollworm, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae)
4. Cotton leafhopper, *Amrasca biguttula biguttula* (Ishida) (Hemiptera Cicadellidae)
5. Cotton whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera : Aleyrodidae
6. Cotton aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae)

7. MEALYBUG, *Phenacocus solenopsis* Tinsley (Cotton mealy bug, Hemiptera:Pseudococcidae
8. Red cotton bug, *Dysdercus koennigii* (Hemiptera: Pyrrhocoridae)
9.Dusky cotton bug, *Oxycarenus laetus* Hemiptera : Lygaedae
10.Cotton leaf roller, *Sylepta derogate*, Lepidoptera : Pyrallidae
11.Bud moth,*Phycitia infusella*, Lepidoptera : Pyrallidae
12.Cotton semi looper, *Tarache notabilis*, Lepidoptera : Noctuidae
13.Green semi-looper, *Anomis flava*, Lepidoptera : Noctuidae
14.Cotton grey weevil, *Myllocerus undecimpustulatus*, Coleoptera : Curculionidae
15.Cotton stem weevil, *Pempherulus affinis*, Coleoptera : Curculionidae

1. Cotton leafhopper (Jassid), ***Amrasca biguttula biguttula*** **(**Ishida) (Hemiptera Cicadellidae)

The cotton leafhopper is widely distributed in India and is the **most destructive pest of American cotton** in the north-western regions. Besides cotton, it also feeds on **okra, potato brinjal** and some wild plants, like **hollyhock, kangi buti**, etc. Adults are about **3 mm long** and **greenish yellow during the summer, acquiring a reddish tinge in the winter.**

Life cycle. The females lay about **15 yellowish eggs on the underside of the leaves**, **embedding them into the leaf veins**. The **eggs hatch in 4-11days** and give rise to nymphs which are **wedge-shaped** and are very active. They **suck cell-sap from the underside of the leaves** and pass through **six stages of growth in 7-21 days**. On transformation into winged **adults**, they live for **5-7 weeks**, feeding constantly on the plant juice. The pest **completes seven generations** in a year.

Damage. Injury to plants is caused both by the nymphs and the adults which suck sap from the foliage and probably also due to the injection of toxins into the plant tissues. The attacked leaves turn pale and then rust-red. With change in appearance, the leaves also turn downwards, dry up and fall to the ground. Owing to the loss of plant vitality, the cotton bolls also drop off, causing upto 35 per cent reduction in yield.

Management. Grow American cotton varieties which are **resistant or tolerant** to leafhopper attack. In Punjab, recommended varieties are F1861, F1378, F846, LH1556 and hybrid LH144, all of which are moderately resistant or tolerant to leafhopper attack.

Spray against leafhopper should be done only at **economic threshold level of 1-2 nymphs per leaf or when second grade injury symptoms (yellowing and curling at margins of leaves) appear in 50 per cent of the plants**. Any one of the following insecticides can be used in **250 litres of water per ha: 750 ml of formothion 25EC or oxydemeton methyl 25EC, 625 ml of dimethoate 30EC, 100 m1 of imidacloprid 200 SL, 50g of acatamiprid 20SP, 100g of thiamethoxam 25WG. At the time of sowing, smear the cotton seed with imidacloprid 75WS@ 5g/kg seed.**

2. Cotton whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera : Aleyrodidae)

- Host Plant: Apart from cotton, this insect also **feeds on** various other plants such as **cabbage, cauliflower, sarson, toria, melon, potato, brinjal, okra and some weeds.**
- In the winged stage, they are **1.0-1.5 mmlong** and their **yellowish bodies are slightly dusted with a white waxy powder.They have two pairs of pure white wings and have prominent long hind wings.**
- **Life-cycle** : Females lay **stalked eggs singly on the underside of the leaves**, averaging **119 eggs per female**. The eggs **hatch in 3-5 days during summer, 5-33 days in winter.** The nymphs **feed on cell-sap** and grow into **three stages** to form the **pupae within 9-14 days in summer and in 17-81 days in winter**. In **2-8 days, the pupae change into whiteflies.** The total **life-cycle is completed in 14-**

Damage.

The damage is caused by both the **nymphs and the adults** by **sucking the sap from the leaves**. Insects **exude honeydew which attracts sooty mould**. Therefore, in severe infestation, the **plants** not only become weak, but the mould **interferes** with the normal **photosynthesis** resulting in poor growth and yield of cotton. B. tabaci is known to transmit number of virus diseases including the **cotton leaf curl, the leaf curl disease of tobacco, the vein clearing disease of okra and the leaf curl of sesame.**

Management.

Grow American cotton varieties which are **resistant or tolerant** to leafhopper attack. In Punjab, recommended varieties are F1861, F1378, F846, LH1556 and hybrid LH144, all of which are moderately resistant or tolerant to leafhopper attack.

3. Red cotton bug, *Dysdercus koennigii* (Hemiptera: Pyrrhocoridae)

- **Host Plant:** This insect is **minorpest of cotton** .Apart from **cotton** it feeds on **okra, maize, pearmillet,etc**. The bugs are **elongated slender insect crimson red with white bands across the abdomen. The membraneous portion of their fore wings, antennae and scutillum is black**. Both **adults** and their **nymphs feed** on the **cell-sap of cotton**, hollyhock, wheat, maize, pearl-millet, clovers etc.
- **Life cycle :** This insect is active throughout the year and **passes winter in the adult stage**. In spring the bugs becomes active and lays, egg on an average , **100-130 eggs in moist soils or in crevices in the ground**. The eggs are **spherical , bright yellow** and are laid in the in cluster or in loose irregular masses of 70-80 eggs each. They **hatch in 7-8 days** and the young nymphs have flabby abdomens, but as they grow older, they become more slender and develop black markings on the body. There are **five nymphal stages** and the development is completed in **49-89 days**. In summer, the life of an adult is very varaible, but in winter, it may live up to three months .The predacious bugs like ***Antilochus cocqueberti*** and ***Harpactor costalis*****feed on nymph and adults**.

Damage : the insect **sucks the cell-sap from the leaves and green bolls of cotton**. Heavily attacked **bolls open badly** and the **lint is of poorer quality**. The **seeds** produced may also have **low germination** and **less oil**. The bugs **stain the lint with their excreta or body juice as they are crushed in the ginning factories**. The staining of lint by the **growth of certainbacteria** inside the bolls is also believed to be initiated by these bugs.

Management. Any one of the following insecticides can be used in **250 litres of water per ha: 750 ml of formothion 25EC or oxydemeton methyl 25EC, 625 ml of dimethoate 30EC, 100 m1 of imidacloprid 200 SL, 50g of acatamiprid 20SP, 100g of thiamethoxam 25WG. At the time of sowing, smear the cotton seed with imidacloprid 75WS@ 5g/kg seed(Seed treatment).**

5. Pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera - Gelechiidae)

- The pink bollworm is one of the **most destructive pests** 0f Cotton and is found in America, Africa, Australia and Asia. It is highly destructive in India and Pakistan.
- The **adult is a deep brown moth, measuring 8-9 mm across the spread wings. There are blackish Spots on the fore wings, and the margins of the hind wings are deeply fringed.**
- **Life-cycle.** The females **lay whitish, flat eggs singly on the underside of the young, new shoots, flower buds and the young green bolls**. The **eggs hatch in 7days** and the caterpillars, on emergence, are **white and turn pink as they grow older**. Soon after emergence, the larvae enter the flower-buds, the flowers or the bolls. The **holes of entry close down**, but the larvae continue feeding **inside the seed kernels**. They become full-grown (8-10 mm) in about **two weeks** and come out of the holes for **pupation on the ground, among fallen leaves, debris**, etc. Within **one week, the moths emerge** to start the life-cycle all over again By **October-November, 4-6 generations are completed.**

- **last generation do not, however, pupate**. Just a few of them reach the ground, but the great **majority keep feeding inside the bolls and connecting to produce what are known as the 'double seeds'**. The hibernating larvae lie curled in double seeds for many months and after passing the winter, they emerge as moths. **The last life-cycle is very long covering 5-10 months**, although during the active season, the life cycle is short, taking only 3-4 weeks. The pest passes through several broods during its active period.

- **Damage.** There is **excessive shedding of the fruiting bodies. The attacked squares, buds, flowers (called rosetted flowers) and young bolls fall off pre-maturely and those which do mature do not open properly. The damaged seed-cotton is difficult to pick, discoloured and gives a lower ginning percentage, lower oil extraction and inferior spinning quality. The infestation ranges from 40 to 85 per cent.**

Management.

(i) **Cultural and mechanical control**. The carryover and multiplication of this pest can be appreciably reduced by the following **cultural and mechanical control measures**:

1. **Pick the seed cotton completely**. Partially unpicked locule (burs) should not be left on the plants.
2. After the last picking, **sheep, goats and other animals should be let into the cotton fields to feed on the plant debris and unopened bolls**. Goats are most effective as they can browse even on the standing plants.

3. The **leftover, unopened and partially picked bolls should be dislodged by** beating against the ground or by plucking them. The burs and bolls so collected should be burnt immediately.

4. **Cut the cotton sticks 5-6 cm below ground level to prevent their re-growth.**

5. **Do not keep the cotton sticks in the fields**. Stack them in the Village premises. This would reduce the number of focal points from which initial infestation spreads to the fields.

6. **Plough the cotton fields deep by the end of February**, preferably with a furrow-turning plough.

7. **fumigation of cotton seed** should be completed before sowing of cotton begins in the area and seed should be sun-dried in thin layers for three consecutive days in the middle of April or fumigated to kill the diapausing larvae of the pink bollworm. For fumigation one (3-g) aluminium phosphide (Celphos) tablet should be used per cubic meter of space giving an exposure period of 48 hours or 2 tablets per cubic meter of space with an exposure of 24 hours.

8. **The seed should be acid-delinted or fumigated before sowing.**

9. Replace the cotton seed by seed-cake for feeding the animals.

10. The damage of the pest can be reduced **by sowing short-duration varieties** and by early termination of last irrigation to the crop.

- Organophosphates. **2. 0 litres of fenitrothion 50EC, 2.0 litres of quinalphos 25EC, 1. 25 litres of monocrotophos 36SL, 5.0 litres of chlorpyriphos 20EC, 2.0 litres of ethion 50EC, 1.25 litres of profenophos 50EC. (c) Carbamctes 2.5 kg of carbaryl 50WP, (d) Synthetic pyrethroids. 500 ml of cypermethrin 10EC, 200 ml of cypermethrin 25EC, 400 ml of deltamethrin 2.8EC, 275 ml of deltamethrin 4EC, 250 ml of fenvalerate 20EC 300 ml of Fluvalinate 25EC, 250 ml of alphamethrin I0EC or asymethrin 5EC. (e) 150 ml of spinosad 48 SC.**
- (iv) At **least 5-6 sprays are required for effective control of bollworms**. **Same insecticide should not be sprayed repeatedly** to avoid the development of pesticide resistance and appearance of secondary pests. Also, avoid using insecticides of the same group in more than three sprays.

(ii) Biological control. **The releases of Trichogramma spp. @ 1,50,000 parasitized eggs** ha at weekly intervals have proved promising for bollworm control.

6. Spotted bollworms, *Earias insulana* (Boisduval) and *E. Vittella* (Fabricius) (Lepidoptera: Noctuidae)

- **Mark of identification.** The full-grown **dull-green caterpillars are 20 mm long having tiny stout bristles and a series of longitudinal black spots on the body. The moths are yellow green and measure about 25 mm across the wings. E. vittella moths are of the same size and have a narrow light longitudinal green band in the middle of the forewing.**
- **Life cycle.** The female moths **lay 200- 400 eggs** at night, **singly on flower buds, brackets and tender leaves of okra or cotton plants**. The **eggs hatch in 3-4 days** and the **caterpillars passthrough 6 stages**, becoming full-grown in **10-16 days**. They **pupate** either on the **plants** or **on the ground** (during November December) among **fallen leaves** and the **moths emerge in 8-14 daysin summer and 18-23 days in winter**. The **life cycle** is completed (usually August to October) **in 17-29days**. **Several overlapping generations** are completed in a year.

- **Damage**. When cotton plants are young, the **larvae bore into the terminal portions of the shoots, which wither away and dry up**. Later on, they cause **shedding of the fruiting bodies.** The **green bolls attacked by spotted bollworm are often infected by fungi which causes bolls to rot and dry up without opening. The infested bolls called aborted bolls open prematurely and produce poor lint, resulting in lower market value.**
- **Management.**
- (i) The pest can be suppressed **with clean cultivation and the destruction of alternative food plants** (Abutilon indicum Sweet, Malvastrum tricuspidatum A. Gray, Sida spp) particularly when cotton or okra is not growing in that locality.
- (ii) The **withering tops** of the plants damaged by the spotted bollworm during June-July should be removed and destroyed to check the multiplication of the pest in the initial stage.
- (iii) Chemical control measures are same as in case of pink bollworm. The economic threshold level is **10 percent incidence** in shoots or reproductive parts.
- (iv)***Trichogramma chilonis*** and *Trichogramma brasilience* are the egg parasitoid against spotted boll worm.

7. American bollworm, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae)

Host plant: **Poly phagous pest and feeds on Cotton, Chickpea, Pigeon pea, Mungbean, Urdbean, Lentil, Soyabean and Cowpea.**

Mark of Identification:- The moth is **stoutly built** and is **yellowish brown** with a **V shaped speck on fore wing**. **Hind wings** are **whitish and lighter in color** with **broad blackish band along outer margin**.

Caterpillar :- Greenish with dark broken grey lines along the side of the body (35 cm long).

Damage:- Small puncture may be seen on bolls .Larva seen feeding on the bolls by thrusting the head in boll and **half body hanging outside**. The **larvae** first **feed** on the **leaves than on the bolls.**

Life cycle:-

Moth **lays eggs on tender parts of plant.**

Hatching period. 2-4 days in April-October and 6 days in February.

caterpillar period. 13-19 days

Pupal period. 8-15 days. They **pupate in soil**

Generation: **8 over lapping.**

ETL 5 % damage in fruiting bodies or **3-4 male moth / pheromone trap/ week 2-3 times**

Management:-

i. Avoid **mono and continuous cropping**

ii. Deep summer ploughing

iii. Avoid mono cropping by growing 0f less preferred crops like **greengram, blackgram, castor, soyabean**along with cotton as inter crops, border crop or alternate crop.

iv. Remove and destroy crop residue to avoid the carryover of the pest

v. Avoid the excessive use of nitrogen fertilizers

vi. Water management to prevent excessive vegetative growth and larval harborage

vii. Monitoring the pest through **light and pheromone** traps Inundative release of **egg parasites Trichogrammaspp @1.5 lac/ha, *Campoletis chlorideae* is a larval parasite of *H. armigera***

viii. Destroy the larvae by hand collection

ix. 10-12 thousand chrysoperla/ Bigha, Apply **NPV @ 0.75ml/l** of water

x. Neem insecticide 300 ppm/5.0ml/lit water

xi. Spray following Insecticides for control

Quinolphos 25 EC – 2 ml/lit, Malathion 50 EC – 2 ml/lit, Deltamethrin 2.8 EC 1.0 ml/lit, Thiodicarb75 SP – 1.75 gm/lit, Ethion 50 EC – 3.0 ml/ lit, Indaxocarb 14.5 SC 1 ml/lit, Spinosad 45 SC –.33 ml/lit

Alphamethrin 10 EC - 0.5 ml/ lit, Chlozopyriphos 20EC - 5 ml/lit

Ornithology: Study of Birds.

- Bird definition: a warm blooded egg laying vertebrate animal distinguish by the possession of feathers, wings, a beak, and typically by being able to fly.
- They belongs to phylum chordata
- Ornithology: The science which deals with study of birds.
- The birds belongs to class aves.
- The body is covered with feathers. Their fore limbs are modified as wings.
- Their mouth parts are in the form of beak. About 0.85 % losses are caused due to bird in storage.
- The damage done by birds to food grains are both quantitative and qualitative.
- The average consumption by birds ranges from 8 to 25 gm per day.

Birds

House crow, *Corvus splendens* (Passeriformes : Corvidae)

Mark of identification :The house crow is grey and has black and grey wings with a black area.

Habits of crow

- It has a habit of community roosting in towns and villages.
- A crow nest is in the form of a platform made of twigs with a cup like depression in the centre.
- The nesting season is from April to June and 4-5 eggs are laid at a time.
- Both sexes incubate and look after the young ones.
- The *koel* lays her own eggs and throws out crow eggs from the nest.
- The young ones of the koel are brought up by the crows.
- The koel acts as a biological parasite on the crow.
- The house crow is an omnivorous bird and feeds on dead rats kitchen scraps, locusts, termites, the eggs of other birds and ripening grains of maize and fruits.

Management

- Dead crow hanging in the top of a pole can effectively be used as scare crow.
- Destroy eggs and nest during June-August
- The maize cobs on plants can be protected by wrapping one or two of the nearby leaves around them
- A large wire –gauze case,2X1X1 meters ,having on one side a covering entrance, can be used as a trap for crows.
- A piece of chapatti dipped in 0.3 percent methyl parathion placed on top of a roof is good bait.

House sparrow,*Passer domestics* (Passeriformes. Ploceidae)

Mark of identification:The female is ash to greyish brown above and fulvous ash-white below
The male is 15 cm long, darker above , with blackish streaks on the wings and a black patch on the thorat and breast.
It has prominent white cheeks.
Habits. This is most familiar bird in cities and villages alike. It breeds practically all year round and makes nest in the holes in walls or ceilings of houses by using straw, rubbish and feathers. The eggs are greenish white, blotched with brown.Three to five eggs are incubated at a time and several successive broods may be raised.
They visit the ripening fields , particularly those of wheat in the spring season and cause much damage both by feeding and causing the grains to shed.

Management

- Destroy eggs and nests during April-May and September-October.
- Bajra seeds soaked in 0.3 percent methyl parathion emulsion and dried, are placed in small cups and hung from the rafters or branches of trees
- Spraying the wheat crop when ears are in the milk stage with thiuram (TMTD)0.6 percent, repels the sparrows and protects the crop

Blue rock pigeon,columba livia Gmelin (columbiformes; columbidae)

It is the most familiar bird near churches, temples, historical buildings with minarets, power houses, railway station, grain ware houses, etc.

It is salty grey with a glistening metallic green, purple and magenta sheen on the neck and upper breast.

Pigeon, *Columba livia* Gmelin.

Habits

- It breeds practically throughout the year and makes nest by collecting a few sticks and lines them with rags and feathers.
- The nest are located in the holes on cliffs,rafters and ceiling of the house, particularly those uninhabitated.
- There are generally two white elliptical eggs in the clutch and both sexes share domestic duties.
- Individually or in small groups, they are always around to pick up grains from here and there.
- In large buildings , they are a nuisance as they cause noise and makes the floor and walls dirty with their droppings

Management

- The meat of the rock pigeon as well as that of the dove is quite tasty and ,therefore they can killed as game
- The strategic places in power house should be protected by installing chicken wire- netting around the weak spots
- Destroys eggs and nests
- They can also be killed by feeding on poisoned bajra grains.

Rose-ringed parakeet,Psittacula krameri, Psitataciformes:Psittacidae.

Mark of identification: This bird is commonly known as tota,it is grass green and possesses hooked red bil. The male has a black and rose- pink collar, whereas the female is plain.

Habits : Their nests consists of natural or dug-out hollows in the trees and they also utilize holes in walls or rockes for this purpose there may be 4-6 pure-white rounded eggs in one clutch. Both male and female incubate and feed the young ones during the breeding seasoni.e. December to April. They gnaw and cut near – ripe fruits such as guava, ber, mango, plum, peaches etc.the birds are equally destructive to ripening cobs of maize , juwar and bajara ears and are often seen carrying and flying with ears of wheat. In maize field, they are seen in large flocks and cause tremendous damage to the crop.

Management

- The control measure include removal of nests and destruction of eggs with fumigation of eggs with aluminum phosphide at the rate of 0.5 g tablets per hole so as to kill the young ones.
- Use *gulel* (slingshot) crackers and make noise to frighten them.
- Killing them with shot-guns is very effective but expensive.
- Dusting of malathion dust on cobs and head of maize and sunflower.

Indian Myna: *Acridotheres tristis* (Passeriformes: Saturnidae)

Mark of identification,Habitate and Management

- **Mark of identification:** It is a dark brown bird with bright yellow bill,legs and patches around eyes. As it flies, large white patches become visible on the wings. It is about 22CM in length. The bird live in pairs or groups. It is found through out India, Myanmar, and Sri lanka.
- **Habits:** It breeds from April-August, raising two broods in succession. The nests are built in tree-hollows and the hole in walls or celings. 4-5 glossy blue eggs are incubated at a time and both sexes participate in raising the young ones. This bird is carnivorous and feed on insects, earthworms, grasshoppers, fruits grains and kitchen scraps. They are pests and pick up all sorts grains from the threshing floors or from the field. They are seen in ripening maize, and wheat fields feeding on the grains.

Management

- (1) Destroying the nests checks their multiplication.
- They can be killed by feeding them ***chapatti*** soaked in 1 per cent fenthion emulsion.
- They can be killed by using ***Gulel***

Common weaver-bird: *Plceus philippinus* (Passeriformes: Ploceidae)

- **Mark of identification:** It is dark streaked, fulvous brown above and plain white fulvous below.
- It is the size of the house sparrow and its colour resembles the female sparrow when it is not in the breeding season.
- It is distributed through out India, Pakistan, Myanmar, and srilanka.
- Habits: The male built a number of intricately and compactly woven nets, which are retort shaped with a long vertical entrance tube. The nets are made of paddy leaves and grasses and are seen in clusters hanging on ***Ber*** or other medium sized tree near ponds or water holes. Mud is used for plastering the egg chamber on the inside. The female lays 2-4 eggs of pure white coloured. The breeding takes place from May-September.
- The bird is active in the paddy season. Becasue it provide food and nesting materials. They can cause quite heavy damage particularly to the early ripening crops.

Management of Birds:

- The periodic collection and destruction of nests would lead to reduction in their population.
- **Scaring:** Many visual and sound devices have been used by man in an attempt to scare birds.Ex. LPG gas gun, rotating lights, scarecrows, reflective mirror or tape.
- **Netting:** Parmanant net can be used to make birds away.
- **Use of gulel :** This mechanical device can be used to disperse the birds groups.
- **Use of chemical:** (1) use of non toxic and sticky materials like lassa.
- **(2):** Use of repellents like cupric oxide and methiocarb.
- **(3) Use of toxic chemicals:** These chemicals like insecticide are prohibited in our country.

Rodents and their management in field and godowns.

- Rodents are omnivorous and feed on grains, vegetables, fruit, meet, and other products in the house or in the field.
- Rodents are responsible for causing enormous losses to crops and stored grains.
- They damage about 20 times the amount they actually consuming by their gnawing activity and by polluting the food grains (droppings, urine, body hair etc).
- It has been estimated that there are about 2500 millions rates are found in India.
- They inflict, on an everage about 5-10 per cent loss in food products alone.
- 84 species of rodents are found in India, out of which 10 are of major significance.
- Only few important species are discussed here.

Habit andHabitat

- Very cunning and claver animal.
- Colour blind.
- Well developed sense organ, smell, taste, hearing.
- Bearchesel like teeth.
- Generally search food in night.
- Good swimmer.
- Good climber
- New afraid of new objects.
- Burrow in field and houses, close to the food materials in houses.

Difference between Mouse and rat

- Mouse.
- Size small to medium size, 12 to 20 cm in length.
- Mice have thin, slightly hairy tail.
- Nose triangular in shape.
- Brown and grey in colour.

- Rat.
- Medium sized to large size,measuring 40 cm in length.
- Thicker, hairless,scaly tail
- Nose blunt and rounded.
- Apart from Brown and grey in colour their colour may black also.

1. House mouse (*Mus musculus)*

It is quick, tends to nibble and run rather than stay longer at food source. They can pass through a hole slightly less than 1.25 cm. They live mostly in houses. They produce 6-10 litter per year with 6-10 young ones per litter. They can climb easily and also can swim when necessary. They are distributed all over India and are omnivorous. Total length including tail is 8-22 cm with pointed snout. They are brownish grey above and whitish to light grey on belly.

2. House rat (*Rattus rattus)*

Lives in close association with human beings. Excellent climber and good swimmer. 4-6 litters / year and tail length 31-43 cm with pointed snout. Dark brownish above (dorsal) and dirty white on belly.

3. Common Indian field mouse (*Mus musculus booduga)*

The body of Indian field mouse is about 5 to 8 cm long with 5 cm long tail. It is brown in color with a white belly. It burrows in field bunds causing extensive damage to bunds and wastage of water. It produces 3 to 9 young ones per litter.

4. Brown rat or Norway rat (*Rattus norvegicus)*

Closely associated with the activity of man. Good climber and swimmer. Prefers wet or damp locations. Do not close the burrow openings. Length from nose to tail 35- 41 cm with blunt snout. Brownish above, white on belly.

1. **Soft furred field rat or grass rat (*Millardia meltada)***

   It occurs in irrigated fields but observed in pastures also. It is nocturnal and lives in simple burrows. It breeds through out the year with litter size of 2-10 young ones. It is small and slender. Adult weight is 100 gm. Total length including tail is 19-29 cm, tail length is 9-14 cm either equal or little shorter than head and body, moderately to poorly haired. The tail is dark above and pale below.

Indian mole rat, *Bandicota bengalensis*, Rodentia : Murinae

- This rat has greyish-brownor black on top and greyish – white colour on the belly.
- It is heavily built and a pig like face and a short stumpy head.
- It breed through out the year and the number of young ones per litter vary from 6-15.
- The mole rat hoards large amount of food in its burrows.
- There are 2-12 burrow ,tunnels has 2-5 linesof which some are blind and have food chamber at the end.
- The burrows are generally found in the field of groundnut, wheat, gram, sugarcane, maize, sorghum, cotton, paddy, and in fruit orchards.
- The mole rat cut the entire paddy ears but rat only part of it.
- Like other species, it migrate from the harvested fields to the newly sown crops.

Indian Mole Rat or Lesser Bandicoot Rat (*Bandicota bengalensis)*

It is an excellent swimmer, often living in flooded rice fields and bunds. Also occurs in the wheat crop fields and godowns. It is nocturnal and fossorial. They hoard large amounts of food in its burrows. Breeds commonly twice a year with 8-10 young ones in each litter. Adult weight is 325 gm. Length from nose to tip of tail is 36-48 cm. Tail is18-20 cm; less than or some times equal to length of head and body together, 160-170 rings clearly seen on scaly tail. Ear 2.5 to 2.6 cm in length, thick and opaque. Snout – short, stumpy, pig like. Fur and colour – thick, short and harsh, spines present, dark brown, pale brown or reddish above.

Soft –furred field rat, Rattus meltada, :Rodentia: Murinae.

- Its fur is soft and dark brownish greyexcept the belly which is pale grey.
- These rats make simple burrows in the field as well as in the bunds.
- The tail is little shorter in length than the rest of the body.
- It produces young ones in two breedings season in North india.
- A female produces 1-4 litters during the breeding seasons.
- This rat makes burrow which are smaller and narrower than those of B. bengalensis and T. indica.
- There are 1-4 opening s to a burrow and they are always kept open, but a few bits of grasses are kept in front of the openings.

Indian gerbil, Tatera indica, Rodentia : Gerbillinae

- It is known as the antelope rat and is found in sandy soil.
- A poor swimmer, it is light brown or radish from the above and white on the belly.
- It lives in the colony and female produces 1-3 liters, in field, there are 5-10 young ones per litter.
- Its burrows are in sandy areas under the cover of a thorny bush or some vegetation.
- The burrows are deeper and shorter in length than those of the mole rat.
- It feeds on seeds in winter , stem, rhizomes and insects in the summer, and in leaves and flowers of plants in the monsoons.

Indian field mouse, Mus booduga, Rodentia : Murinae.

- It is found in dry as well as in the wetlands and is a fairly good swimmer.
- It is brown from above and whitish or dull grey on the under side.
- The tail is equal to or shorter than the body and is dark above and pale below.
- It makes small burrows without any branches having only one bed chamber.
- The field mices live in pairs and produces young ones 6-13 per litter.
- It feeds on paddy grains and at times steals from the food chamber of *B. bengalensis*.

Nature and Symptoms of damage

Rodents attack rice at all stages of growth from planting to harvest and if there is opportunity, even they will continue to attack the grain in store. Freshly sown seed may be dug up and the seed eaten. On young rice plants, rodents attack the heart of the stem discarding the leaves. The rodents make the rice stems fall by gnawing 5-15 cm above ground level. Some rodent species may store grain in their burrows. Large rodents, besides feeding on the crop may cause serious damage to the bunds.

Management of Rodents.

- Cultural control : Deep ploughing up to 45 cm,reduction of size and trimming of bunds.
- Weed management, and removal of burrows .
- Mechanical control : rodent proof containers, plastering structure,traping of rats.
- Biological control : Snakes, owls, eagles, mangooses, cats checks the rat population.
- Chemical control : Poison baits : (A) acute poisons : which are uded in a single dose Ex. 1. strychnine hydrochloride.2. Zinc phosphide.3. Norbormide (Raticate).4. Sodium fluoro- acetate.5. Thallium sulphate. 6.(ANTU) Alfanaphthyl thiourea.
- (B) Chronic poison: Which are used in multiple doses . Which acts as blood anticoagulants. 1. Hydroxy coumarins (warfarin, fumarin, tomarin and recumin).
- Indan dions (Pival, Radione and Valone).These chemicals case external and internal haemorrhage.
- Bromadiolane, and Brodicacoum are lethal in a single dose but rate die after several days of poisoning. Bromadiolane bait (0.005% Bromadiolane) can be prepared by mixing 20 gm of 0.25 per cent Bromadiolane powder ,20 gm of oil and 20 gm of powdered sugar in 1 kg of any cereal flour.32

Management of Rodents.

- Zinc phosphide 2% bait :
- 2 gm zinc phosphide, 98 gm bait (whole or cracked grains of wheat, gram maize, bajra or sorghum smeared with vegetable oils.
- Fumigation with aluminium phosphide : aluminium phosphide one tablet of 3 gm/per burrow should be introduced after that burrow should be closed tightly.

Entomology: The term entomology has been derived from the **Greek words, entomon= insect and logos = knowledge**.Itis the **branch of zoology** that **deals with insects only** under class **insecta** of the phylum **arthropoda.**

Agricultural entomology : This mainly concerns with the study of insects which are **directly related with the crops and stored commodities**.

Applied entomology : The application of **pure entomology to the control of insect pests.**

Insect: Insect are those **tracheae arthropod** in which the body is devided in to three region head , thorax and abdomen with three pair of legs and **development through metamorphosis** is known as insect. The world insect is derived from**Latin world (Insectum=having cut into)**. Insects are also known as **hexapoda** owing to the presence of six legs. The true insects.

Mite: An organism whose body is divided into **two region (cephalothorex and abdomen),** four pairs of legs and **sucking mouth** parts and **they have no antenna and compound eye.**

What is a pest: An insect (or any other living being) whose **population increases** to such an extent as to cause **economic losses** to crops or a nuisance and health hazards to **man and his live stock** will be declared a pest.

Pest: Any organism **detrimental to man or its property** is known as pest.

Insect pest: When any insect **causes economic damage** is known as insect pest.

Host. The term host means **any plant or animal on or in which another organism lives for nourishment, or protection.**

Host: This is an organism, which **harbor** another organism, e.g. the rice meal moth,corcyra cephalonica St is a host of many natural enemies.

Alternative host: A host used by a pest or pathogen **when the primary or the preferred host is not present.** Alternative host are **not required for the completion of the pest or parasite life cycle.**

General equilibrium position: General equilibrium position is the **average population density** of an insect over a **long period of time, unaffected by the temporary intervention of pest control.**

Economic threshold level: The pest**population density** at which**control/ management action should be taken** to prevent an increasing pest population from reaching the economic injury level. This is also known as action threshold.

Economic injury level: The **lowest numbers of insects** that will cause economic damage.

Damage boundary: The **level of injury** where **damage can be measured.**

Economic damage: The injury done to a crop which will justify the cost of artificial control measure.

Economic pest: A pest causing a crop loss of **about 5to 10 per cent** according to definition.

Key pest: A **perennial, severe pest** that causes **serious and difficult crop production problems;** a pest that dominates cultural activities.

Minor pest: Insect which normally cause a **loss ranging from 05 to 10 per cent** is known as minor pest .

Major pest: The insect which normally cause **loss more than 10 per cent or more** is called major pest.

Secondary pest: Pest species **that are usually present at low levels and are held in check by the action of natural enemies;** can assume full pest status **when natural enemies are destroyed by the pest management tactic** (e.g. insecticide application).

Monophagus: Monophagus insects are **confined to a single species of plants**. A strictly monophagus insect like the mulberry silkworm is rare to find.

Oligophagus: Oligophagus insects characteristically **feed on a group of botanically related plants. Usually within a single plant family**.eg the diamond back moth is confined to the plant of Cruciferae.

Polyphagus: Polyphagus insects are those that **accept many plant from a diverse range of plant family**, even though preference still exists, e.g. locust, grasshoppers hairy caterpillars, gram cutworm and termite.

Seasonal pest: The insect which **occur mostly during particular part of the year are called as seasonal pest** and the incidence of these pest are governed by climatic factor

Occasional pest: Many insects **occur rather infrequently and close association with a particular crop is absent** e.g mango stem borer. **Occasional pest:** a pest with general equilibarium position substantially below the economic injury level; highest pest population fluctuations occasionally and sporadically exceed the economic injury level.

Persistent pest: Insect which **occur on a crop almost throughout the year** are called as persistent pest.

Potential pest: These insects **normally do not cause any economic damage**, but may become serious pests resulting from some **changes in the ecosystem**, e.g. armyworm on wheat.

Sporadic pest: Insect which **occur in a few isolated localities** are known as sporadic pest

Epidemic pest: When pest **occur in a severe form in a particular area or locality** is known as epidemic pest

Endemic pest: When **infestation occurs at a regular feature** and confined mostly to a particular area or locality

Plant protection: refers to the measure which is used to **protect the crop from pest and disease.**

Pest control: **Any method employed to reduce the pest population and to prevent damage caused by them** are known as pest control.

Integrated pest control: A **multidisciplinary ecological approach** to the management of pest population which utilizes a variety of control tactics compatibility in a single coordinated pest management system is termed as integrated pest control.

IPM: According to **FOA.(1967)** it is **the system** that in context of the associated environment and population dynamics of pest species , utilizes all the suitable technique and methods in as compatible manner as possible and **maintains the pest population at a level below those causing economic injury.**

Biological control: Metcalf and flint (1962) defined biological control as the **destruction and suppression** of undesirable insects other enemies or weeds by the introduction, **encouragement or artificial increase** of their natural enemies.

Biological control: The employment of **any biological agent for pest suppression**.

Parasite: parasite is an organism which **at one time or other lives on the body of the host which may or may not be killed after it has completed development**.

Parasitoid: A parasitoid is an organism **which completes its life on one host only and kills it.**

Predator: Predator is a **free living organism and kills the host immediately** normally larger than prey (host) requires more than one host to develop and is very specific unlike parasitoids, e.g. lady bird beetle (***Coccinell septempunctata, Coccinella sexmaculata***) and green lace wing (***Chrysoperla carnea***)

Pesticide: Pesticide is **a chemical which kills the pests** by its **chemical action**. Insecticide is a pesticide and the term is used for those chemicals which kill the insects. The term pesticide is a broad group which contains chemicals used to kill a wide range of