

STORED GRAIN PESTS

In India, post-harvest losses caused by unscientific storage, insects, rodents, micro-organisms etc., account for about 10 per cent of total food grains. The major economic loss caused by grain infesting insects is not always the actual material they consume, but also the amount contaminated by them and their excreta which make food unfit for human consumption. About 500 species of insects have been associated with stored grain products. Nearly 100 species of insect pests of stored products cause economic losses

Storage insect pests are categorized into two types viz.

- Primary storage pests : Internal and External feeders
- Secondary storage pests

Primary storage pests: Insects that damages sound grains are primary storage pests

Common name	Pest	Family	Order
Internal Feeders			
Rice weevil	<i>Sitophilus oryzae</i> , <i>S. zeamais</i> , <i>S. granarius</i>	Curculionidae	Coleoptera
Lesser grain borer	<i>Rhyzopertha dominica</i>	Bostrychidae	Coleoptera
Angoumois grain moth	<i>Sitotroga cerealella</i>	Gelechiidae	Lepidoptera
Pulse beetle	<i>Callosobruchus chinensis</i> , <i>C. maculatus</i>	Bruchidae	Coleoptera
Cigarette beetle	<i>Lasioderma sericorne</i>	Anobiidae	Coleoptera
Drug store beetle	<i>Stegobium paniceum</i>	Anobiidae	Coleoptera
Tamarind Beetle	<i>Pachymeres gonagra</i>	Bruchidae	Coleoptera
Sweet Potato weevil	<i>Cylas formicarius</i>	Apionidae	Coleoptera
Potato tuber moth	<i>Phthorimoea operculella</i>	Gelechiidae	Lepidoptera
Arecanut beetle	<i>Araecerus fasciculatus</i>	Anthribidae	Coleoptera
External Feeders			
Red flour beetle	<i>Tribolium castaneum</i> , <i>Tribolium confusum</i>	Tenebrionidae	Coleoptera
Indian meal moth	<i>Plodia interpunctella</i>	Phycitidae	Lepidoptera
Fig moth or almond moth	<i>Ephestia cautella</i>	Phycitidae	Lepidoptera
Rice moth	<i>Corcyra cephalonica</i>	Galleriidae	Lepidoptera
Khapra beetle	<i>Trogoderma granarium</i>	Dermestidae	Coleoptera

Secondary storage pest: Insects that damage broken or already damaged grains secondary storage pests.

Common name	Pest	Family	Order
Saw toothed grain beetle	<i>Oryzaephillis surinamensis</i>	Silvanidae:	Coleoptera

Long headed flour beetle	<i>Latheticus oryzae</i>	Tenebrionidae	Coleoptera
Flat grain beetle	<i>Cryptolestus minutus</i> ,	Cucujidae	Coleoptera
Grain lice	<i>Liposcelis divinatorius</i>	Liposcelidae	Psocoptera
Grain mite	<i>Acarus siro</i>		Acari

Primary storage pests

Internal Feeders

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

Distribution and status

World-wide and is found practically throughout India. It is the most destructive pest of stored grain. The rice weevil may be found in the paddy fields as well.

Host range: Rice, sorghum, wheat, barley, maize

Bionomics

Full grown larva is 5 mm in length and plumpy, fleshy, legless creature. Reddish-brown beetle adult is 3 mm in length, with a cylindrical body and a long, slender, curved rostrum. Its elytra bear four light reddish or yellowish spots.



The rice weevil breeds from April to October and hibernates in winter as an adult inside cracks and crevices or under wheat bags in the godowns. During the active season, females lay about 400 eggs on the grain by making a depression and the hole is sealed with a gelatinous secretion. Eggs hatch in 6-7 days and the young larvae bore directly into grain, where they feed and grow to maturity. Then, they pupate inside the grain. The pupal stage lasts 6-14 days. On emergence, adult weevil cuts its way out of the grain and lives for about 4-5 months. At least generations are completed in a year.

Damage symptoms

Both the adults and the grubs cause damage. The developing larva lives and feeds inside the grain causing irregular holes of 1.5 mm diameter on grains of rice, sorghum, wheat, barley, maize before harvest and in storage. The weevils destroy more than what they eat.



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

Distribution and status

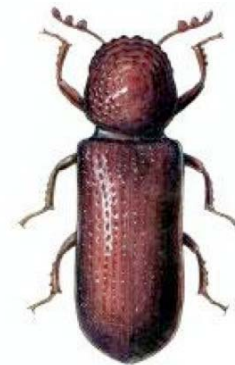
India, Algeria, Greece, United States, New South Wales (Australia), Japan China.

Host range

Wheat, rice, maize, sorghum, barley, lentils, army biscuits, ship biscuits, stored, dried potatoes, corn flour, beans, pumpkin seeds, tamarind seeds and millets.

Bionomics

The larva is about 3mm long, dirty white, with light-brown head and a constricted elongated body. The adult is a small cylindrical beetle measuring about 3 mm in length and less than 1 mm in width. It is shining dark brown with a deflexed head, covered by a crenulated hood-shaped pronotum. No morphological difference separates the two sexes.



The pest breeds from March to November and in December, it enters hibernation as an adult or as a larva. A single female can lay 300-400 eggs in 23-60 days at the rate of 4-23 eggs per day. The eggs are laid singly among the frass or are glued to the grain in batches. When freshly laid, the eggs are glistening white, but later on a pink opaque line appears on them. The incubation period is about 5-9 days.

Larva cuts a circular hole in the pedicel end of the eggs and comes out of it. Larval period 23 - 50 days, pupal period 4 - 6 days and adult live for about 40 - 80 days. There are 5 -6 generations in a year.

Damage symptoms

Both the adults and the grubs cause damage. The adults and grubs bore into the grains feed and reduce them to mere shells with many irregular holes. The adults are powerful fliers and migrate from one godown to another, causing fresh infestation. Adults produce a considerable amount of frass, spoiling more than what they eat.



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

Distribution and status

Worldwide. In the Indian sub continent, the pest is more abundant in the mountainous areas or where the climate is rather mild.

Host range

Paddy, wheat, maize, sorghum, barley, oats etc.

Bionomics



A full grown larva is about 5 mm long, with a white body and yellow brown head. The adult is a buff, grey yellow, brown or straw coloured moth, measuring about 10-12 mm in wing expanse. The characteristic feature is the presence of the narrow pointed wings fringed with long hair.

Breeding takes place from April to October. The insect overwinters as a hibernating larva and as the season warms up, it pupates in early spring. Females start laying eggs singly or in batches on or near the grain. The eggs are small and white, when freshly laid, turning reddish later on. A single female lays, on an average, 150 eggs, usually within a week after mating. Egg period is 4-8 days. The larval stage may last about 3 weeks. Before pupation, the larva constructs a silken cocoon in a cavity. Pupal period is 9 -12 days and the adult live for about 4 - 10 days. During the active season, the life-cycle is completed in about 50 days. Several generations completed in a year.

Damage symptoms

The damage is at its maximum during the monsoon. Only the larvae cause damage by feeding on the grain kernels before harvest and also in store. The larva bores into grain and feeds on its contents. Exit holes of 1 mm diameter with or without a trap door, are seen on the affected cereal grains. As it grows, it extends the hole which partly gets filled with pellets of excreta. It imparts unhealthy appearance and smell. In a heap of grain, the upper layers are most severely affected.



4. Pulse beetle: *Callosobruchus maculatus (chinensis)* (Bruchidae: Coleoptera)

Distribution and status

USA, Mauritius, Formosa, Africa, China, the Philippines, Japan, Indonesia, Sri Lanka, Myanmar and India.

Host range

Gram, mung (*Phaseolus aureus*), moth (*Phaseolus aconitifolius*), peas, cow peas, lentil and arhar (*Cajanus cajan*), cotton seed, sorghum and maize.

Bionomics

Larva is whitish with a light-brown head. The mature larva is 6-7 mm long. The adult beetle measuring 3-4 mm in length, is oval, chocolate or reddish brown and has long serrated antennae, truncate elytra, not covering the pygidium.



The pest breeds actively from March to the end of November. It hibernates in winter in the larval stage. A single female lays small, oval, scale like 34-113 eggs at the rate of 1-37 per day. Egg period is 6 -16 days, larval period 10 -38 days. The hibernating larvae take 117-168 days to complete their development. The pupal stage lasts 4-28 days. The adult escapes by cutting a circular hole in the seed coat and such grains can be spotted easily. The average life-span of an adult is 5-20 days. The insect passes through 7-8 overlapping generations in a year.

Damage symptoms



The adult and grub feed on the grain by making a small hole. Infested stored seed can be recognized by the white eggs on the seed surface and the round exit holes with the 'flap' of seed coat. Kabuli types are particularly susceptible.

5. Cigarette beetle: *Lasioderma serricorne* (Anobiidae: Coleoptera)

Bionomics



Adult light brown round beetle with its thorax and head bent downwards and this presents a strongly humped appearance to the insect. The elytra have minute hairs on them. Antenna is of uniform thickness. The creamy whit oval eggs are laid on the surface of stored material and the incubation period is 9- 14 days. The larval and pupal periods range respectively from 17 – 29 days and 2-8 days. Grub whitish hairy grub.

Damage symptoms

Both grubs and adults bore into tobacco products viz., cigarettes, cheroots and chewing tobacco. Presence of circular pin head sized bore holes on processed tobacco is the typical symptom of attack. It also attacks the grain of wheat, peanut, cocoa, bean, cotton seed etc.

6. Drug store beetle: *Stegobium paniceum* (Anobiidae: Coleoptera)

Bionomics



Adult reddish striated elytra and Antenna is clubbed. It of 10 – 40. Grub is not

brown small beetle has measured 3 mm long. lays the eggs in batches hairy but is pale white,

fleshy with the abdomen terminating in two dark horny points. LP: 10 – 20 and PP: 8 -12 days.

Damage symptoms

Circular pin-head sized bore hole on turmeric, coriander, ginger, dry vegetable and animal matter.

7. Tamarind beetle: *Pachymeres gonagra* (Bruchidae: Coleoptera)



Small grey coloured adult. makes circular holes on fruits of tamarind both in tree and storage.

8. Sweet potato weevil: *Cylas formicarius* (Apionidae: Coleoptera)

Bionomics



Whitish apodous with brown head. Adult is slender ant like with a long snout and shiny black with reddish brown thorax and legs. Grubs and adults bore into the tubers and make them unfit for consumption. Damage occurs both in field and storage

9. Potato tuber moth: *Phthorimaea operculella* (Gelechiidae: Lepidoptera)

Bionomics

Larva is pale greenish. Adult is small with narrow fringed wings; forewings grey brown with dark spots and hindwings dirty white. Damage occurs both in field and storage. Tubers bored by caterpillars associated with fungal or bacterial infection



10. Arecanut beetle: *Araecerus fasciculatus* (Anthribidae: Coleoptera)

Bionomics

Adult is grey brown.



Damage symptoms

Internal content is eaten leaving outer coat intact. Causes more contamination than the actual damage. Coffee, cocoa, spices, maize, groundnut, brazilnut, dried cassava roots and processed foods.

External Feeders

1. Red flour beetle: *Tribolium castaneum* (Tenebrionidae: Coleoptera)

Distribution and status: Worldwide

Host range

Wheat-flour, dry fruits, pulses and prepared cereal foods, such as cornflakes.

Bionomics



The young larva is yellowish white and measures 1 mm in length. As it matures, it turns reddish yellow, be

The insect breeds from April to October and passes the winter mostly in the t stage. The females lay white
days. Pupation takes place in the flour. The pupa is yellowish and hairy. The pupal stage
lasts 5-9 days. The development period from egg to the adult is 26-30 days in summer

Damage symptoms

Both the larvae and adults cause damage. The greatest damage is during the hot and humid monsoon season. The larvae are always found hidden in the food. The adults, however, are active creatures, but mostly found concealed in flour. Adult construct tunnels as they move through flour and other granular food products. In severe infestation, the flour turns greyish and mouldy, and has a pungent, disagreeable odour making it unfit for human consumption.

2. Indian meal moth: *Plodia interpunctella* (Phycitidae: Lepidoptera)

Distribution and status: The pest is worldwide.

Host range

It infests grains, meals, breakfast foods, soybean, dried fruits, nuts, s, dried roots, herbs, dead insects, etc.

Bionomics

Larva is white, often tinged with green or pink, a light-brown head, On reaching maturity, the larva is 8-3 mm in length. The adult moth is about 13-20 mm in wing expanse with a coppery lustre.



Breeding continues throughout the year. The female moth lays 30-350 minute whitish ovate eggs, singly or in clusters, on or near the appropriate foodstuffs. The egg period is 2 days to 2 weeks depending upon weather. The larvae become full-grown in 30-35 days. They crawl up to the surface of the food material and pupate within a thin silken cocoon. The pupal stage lasts 4-35 days. In summer, the life-cycle is completed in 5 or 6 weeks and there are about 4-6 generations in a year.

Damage symptoms

Only the larva causes damage. Crawling caterpillars completely web over the surface of a heap of grains with silken threads. The adults fly from one bin to another and spread the infestation.

3. Almond Moth / Fig moth: *Ephestia cautella* (Pyralidae:Lepidoptera)

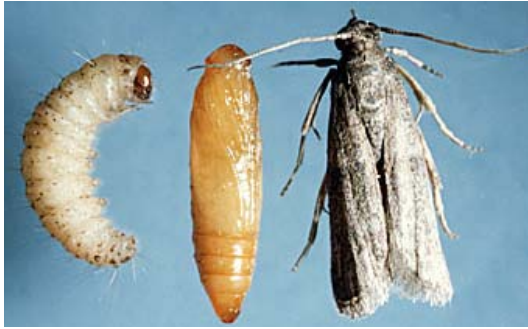
The pest is also known as the dried currant moth.

Distribution and status: Worldwide

Host range

It is a serious pest of dried fruits such as currants, raisons, dried apples, dates, berries, figs, almonds, walnuts, tamarind seeds, etc. It has also been recorded on lac, malted milk, dried mango, pulp, garlic bulbs, various cereal grains and grain products.

Bionomics



The adult moth has greyish wings with transverse stripes on the outer region and the wing expanse is about 12 mm. The female lays whitish eggs indiscriminately in cracks and crevices of the receptacles or on the food stuff. While feeding, the larvae spin tubes in the food material and are full-grown in 40-50 days. The full-grown larva is white with pinkish tinge and measures 1.5 cm. The larvae pupate inside the cocoons and pupal stage lasts about 12 days. The life cycle is completed in about two months and there are 5-6 generations in a year.

Damage symptoms

The caterpillars make tunnels in the food materials. The number of silken tube is sometimes extremely high and these clog the mill machinery where the infested grains have been sent for milling.

4. Rice moth: *Corcyra cephalonica* (Pyralidae: Lepidoptera)

Distribution and status

The rice moth is distributed in Asia, Africa, North America and Europe. In the larval stage, it is an important stored-grain pest in both India and Pakistan.

Host range

It also infests rice, sorghum, maize, gram, groundnut, cotton-seed, milled products, cocoa beans and raisins.

Bionomics



The rice moth is active from March to November. It passes winter in the larval stage. The larvae are found in groups of 3-5



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bags and on other objects in the godowns. A single female lay 62-150 eggs during its life-span of 24 days. The eggs hatch in 4-7 days and the larvae under silken web-like shelters,

preferring the partially damaged grains. They are full-fed in 21-41 days, after which they make silken cocoons among the infested grains. The pupal stage lasts 9-14 days and the adults live for - one week. They complete life-cycle in 33-52 days and the pest completes approximately 6 generations in a year.

Damage symptoms

The larvae alone damage the grains of rice and maize by feeding under silken webs. When infestation is high, the entire stock of grains may be converted into a webbed mass. Ultimately, a characteristic foul odour develops and the grains are rendered unfit for human consumption.

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

Distribution and status: Worldwide

Host range

The Khapra beetle will attack any dried plant or animal matter. It prefers grain and cereal products, mainly wheat, barley, oats, rye, maize, rice, flour, malt, and noodles. It can also feed on animal products such as dead mice, dried blood, and dried insects

Bionomics

The insect breeds from April to October and hibernates in the larval stage from November to March in cracks and crevices. Female begins to lay white translucent eggs on the grains, singly or sometimes in clusters of 2 -5. The eggs are rather cylindrical, rounded at one end and narrow at the other. A female may lay 13 - 35 eggs in 1 - 7 days at the rate of 1 - 26 eggs per day. The egg period varies from 3 -10 days. Larval period is 20 - 40 days and pupal period is 4 - 6 days. Pupation takes place in the last larval skin among the grains. The adults are incapable of flying. There are 4-5 generations in a year.



Fresh yellowish-white larva grows 4mm long and turns brown. The adult is a small dark-brown beetle, 2-3 mm long, with a retractile head and clubbed antennae. The entire body is clothed in fine hairs.

Damage symptoms

The greatest damage is done in summer from July to October. The grubs eat the grain near the embryo or at any other weak point and from there proceed inwards. They usually confine themselves to the upper 50 cm layer of grains in a heap or to the periphery in a sack of grains.



They can reduce the grain to a mere frass. Since the larvae are positively thigmotactic, they can be collected by merely placing gunny bags on a heap of grain.

Secondary pest

1. Saw toothed grain beetle: *Oryzaephilus surinamensis* (Cucujidae: Coleoptera)

Bionomics

It is slender, dark, narrow, flattened beetle having a row of saw like sharp teeth on each side of the prothorax. The antenna is clubbed and elytra cover abdomen completely. It lays 300 whitish eggs loosely in cracks of storage receptacles of godown. The eggs period is 3 -17 days. The larva is slender, pale cream in colour with to slightly darken patches on each segment. The larval period is 14- 20 days. It pupates in a protective cocoon like covering with sticky secretion. The pupal period is 7-21 days.



Damage symptoms

It feed on grains, dried fruits etc by scarving of grain surface or burrowing holes in them. It attacks rice, wheat, maize, cereal products, oil seeds and dry fruits.



2. Long headed flour beetle: *Latheticus oryzae* (Tenebrionidae: Coleoptera)

Bionomics

Bionomics



The beetle is light brown in colour with longated body, measuring 2 -3 mm in length and resembles *Tribolium castaneum*. It lays 400 white eggs singly on grain and seams of the bags. The incubation period is 7 – 12 days. The grub is small, white active which feeds

voraciously. The larval period is 15-80 days. It pupates for 5-10 days. Life cycle is completed in 25 days at 35 ° and 70% relative humidity.

Resembles *Tribolium*. Head is longer in proportion to the body than that of *Tribolium*, paler and brighter than *Tribolium*.

Damage symptoms

Both grubs and adult beetles feed on the milled products. It occurs as secondary infestation in stored grain. It attacks cereal flour, packaged food, rice and rice products. Occurs as secondary infestation in stored sorghum, wheat, etc.

3. Flat grain beetle: *Cryptolestes minutus* (Cucujidae: Coleoptera)

Bionomics

It is smallest among the stored grain insect pests. It is light to dark reddish brown beetle measuring 1.5 mm to 2.0 mm. It lays white eggs loosely in flour, grain or crevices. The egg period is 5 days. The larva is cigar like yellowish white with two reddish brown spots at anal segment. The larval period is 21 days. It pupates in a gelatinous cocoon. The life cycle is completed in 42 days.

Damage symptoms

Both grubs and adults feed on broken grains or on milled products. In case of heavy infestation it cause heating in grain and flour. It attacks rice, maize, wheat with excessive broken, different flours, ground nut particularly with high moistures and mouldy grains.

4. Grain lice: *Liposcelis divinatorius* (Psocoptera)

Bionomics



It is pale grey or yellowish white coloured, small, pin head sized louse with filiform antenna. It lays about 7-60 eggs. The metamorphosis is incomplete.

Damage symptoms

They are scavengers affecting only germ portion in heavy infestation. It thrive on insect fragments and broken grains. It attacks all starchy material.

5. Grain mite: *Acarus siro* (Acarina)

Bionomics

It is pale straw to dark reddish about 100 eggs. The eggs are hatched into which moult into nymphs. There are 1-3



brown mite. It lays 6 legged larvae instars. The life cycle

is completed in 9-12 days at 23 ° C and 70 % relative humidity.

Damage symptoms

It feeds on the surface of the grains. It attacks cereal grains, flour and other eatables.

Minor Pests of Stored Grains

The other insect species recorded as minor pests on stored grains and products in India are the; the cadelle, *Tenebroides mauritanicus* (Trogossitidae: Coleoptera) and the black fungus beetle, *Alphitobius laevigatus* (Tenebrionidae: Coleoptera)

MANAGEMENT OF STORAGE PESTS

The effective management of storage pests may be ensured by drying the grains properly before storage, storing new grains in the clean godowns or receptacles and plugging all cracks, crevices and holes in the godowns thoroughly. If infestation of grain has already taken place, then application of chemicals becomes necessary.

1. Surface treatment

Disinfect old gunny bags by dipping them in 0.0125 per cent fenvalerate 20EC or cypermethrin 25EC for 10 minutes and drying them in shade before filling with grains or use new gunny bags. Disinfect empty godowns or receptacles by spraying 0.05 per cent malathion emulsion on the floor, walls and ceiling.

2. Seed treatment.

Mixing of malathion 5 per cent at the rate of 250 g per quintal of seed is recommended. The grains may also be treated with/25 ml of malathion 50 EC or 2 ml of fenvalerate 20EC or 1.5 ml of cypermethrin 25EC or 14 ml of deltamethrin 2.8EC per quintal of seed by diluting in 500 ml of water. Against pulse beetle (dhora), cover the pulses stored in bulk with 7 cm layer of sand or sawdust or dung ash.

3. Fumigation

Metallic drums or wooden boxes can be used for fumigating small quantities of grain. In India, ethylene dichloride and carbon tetrachloride mixture has been recommended for fumigation of foodgrains in storage at farm level, and hydrogen phosphide in the form of aluminium phosphide or methyl bromide for protection in warehouses, godowns and silos.

Mixture of ethylene dichloride and carbon tetrachloride at the rate of 1 litre for 20 quintals of grain or 35 litres per 100 m³ of space with exposure period of 4 days is recommended. Methyl bromide is used at the rate of 3.5 kg per 100 m³ of space with 10-12 hours exposure. The fumigant, hydrogen phosphide (aluminium phosphide), is available in tablet form and can be used at the rate of one tablet (3 g) per metric tonne or 25 tablets per 100 m³ of space with an exposure period of 7 days.

Use of improved storage receptacles:

The grains can be best protected by using improved insect-proof receptacles of various types.

(a) Indoor Bins

Domestic metal bins, Gharelu theka, Pucca kothi, Welded wire-mesh bin, Reinforced cement ring bins, Paddy straw-mud structure.

(b) Outdoor Bins

Flat and hopper bottom-metal bins, Composite bins, Partly underground and above ground structures, Seed storage bins, Ferro-cement bins, Pusa bin, Improved godowns, Bulk storage installations and Vacuum process storage.

INTEGRATED MANAGEMENT OF STORED PRODUCE PESTS

The control methods of stored produce pests can be categorized into preventive and curative measures.

Preventive measures

- Brush the cracks, crevices and corners to remove all debris in the godown.
- Clean and maintain the threshing floor/yard free from insect infestation and away from the vicinity of villages.
- Clean the machines like harvester and thresher before their use.
- Made the trucks, trolleys or bullock carts free from infestation.
- Clean the godowns/ storage structures before storing the newly harvested crop to eliminate various bio stages of pest hiding.
- Provide a metal sheet upto a height of 25 cm at the bottom of the wood in doors to arrest the entry of rats.
- Fix up wire meshes to windows, ventilators, gutters, drains etc., to prevent entry of rats, birds and squirrels.
- Remove and destroy dirt, rubbish, sweepings and webbings etc from the stores.
- Close all the rat burrows found in godown with a mixture of broken glass pieces and mud plastered with mud/ cement.
- Plaster the cracks, crevices, holes found on walls, and floors with mud or cement and white wash the stores before storing of grains.
- Provide dunnage leaving gangway or alleyway of 0.75 to 1 m all around to maintain good storage condition.
- Store the food grains in rat and moisture proof storage structures.
- Disinfest the storage structures receptacles by spraying malathion 50 EC @ 3 lit 100 m before their use.

Curative measures

i) Ecological methods

- Manipulate the ecological factors like temperature, moisture content and oxygen through design and construction of storage structures/ godown and storage to create ecological conditions unfavourable for attack by insects.
- Temperature above 42⁰ C and below 15⁰ C retards reproduction and development of insect while prolonged temperature above 45⁰ C and below 10⁰ C may kill the insects.
- Dry the produce to have moisture content below 10% to prevent the buildup of pests.

- Kill the pests bio stages harbored in the storage bags, bins etc., by drying in the sun light.
- Store the grains at around 10 % moisture content to escape from the insects attack.
- Manipulate and reduce oxygen level by 1% to increase the CO₂ level automatically, which will be lethal to all the stages of insects.

ii) Physical methods

- Provide a super heating system by infrared heaters in the floor mills and food processing plants to obtain effective control of pests since mostly the stored produce insects die at 55 –60°C in 10 – 20 minutes.
- Modify the storage atmosphere to generate low oxygen (2.4% and to develop high carbon di oxide (9.0 – 9.5) by adding CO₂ to control the insects.
- **Seed purpose:** Mix 1 kg of activated kaolin (or) lindane 1.3 D (or) malathion 5 D for every 100 kg of seed and store/pack in gunny or polythene lined bags.
- **Grain purpose:** Mix 1 kg activated kaolin for every 100 kg of grain and store. To protect the pulse grains, mix activated kaolin at the above dosage or any one of the edible oils at 1 kg for every 100 kg of grain or mix 1 kg of neem seed kernel for every 100 kg of cereal / pulse and store.
- Do not mix synthetic insecticides with grains meant for consumption.

iii) Cultural methods

- Split and store pulses to escape from the attack by pulse beetle since it prefers to attack whole pulses and not split ones.
- Store the food grains in air tight sealed structures to prevent the infestation by insects.

iv) Mechanical methods

- Sieve and remove all broken grains to eliminate the condition which favour storage pests.
- Stitch all torn out bags before filling the grains.

v) Chemical methods

- Treat the walls, dunnage materials and ceilings of empty godown with malathion 50 EC 10 ml/L (or) DDVP 76 WSC 7 ml/L1 at 3 LI spray solution/10 sq.m.
- Treat the alleyways and gangways with malathion 50 EC 10 ml/L or DDVP 76 WSC 7 ml/ L (1 L of spray fluid/270 m³).
- Spray malathion 50 EC 10 ml/ L with @ 3 L of spray fluid / 100 m² over the bags.
- Do not spray the insecticides directly on food grains.
- Use knock down chemicals like lindane smoke generator or fumigant strips pyrethrum spray to kill the flying insects and insects on surfaces, cracks and crevices.
- Use seed protectants like pyrethrum dust, carbaryl dust to mix with grains meant for seed purposes only.
- Decide the need for shed fumigation based on the intensity of infestation.

- Check the black polythene sheets or rubberized aluminium covers for holes and get them ready for fumigation.
- Use EDB ampoules (available in different sizes 3 ml, 6 ml, 10 ml, 15 ml and 30 ml) at 3 ml/quintal for wheat and pulses and 5 ml/ quintal for rice and paddy (Do not recommend EDB for fumigation of flour oil seeds and moist grains)
- Use EDCT (available in tin containers of 500 ml, 1 liter and 5 litres) at 30 – 40 litres/ 100 cubic meter in large scale storage and 55 ml/quintal in small scale storage.

FUMIGATION

Use fumigants like ethylene dibromide (EDB), ethylene dichloride carbon tetra chloride (EDCT), aluminium phosphide (ALP) to control stored produce pests effectively. Apply aluminum phosphide (available in 0.6 g and 3 gram tablets) @ 3 tablets (3 gram each) per tonne of food grains lot with help of an applicator. Choose the fumigant and work out the requirement based on the following guidelines.

- 3 tablets of aluminum phosphide 3 g each per tonne of grain.
- 21 tablets of aluminium phosphide 3 g each for 28 cubic meters
- Period of fumigation is 5 days

Mix clay or red earth with water and make it into a paste form and keep it ready for plastering all round the fumigation cover or keep ready sand snakes. Place the required number of aluminium phosphide tablets in between the bags in different layer. Cover the bags immediately with fumigation cover. Plaster the edges of cover all round with wet red earth or clay plaster or weigh down with sand snakes to make leaf proof. Keep the bags for a period of 5-7 days under fumigation based on fumigant chosen. Remove the mud plaster after specified fumigation periods and lift cover in the corner to allow the residual gas to escape. Lift the cover after few hours to allow aeration.

STORED GRAIN PESTS

1.	Presence of irregular holes of 1.5 mm diameter on grains of rice, sorghum, wheat, barley, maize in storage is due to attack by _____ Rice weevil: <i>Sitophilus oryzae</i>
2.	Identify the pest- Dark brown beetle with head bent under the thorax; cover covered by a crenulated hood-shaped pronotum and the posterior abdominal end blunt . Lesser grain borer: <i>Rhyzopertha dominica</i>
3.	Identify the pest- Brownish grey colored beetle with truncate elytra, having elevated ivory like spots near the middle of dorsal side. Pulse beetle: <i>Callosobruchus maculatus (chinensis)</i>
4.	Name a storage pest on tobacco Cigarette beetle: <i>Lasioderma serricorn</i>
5.	Adult is slender ant like with a long snout and shiny black with reddish brown thorax and leg. Sweet potato weevil: <i>Cylas formicarius</i>
6.	Name two lepidopterous storage pest - Angoumois grain moth: <i>Sitotroga cerealella</i>, Indian meal moth: <i>Plodia interpunctella</i>

7.	Damage by potato tuber moth (<i>Phthorimoea operculella</i>) occurs both in field and storage- Say true or false
8.	Name a storage pest on arecanut, coffee and cocoa - Arecanut beetle: <i>Araecerus fasciculatus</i>
9.	Gaseous quinones released to the medium produces a readily identifiable acid odour in heavy infestations of _____ Red flour beetle: <i>Tribolium castaneum</i>
10.	Long headed flour beetle: <i>Latheticus oryzae</i> resembles _____ <i>Tribolium castaneum</i>
11.	Name some storage pests belonging to Tenebrionidae - Red flour beetle, Long headed flour beetle
12.	Name the family to which Angoumois grain moth and potato tuber moth belong - Gelechiidae
13.	Name a dermestid storage pest - Khapra beetle
14.	<i>Pachymeres gonagra</i> is a storage pest of _____ Tamarind
15.	Aluminium phosphide is used @ of _____ per ton of food grains. 3 tablets of aluminum phosphide 3 g each
16.	Malathion 50 EC should be sprayed over the gunny bags in 100 m ² at _____ 10 ml/ L with @ 3 L of spray fluid
17.	Pulses for storage should be mixed with ----- kg of edlble oil/activated clay for every 100 kg one
18.	Saw toothed gain beetle is a primary / secondary feeder
19.	Name the pests that occur both in the field and storage Rice weevil, pulse beetle, tamarind beetle, Angoumois grain moth, sweet potato weevil and Potato tuber moth
20.	Merely placing the gunny bags on the heap of grains helps in the collection of _____ Khapra beetle <i>Trogoderma granarium</i>
21.	Adults of _____ are powerful fliers and can move across godowns Lesser grain borer <i>Rhizopertha dominica</i>
22.	Angoumois grain moth is an internal/external feeder
23.	Rice moth <i>Corcyra cephalonica</i> is an internal/external feeder
24.	_____ is not recommended for fumigation of flour oil seeds and moist grains EDB
25.	Pulse beetle prefers whole pulse/split pulse