



STORAGE INSECT PESTS AND THEIR DAMAGE SYMPTOMS: AN OVERVIEW

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ABSTRACT

Stored product pests gain access to the grain storage from the standing crop in the field to various stages of grain processing and storage. Although, about one thousand species of insects have been associated with stored products in different parts of the world, a few pests are considered as pests causing severe damage to the stored grains. The stored grain insect pests can be categorized on the basis of their feeding behaviour as internal and external feeder or as major and minor pests based on the severity of damage, they cause. This paper gives an overview of damage symptoms and biology of some of the major pests of stored grains viz., rice weevil, *Sitophilus oryzae*, lesser grain borer, *Rhyzopertha dominaca*, khapra beetle, *Trogoderma granarium*, red flour beetle, *Tribolium castaneum*, cigarette beetle, *Lasioderma serricorne*, drug store beetle, *Stegobium paniceum*, pulse beetles *Callosobruchus* spp., Angoumois grain moth, *Sitotroga cerealella*, rice moth *Corcyra cephalonica*, saw toothed grain beetle *Oryzaephilus surinamensis*, long headed flour beetle, *Latheticus oryzae*, and almond moth *Cadra cautella*.

Key word: Stored insect pests, feeders, external, internal, secondary, rice weevil, lesser grain borer, khapra beetle, cigarette beetle, drug store beetle, pulse beetles, saw toothed grain beetle, lesser headed flour beetle, rice moth, almond moth

INTRODUCTION

Stored grains are ravaged by a number of insect pests. The stored grain pests infest grains to fulfill their food and shelter requirements resulting in qualitative as well as quantitative losses. The tropical climate of India is highly favourable for continuous occurrence of storage insect pests throughout the year. A number of insect pests gain access to the grain storage at various stages of processing of food grains/ seeds viz., during the process of development and maturation of seeds/ grains, processing in threshing yards, during transit or while in storage. Some insect pests initiate damage at the ripening stage of crops and continue during storage. Major sources of infestations are old bags, storage structure, old containers, and cross over infestation (Pruthi and Singh, 1950).

The spread and distribution of stored product pests are facilitated by movement of grains from one area to another either passively or by active flight of insect pests as some of the adult insects are strong fliers. Nearly one thousand species of insects have been associated with stored products in different part of the world. These may destroy the grains and contaminate the rest with undesirable odours and flavours. Majority of insect

pests belong to the orders Coleoptera and Lepidoptera (Khare, 1994).

CLASSIFICATION

The stored grain insect pests can be categorized as major or minor pests based on the severity of damage. On the basis of their feeding behaviour, these can be grouped as external and internal feeders (Cotton, 1960).

External feeders: This group of insects feed on germ and endosperm from outside. These may attack whole seed and damage the germinal portion or feed on the seeds, which have already been damaged/ infested by other insects or broken mechanically. These insect pests or their stages are generally visible among the seeds e.g. rice weevil, pulse beetle, granary weevil, Angoumois moth etc.

Internal feeders: These insects mostly lay eggs inside or on the surface of grains, spend a part or entire larval and pupal life inside the grains and only emerge as adults. These contribute significant loss of germination which is not detectable outside e.g. rice weevil, pulse beetle, granary weevil, Angoumois moth etc.

Secondary feeders: These include insects and mites

which develop after the infestation of other pests as they feed on cut and broken seeds, moulds and detritus, dead insects, animal wastes *e.g.*, common grain mite, cheese mites, and psocids. Damage by these result in loss of germination, contamination like webbing and ball formation, and inconspicuous deterioration of grains/seeds. The damage by these also cause fungal activity, hotspot formation and moisture migration across the stored grains.

STORED PRODUCT PESTS- AN OVERVIEW

Rice weevil - *Sitophilus oryzae* (Coleoptera: Curculionidae)

This is one of the serious pests of paddy, wheat, millet, barley, maize, sorghum and other cereals causing considerable qualitative and quantitative loss during the storage. Hot and humid climate favour its development. It is one of the cosmopolitan pests, and both larvae and adult stages cause economic damage. Adult is a tiny weevil of about 2.5 mm long and dark brown or reddish brown. Head protrudes into a cylindrical rostrum formed into a snout with strong pair of jaws at the distal end and prominent antennae emerging from the base of rostrum. Apparently two sexes are alike but rostrum is short and broader in males.



Fig. 1. Damage by rice weevil leaving only intact pericarp shell of wheat grains (left) and adult rice weevil (right)

In case of heavy infestation, only pericarp of the kernel is left behind, while rest of the mass is eaten up (Fig. 1). This pest can also infest cereal crops at maturing stage in the field. Female starts laying eggs after 4-5 d of the emergence and 300-400 eggs are laid by each individual. Eggs are translucent and white. measures 0.7mm long and 0.3mm broad. Female makes a slit like opening with mandibles and rostrum in sprout part of the grain to lay egg in the hole and plug it with secreted material from the ovipositor. Eggs hatch in about four to five days under hot and humid weather but might take six to nine days during cooler months. The newly hatched grub bores into the kernel of the

grain. Grubs are white, curved, translucent, with yellow or brown head and biting jaws. As soon as it emerges from egg, it starts feeding on the starchy material of the seeds, till it becomes fully grown and leaves behind only an intact pericarp shell filled with frass. The grub stage lasts for 19-34 d and then pupates to a non feeding pupal stage after passing 2-3 d as prepupa. Pupal period lasts for one wk and the adult emerging out of grain is at once ready for breeding. Grain with emergence hole becomes quite hollow and can float in water. This pest completes its life cycle within a month at $28 \pm 1^\circ\text{C}$ and 70% RH. Severely damaged lots of grains resemble mouldy grains.

Lesser grain borer - *Rhyzopertha dominaca* (Coleoptera: Bostrychidae)

Originated from India, this insect has now spread throughout the world. Lesser grain borer is regarded as second in importance to rice weevil as destroyer of the stored grains. At one time this was often found in wheat packings but now it is the major pest of nearly all cereals. It is mostly found in warmer regions of the world and damages wheat, barley, maize, paddy, sorghum and other products. It belongs to that group of insects, which bore into wood in both larval and adult stages. These beetles resemble rice weevil in colour but without snout. It is nearly 2-2.5 mm long with small triangular head which is deflexed under the thorax. It possesses powerful jaws to cause serious damage to grains. Wings are well developed and adults are good fliers. It prefers dark and dingy places.



Fig. 2. Presence of profuse powdery substance revealing damage by lesser grain borer (left) and adult beetle (right)

Both adult and larvae cause serious damage. Heavily infested grains become hollowed out and only thin shell remains. As many as four beetles can be present in bigger grain like maize. Female lays 300-500 eggs in its total lifetime. Eggs are laid either on the seed surface near the embryo end which is soft and easy for young larva to penetrate or interstices of the grain or in other parts of the stores like on cracks and crevices, bags,

walls etc. Eggs are pear shaped and white but later on changes to pinkish opaque. The larvae bore straight into the grain immediately or feed on farinaceous material in the store for some period and then penetrate into the grain in first or second instar. Incubation period is 4-7 d. Newly hatched larva is active and campodeiform, and undergo five moults. Full grown larva is dirty white with pale brown head and curved abdomen covered with tiny hairs. Larva lasts for 35-40 d. With fall in temperature it becomes less destructive. A single kernel of wheat provides food for 5-6 larvae. Pupal period is 7-8 d. It completes life cycle normally in 6-8 wk. Adults are good fliers and can migrate from one godown to other. After severe infestation adults produce frass and spoil more than what they eat. Profuse powdery substance is the characteristic of its damage (Fig. 2).

Khapra beetle, *Trogoderma granarium* (Coleoptera: Dermestidae)



Fig. 3A. Superficial grain damage by khapra beetle

Its habit of congregation in cracks and crevices of bricks, masonry and wood storage has given it, the name 'khapra'. It is a tropical/ subtropical insect mainly found in hot and dry regions. It prefers low humidity and high temperature. It is an external feeder and none of the stage lives in the grain. It is a serious pest of wheat but can also damage jowar, rice, maize, sorghum, oilseeds and pulses. Generally, infestation occurs in superficial layers of grain as this insect is not able to penetrate beyond some depth into the grain but in case of heavy infestation, whole lots are damaged (Fig. 3A). Adult is oval in shape and has grey and pale brown markings (Fig. 3B). Head is essentially hidden beneath hood like pronotum. Female lays eggs 5-6 d after breeding. A single female lays about 100-120 eggs on grain surface or crevices. At 35°C, incubation period is 4-6 d but it can vary depending upon the temperature and humidity.

The larva is brownish white in colour, body covered with bundles of long, reddish brown movable and erectile hair on the posterior segments and forming a sort of tail in the posterior end. First stage larvae feeds on broken grains and debris resulting from the feeding of older larvae as it cannot attack the whole grain. Larval period extends up to 20-25 d at 30°C whereas pupal period is 4-8 d. It is highly resistant to starvation. Under abnormal conditions, larva can survive without food for few years. Although it attacks almost all part of the grain, it prefers germ portion and as such the viability of the seed is lost long before any quantitative damage occurred. Severe infestation results in reduction of whole grains to mere frass. Adults do not feed and are short lived. Destructive stage is larva.



Fig. 3B. Adult khapra beetle

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



Fig. 4. Wheat flour infested with red flour beetles (left) and adult beetle (right)

Cosmopolitan in distribution, it is the worst pest of flour mills. It feeds on cereals, flour, starchy material, fruit nuts, millets and prepared cereal foods. It usually feeds on broken grains and results in dust formation. Infested flour emits sour and pungent smell, which is due to some secretions of beetles. Destructive stage is adult and larva. Adults are flat, 5-6 mm in length and reddish brown (Fig. 4). Head, thorax and abdomen are distinct and antennae are well developed of which the

last segment being abruptly much larger than preceding ones. Neither adult nor larvae can usually damage sound grains but feed only on those grains which have already been damaged by other insects. Apical portion of antenna is clubbed. Individual female lays 400-450 eggs in its whole life. Eggs are sticky and are laid on the grains or debris of the grains. These are small, cylindrical, rounded at both ends and of wheatish colour. Incubation period is 5-10 d. Larvae are very active, cylindrical and pupate after 3-4 wk. Pupation takes place on the grain surface, which lasts for 6-8 d. Adult has 4-5 d longevity and feeds throughout the life. The presence of larval stage, dead and live adults and odour represent damaged material. Both adults and larvae cause damage.

Cigarette beetle *Lasioderma serricorne* (Coleoptera: Anobiidae)

It is a cosmopolitan but prefers warm environment. It feeds on a large number of food varying from spices, chocolate, cocoa and tobacco leaves. Adult is a small, oval, reddish brown beetle of about 2.5 mm length. Head is projected downwards with concealed antennae. Adults can fly freely. After a day of emergence, female starts laying eggs on the grains. Eggs are laid in folds and crevices of food material. Eggs are ovoid, elliptical, whitish becoming opaque and dull in colour just before hatching. A single female lays about 110 eggs, which hatch in 5-6 d and larval stage lasts for 25 d followed by pupal period of 5-7 d. Newly hatched larvae are less than one mm in length and covered with fine hairs. Head of larvae is yellowish, has a semi transparent and whitish body. The larvae cause damage by making small galleries. After 25-30 d of larval life, it constructs a smooth lined cell in which it rests. Larvae lay quiescent in curved position within the cell, which gradually took pupal form. Newly formed pupa is glossy white but changes to reddish brown colour after a few days. Female adult is slightly bigger than males. Insect prefers higher temperature.

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

It is distributed in tropical, subtropical and temperate regions. It is primary pest of turmeric, ginger, pepper, coriander seeds, cumin seeds, etc. Adults and grubs feed/ destroy the grains/ seeds. Adults are short lived, pale brown, smaller than *L. serricorne*. Females can lay 50-80 eggs in the powdered material, which hatches within 8-10 d. Larval life is for 4-5 wk followed by pupal period of 6-10 d.

Pulse insect pests

All pulse pests belong to the family Bruchidae of order Coleoptera. According to Pruthi and Singh (1948), these beetles can be grouped into three categories depending upon their behaviour: (a) those which remain breed in stored grains in stores; (b) those which breed both in field and stores. A large number of pulse beetles belong to this group. These infest grains when it is in the field and after harvesting move to stores and cause more damage; and (c) those which infest grain in field and brought to store but cannot breed in the store. Adult bruchids fly from infested stores to nearby fields. As pod develops females lay eggs on it or within it. Eggs hatch and grub bore into soft developing pulses.



Fig. 5. Cowpea seeds infested with pulse beetle

Pulse beetle *Callosobruchus maculatus* (Coleoptera: Bruchidae)

This is a very important pest of grain legumes both in storage and field. It is distributed throughout India. It attacks peas, chickpea, pigeon pea, black gram, horse gram, cowpea etc. Larva which grows inside eats endosperm, and then the seed is totally damaged (Fig. 5). Adults are non-feeding. Cross infestation is very common, as adults are capable of flying. Adults are black, dark 5-6 mm in size. It can be identified from other species by elevated ivory like spots near the middle of the body; elytra bears white patches; antennae are prominent. Infestation starts from maturing pods. Females lay about 80-100 eggs per individual; the eggs are attached to the substratum by means of transparent glue like substance. Freshly laid eggs are creamy but become white later on. Egg period is for 3-7 d. Legless larva is cylindrical, fleshy and with wrinkled body. It is white or creamy yellow in colour and remains inside the seed in curved position. Mouthparts are dark brown. Newly hatched larvae enters in the seed through the seed coat. Larval stages develop inside the whole pulse seed after hatching from egg. Seed germination is spoiled

even during developing stages of beetle. Adults come out of the seed after pushing out a circular lid prepared by prepupal stage of larvae and generally one hole is present in the infested seed but sometimes it may be higher depending on the size of the seeds.

C. chinensis is smaller than *C. maculatus* and it is less brownish. Habits and nature of damage match with those of *C. maculatus* but this species can develop in smaller seeds also and more than one emergence holes are present on a damaged seed. Duration of life cycle is also shorter comparatively (Raina, 1970).

Saw toothed grain beetle *Oryzaephilus surinamensis* (Coleoptera: Silvanidae)

This is generally associated with starchy food and found in warm places. Common name is due to its peculiar structure of thorax which bears six tooth like projections on each side. It is a cosmopolitan pest of stored grain and grain products and reported to occurs in flour mills, warehouses, glossary stores, etc. Generally beetles live from six to ten months. Female lays six to ten eggs per day and 50 to 300 small and white eggs in her life span, loosely in food medium or in cracks and crevices. Larvae moult three times generally. Adults live 6 to 8 months but die in dust free undamaged grain. Larvae feed on endosperm of broken grains or starchy food.

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

It was first recorded in 1880 from Kolkata in rice. It infests broken grain and bran. Generally associated with *T. castaneum* and lifecycle and behaviour is almost similar to flour beetle. Eggs are translucent and smooth. Grubs are creamy white with dark eyes. Body of larvae is covered with pale coloured hairs. Lifecycle is completed in about 25 to 39 d at normal temperature and humidity.

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

It is named because first in 1736 it was noticed as a pest in Angoumois province of France. It is regarded as one of the most destructive internal feeder in stored grains. The initial infestation takes place when the grain is in or passing through milk stage in the field and usually a small percentage of grain kernels is infested. When wheat is in straw it is easy for the moths to make their way from one wheat head to another. By the time grains are threshed and stored, infestation increase rapidly. In storage, the infestation is restricted to upper

surface. Early infestation is difficult to detect because hole made by young is so small that it cannot be seen. Larva enters and eats its way in the grain, then turns about and spins a silken web over the opening by which it entered thus it is difficult to locate it. The appearance of moths in the stores and round holes on the grain or sometimes heating of the grain in the bin provides the first indication of infestation. Infested grains are hollow and filled with excreta or webs of larva leaving a circular opening for moths' emergence. If the pest is breeding in farm godowns, the moth is attracted by instinct to the nearby field in search of maturing grains to lay eggs.

It is found throughout the world mostly in warm temperate climate. It attacks grains in field as well as in storage. It is a serious pest of whole grains of paddy, sorghum, bajra, wheat etc. Only larvae feed on the kernel. It is capable of tunneling sound grains. Infestation is hidden and cannot be easily assessed in the early stages. Germination is seriously affected after infestation. Out of all lepidopteran storage insect pests, it is the most destructive. Adult moth measures 8-10 mm with fringed wings and is good flier. Adult longevity is about 1-2 wk. Infestation starts in maturing cereal crops right in fields. Each individual lays about 120-350 eggs, laid singly or in small clusters on the surface of the grain, which look white at early stage but changes to bright red later on. Small larvae hatch out after nearly one wk and enter inside the grain through joints of the husk. Larvae feed inside the grain (endosperm) for about 3-4 wk, and then it pupates. Full grown larvae are nearly 5 mm long, white with yellowish head. Larva spins a silken cocoon inside the grain and changes into reddish brown pupa. Before pupation, larvae cut a small circular opening on the husk which is covered by silken cover to come out. Pupal stage is for 7 d. Destructive stage is larva and damaged grain is very light in weight.

Rice moth *Corcyra cephalonica* (Lepidoptera: Pyralidae)

It is widely distributed in all rice growing areas of the world and serious pest of stored paddy, rice and other cereals. It flourishes well in humid climates and also attacks wheat, maize, sorghum, barley, millets, soybean and oilseeds. Larva is mainly responsible for damage. Young larva feeds on the broken grain or on the grains, which are already damaged by other insects. As the larvae grow old it becomes capable of feeding on entire grains, which are already damaged by others. Besides polluting the grain with large quantities of frass and silken cocoons, webbing together the grains into

large lumps occur. Presence of such webbing leads to serious public discrimination. Adults are 10-12 mm in length, readily distinguished by closed straight beak formed by palpi pointed forward, and antennae are not crossed over wings while insect is at rest. Female is larger than males and adult life is short about 7-10 d. Head has tufts of hair, with greyish forewings and creamy hind wings. Females lay about 200 eggs which are small, oval, white and are laid anywhere on bags, walls, or on grains, Young larva is creamy white with prominent pale brownish yellow head. Larva webs silken shelter soon gets densely covered with broken grain and frass. Larval life is for 4-5 wk and it pupates inside the silken cocoon for 8-10 d.

Almond moth *Cadra cautella* (Lepidoptera: Phycitidae)

Almond moth, also known as fig moth is widely spread in the tropics and subtropics. It is a serious pest of figs, rough rice, dry fruits, wheat, barley, sorghum, soybean, and oilseeds etc. Adult moth has a dark band on the forewings and is three fourth of the size of *C. cephalonica*. It has greyish body, while at rest, its forepart is elevated giving a distinct slope to the wings. Females lay about 200-250 eggs per individual, indiscriminately scattered in stores, in cracks, on grains or other surfaces. Eggs measure less than 1 mm, and hatch within 3-4 d. The young larvae spin silk profusely and at maturity these form small silken tubes among the food particles or in the grain wherein they remain lodged and grow. Larval stage is the damaging stage. Full grown larvae are white with pinkish tinge. Its

characteristic colour and habit of spinning tubes in food material are most conspicuous diagnostic characters. Pupal period is 7-10 d. Moths are generally more abundant during rainy and humid seasons.

CONCLUSION

Stored grains provide diverse niches for a variety of insect pests to thrive and complete their lifecycle. While external feeders are conspicuous by their presence, the internal feeders are very often discernible only after a considerable damage is caused. Understanding the symptoms of damage, lifecycle and biology of major stored product insect pests would help in monitoring and assessment of their damage so as to devise suitable strategies for controlling these pests. Grain handlers are essentially to be imparted with the knowledge of identification of major stored product insect pests, their life stages and associated damage symptoms in the grains to ensure safe storage of grains.

REFERENCES

- Cotton, R.T. 1960, Pest of stored grain on grain products. Burges comp. Minniapolis, Minn. 289 pp.
- Khare, B.P. 1994. Pests of stored grain and their management. Kalyani Publishers, New Delhi. 304 pp.
- Pruthi, H.S. and M. Singh. 1948. Pests of stored grain and their control. Indian Council of Agricultural Research, New Delhi. India. 88pp.
- Pruthi, H.S. and M. Singh. 1950. Pests of stored grain and their control. Special number. Indian Journal of Agricultural Science 18:1-52.
- Raina, A.K. 1970. *Callosobruchus* species infested stored pulses (grain legumes) in India and comparative study of their biology. Indian Journal of Entomology 32(4):303-310.