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NATIONAL INSTITUTE OF PLANT HEALTH MANAGEMENT

Department of Agriculture, Cooperation & Farmers Welfare
Ministry of Agriculture & Farmers Welfare, Government of India
Rajendranagar, Hyderabad - 500 030, Telangana, India.



Hand book on Stored grain pests and their identification

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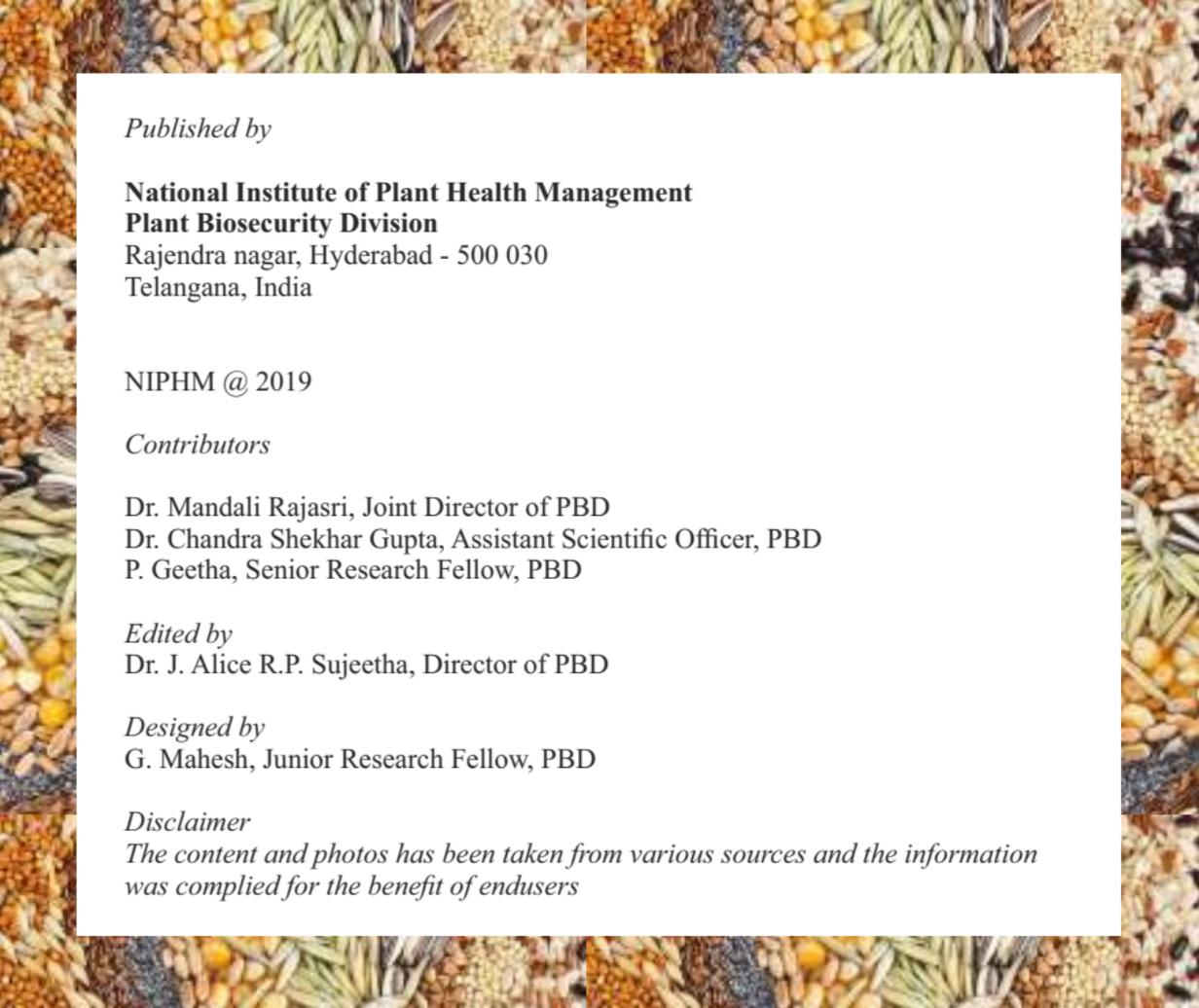


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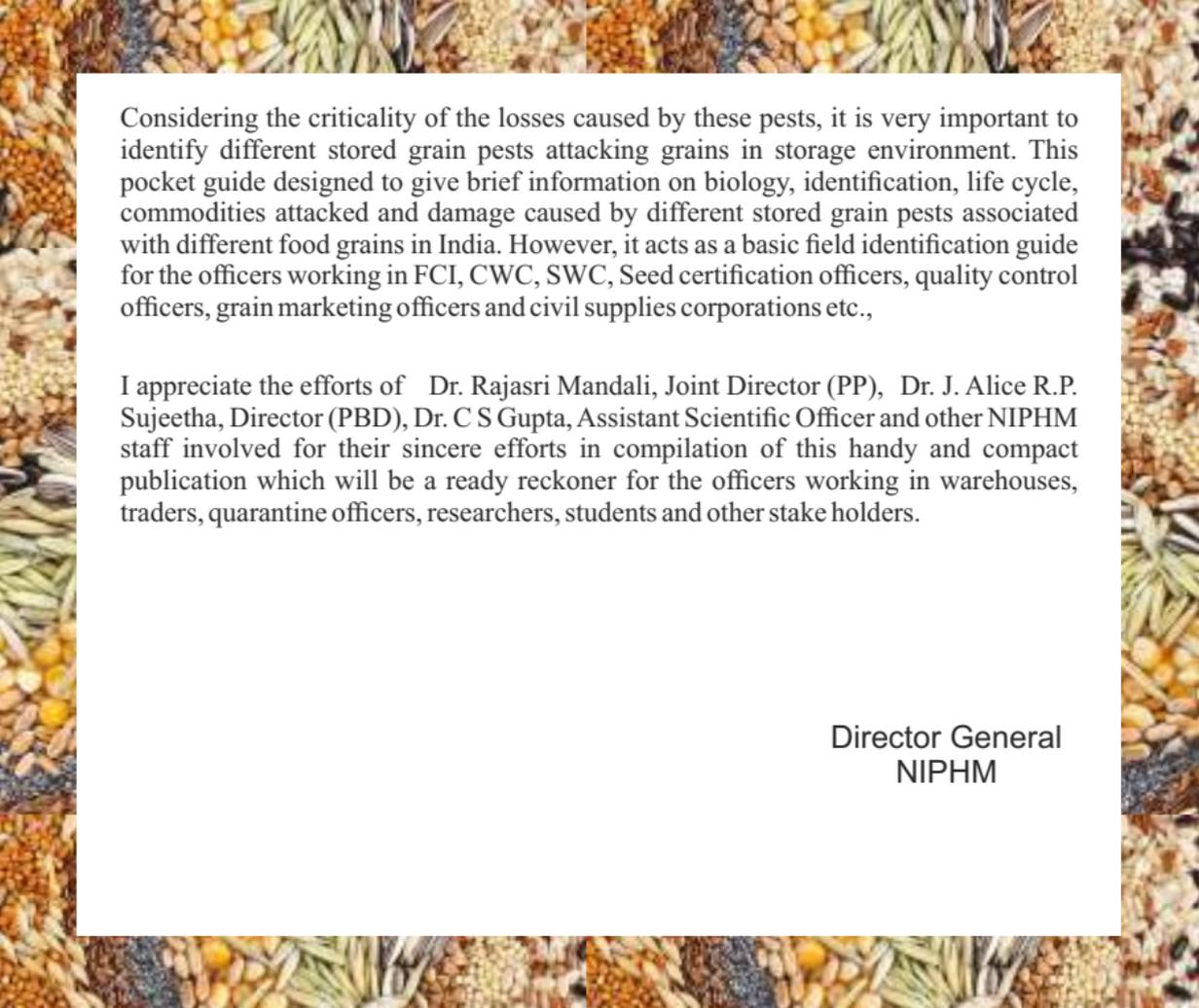
Preface

“A grain saved is a grain produced”

Poor grain storage and resultant storage losses have been a persistent problem in India. According to FAO, produce worth \$14 billion is damaged annually. It is a paradox that millions go hungry in India everyday while food goes to waste. Storage losses in India amount to 12 to 16 million metric tons of food grains each year, an amount that the World Bank stipulates could feed one-third of India's poor. India has been ranked at the 103rd position among 119 countries on the Global Hunger Index, with the highest food insecurity. The high volume of losses, if reduced, can generate significant value and address food insecurity.



The storage losses are affected by several factors viz., biotic (insect, pest, rodents, fungi) and abiotic factors (temperature, humidity, rain). Among all the biotic factors, insect pests are considered most important and cause huge losses in the grains. Losses can be minimized by physically avoiding the entry of insects and rodents, and maintaining the environmental conditions that avoid growth of microorganisms. The knowledge of control points and identification of insect and other pests that cause storage losses can help in reducing losses during the storage. Taking the timely preventive actions for biotic and abiotic factors can be very effective in reducing the storage losses. Hence, there is every need to improve the scientific storage of grains and technical efficiency of the professionals involved in the maintenance of grain storage management.



Considering the criticality of the losses caused by these pests, it is very important to identify different stored grain pests attacking grains in storage environment. This pocket guide designed to give brief information on biology, identification, life cycle, commodities attacked and damage caused by different stored grain pests associated with different food grains in India. However, it acts as a basic field identification guide for the officers working in FCI, CWC, SWC, Seed certification officers, quality control officers, grain marketing officers and civil supplies corporations etc.,

I appreciate the efforts of Dr. Rajasri Mandali, Joint Director (PP), Dr. J. Alice R.P. Sujeetha, Director (PBD), Dr. C S Gupta, Assistant Scientific Officer and other NIPHM staff involved for their sincere efforts in compilation of this handy and compact publication which will be a ready reckoner for the officers working in warehouses, traders, quarantine officers, researchers, students and other stake holders.

**Director General
NIPHM**

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Stored Grain Pests and their Identification

Introduction

In India, post-harvest losses caused by unscientific storage, insects, rodents, microorganisms 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.

Losses of grain in storage due to insects are the final components of the struggle to limit insect losses in agricultural production. These losses can exceed those incurred while growing the crop. Losses caused by insects include not only the direct consumption of kernels, but also include accumulations of frass, exuviae, webbing, and insect cadavers. High levels of this insect detritus may result in grain that is unfit for human consumption.



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



Egg



Larva



Adult



Damage

Commodities attacked: cassava, wheat, rice, maize, jowar, chickpea, barley, dried stored products, lentil, pea, rye, broad bean, adzuki bean, mung bean and cowpea.

Identification: Adults 3-4 mm, dark brown to black, elytra each with two dull orange spots, flight wing (under elytra) present, thorax with circular shape punctures. These species are externally identical and only be distinguished by examination of genitalia. Larvae- apodus.

Life cycle:

Optimum 25 days at 30°C, 70% RH. Range 15-34°C maximum population growth rate per month -25.

- **Eggs-** laid singly in operated hole in grain then covered with waxy plug.
- **Larvae-** immobile, develop concealed within single grain.
- **Adult-** on emergence leave ragged hole in grain, long-lived feed, fly.

Damage: Both grub and adults cause the damage. Grains are hollowed out; kernels are reduced to mere powder. *S. oryzae* starts its attack in field itself. Adults cut circular holes. Dry heating takes place during heavy infestation. Grains which float in water often indicate larval damage.

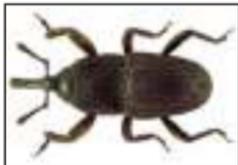
3. Granary weevil - *Sitophilus granarius* (Curculionidae: Coleoptera)



Egg



Larva



Adult



Damage

Commodities attacked: barley, wheat, dried stored products, rice, jowar, chickpea, oats, sunflower, broad bean and maize.

Identification: Adult-3-4 mm, dark brown, oval, long legs, front of head with long snout, elytra unmarked, flight wings (under elytra) absent, thorax, with oval-shaped punctures. Larvae apodous.

Life cycle:

Optimum 25 days at 30°C, 70% RH range 11-34°C. Maximum population growth rate per month -15.

- **Eggs-** laid singly in operated hole in grain then covered with waxy plug.
- **Larvae-** immobile, develop concealed within single grain.
- **Adults-** on emergence leave ragged hole in grain, long-lived, feed, cannot fly.

Symptoms of damage: Both grub and adults cause the damage. Grains are hollowed out; kernels are reduced to mere powder. Adults cut rectangular holes. Heating takes place during heavy infestation, which is known as 'dry heating'. It can also cause serious damage under hot conditions before populations die out. Larval stages feed inside the grain on the kernels, leaving only the hulls. Severe infestations can reduce stored grain to a mass of hulls and frass.

4. Khapra beetle - *Trogoderma granarium* (Dermestidae : Coleoptera)



Egg



Larva



Adult



Damage

Commodities attacked: groundnut, cotton, dried stored products, barley, rice, millets, sesame, sorghum, wheat, maize, cowpea, chickpea, sunflower, bajra and broad bean.

Identification: Adult-2-3 mm, oval, hairy, elytra, unmarked or light markings. Antennal club three to eight segments; segment jointed symmetrically. Larvae- cruciform, oval, with bands of hairs.

Life cycle:

Optimum-25 days at 33-37°C, 45-75% RH Range- 20-40°C, % RH > 2% Maximum population Growth rate per month – 13.

- **Eggs-** laid amongst commodity.
- **Larvae-** mobile, cast skins left in infested material, survive without food for years.
- **Adults-** short lived, do not feed on commodity, do not fly.

Symptoms of damage: Adults are harmless. Grub damages the grain starting with germ portion, surface scratching and devouring the grain. It reduces the grain into frass. Excessive moulting results in loss of market value due to insanitation caused by the cast skin, frass and hair. Crowding of larvae leads to unhygienic conditions in warehouses. Damage is confined to peripheral layers of bags in bulk storage.

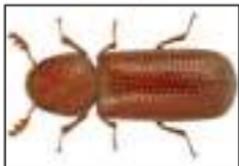
5. Lesser grain borer - *Rhyzopertha dominica* (Bostrichidae: Coleoptera)



Egg



Larva



Adult



Damage

Commodities attacked: oats, wheat, rice, maize, jowar, chickpea, barley, chilli, coriander, turmeric, cassava, beans, ginger, ground nut, lentil, black gram and mung bean.

Identification: Adults – 3 mm, dark reddish-brown, cylindrical in cross-section. Head bent downwards and concealed. Tip of abdomen tapered, end of elytra curved gradually. Larvae – scarabaeiform, legs fully developed.

Life cycle:

Optimum- 25 days at 34°C, 70% RH. Range- 20-38°C, >30% RH maximum population growth rate per month-20.

- **Eggs-** laid on commodity or in tunnels bored by adults.
- **Larvae-** internal feeders producing lots of flour, immobile when mature.
- **Adults-** long-lived, feed and bore into commodity, fly.

Symptoms of damage: Grubs and adults cause damage and are voracious feeders. Adults reduce the grain kernels to mere frass. Grubs eat their way into the grain or feed on the grain dust and are capable of attacking grain externally.

6. Pulse beetle - *Callosobruchus chinensis* (Bruchidae : Coleoptera)



Egg



Larva



Adult



Damage

Commodities attacked: pigeonpea, chickpea, soybean, lentil, black gram, mung bean, cowpea, hyacinth bean, buffalo-bean, rice, pea, winged bean, wheat, vetch, cowpea, moth beans and groundnut.

Identification: Adults are 2.0-3.5 mm long. The antennae are pectinate in the male, and serrate in the female, elytra patterned and do not fully cover abdomen. Inner ridge of lower side of hind femur with or without spine. Larvae-scarabaeiform, legs partly developed.

Life cycle:

Optimum-21 days at 32°C, 90% RH. Range – 18-37°C, 20-90% RH. Maximum population growth rate per month – 50.

- **Eggs-** glued individually to pod or seed.
- **Larvae-** on hatching bore directly into seed, develop concealed within seed.
- **Adults-** short lived, do not feed on commodity, fly.

Symptoms of damage: Grubs eat up the grain kernel and make a cavity. Adults come out making exit holes.

7. Cowpea weevil - *Callosobruchus maculatus* (Bruchidae : Coleoptera)



Egg



Larva



Adult



Damage

Commodities attacked: gum arabic tree, pigeonpea, chickpea, soybean, lentil, black gram, mung bean, cowpea, rice, pea, winged bean, wheat, vetch, cowpea, moth beans, groundnut and wild sweet pea.

Identification: Adults – 3-4 mm, globular with long legs and antennae, elytra patterned and do not fully cover abdomen. Inner and outer ridge of lower side of hind femur each with spine. Larvae- scarabaeiform, legs partly developed.

Life cycle:

Optimum-21 days at 32^oC, 90% RH. Range – 18-37^oC, 20-90% RH. Maximum population growth rate per month – 50.

- **Eggs-** glued individually to pod or seed.
- **Larvae-** on hatching bore directly into seed, develop concealed within seed.
- **Adults-** short lived, do not feed on commodity, fly.

Symptoms of damage: Grubs eat up the grain kernel and make a cavity. Adults come out making exit holes. Infestation may start in the pods before harvest and carry over into storage where substantial losses may occur. As adult emerged from the seeds they leave behind neat circular holes in the seed, behind which is a large cavity left by the larvae.

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



Egg



Larva



Adult



Damage

Commodities attacked: wheat, rice, maize, jowar, chickpea, barley, bell pepper, coriander, black pepper, ginger, turmeric, oats and weed e. colonum.

Identification: Adults- labial palps long and strong curved upwards. Forewing (5-6 mm) pale greyish-brown with single small black spot in centre, two-thirds from base. Wings heavily fringed with fine hairs, forewing tapered to apex, rear wing with finger-like projection.

Life cycle:

Optimum- 30 days at 30°C, 75% RH. Range- 16-35°C, RH >30%. Maximum population growth rate per month-50.

- **Eggs-** laid on commodity.
- **Larvae-** excavate cavity in grain, remain concealed there, make neat hole (covered with silk) in grain surface prior to pupation.
- **Adults-** exit through hole often leaving silken 'door', still attached to grain, short-lived, do not feed, fly.

Symptoms of damage: Larvae damage grains, adults being harmless. Grains are hollowed out. It attacks both in fields and stores. In stored bulk grain, infestation remains confined to upper 30 cms depth only. Caterpillar enters the grain through crack or abrasion on grain. It feeds inside and remains in a single grain only.

9. Indian meal moth - *Plodia interpunctella* (Pyralidae : Lepidoptera)



Egg



Larva



Adult



Damage

Commodities attacked: groundnut, wheat, rice, maize, jowar, barley, prunus, dried stored products, oats, sunflower, walnut, pistachio, almond, cocoa, milled cereal products, spices, beans, lentils and chocolate.

Identification: Adults- labial palps point forwards. Forewing (7-9 mm) bi coloured cream and reddish-brown. Larvae- 15 mm, unmarked creamy white, rim of abdominal spiracles evenly thickened.

Life cycle:

Optimum- 30 days at 30°C, 75% RH. Range- 15-35°C, RH 25-90%. Maximum population growth rate per month-60.

- **Eggs-** stuck to commodity.
- **Larvae-** external feeders produce silk webbing.
- **Adults-** short-lived, do not feed on commodity, fly.

Symptoms of damage: Larva causes serious damage to ear and grain of maize; contaminates the grain with excreta, cast skins, webbings, dead individuals and cocoons; prefers to eat the germ portion and hence grains lose viability. It feeds superficially but may construct more than one silken tunnel.

10. Almond moth - *Cadra cautella* (Pyralidae : Lepidoptera)



Larva



Adult



Damage

Commodities attacked: groundnut, fig, soybean, cotton, flax, cassava, wheat, rice, maize, jowar, barley, dried stored products, oats, sunflower, walnut, almond, cocoa, apricot and mango.

Identification: Adults- labial palps short and curved upwards. Forewing (7-9 mm) grey with darker markings. Larvae-15-20 mm, white to pink with black spots (base of hairs), rim of abdominal spiracles evenly thickened.

Life cycle:

Optimum- 26 days at 30°C, 75% RH. Range- 17-37°C, RH >20%. Maximum population growth rate per month- 60.

- Eggs- laid on loose in commodity.
- Larvae- external feeders produce silk webbing.
- Adults- short-lived, do not feed on commodity, fly.

Symptoms of damage: Larva feeds on germ portion leaving the rest of the kernel undamaged. In bulk infestation its damage is limited to peripheral top layers only. Web formation covers the bags, floor-space and mill machinery thereby leading to clogging in mills.

11. Rice moth - *Corcyra cephalonica* (Pyralidae : Lepidoptera)



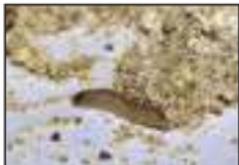
Egg



Larva



Adult



Damage

Commodities attacked: cassava, nutmeg, wheat, rice, maize, jowar, chickpea, dried stored products, cotton, apricot, sesame, groundnut, bell pepper, maize and redgram.

Identification: Adults- labial palps; male – short, hidden by scales; female- curved downwards. Forewing (78-13 mm) grey with no markings. Males much smaller than females. Larvae- 15-20 mm, white, rim of abdominal spiracles evenly thickened on one (rear) side.

Life cycle:

Optimum- 27 days at 30°C, 75% RH. Range- 17-37°C, RH >20%. Maximum population growth rate per month-10.

- **Eggs-** laid on loose in crevices in commodity.
- **Larvae-** external feeders produce lots of silk webbing, irregular holes bitten into attacked material.
- **Adults-** short-lived, do not feed on commodity, fly.

Symptoms of damage: Larva is only responsible for damage. It contaminates food grains with frass, moults and dense webbing. In whole grains, kernels are bound into lumps upto 2 kg.

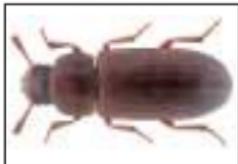
12. Red flour beetle - *Tribolium castaneum* (Tenebrionidae : Coleoptera)



Egg



Larva



Adult



Damage

Commodities attacked: groundnut, oats, brazil nut, barley, walnuts, lentil, rice, beans, lima bean, pea, almond and rye.

Identification: Adults- 3-4.5 mm, flattened, parallel-sided, reddish-brown. Gap between eyes – 33% of head width. Last three segments of antennae as distinct club. Structure between base of front legs widest at tip (like 'axe head'). Eye divided number of facets at narrowest point – 2. Larvae- elateriform.

Life cycle:

Optimum- 20 days at 35-68°C, >70% RH. Range- 22-40°C, RH >1%. Maximum population growth rate per month-70.

- **Eggs**- laid on commodity.
- **Larvae**- mobile external feeder.
- **Adults**- long-lived, feed on commodity, fly.

Symptoms of damage: Grubs feed on milled products. Flour beetles are secondary pests of all grains and primary pests of flour and other milled products. In grains, embryo or germ portion preferred. They construct tunnels as they move through flour and other granular food products. In addition they release gaseous quinines to the medium, which may produce a readily identifiable acid odour in heavy infestations.

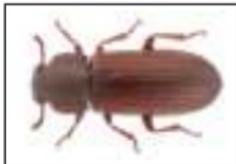
13. Confused flour beetle- *Tribolium confusum* (Tenebrionidae: Coleoptera)



Egg



Larva



Adult



Damage

Commodities attacked: oats, rice, maize, jowar, chickpea, barley, bajra, groundnut, hemp, cassava, sunflower and rye.

Identification: Adults- 3-4.5 mm, flattened, parallel-sided, reddish-brown. Gap between eyes – 50% of head width. Segments of antennae gradually wider towards tip. Structure between base of front legs widest at tip (like 'axe head'). Larvae-elateriform.

Life cycle:

Optimum- 25 days at 32.5°C, >70% RH. Range- 19-37.5°C, RH >1%. Maximum population growth rate per month-60.

- **Eggs**- laid on commodity.
- **Larvae**- mobile external feeder.
- **Adults**- long-lived, feed on commodity, do not fly.

Symptoms of damage: Grubs feed on milled products. Flour beetles are secondary pests of all grains and primary pests of flour and other milled products. In grains, embryo or germ portion preferred. They construct tunnels as they move through flour and other granular food products. In addition they release gaseous quinines to the medium, which may produce a readily identifiable acid odour in heavy infestations.

14. Groundnut bruchid- *Caryedon serratus* (Chrysomelidae: Coleoptera)



Egg



Larva



Adult



Damage

Commodities attacked: groundnut, dried stored products, african oil palm, cotton, beans, cocoa, indian tamarind and bajra.

Identification: Adults- 17 mm, globular with long legs and antennae, elytra light brown and do not fully cover abdomen. Femur of hind leg enlarged, with one large tooth and 11-12 smaller 'teeth' on lower edge. Larvae-scarabaeiform, legs partly developed.

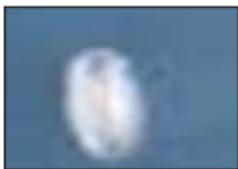
Life cycle:

Optimum, 42days at 30-33°C, 70-90% RH. Range- 23-35°C.

- **Eggs-** glued individually to pod or seed.
- **Larvae-** on hatching bore directly into seed, develop completely within seed but may pupate in flimsy cocoon outside seed.
- **Adults-** leave neat exit hole in seed, short lived, do not feed on commodity, fly.

Symptoms of damage: Grub causes the damage. Circular hole on fruits and seeds of tamarind both in tree and storage.

15. Sawtoothed grain beetle - *Oryzaephilus surinamensis* (Silvanidae: Coleoptera)



Egg



Larva



Adult



Damage

Commodities attacked: oats, wheat, rice, maize, sorghum, chickpea, barley, dried stored products, neem, locust bean, sunflower, millets, rye and broad bean.

Identification: Adults- 3 mm, dark brown to dark grey, highly flattened, parallel-sided. Thorax with three longitudinal ridges. Side of thorax with six tooth – like projections. Length of head behind the eye. Larvae- campodeiform.

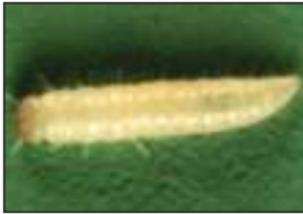
Life cycle:

Optimum, 20 days at 30-33°C, 70-90% RH. Range- 20-38°C, RH > 10%. Maximum population growth rate per month – 50.

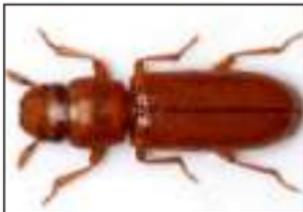
- **Eggs**- laid amongst commodity.
- **Larvae**- mobile, external feeders.
- **Adults**- long-lived, very active, walk long distances, feed on commodity, fly.

Nature of damage: Adults and grub cause roughening of grain surface and off odour in grain. Grains with higher percentage of broken, dockage and foreign matter sustain heavy infestation, which leads to heating of grain.

16. Longheaded flour beetle - *Latheticus oryzae* (Tenebrionidae : Coleoptera)



Larva



Adult



Damage

Commodities attacked: rape, grasses, dried stored products, wheat, rice and maize.

Identification: Adults- 3 mm, parallel-sided, slender, flattened, yellowish-brown. Eyes crescent-shaped from side. Antennae with distinctive five-segmented club, final segment narrower than preceding one. Larvae - elateriform.

Life cycle:

Optimum, 22 days at 35°C, 85% RH. Range- 25-40°C, RH > 30%. Maximum population growth rate per month – 10.

- **Eggs-** laid amongst commodity.
- **Larvae-** mobile, external feeders.
- **Adults-** long-lived, feed on commodity, fly.

Symptom of damage: Both grubs and adults feed.

17. Cigarette beetle - *Lasioderma serricorne* (Anobiidae : Coleoptera)



Egg



Larva



Adult



Damage

Commodities attacked: cinnamon, cumin, cassava, tobacco, dried stored products, cocoa, ginger, groundnut, peppers, safflower, turmeric, yam, sweet potato, rice, aniseed, wheat and cowpea.

Identification: Adults- 3-4 mm, brown, globular. Antennae long, segments saw-like, elytra smooth with fine hairs. Larvae- scarabaeiform, legs fully developed.

Life cycle:

Optimum- 26 days at 30°C, 70% RH, range- 20-38°C RH > 25%.
Maximum population growth rate per month-20.

- **Eggs**- laid in crevices in commodity.
- **Larvae**- internal feeders, immobile when mature.
- **Adults**- active, short-lived, do not feed on commodity, fly.

Symptoms of damage: Grub causes the damage which made circular, pinhead sized bore holes on processed tobacco.

18. Drugstore beetle - *Stegobium paniceum* (Anobiidae : Coleoptera)



Egg



Larva



Adult



Damage

Commodities attacked: cinnamon, cumin, cassava, tobacco, dried stored products, cocoa, ginger, groundnut, peppers, safflower, turmeric, yam, sweet potato, rice, aniseed, wheat and cowpea.

Identification: Adults- 3-4 mm, brown, globular, last three segments of antennae form loose club, elytra with fine longitudinal ridges and fine hairs. Larvae- scarabaeiform, legs fully developed.

Life cycle:

Optimum- 40 days at 30°C, 60-90% RH, range- 15-34°C RH> 35%. Maximum population growth rate per month-8.

- **Eggs**- laid in crevices in commodity.
- **Larvae**- internal feeders, immobile when mature.
- **Adults**- active, short-lived, do not feed on commodity, fly.

Symptoms of damage: Circular pinhead sized bore holes, caused by grubs.

19. Maize weevil - *Sitophilus zeamais* (Curculionidae: Coleoptera)



Egg



Larva



Adult



Damage

Commodities attacked: maize, cassava, wheat, rice, jowar, chickpea, barley, dried stored products, lentil, pea, rye, broad bean, adzuki bean, mung bean and cowpea.

Identification: Adults 3-4 mm, dark brown to black, elytra each with two dull orange spots, flight wing (under elytra) present, thorax with circular shape punctures. These species are externally identical and only be distinguished by examination of genitalia. Larvae-apodous.

Life cycle:

optimum 25 days at 30°C 70% RH range 15-34°C maximum population growth rate per month -25.

- **Eggs-** laid singly in operated hole in grain then covered with waxy plug.
- **Larvae-** immobile, develop concealed within single grain.
- **Adult-** on emergence leave ragged hole in grain, long-lived feed, fly.

Damage: Both grub and adults cause the damage. Grains are hollowed out; kernels are reduced to mere powder. *S. zeamais* starts its attack in field itself. Heating takes place during heavy infestation, which is known as 'dry heating'. Damage is distinctive; both adults and larvae feed directly on the kernel. Larvae feed internally and newly emerged adults leave a ragged exit hole and will also feed on the damaged kernel. Maize weevil infestations produce heat and moisture.

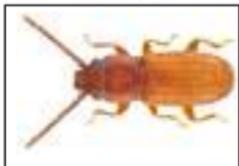
20. Rusty/Flat grain beetle – *Cryptolestes ferrugineus* (Laemophloeidae: Coleoptera)



Egg



Larva



Adult



Damage

Commodities attacked: cereal grain and products, other dried material of plant origin, packaged and processed goods.

Identification: Adults- 1.5-2 mm, reddish-brown, highly flattened, parallel-sided. Hair-like antennae, up to length of body. A ridge runs from above each eye down side of thorax. Species difficult to distinguish except by examination of genitalia. Larvae- campodeiform.

Life cycle:

Optimum- 21 days at 35°C, 90% RH. Range- 20-42.50°C, 40-90% RH. Maximum population growth rate per month-60.

- **Eggs-** laid amongst commodity.
- **Larvae-** mobile, external feeders.
- **Adults-** long-lived, walk with characteristic sway, feed on commodity, fly.

Damage: Both larvae and adults feed on germ and endosperm. Heavy infestations may cause grain to heat and spoil. Beetles may spread fungal spores through grain. They are the main insect pest of farm-stored cereals.

21. Psocids

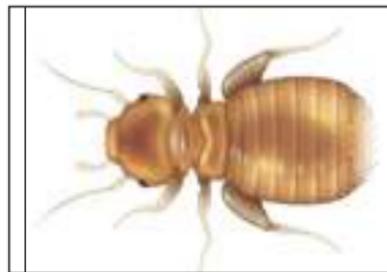
Psocids are major problem for the effective protection of stored products worldwide. Psocids are the smallest pests of stored commodities. Psocids act as nuisance pests or contaminants of low economic importance. This ignorance has mostly been due to the fact that damage to bulk commodities by these pests has always been overshadowed by major pests, such as beetles. Among psocids, members of genus *Liposcelis* are the most frequently encountered pests in grain storages on farm, export terminals, warehouses with bagged commodities and even in kitchen pantries.



22. *Liposcelis bostrychophila* (Liposcelididae, Psocoptera)



Feeding on Grains



Adult

Lifecycle: Development occurs during the summer and lasts between 20 and 40 days; Optimum conditions: At a constant temperature of 27°C and 65% relative humidity the development lasts about 30 days, of which seven are the egg stage. Six to eight generations can be produced in a year.

Identification: Adults 0.7 to 1mm. highly flattened, wingless femur of hindleg enlarged, translucent to dark brown.

Commodities attacked: Any dried material of plant and animal origin especially of slightly damp, a common pest of crop residue.

Nature of damage: *Liposcelis* are secondary pest which are able to excavate the soft endosperm from the damaged and broken grain. They feed preferentially on damaged grain germ and capable of completely eating out the germ. Psocids will also eat mould spores and fungal hyphae.

23. *Liposcelis entomophila* (Liposcelididae, Psocoptera)



Larva



Damage

Identification: Adults 1mm. highly flattened, wingless femur of hindleg enlarged, translucent to dark brown.

Commodities attacked: Any dried material of plant and animal origin especially of slightly damp, a common pest of crop residue.

Optimum conditions: At a constant temperature of 18°C and 60% relative humidity the development lasts about 30 days, of which seven are the egg stage. Six to eight generations can be produced in a year.

Nature of damage: *Liposcelis* are secondary pest which are able to excavate the soft endosperm from the damaged and broken grain. They feed preferentially on damaged grain germ and capable of completely eating out the germ. Psocids will also eat mould spores and fungal hyphae.

24. Storage Mites



Lepidoglyphus destructor



Tyrophagus putrescentiae

Mites as pests At least twelve mite species infest stored grain. The most common are species of *Acarus*, *Tyrophagus*, *Glycyphagus* and *Lepidoglyphus*. Mites can cause direct damage by eating out the germ and can taint produce. The most serious effects potentially result from allergens that mites contain or produce. Mites may also transmit fungal spores and act as vectors of human pathogens. Living and dead mites have been found in foods ranging from biscuits to baby food. Such contamination is causing increasing concern. Mites can survive inside grain and populations build up quickly.

Life cycle: Females may lay up to 250 eggs in a month. Some mites may also enter a highly resistant, non-feeding resting stage known as a hypopus. Mites thrive in high humidity conditions. Mites mainly feed on the germ. Mites can subsist on organic debris in cracks, crevices and corners of storage areas.

Optimum conditions: Mites multiply under high humidity conditions (over 65% relative humidity) and upper temperature limit of 35-37°C. Commodities

25. *Acarus* , *Glycyphagus*



Acarus siro

Commodities attacked: flour, grain, seeds and bulbs and Also fungi that develop on these products.

Identification: Mites are pale, pearly or greyish white and about the size pinhead. They have translucent ,soft, wingless bodies with no pronounced demarcation between body parts .The first two pairs of legs are widely separated from the two hind pairs of legs. There are two pairs of fairly long hairs trailing and the end of the body.



Glycyphagus domesticus

Damage: Both the mould and grain mites cause direct damage by eating the germ of the grain and spreading fungi in the commodities. Heavily infested commodity becomes tainted with off-flavours caused by squashed mite bodies when it is moved or processed. During heavy infestation from the mould mite, the dead and live mites settle as a brownish dust layer on stacks of commodities and floors of stores.

26. Rodents

Rodents: Rats have been estimated to damage more than 1% of the world cereal crops and 3-5% in developing countries. Rats consume about 25gm of food per day and mice eat approximately 3-4 gm per day. They contaminate a lot of the stored produce with urine, feces, hair and pathogenic agents. Infested batches often have to be declared unfit for human consumption. As rodents mainly feed on the embryo, they cause particular damage to the nutritional value and germination ability of seeds. Produce leaking out of bags or containers. Bag stacks collapsing. Droppings shape, size and appearance of droppings can provide information as to the species of rodents and the degree of infestation.



27. Black rat (*Rattus rattus*) Black rats can be found only rarely in India.

Identification: 16 – 24 cm in length, with a tail longer than the head and body. 150 – 200g in weight. Pointed nose, large ears and a slender body when compared to the Brown Rat (*Rattus norvegicus*).

Lifecycle: 5 – 10 young per litter; 3 – 6 litters a year. Gestation period of about 3 weeks. 12 – 16 weeks from birth to sexual maturity.

Habits: Appearance confined mainly to ports. Often climbs, agile, rarely burrowing and rarely outdoors in India. Preferred food is moist fruits. Will eat around 15g of food a day and drink 15ml.



Rattus rattus

28. Brown rat (*Rattus norvegicus*)

Brown rats usually prefer ground living and burrowing, but sometimes they can be known to climb.

Appearance: Up to 40 cm in length, with a tail shorter than the head and body. 350 – 500g in weight. Blunt nose, small ears and a thicker body when compared to the Black Rat (*Rattus rattus*).

Lifecycle: 7 – 8 young per litter; 3 – 6 litters a year. Gestation period of about 3 weeks. 10 – 12 weeks from birth to sexual maturity

Habits: Usually ground living and burrowing, but sometimes climbs. The only species to occur in sewers in India. Preferred food is cereals. Will eat around 30g of food a day and drink 60ml.



Rattus norvegicus

29. The House Mouse, *Mus musculus*

This species is also cosmopolitan, There are many subspecies and colour variations are extreme: the fur dorsally is usually brown to brownish grey (although black and other colours occur), and grey ventrally. The head+body length is 70-110 mm, and a fully grown adult weighs 15-30 am. The tail is about as long as the head+body length. The ears are quite large in relation to the rest of the body, while the feet are comparatively small and the snout pointed. The house mouse is a good climber and lives in social groups. It can be a serious pest in agricultural fields and buildings, but has also been recorded in native or natural vegetation.



Mus musculus

30. Bandicoot rat (*Bandicota indica*)

Bandicoot rat (*Bandicota indica*) is the largest, weighing 0.5 to 1 kg (1.1 to 2.2 pounds). The shaggy, blackish brown body is 19 to 33 cm (7.5 to 13 inches) long, not including a scantily haired tail of about the same length. Greater bandicoot rats are found on the Indian subcontinent. It is a serious pest in agricultural fields and warehouses.



Bandicoot rat
(*Bandicota indica*)

31. *Bandicota bengalensis* (Lesser bandicoot rat)

Bandicota bengalensis (Lesser bandicoot rat) is 270 mm in head and body, the tail is 220 mm, dark in colour. Body weight is 250-600 g. The fur is coarse and rough looking and the longer guard hairs are prominent. Animals range from brownish grey to almost blackish. It is a serious pest in agricultural fields and warehouse.



Bandicota bengalensis
(Lesser bandicoot rat)



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