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Identification of Major Stored Grain Pest and Its Management

Sanju Singh[1]* and Mitesh Makwana[2]

[1]Technical Assistant, Department of Agriculture, District Fatehpur, Government of Uttar Pradesh - 212601

[2,3]Ph.D Research Scholar, Department of Entomology, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh-474002

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*Corresponding Author

Sanju Singh*

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INTRODUCTION

Stored grains are heavily damaged by insect pests. These pests cause damage to stored grains as well as field and resulting in both qualitative and quantitative losses. The main reason behind the occurrence of stored grain pests is the presence of favorable environment condition for their growth and survival. At various processing stages of grains, i.e., during the process of development and maturation of seeds, processing in threshing yards, during transmission of seeds, or storage large number of insect pests gain access to stored grains. Some pests start damaging the seeds at the ripening stage with continue till during storage. Pest several damaged likes, Old bags, storage structures, old containers are the major source of infestation. The dispersal and distribution of stored grain pests are caused by the movement of grains from one area to another area either by a passive or active flight of pests as some adult insects possess strong flight. Damage grain Undesirable smells and flavor during infestation by the stored pest. The stored grain pests belonging to mainly two orders, i.e., Coleoptera and Lepidoptera. Stored grain pests possess a serious threat to dried, stored, durable and, perishable agricultural products and non-food derivatives of agricultural products worldwide. Stored grain pests cause serious post-harvest losses, almost 9% in developed countries to almost 20% or more in developing countries. Almost 8–10%, i.e., 13 million tons of grains lost due to insects and 100 million tons due to failure to store properly is estimated in stored food products all around the world. Approximately one-third of the world's production, which values almost $100 billion has been destroyed by almost 20,000 species of field and stored grain pests. The largest order of stored grain pests Coleoptera followed by Lepidoptera that accounting for almost 60% and 10% respectively.

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Stored grain pests easily feed on grain, bore into the kernel and then destroy the germ portion, cause heat and then cause deterioration in-stored grain products thus resulting in huge losses mainly due to nutritional depletion and reduction in market value besides cause contamination by their excretory products, that can be extremely hazardous to human health who process and infest the grains so the loss caused by insect pests is not in terms of quantity but mostly in terms of quality. Qualitative loss in stored grain is caused by chemical changes in proteins, carbohydrates, amino acids which negatively affect the nutritional value of grains.

Classification of stored grain pests

Stored gain pests are grouped into two kinds On the basis of feeding ability. They are classified as primary and secondary pest.

1. **Primary insect pests: -** which infests the whole grains and are capable of damaging all type of storage grains. For e.g. Bruchids family, Rhizopertha and Sitophilus spp.
2. **Secondary insect pests: -** As the name indicates these pests are secondary because these pests attack on already infested crops these generally feed on cut and broken grain, molds, dead insects, animal wastes etc. e.g., red rust flour beetle and saw toothed grain beetle etc. Damage caused by these pests' results in loss of germination, contamination like ball formation, and webbing besides deterioration of grains.

Based on their feeding behavior

These insects can be classified as external feeders and internal feeders

- **External feeder:** As the name indicates these pests feed on external or surface parts of the grains such as the outside part of germ and endosperm. These pests are generally visible among the seeds such as Red rust flour beetle and Khapra beetle.
- **Internal feeders:** larvae/pupae remain inside the grains and finally insect laid eggs inside/on the grain. Rice weevil, pulse beetle, and Rhizopertha. As the name indicates these pests are usually found inside the seeds. These pests mostly lay eggs inside or on the surface of grains, then spend a part or entire larval and pupal life within the grains and emerge as an adult.

List of stored grain pests

Primary insect pests

Common Name	Scientific Name	Order	Family	Damaging Stages
Pulse beetle	*Callosobruchus chinensis*	Coleoptera	Bruchidae	Adults and Grubs
Rice weevil	*Sitophilus oryzae*	Coleoptera	Curculionidae	Adults and Grubs
Lesser grain borer	*Rhizopertha dominica*	Coleoptera	Bostrichidae	Adults and Grubs
Potato tuber moth	*Phthorimaea operculella*	Lepidoptera	Gelechidae	Larvae
Tobacco beetle	*Lasioderma serricorne*	Coleoptera	Anobiidae	Adults and Grubs
Sweet Potato weevil	*Cylas formicarius*	Coleoptera	Brentidae	Grubs and Adults

Secondary insect pests

Common Name	Scientific Name	Order	Family	Damaging Stages
Khapra beetle	*Trogoderma granarium*	Coleoptera	Dermestidae	Only Grubs
Red-rust flour beetle	*Tribolium castaneum*	Coleoptera	Tenebrionidae	Adults and Grubs
Saw-toothed beetle	*Oryzaephilus surinamensis*	Coleoptera	Silvanidae	Adults and Grubs
Rice meal moth	*Corcyra cephalonica*	Lepidoptera	Galleridae	Larvae
Indian meal moth	*Plodia interpunctella*	Lepidoptera	Pyralidae	Larvae

Pulse beetle (*Callosobruchus chinensis):*

Mark of Identification: The pulse beetle, also known as the pulse weevil or pea weevil, is a common pest that infests pulses or leguminous crops such as peas, lentils, chickpeas, and beans. Pulse beetles are small insects ranging from 2 to 4 mm in length. They are usually reddish-brown to dark brown. Elongated, cylindrical body with a slightly curved or arched form. A pair of antennae that is usually shorter than their bodies. The larvae of pulse beetles are creamy white with a curved body, and they develop inside the seeds.

Rice weevil (*Sitophilus oryzae*):

Mark of Identification: The rice weevil (*Sitophilus oryzae*) is a common stored grain pest that infests various grains, including rice, wheat, barley, and other stored grains. Small beetles, measuring about 2 to 3 mm in length. They are reddish-brown to black in color. Body is elongated, narrow, and curved body. The most distinctive feature is their elongated snout or "nose," which extends from the front of their head. Bent or elbowed antennae that emerge from the sides of their snout. Elytra (hardened forewings), rice weevils possess functional wings, but they are not strong fliers. Instead, they primarily crawl to infest grains. Rice weevils are known for infesting stored grains, particularly whole grains. They bore small holes into the grains to lay their eggs, and their presence is often identified by the emergence of these small holes or by the sight of the adult weevils.

Lesser grain borer (*Rhizopertha dominica*):

Mark of Identification: *Rhizopertha dominica* is a significant pest known for infesting stored grains, particularly cereal grains like wheat, barley, rice, maize, and other stored products. Small, elongated beetle, typically measuring about 2 to 4 mm in length. It has a cylindrical body with a reddish-brown to dark brown coloration. Similar to other grain beetles, slender and elongated body with a slightly flattened appearance. The adult beetle has distinctively serrated antennae and hardened forewings (elytra) that protect its body. Highly adaptable and can thrive in a range of temperatures and moisture conditions. They prefer infesting whole grains but can also attack broken or damaged grains.

Potato tuber moth (*Phthorimaea operculella*):

Mark of Identification: It is a widespread pest that primarily attacks crops like potatoes, but it can also infest other members of the Solanaceae family. Small, grayish-brown moth, typically with a wingspan of around 10-12 mm. The forewings of the moth have irregular dark spots and distinct markings. Larvae are especially damaging during storage. They create tunnels within the tubers, leading to rotting and loss of quality, making the potatoes unfit for consumption or commercial use.

Tobacco beetle (*Lasioderma serricorne*):

Mark of Identification it is also known as the cigarette beetle (*Lasioderma serricorne*), is a common stored product pest notorious for infesting tobacco products, as well as other dried plant materials, spices, grains, and a variety of stored food products. Beetle is a small, oval-shaped insect, usually about 2 to 3 mm in length. It has a reddish-brown to light brown coloration. Tobacco beetles prefer warm and humid environments.

Sweet Potato weevil (*Cylas formicarius*):

Mark of Identification: The sweet potato weevil (*Cylas formicarius*) is a destructive pest that targets sweet potatoes and related plants. Weevils are beetles that range from about 6 to 12 millimeters in length. They have elongated bodies and are usually reddish-brown to black in color. Their bodies are covered in fine hairs. Sweet potato weevils thrive in warm climates and are prevalent in tropical and subtropical regions. They target sweet potatoes and can also infest related plants, such as morning glories.

Khapra beetle *(Trogoderma granarium):*

Mark of Identification: The Khapra beetle is a highly destructive pest of stored grains, particularly known for its infestations of cereals, rice, wheat, barley, and other stored food products. Khapra beetle is a small, oval-shaped insect, approximately 2 to 3 mm in length. It has a reddish-brown to dark brown color and is covered in fine hairs. It often appears to have a slightly mottled or speckled appearance. Khapra beetles undergo complete metamorphosis with four life stages: egg, larva, pupa, and adult. Female beetles lay eggs on or near stored grains. Khapra beetles thrive in warm and dry conditions. They can survive for long periods without food and are highly resilient to insecticides and fumigants. Infestations can remain dormant and undetected for extended periods until favorable conditions trigger their activity.

Red-rust flour beetle *(Tribolium castaneum):*

Mark of Identification: it is also known as the red-rust flour beetle (*Tribolium castaneum)*, is a common pest found in stored food products, particularly flour, cereals, grains, and various milled products. Appearance: The red flour beetle is a small, reddish-brown beetle, typically measuring about 3 to 4 millimeters in length. It has a flattened body and distinct antennae ending in a club-like shape. Red flour beetles undergo complete metamorphosis, consisting of four stages: egg, larva, pupa, and adult. Beetles infest stored grains, flour, cereals, and processed food products. Both larvae and adults feed on the stored products, causing damage by contaminating the food with their presence, excrement, and shed skins.

Saw-toothed beetle *(Oryzaephilus surinamensis):*

Mark of Identification: it is a small beetle commonly found in stored food products. They are small insects, typically ranging from 2 to 3 mm in length. Beetles are usually reddish-brown to dark brown in color. Flattened body with distinct saw-like projections or "teeth" along the sides of the thorax. These projections are easily visible under magnification and give the beetle its name. Long and slender antennae that are distinctly clubbed at the end. Pest infests stored food products, especially grains, cereals, flour, nuts, and other processed food items.

Rice meal moth *(Corcyra cephalonica):*

Mark of Identification: commonly known as the Indian meal moth *(Plodia interpunctella*), is a widespread stored product pest. Adult moth has a wingspan of around 12-20 mm. Its forewings are pale gray with irregular bands of bronze or copper-colored markings near the wingtips. When at rest, the moth holds its wings folded together along its back. Eggs being laid in or near stored food products.

Indian meal moth *(Plodia interpunctella):*

Mark of Identification: The Indian meal moth (*Plodia interpunctella*) can be identified by several distinctive characteristics at different stages of its life cycle:

Adult Moth: The adult Indian meal moth has a wingspan of about 12 to 20 mm. Its forewings are pale gray with reddish-brown or copper-colored markings near the wingtips. When at rest, these moths often fold their wings in a distinctive triangle shape. Wing Pattern: The most noticeable characteristic is the distinctive wing pattern, which consists of irregular bands of bronze or copper-colored markings on a pale gray background.

Larvae (Caterpillars): larvae or caterpillars of Indian meal moths are small and worm-like, typically creamy-white in color with a brown head. larvae spin silken threads, creating webbing in the infested food materials as they feed

Pupae: Transformation Stage: Before transitioning into adult moths, Indian meal moth larvae undergo pupation. The pupae are enclosed within silken cocoons and may be

found in cracks, crevices, or near the infested food sources.

Management of stored grain pest

For effective management of storage insect pests integrated pest management approach should be followed which includes many methods likes sanitation of storage facility, cleaning of grains before storage, monitoring of pest incidence, temperature and moisture control inside and outside the storage structure/area and need based use of grain protectants.

Sanitation

Sanitation of storage facility, inside and outside space, and also nearby habitats to remove the pests stages as well as pest habitats. Sanitation helps to prevent the pest population build-up and further damage. Insecticides like Deltamethrin 2.5 WP (40 gm/l) and Malathion 50 EC (1 % or 3 liter/100m^2) can be used.

Sun drying of grains

Sun drying is the most common practice followed before storage of any food grains. This technique minimizes the storage losses by molds, discoloration, respiration and insect damage. Cereals moisture decrease and after storage to minimizing grain losses optimum moisture content for cereals and grain less than 10 percent than long storage and easily safe food grains.

Protectants

Grain protectants mainly contact insecticides are used to kill the insect pests in storage godowns and structures. The insecticides can be used as prophylactic or curative control measure. The insecticides like Deltamethrin 2.5% WP and Malathion 50% EC are used at recommended doses on walls, floor, alleyways and surface grain bags to kill cowling insect stages. Malathion 50% EC is diluted with water in the ratio of 1: 100 and 3 liters emulsion is sprayed on 100 sq. mtr. Surface area after 15 days interval. Similarly, 40 gm of Deltamethrin 2.5% WP is dissolved in 1 liter of water and 3 liters emulsion is sprayed on 100 sq. mtr. surface area after 90 days. For curative control, the grain stacks or godowns can be fumigated with fumigants like Phosphine at recommended dose. For effective fumigation the storage containers should be air tight or grain stacks should be covered with gas proof fumigation covers.

Storage structures

The basic understanding of storage structure include the prevention of migration of the air and moisture to avoid oxygen availability to any living entity while storage. Generally grain storage structures are categorized based on the availability of material, storage capacity, the economic aspects of the structure etc. India, 59–70% of food grains is stored in the conventional storage systems, constructed using paddy or wheat straw, bamboo, wood, bricks, mud, cow-dung, etc. Here, storage can be done indoors, outdoors or inside, or underground (Singh et al., 2017).Modern storage structures like Pusa bin (Developed by ICAR-IARI), domestic Hapur bin (Indian grain storage institute), PAU bin (Punjab Agricultural University) etc. have been used for small to quantity storage (1 to 3 tonnes).

CONCLUSION

To avoid the post harvest losses of food grains the proper care of storage facilities, continuous monitoring and use of proper prophylactic and curative measures are essential. From augmenting the existing storage capacities by construction of new ones through various means both public and private partnerships is need of the hour to revamp the existing storage pest management in the country. Use of new systems of grain storage including silo storage, controlled atmosphere storage and using integrated pest management techniques would greatly reduce the cost of preservations and increase the available food free from contaminations.