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Storage pests attacking stored seeds and their management

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In India, Agriculture is a way of life for nearly seventy per cent of the population. The impressive growth registered in agricultural production made the country self sufficient with a record of food grain production of 246 million tones in 2013-14. Seed is the critical determinant of the agricultural production. Post harvest seed management is one of the vital components as there is a tremendous loss of the produce after harvesting and storing. Post harvest losses are huge at the farm and trade level, where nearly 70 per cent of the farm produce is stored either for food, feed or seed. On an average, losses due to insects at storage are reported to be in the range of 10-20 per cent but at times may be as high as 30 per cent. In fact, insects causes the highest loss of grain. These insect pests inflict their damage on stored products mainly by direct feeding. The damage created by insects on the grain can affect the farmers because their grain may lose value for marketing, consumption or planting.

Losses caused by insects :

Weight loss : Estimates of the weight loss as a result of insect feeding vary widely with the commodity, locality and the storage practices involved. For grain legumes in the tropics, stored under traditional conditions, a loss in the range of 10-30 per cent might be expected over a full storage season.

Loss in quality/market value : Infested produce contaminated with insect debris has an increased dust content. Grains are holed and often dis coloured. Food prepared from infested produce may have an unpleasant odour or taste.

Promotion of mould development : Insects, moulds and the grains themselves produce water in respiration, *i.e.* a breakdown of carbohydrate substrate. In humid conditions, without adequate ventilation, mould development and "caking" can spread rapidly, causing severe losses.

Reduced germination in seed material : Damage to the embryo of the seed will usually prevent germination.

Reduced nutritional value : Removal of the embryo by storage pests will tend to reduce the protein content of the grain.

Thumb rules in management of storage pests:

– One per cent reduction in seed moisture doubles the storage potential of the seed.
– Reduction of 10^0 F temperature nearly doubles the storage life.
– Good seed storage is achieved when the per cent relative humidity in storage environment and temperature in F add to hundred Eg. 50 per cent and 50^0F.

Management of insect pests of stored seed: Among the present methods of insect control, following are the important methods which can help in safe storage of food grains particularly at farmer's level (Gahukar, 1994).

– Preventive measure
– Curative measures

Preventive measures : "Prevention is better than cure". Hence, the following preventive measures are recommended.

Hygiene or sanitation :

– Threshing floor/yard should be clean, free from insect infestation and away from the vicinity of villages/ granaries.
– Clean the harvesting and the threshing machines before their use.
– Trucks, trolleys or bullock carts which are used for transportation of food grains should be made free from insect infestation.
– Clean the storage structure/godowns before storage of newly harvested crop.
– All dirt, rubbish, sweepings and webbings should be removed from the stores and disposed destroyed.
– All the cracks, crevices, holes existing in the floors, ceiling should be plastered with mum or cement permanently.
– All the rat burrows should be closed with a mixture of broken glass pieces and mud and then plastered with mud/cement.
– White wash the store rooms before storage of food grains.
– Food grains should be kept in stores which are rat and moisture proof.
– Proper stacking of bags also helps in grain protection.

Disinfestation of stores/receptacles: Before the use, the receptacles/store rooms should be disinfested with approved residual insecticides preferably by spraying

Insects attacking stored seeds			
Common name	Scientific name	Family	order
Internal feeders			
Rice weevil	*Sitophilus oryzae* (L.)	Curculionidae	Coleoptera
Maize weevil	*Sitophilus zeamais* (Motsch)	Curculionidae	Coleoptera
Granary weevil	*Sitophilus granarius* (L.)	Curculionidae	Coleoptera
Lesser grain borer	*Rhizopertha dominica* Fab.	Bostrichidae	Coleoptera
Pulse beetle	*Callosobruchus maculatus*	Bruchidae	
	C. chinensis L.		Coleoptera
Cigarettee beetle	*Lasioderma serricorne* (F.)	Anobiidae	Coleoptera
Drug store beetle	*Stegobium paniceum* L.	Anobiidae	Coleoptera
Tamarind beetle or	*Caryedon serratus* (Oliv.)	Bruchidae	Coleoptera
Groundnut bruchid			
Angoumois grain moth	*Sitotroga cerealella* (Oliv.)	Gelechidae	Lepidoptera
Grain lice	*Liposcelis divinitotrius* (Muli)	Liposcelidae	Psocoptera
	L. transvallensis (Enderlein)	Liposcelidae	Psocoptera
External feeders			
Khapra beetle	*Trogoderma granarium* (Everts)	Dermestidae	Coleoptera
Red flour beetle	*Tribolium castaneum* (Herbst.)	Tenebrionidae	Coleoptera
	T. confusum J. Du.Val.	Tenebrionidae	Coleoptera
Saw goothed beetle	*Oryzaephilus surinamensis* (Linn.)	Silvanidae	Coleoptera
Flat grain beetle	*Cryptolestes ferrugineus* (Stephens)	Cucujidae	Coleoptera
Longheaded flour beetle	*Latheticus oryzae* (Water)	Tenebrionidae	Coleoptera
Warehouse moth (or) Almond moth	*Ephestia cautella* (Walker)	Phycitidae	Lepidoptera
Indian meal moth	*Plodia interpunctella* (Hubner)	Phycitidae	Lepidoptera
Rice moth	*Corcyra celphalonica* (Staint)	Galleriidae	Lepidoptera

Malathion 50 per cent EC, with dilution of 1:100 and applied at the rate of 3 lit/100 m^2.

Legal method: Entry of an insect which is not found in the particular area can be prevented by the imposition of Destructive Insect Pests Act, 1914.

Curative measures : The infestation of stored grain insect pests can be controlled by the following methods :

– Non-chemical control measures.

– Chemical control measures.

Non-chemical control measures: The measures where chemicals are not used for the control of insect pests of stored grains are:

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

– Temperature

– Moisture content of grain

– Availability of oxygen.

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

Temperature: Temperature ranging from 20^0C to 40^0C accelerate the development of insects but above 42^0C and below 14^0C retards reproduction and development, while prolonged temperature above 45^0C below 10^0C may kill the insects, Heating of grains to 50^0C will be lethal to insects but it is not advisable, because the grains are affected and lose the viability.

Moisture content of grain: Moisture is the critical factor in safe storage of food grains. Grains stored at around 10 per cent moisture content escape from the attack of insects (except khapra beetle).

Availability of oxygen: In storage, oxygen is consumed by grains and insects during respiration and carbon dioxide is produced. Insects respire at the rate of 20,000 to 1,30,000 times than that of the same weight of thegrains. Thus, O_2 level will reduce below 1 per cent and CO_2 level will automatically increase which will be lethal to all the stages of insects.

Mechanical control measures: Among other methods, mechanical methods are quite practicable. Several

mechanical devices have been designed and developed both for monitoring and mass trapping stored product insects.The behaviour of the stored product insects is exploited using entolaters and different kinds of traps *viz.*, probe traps, light traps and pheromone traps etc.

Environmental modification: Manipulation of storage temperatures or humidity can be used to destroy many stored product pests. Heat treatment kills some pests outright, while cold treatment usually blocks their development. For adequate control, it may be necessary to subject products to a prescribed period of high temperatures followed by cold, after which they should be kept stored at a constant, lowered temperature. In general, a temperature of 60 degrees Fahrenheit prevents insect feeding; 40 degrees Fahrenheit kills insects over a period of time. Some products can be frozen to protect them from insect damage.

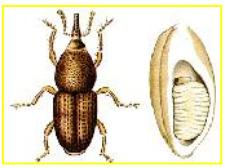
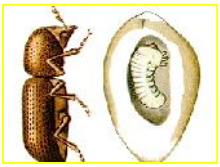
Desiccants : Dusts, such as silica gel or diatomaceous earth, can be combined with certain stored grains to provide protection against insect damage. These dusts kill target insects by desiccation. Dusts are removed from grain and other stored food before processing by a cleaning operation that also removes other debris. Because sorptive dusts are inert, they do not leave any potentially harmful residues on the food if traces of the desiccant remain.

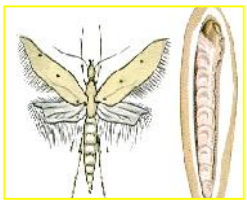
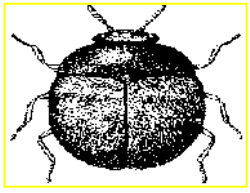
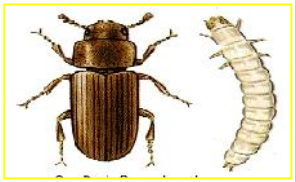
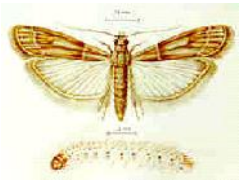
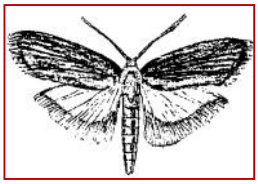
Chemical control:

Prophylactic treatments : The seed stocks require very careful handling to prevent quality deterioration.The regular prophylactic treatments with pesticides like malathion 50 EC (1:100 in water), DDVP (1:150 in water), Deltamethrin (120 g in 3 lt water) per 100 sq. mtrs is required for proper storage.

Fumigation: It plays an important role in management of insect infestation. Fumigation with aluminium phoshide

Internal feeders

Hosts	Insect	Damage	Illustration
Rice, maize and other cereals in storage	Rice weevil *Sitophilus oryzae*(L)	The developing larva lives and feeds inside the grain hollowing it out in the process. In rice (the preferred host) the entire grain is usually destroyed by the time the adult emerges.	
Stored cereals and Other stored foodstuffs	Lesser grain borer R*hyizopertha dominica* (F.)	Both larvae and adults feed on the grains, usually from the outside, and in a rather haphazard manner. The adults are quite long-lived. They are both primary pests and can attack rice grains (paddy rice) more readily than *Sitophilus*	
Cowpea, soybean and other pulses	*Callosobruchus chinensis* (L.) *C.maculatus*(F.)	The larvae bore into the pea or bean. Infestations usually originate from farm stores but the adult beetles can fly for up to about half a mile. The infested pods are then harvested and taken into the farm stores where further development takes place	
Stored leaf and cigarettes of tobacco Cocoa beans, groundnut, peas and beans, many stored grains and flours	Cigarette beetle (Tobacco beetle) *Lasioderma serricorne*	The larvae can attack undamaged cereal grains and pulse seeds, and often show preference for the germ of the seed for feeding. In packaged cigarettes holes are made in the packets by larvae and adults	
Dried herbs and spices	Drug store beetle: *Stegobium paniceum.*	Grubs damage dried herbs and spices by making small cylindrical galleries through the commodities. Adults feed very little if at all. In *Stegobium* the last three segments form a large loosely segmented club. The elytra have longitudinal striae or grooves which are not present in *Lasioderma.*	

External feeders			
Hosts	Insect	Damage	Illustration
Paddy, maize and wheat, both in the field and in grain stores- Sorghum and other stored grains, and dried fruits	Angoumois grain moth *Sitotroga cereallla*	Infested grains with mature larvae or pupae can be recognized by the presence of a very small window in the grain. On emergence the adult pushes its way through this small circular window and the `trap door' is left hinged to the grain, which is characteristic of this pest	
Cereals and groundnut (main). pulses, spices and various cereal and pulse cakes (alternative).	Khapra beetle *Trogoderma granarium*	The larvae bore in the stored cereal grains and pulses, usually hollowing out the grain. Development is rapid in the hot humid tropics and very large populations may build up quickly. The pest is fairly polyphagous and can survive in facultative diapause for a year or longer in the absence of food	
Maize, wheat and other stored grains (main). Many types of stored foodstuffs (alternative).	Red flour beetle *Tribolium castaneum* (Herbst)	Infestation is apparent by the appearance of adults on the surface of the grain; there is extensive damage to previously holed or broken grains, or grain damaged by other pests. Damage is done by both larvae and adults	
Flour, animal feed and other ground material	Confused flour beetle: *Tribolium confusum*	The adult resembles that of the red flour beetle and is difficult to distinguish without a microscope or magnifying glass. Larvae and adults feed on flour, animal feed and other ground material. Un-like the red flour beetle, the confused flour beetle is more common in flour mills than elsewhere, and the adults do not fly	
Stored grains (main). Other plant and animal stored products (alternative)	Saw-toothed grain beetle *Oryzaephilus surinamensis* (L.),	Oryzaephilus beetles are general feeders, and usually secondary on stored products, following the more destructive primary pests such as grain weevils and pyralid moths. Their actual diet consists of fragments of animal and plant debris. 0. surinamensis is more frequently found on cereal products and 0. mercator on oil-seed products.	
	Indian meal moth *Plodia interpunctella*	The adult moth is distinctive, with the outer half of the forewings a coppery-red separated from the creamy inner half by dark grey bands; body length is 6-7 mm and wingspan is 14-16 mm.	
	Tropical warehouse Moth (= Almond moth; *Ephestia cautella*	The adult moth is greyish with rather indistinct markings on the wings.It is about 13 mm long. When at rest the wings are folded along the abdomen. The adult moths live for less than two weeks Webbing in the grain and on the surface of bags, with cocoons between adjacent surfaces	
Rice, jowar, other millets, whole cereals, cereal products, dals, processed products of cereals, pulses, oilseeds, nuts, dry fruits and milled spices.	Rice moth: *Corcyra cephalonica (Staint)*	Larva is only responsible for damage. It pollutes food grains with frass, moults and dense webbing. In case of whole grains, kernels are bound into lumps up to 2 kg. It is more common in dark stores. Infestation is normally limited, to upper 45 cm only, in bulk grains	

Safer reduced risk pesticides were identified for management of stored grain pest				
Sr.No.	Insecticides	Dose	Group	Crop
1.	Spinosad	4.4 mg/kg seed	Novel insecticides	Paddy, maize, sorghum
	Emamectin benzoate	40 mg / kg seed		
2.	Diatomaceous earth	5 g/kg	Inert dusts	Paddy, sorghum
	Fly ash			
	Rice husk ash			
3.	Neem-Azal	0.75 ml/kg	Neem formulations	Bengalgram, greengram
	Eco-neem plus	5 ml/kg seed		Blackgram, redgram
	NeemIndia	5 ml/kg seed		

tablets (3 g each) @ 3 tablets per MT is required to be applied with minimum exposure period of 7 days to obtain desired mortality.

Seed treatment with novel insecticides : The seed treated with newer insecticides like Spinosad, Emamectin benzoate and stored in HDPE bags were found to be more effective for safe storage of seeds for longer periods with a good maintenance of germinability and vigour.

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