

8. Stored grain insect pests

A **storage pest** is an insect or other animal that damages or destroys stored food or other stored valuable organic matter.

- Why storing is important? It has vital role to feed the future populations and to use the product in time of scarcity.
- The greatest damage to stored grain is generally caused by insects. A high rate of reproduction and a short development period enable insects to cause important damage by rapidly developing from a small number of individuals to a large mass.
- Loss due to insect pests in storage have two types

✓ **Direct losses**

- They consume the kernel as the result direct loss of weight can be happened
- Contamination- presence of dead insects, Pupal cases, cocoons presenting odors

✓ **Indirect losses**

- They consume bulk of the grain as the result it attacks fungi and exposes it for molds
- They can reduce germination of seed grain

E.g. Ephestia- feeds on germinal parts

- Source of infestations-
 - o Cross infestation- could be due to:
 - Clean produce is brought to a dirty store
 - Clean store may receive infested produce
 - Field infestation (hidden infestation); e.g. pulse beetles and paddy moths
 - leftover seed from stores, seeds under the stacks; old containers and bags;
 - Trucks, trollies and bullock carts and entry of insects from neighboring stores.

Categories of storage pests

The largest group of storage pests are **beetles (Coleoptera)**, followed by **moths (Lepidoptera)**. There are still others including dust lice (Psocoptera) which cause little damage to stored produce but may become a hygienic problem if they occur in large numbers.

Storage insect pests categorized into two types:

- i) Primary pests - that are capable of penetrating and infesting intact kernels of grain and have immature stages that can readily develop within a kernel of grain;
- ii) Secondary invaders - that cannot infest complete grain parts but feed on broken kernels, debris, higher moisture weed seeds and grain damaged by primary insect pests. In general, the immature stages of these latter species are found external to the grain

- A) Primary
 - They penetrate the protective testa of grain
 - Cause quality/quantity loss of products

E.g. -Maize weevil, Angoumois grain moth and Rice weevil

B) Secondary

- Feeds on broken and damages grains
- Like Dry fruits, maize, cereals and oilseeds
- Usually uses cracked grains

Eg. Red flour beetle, Long-headed flour beetle, Saw toothed grain beetle

Individual insect pests

- A) Maize weevils
- B) Angoumois grain moth
- C) Bean Bruchids

➤ **Maize weevils:** *Sitophilus zeamais*, Coleoptera

- Host- cereals, maize, sorghum, rice in storage

Damage

- Larvae and adult

- Larvae bores a tunnel to inside parts of the grain
- Adults- circular exist holes on the surface of the grain

Description

- Eggs- are white and oval, laid inside the grain
- **Angoumois grain moth:** *sititoroga cerallea* , Lepidoptera, Glechidae
 - Originated from 'Angoumis' in France
 - It attacks different cereals- Maize, Rice, Sorghum

Damage

- Larvae- stage of damage
- Produce small windows on the grain, the small windows are 'trap doors'/holes

Descriptions

- Eggs- pinkish, Oval, laid on the surface of the grain, microscopic
- Larvae- short caterpillar with reduced abdominal prolegs
- It immodestly (arrogantly) bore and found inside the grain
- Pupae- brown, delicate cocoon, found inside the grain
- Adults- moth
- **Bean Bruchids:** *Callosobruchus* spp., Coleoptera, Bruchidae
 - Major hosts- different beans= Soybeans, pigeon peas, chick pea, pluses

Damage

- Larvae- bore the grain and develops inside the seed
- Adult- feeds inside the germ of the seed both adult and larvae produces circular hole on the grain

Description

- Eggs- laid in the field on pods and insides, white and oval

- Infestation starts in the field
- Larvae- curved, white in color, found inside the grain
- Pupae- brown found in pods and seeds
- Adults- weevil like insect but they are very big and large
- Strong feelers

General methods of control

(a) Remove infested material. Do not mix new grain with old; old material that must be kept should be thoroughly fumigated.

(b) Clean the storage structure.

- brush away all traces of spilled grain, dust, etc.;
- remove dust from handling equipment and machinery;
- disinfect sacks and baskets by sunning or chemical treatment
- Sanitation- to avoid cross infestation
- Botanicals- recent big options- Neem tree, Tagetus, Indod
- Chemicals- effective in large scale stores, feasible with fumigation
- using airtight containers for **storage**, periodic laundering of garments, trapping, freezing, heating and the use of chemicals; mothballs contain volatile **insect** repellents such as 1,4-Dichlorobenzene which deter adults, but to kill the larvae, permethrin, pyrethroids or other insecticides .

9. Agricultural pesticide and its application

1. Pesticides

Pesticides are the chemicals that kill the pests. These may be acaricides, insecticides, herbicides, fungicides, ovicides, rodenticides etc. The chemicals used for killing insect population are called insecticides. Insecticides have been in use since time immemorial (200 BC) but their regular use dates back to 1865 when Paris green was used against Colorado

beetle on potato in USA. Till the discovery of insecticidal properties of DDT (dichloro-diphenyl-trichloroethane), the inorganic chemicals and a few plant products dominated the field of pest-control. The discovery of DDT followed by BHC (benzene hexa-chloride) in 1941 the entire concept of insect control was revolutionized. During the last four decades phenomenal progress has been made in the development of synthetic insecticides with addition of organo-phosphates,

1. 1. Types of pesticides

Pesticides are natural or synthetic compounds that are poisonous and can kill pests including insects and rodents. Before the Second World War, pesticides were mainly made up of minerals or plants. They were highly toxic to mammals and had long-term residual effects, easily causing environmental pollution. Since the end of the Second World War, more effective pesticides including organochlorines, organophosphates, carbamates and synthetic-pyrethroids have been gradually developed.

1.2. Classification of Pesticides

There are various ways by which pesticides are classified. Pesticides can be classified according to four distinctive functions, namely, stomach poisoning, contact poisoning, fumigation or systemic action.

- **Stomach poisoning:** the pesticide enters the body of pests via their mouthpart and digestive system and causes death by poisoning. Pesticides that function in this way are known as stomach poison.
- **Contact poisoning:** the pesticide enters the body of pests via their epidermis upon contact and causes death by poisoning. Pesticides that function in this way are known as contact poison.
- **Fumigation:** the pesticide in gas form enters the body of pests via their respiration system and causes death by poisoning.

- **Systemic action:** pesticides consumed by a host organism will stay in its body fluids. Pests feeding on the body fluids of the host organism will then be killed by poisoning.

Pesticides can be classified by their chemical nature:

1. Organochlorine Pesticides: They are the synthetic organic pesticides that are earliest discovered and used. Their characteristics are broad-spectrum, long residual effect and relatively low toxicity. However, due to their stable chemical nature, they are hard to break down in the natural environment. Prolonged use in large quantities will easily lead to environmental pollution and accumulation in mammals, resulting in cumulative poisoning or damage. Organochlorine pesticides are therefore banned under general circumstances and gradually replaced by other pesticides.

2. Organophosphate Pesticides: Organophosphate pesticides are characterised by their multiple functions and the capacity of controlling a broad spectrum of pests. They are nerve poisons that can be used not only as stomach poison but also as contact poison and fumigant. These pesticides are also biodegradable, cause minimum environmental pollution and slow pest resistance. Temephos and Fenitrothion are examples of organophosphate pesticides.

3. Carbamates: Carbamate pesticides work on the same principle as organophosphate pesticides by affecting the transmission of nerve signals resulting in the death of the pest by poisoning. They can be used as stomach and contact poisons as well as fumigant. Moreover, as their molecular structures are largely similar to that of natural organic substances, they can be degraded easily in a natural manner with minimum environmental pollution. Propoxur is an example of carbamate pesticides.

4. Synthetic-pyrethroid Pesticides: Synthetic-pyrethroid pesticides are a pesticide synthesized by imitating the structure of natural pyrethrins. They are comparatively more stable with longer residual effects than natural pyrethrins. Synthetic-pyrethroid pesticides are highly toxic to insects but of only slight toxicity to mammals. A lletthrin and Permethrin are examples of synthetic-pyrethroid pesticides.

5. Microbial Insecticides: Microbial insecticides control pests by means of pathogenic micro-organisms including bacteria, fungus and viruses. *Bacillus thuringiensis israelensis* (B.t.i.) is an example of microbial insecticides. By induce plants to produce toxic substances against the pest as well as they are toxic to pests and invade the host tissue and reduce immune system of the pest.

6. Insect Growth Regulators: Insect growth regulators are compounds developed by copying insect juvenile hormone. The main functions are to interfere with the growth and hatching of larvae into adults, and to prevent the formation of exoskeleton so as to prohibit the growth of the insect. As its ability to live as a living organism is curtailed, the insect may die eventually as well as the whole insect population. Methoprene is an example of insect growth regulators.

2. Application of Pesticides

When using pesticides, one should choose the suitable type and formulation according to the target pest and the purpose. The chosen pesticide should be applied by suitable methods. Application methods can be generally classified as follows:

I. Spraying

There are broadly two kinds of spraying: **space spraying** and **residual spraying**. Liquid pesticides are released from various types of sprayers,

forming small droplets that float in the air or settle on object surfaces with which the passing insects will come into contact. **Space spraying** is to apply knockdown pesticide over the space where there are pest activities. It is mainly used to combat flying insects like mosquitoes, midges, flies and wasps. **Residual spraying** is to apply residual pesticide over the object surfaces on which there are pest activities. It is mainly used to combat crawling insects or those staying on an object surface for a long period of time, e.g. cockroaches, fleas, ticks and ants.

Sprayers

Sprayers are the most commonly used pest control equipment. They are light, convenient and come in various types, suitable for indoor and outdoor small scale / local control operations to eradicate pests of public health importance, e.g. mosquitoes, flies and cockroaches. Sprayers available on the market include manual sprayers and compression sprayers.

i. Hand Pump

A **hand pump** operates on a simple piston principle whereby the pesticide is drawn out from the solution cylinder. The holding capacity of the solution cylinder is usually about 0.5 to 1.0 litre. When the piston is pulled backward, the pesticide will be drawn out from the cylinder. When the piston is pushed forward, the pesticide will be released from the nozzle. Manual sprayers are usually used in small scale knockdown operations.

ii. Compression Sprayers

A **compression sprayer** is composed primarily of three parts, including the solution tank, the pressurized device (piston) and the nozzle system (control / tube / resonator / nozzle). Air inside the solution tanks is compressed and pressurized by using the piston. When the trigger on / off (valve) is released, the liquid pesticide is pushed into the tube by high pressure and transferred

to the nozzle system where it will be broken up into droplets, each with a volume diameter of about 100 to 400 microns.

The length of the application wand of the compression sprayer can be adjusted according to need. Its nozzle can also be replaced or adjusted to suit various spraying purposes -

- ✚ **Fan nozzle:** offering the widest spraying angle, suitable for residual spraying.
- ✚ **Cone nozzle:** suitable for general space spraying, such as the elimination of flies.
- ✚ **Jet:** the cone nozzle can be adjust to spray jet, allowing the liquid pesticide to reach its target (such as a wasp nest high up) at a far distance.

iii. Thermal Foggers

A **thermal fogger** is composed primarily of two parts including the pulse-jet engine and the formulation system. The pulse-jet engine generates a high temperature air stream, evaporating the formulation which will then be released through the resonator. When come into contact with cold air, the vapour will immediately condensed into small droplets. With a diameter of less than 50 microns, these droplets are highly effective in penetration, diffusion and adhesion, suitable for outdoor pest control work covering a large area. The fog produced by a thermal fogger is highly visible, facilitating the monitoring of aerosol diffusion and penetration.

iv. Cold Foggers

A **cold fogger** is composed primarily of three parts including the driver (engine and air compressor), the solution tank and the nozzle system. Activated by the two-stroke petrol engine, the centrifugal fan of the fogger generates a high speed air stream channeling the fogging solution into the nozzle system via a delivery tube. The pesticide solution will then be broken

up into droplets with a diameter of about 50 to 100 microns by the centrifugal force of a high-spin atomizer. The cold fogger is a high performance spraying machine with wide coverage. With a light breeze, the insecticide mist can cover 70 to 100 meters. The cold fogger is suitable for outdoor pest control work involving a large area, and can be fitted with different nozzle orifices to adjust the speed of fogging and droplet size.

v. Ultra Low Volume (ULV) Sprayers

The structure and operating principle of **ULV sprayers** are the same as those of cold foggers. The size of droplets generated by an ULV sprayer may vary from several cubic microns to less than a hundred cubic microns (the largest). Droplets of this size have strong penetration force and are most effective in controlling pests such as mosquitoes. In comparison with other cold foggers, ULV sprayers are more effective as they can deliver the correct-sized droplets with high uniformity. Environmental conditions such as temperature, wind direction and wind speed should be noted when spraying is conducted, in particular during fogging applications. The size of droplets also has an important bearing on the effectiveness of spraying operations. Droplets with a big diameter will not be able to remain suspended in the air, and their contact with insects in flight will be reduced. Droplets with a small diameter will be susceptible to the turbulence created by insects in flight or other air currents. This will also reduce their contact with insects. In outdoor applications, most droplets will be carried away by the rising air current and dissipate in the atmosphere. The droplet size also affects the ability to penetrate into vegetation and other objects.

I. Dusting

A duster is used to spray or scatter powder pesticides in areas needed to be treated. The body of pests will be stained with the powder as they pass through it. Powder pesticides are especially suitable for treating those areas / objects that cannot be wetted, such as carpet surface and books. By using

the right nozzle, powder pesticides can be sprayed into the cracks and crevices or holes. Attention should be paid to the weather and situation on the ground during the application. Dusting should not be conducted outdoors under windy conditions. Dustable powder should not be applied on rainy days nor can it be applied in moist or damp areas. Dusting suitable for controlling fleas, cockroaches, and the larvae of certain insects .

II. **Fumigation**

Gas pesticides are used in fumigation. Its advantage lies in the small molecules which have a strong penetration force than any other pesticides. It is especially suitable for treating areas with many cracks and crevices where pests like to shelter. Another advantage of fumigation is the easy dispersion of gas, which will not leave any residue on the surface of treated objects. However, due to its strong penetration force, preparation must be thorough before fumigation is conducted, and the area to be treated must be completely enclosed to avoid leakage of pesticide. There is also a need to ensure that the pesticide is dispersed completely after application before the treated area is unsealed. Also, certain fumigant gas pesticides are highly toxic and are not suitable for use in places where there are human and animal activities.

III. **Baiting**

In general, no special equipment is required for baiting. Only a simple device, such as a rodent bait box or cockroach bait box, is needed to put in the baits. It is most important to choose a suitable location for placing the baits. The baits should be placed:

1. Near to active runways / activity areas of pests so that the baits can be easily discovered;
2. In areas not easily accessible to humans and non-target organisms;
3. Far away from food

Problems with Pesticide Use

Much of the increasing interest in IPM stems from the undesirable side effects of pesticide use, including:

- ✦ Development of pest populations that are resistant to pesticides
- ✦ Exposure of people (acute and chronic effects) user and consumer risks and other non-target organisms to potential health hazards
- ✦ Environmental contamination by pesticides
- ✦ Economic and energy costs
- ✦ Disruption of natural control
- ✦ Target pest resurgence
- ✦ Induced secondary pest outbreaks
- ✦ Environmental pollution and effects on wildlife
- ✦ Effects on pollinators

In comparison to other types of controls used in IPM programs, pesticides can:

- ✦ provide short-term control, but rarely a long-lasting solution to pest problems
- ✦ require careful planning to ensure proper storage of chemicals around homes
- ✦ create a waste disposal problem for the more toxic chemicals

When pesticides are necessary in a pest management program, the customer should have help in choosing the most appropriate pesticide and method of application. Pesticides should only be considered after careful assessment indicates their use is required, based on all the available information. There are several approaches the dispenser can recommend to limit negative impacts of pesticides, such as:

- ✚ Choose "preferred pesticides" where possible
- ✚ Choose ready-to-use formulations, rather than concentrates
- ✚ Choose application methods that limit the amount of pesticide used
- ✚ Limit treatments to only the plants or site where pests are a problem
- ✚ Notify anyone who could enter a treated area to prevent exposure to pesticides