

# NON-CHEMICAL METHODS IN STORAGE INSECTS MANAGEMENT



# Introduction

- Non-chemical methods to control insects without using chemicals. In general these methods might take more time, but they are less expensive and useful in small scale storage
  - **Cultural Control**
  - **Physical Control** (Temperature, Heat, Pressure, UV trap etc.)
  - **Mechanical Control** (Entoleter)
  - **Behavioral Control** (Insect Pheromones)
  - **Biological Control** (parasitoids predators & pathogens)
  - **Microbial Control** (*Bt*, *Beauveria*, *Metarhizium* etc.)
  - **Botanicals** (Plant extracts & Essential oils)
  - **Juvenile Hormone Analogues** (Methoprene & Hydropene)

# 1. Cultural control

- Food grains store houses must be clean all around and free from dirt, egg shells and dead larvae
- All cracks and crevices made in the flour walls and ceiling of the store should be filled up with cement
- For better dis-infestation, go-downs should be superheated with burning charcoal @ 8 kg/cubic feet space so as to raise the temperature of the room to about 150°F. During temperature treatment the doors should be tightly closed for 48 h after which go-downs should be allowed to cool and cleaned before storage

## 2. Physical Control

### i) Temperature, Heat and Pressure

- kills several life stages of insects at a time
- Insect growth, reproduction and activity must rely on warm condition to remain active
- Grain temperature raised up to 55-65°C for 10 to 12 h can effectively kill all life stages of stored grain pest in ware houses
- Insects become inactive and eventually die at a temperature below 12 °C
- Grain moisture ranges from 12-15% - most favorable for insect development

- Low pressure is a pest management tool and best alternative to fumigants
- Low pressure creates a low oxygen controlled atmosphere that kill stored product insects

## **ii) Inert Materials**

- Filling the space in between the grains with inert and minerals like fine sand, lime, certain types of kaolin clay and ash protects the grains from insects
- Insects coated with inert materials show massive dehydration and die very soon
- These kill insects by desiccation and its effectiveness is increased with the decrease in relative humidity

### iii) Activated clay or charcoal



- Activated clay absorb oxygen from the air and thus remove even more oxygen
- Acid treated clay particles are with sharp edges and abarate the body to kill by desiccation
- Wash small pieces of clay or charcoal in diluted HCl or  $H_2SO_4$  rinse them with clean water, let the pieces dry
- The amount of activated clay or charcoal needed will be about 0.5 to 1.0 % of the total amount of grain that has to be treated
- Sand (1 kg of sand/10 kg of product), Ash (1 kg of ash/40 kg of product), Clay (1 kg/10 kg of product)



## iv) Ionizing Radiation

- Seeds are treated with both  $\gamma$  and  $\beta$  radiation to control stored grain insects.  $\gamma$ -radiation is generated by Cobalt 60 while  $\beta$  -radiation is generated electrically
- Low ionizing radiation damage insects by causing the production of highly reactive free radicals or ions
- Colourized light and sound also control stored grain insect. Light is used to lure and trap flying insects by mass killing
- 1 MHz sound exposure for 5 minutes can kill all of stages of *Sitophilus granarius*
- UV lamp with 4 W lamp can be used during night hours in warehouse corners which emits 250 nm rays - kept in storage go-downs at 1.5 m above ground level



- It attracts *Rhyzopertha dominica*, *Tribolium castaneum* and *Oryzaephilus surinamensis* in large numbers. 2-3 traps are sufficient with go-down measuring 60 x 20 m with 5 m height
- Useful during post fumigation periods to trap the resistant strains and left over insects to prevent build up of the pest populations





# 3. Mechanical control

- **Entoleter:** Centrifugal force technology is used to separate all type of admixtures, hairs and fecal pellets of rat and life stages of stored insects



# How to extract eggs of *T. castaneum* in infested flours

Pass sterilized wheat flour through 100 mesh



Release 50 pairs of adults



Pass flour through 50 mesh sieve 24 hours after release



Discard adults



Pass flour through 100 mesh sieve



Collect eggs retained in sieve

## 4. Behavioral Control (Insect Pheromones)

- *Trogoderma* pheromone, 14-methyl 8-hexadecenal is now used to capture and kill large numbers of *Trogoderma granarium*
- Wheat germ oil combined with sex pheromone is used to attract and trap *Trogoderma* larvae
- Pheromones are also used to capture grain moths in warehouses
- For example, several species of stored-product Pyralids respond to the synthesized sex pheromone (Z, E) - 9, 12-tetradecadien-1-ol acetate



- Effective manipulation and suppression of stored product insects
  - pheromones are used with entomopathogens
- More feasible method in which pheromone-baited device is used with an open reservoir containing a pathogen such as *B. thuringiensis*
- It helps to distribute a pathogen among stored-product insects. Further, spore transfer to the subsequent generations increases the intensity to kill more number of larvae and adults contaminated by contact
- pheromone (14 - methyl -8 hexadecenal) mixed with a protozoan pathogen, *Mattesoa trogodermae* (32 adults/m<sup>2</sup>) substantially suppresses subsequent generations of *T. granarium* population of adult males



- A very high lethality is observed in *Plodia interpunctella* in maize when insects are exposed to *B. thuringiensis*. However, spores and crystals of *B.t* are capable of rapidly killing larvae that feed on them.





# 5. Biological Control

- Effective control of stored grain insects various parasitoids, predators, pathogens and other living organisms are employed in natural conditions to suppress the population
- *Xylocoris flavipes* and several other anthocorid bugs are promising agents for bruchids population in stored legumes

## Parasitoids used to control certain stored grain pest

Parasitoid name	Family	Order	Used against stored insect
<i>Bracon hebetor</i>	Braconidae	Hymenoptera	<i>Oryzaephilus surinamensis</i>
<i>Venturia canescens</i>	Ichneumonidae	Hymenoptera	<i>O. surinamensis</i> , <i>Plodia interpunctella</i> , <i>Sitophilus oryzae</i>

Parasitoid name	Family	Order	Used against stored insect
<i>Peregrinator biannulipes</i>	Reduviidae	Hemiptera	<i>Sitophilus granarius</i>
<i>Xylocoris flavipes</i>	Anthocoridae	Hemiptera	<i>Plodia interpunctella</i>
<i>Lyctocoris spp</i>	Anthocoridae	Hemiptera	<i>S. oryzae</i>
<i>Amphibolus wenator</i>	Reduviidae	Hemiptera	<i>S. oryzae</i>
<i>Bracon hebetor</i>	Braconidae	Hymenoptera	<i>S. oryzae</i>
<i>Antrocephalus spp.</i>	Chalcididae	Hymenoptera	<i>S. oryzae</i>



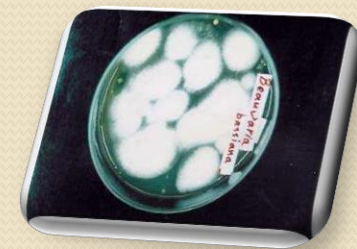
# 6. Microbial Control



*Paecilomyces fumosoroseus*

Photo: F. Ithara

- *Bt* toxins and many entomopathogens, separately and in combination with botanicals are used against stored grain insects
- Mustard oil with *Paecilomyces formosoroseus* or *Nomuraea rileyi* fungi causes significant reduction in oviposition and adult emergence in *Bruchidius incarnates*
- Four fungal species, *Beauveria bassiana*, *Lecanicillium lecanii*, *Metarhizium anisopliae* and *Paecilomyces farinosus* are effective against Indian meal moth
- Effective control of Saw toothed grain beetles and Indian meal moth by *B. bassiana* and granulosis virus



# 7. Botanicals (Plant extracts & Essential oils)

## i) Parts of plants as natural additives or repellants

### 1. Leaves

- Whole dried leaves of certain plants can be mixed with the stored products in a number of cases
- Effectiveness of this method of protection depends not only on the type of the plant and quantity used



### Example:

- Powder made from the leaves of **Persian lilac protects against grain weevil**. It should be used in a concentration of 40-80 g of powder for every 1 kg of product (a concentration of 4-8%)
- 3 g of the dried and powdered leaves of *Hyptis spicigera* is sufficient to protect 1 kg of pulses against bean weevil (a concentration therefore of 0.3%)



## 2. Twigs

- In Latin America the twigs of the muna-bush are used to protect stored potatoes against the potato tuber moth. The walls and floors of the store are covered with muna-twigs before the potatoes are deposited. Once the storage space is full the potatoes themselves are covered with a layer of twigs





### 3. Rhizomes

- **Sweet flag rhizome** - Used to protect wheat and rice. Dried rhizomes are mixed with rice at a concentration of 1 % before it is stored. Before grain is stored it should be well mixed with dried powdered sweet flag
- **Rhizome of turmeric** has insecticidal properties. 20 g of dried pulverised rhizome added to 1 kg of stored product has been found to be highly repellent against Grain weevils and the Lesser grain borer



## Seeds

- *Anona reticulata* seed used to mix with and cover sorghum, millet and cowpeas. 0.5 - 2 % seed powder gives protection against Cowpea bruchids for 3 months through its repellent effect
- Neem seed powder @10-20 g per kg of wheat to protect from rice weevils, Lesser grain borers and Khapra beetles



## Essential oils and their action against stored grain pest

Essential oil	Scientific name	Action	Activity	Insect pest
Garlic	<i>Allium sativum</i>	Fumigant	Diallyl sulphate	Adult <i>Tribolium castaneum</i>
Eucalyptus	<i>Eucalyptus nicholii</i>	Fumigant	Cineole	Adult of <i>T. castaneum</i> and <i>Rhizopertha dominica</i>
Ajwain	<i>Carum copticum</i>	Fumigant	1,8-cineol	Eggs, larvae and adult of <i>S. oryzae</i>
Neem	<i>Azadirachta indica</i>	Fumigant		Adult of <i>S. oryzae</i> and <i>R. dominica</i>
Clove	<i>Syzigium aromaticum</i>	Fumigant		larvae of <i>Corcyra cephalonica</i> and <i>T. castaneum</i>

## 8. Juvenile hormone analogues

- Insect growth hormones are used in closed environment and found relatively more successful against several stored-product moths and beetles
- IGRs disrupt oviposition behavior in insects and cause impairment of reproduction
- Two IGRs **methoprene** and **hydropene** are applied to prevent emergence of pupae in *Tribolium castaneum* and in *Tribolium confusum*
- Methoprene also shows inhibition of emergence of adult *Oryzaephilus mercator* and *O. surinamensis* at 1 mg/kg while hydrophene shows complete inhibition of adult progeny in *Sitophilis granarius* at 10-20 mg/kg





THANK YOU