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International Journal of Zoology and Animal Biology
ISSN: 2639-216X

# Biological Suppression of Stored Grain Insect Pests

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**Mini Review**

Volume 2 Issue 2

**Received Date:** April 12, 2019

**Published Date:** April 30, 2019

**DOI:** 10.23880/izab-16000146

## Mini Review

Stored products include all durable agricultural commodities which can be dried and stored in bulk. Due to un-controlled environmental conditions and poor warehousing technology, stored grain infestation is a very serious problem as various life stages of insects cause economic damage and deteriorates the quality of food grains and products. There are number of stored grain insect pests that infest food grains in farmer's go downs and public warehouses. More than 70 insect pests have been identified which attack stored grains and cereal products in store houses. The overall damage caused by these insect pests worldwide is estimated to be 10-40% annually [1]. Therefore, there is an urgent need to suppress the insect pest population of stored grain/products in order to maintain stored quality and its proper management.

Insecticidal use is a widespread practice for controlling pests of stored products. However, the ever increasing problems of insecticide resistance in stored grain insects, relatively limited number of insecticides available for stored product protection and the increasing environmental and health concerns surrounding insecticidal use have sparked renewed interest in the ecofriendly approaches to control insect pests of stored products. Therefore, non-chemical methods with special reference to biological control including behavioral, botanical and microbial control can be practiced solely or in combination as effective alternative of chemical control. Few natural products such as volatile oils and their constituents can also be used to control stored grain insects. Further, volatile repellents after evaporation in the medium deter insects from feeding and cause high mortality rate in insects.

## Behavioral Control

Pheromones are used in behavioral control of insects either by applying male specific or female specific pheromonal substances. These are used for surveillance and detection of an infestation in stored grains. These are used to uphold communication disruption or mass trapping of insects by lures and attract. The primary component of the khapra beetle, *Trogoderma granarium* pheromone, 14- methyl-8-hexadecenal is now used to capture and kill large numbers of *T. granarium*. Wheat germ oil combined with sex pheromone is also used to attract and trap *Trogoderma* larvae. Lesser grain borer, *Rhyzopertha dominica* produces an aggregation pheromone that attracts both sexes. Synthesized pheromones are used in baited traps which were found effective in monitoring populations. Pheromones of other grain-infesting beetles and weevils are also identified and are used for trapping *Tribolium* spp., *Sitophilus* spp., *Stegobium paniceum* and *Lasioderma serricorne* in ware houses [1].

## Biological Control

### Parasitoids

Release of larval parasitoid, *Bracon hebetor* could cause 93.4% mortality in Corcyra *Cephalonica larvae* [2] and activity of *B. hebetor* in Corcyra rearing room was observed throughout the year, except during April in Gujarat [3]. Combine release of egg parasitoid, *Trichogramma pretiosum* and larval parasitoid, *B. hebetor* found effective in suppressing Indian meal moth (84%) and almond moth (98%) population, while *B. hebetor* alone had suppressed almond moth population by 97.3%

[4]. *T. pretiosum* and *T. carverae* were found to be most suitable bio-agents against fig moth, *Ephestia cautella* and *E. kuehniella* [5]. Laboratory studies have shown the potential of solitary ectoparasitoid, *Anisopteromalus calandrae* in suppressing populations of maize weevil, *Sitophilus zeamais* in corn [6]; rice weevil, *S. oryzae* in wheat [7]; *R. dominica* in stored wheat [8]; pulse beetle, *Callosobruchus chinensis* [9] and *C. maculatus* [10]. Some other parasitoid found parasitizing and controlling stored grain insect pests are solitary ectoparasitoid, *Choetospila elegans* on *S. zeamais* in corn; larval-pupal ectoparasitoid, *Dinarmus basalis* on *C. chinensis*.

### Predators

Anthocorid bug, *Xylocoris flavipes* is a cosmopolitan predator of different prey (pests) of stored commodities namely *Tribolium casteneum*, *T. confusum*, *Crytolestes pusillus*, *R. dominica* and *T. granarium* and one of the most studied candidates of biological control agent among the predatory bugs [11]. *Dorylus labiatus* is a most efficient predatory ant species on larvae and pupae of *C. chinensis* in stored chickpea with 84.64 and 98.26% mortality, respectively. *Monomorium minimum*, another predatory ant was found to be the most efficient egg predating species with 84.85% egg mortality [12]. According to Rahman, et al. [13], *X. flavipes* killed small and large larvae of *C. pusillus* than those of *T. confusum* and *T. castaneum* in the jar filled with wheat kernel and host. Females were reported to be more predaceous than those of males. Inoculative release of *X. flavipes* and *Blaptostethus pallescens* @30 nymphs/10kg of rice released separately had reduced significantly the emergence of *C. cephalonica* moth [14].

## Botanical Control

Plant extracts, essential oils have shown insecticidal activity against field crop pests and household insect pests. Many of these oils have also shown high oviposition and growth inhibitory activity. The neem oil and kernel powder gave effective grain protection against stored grain insect pests like *S. oryzae*, *T. castaneum*, *R. dominica*, and *C. chinensis* at the rate of 1 to 2% kernel powder or oil [15]. Coconut oil has been found effective against *C. chinensis*, for a storage period of six months, when applied to green gram at 1% [16]. The powders of *Rauvolfia serpentina*, *Acorus calamus*, and *Mesua ferrea* are used as a grain protectant against *R. dominica* [17]. Similarly, volatile compound diallyl disulphid isolated from neem have shown potent toxic, fumigant and feeding deterrent activity against stored grain pests, *S. oryzae* and *T. castaneum* [18]. Methyl salycylate from *Securidacalonga pedunculata* exhibited repellent and toxic properties against *S. zeamais* and *R. dominica* [19]. The herbal pallets made from neem seed (*Azadirachta indica*) Powder, Sitafal (*Annona swuamosa*) seed powder, asafoetida (*Serula foetida*), chilli powder and eucalyptus oil showed significant insecticidal activity against *Bruchus chinensis* [20]. Treatment with *Carissa schimperi* 5% and *Tagitus minuta* 5% was effective against *S. zeamais* and can solve poor resources farmers' problems by integrating them with other control measures [21].

## Microbial Control

### Fungi

Conidia of *Metarhizium anisopliae* in stored wheat along with dust carriers has given significantly higher adult mortality of *T. castaneum* and less grain infestation [22]. Samodra, et al. [23] reported that *Beauveria bassiana* formulated in kaolin showed the highest mortality of *S. oryzae* and lowest grain weight loss in stored rice followed by talc and tapioca flour. According to Dhuyo, et al. [24], first and second instar larvae of larger grain borer, *Prostephanus* truncates were more susceptible to *B. bassiana* in stored maize than the third instar while pupal stage was found to be significantly more susceptible than other stages.

### Bacteria

McGaughey, et al. [25] noticed good control (92%) of *Plodia interpunctella* and *E. cautella* in bulk wheat and corn by treating the surface layers with dust or aqueous suspension of *Bacillus thuringiensis*. Ahmedani, et al. [26] evaluated three commercial formulations of *B. thurinsiensis* against *T. castaneum* and reported Ecotech Pro as more effective than Dipel ES and Bactospeine in suppressing the pest.

### Viruses

A nuclear polyhedrosis and a granulosis virus have been isolated from *E. cautella*. Both the viruses infect *P. interpunctella*, whereas granulosis virus from *P. interpunctella* does not cross-infect *E. cautella* [27]. Another nuclear polyhedrosis virus has been isolated from *C. cephalonica* [28]; but it is not known whether it will cross-infect other moths or not. In all cases the young larvae were found most susceptible.

### Nematodes

Strain Hawaii of *Steinernema feltiae* and strain USA/SC were found most virulent against *T. confusum* and *E.*

*kuehniella* larvae, respectively [29]. The efficacy of three strains of *S. feltiae* against *S. oryzae* at five different concentrations and four different temperatures was tested by Laznik, et al. [30]. They found all the strains as most effective at 25 °C and highest concentration of nematode.

Entomopathogens viz., fungi, bacteria, virus and nematodes have an important place in the biological control because they have a wide host range, are harmless to the environment and human, and could be applied with conventional sprayers. They can be used more against stored product pests with the development of new biotechnical methods such as collecting pests in some stations to meet them with entomopathogens [31].

## Conclusion

Biological control is an ecofriendly approach and can be easily followed without any risk. Use of pheromones, botanicals and biocontrol agents viz., *X. flavipes*, *A. calandrae* and *B. bassiana* have been found to effectively suppress some of the storage insect pests. Biological control of stored grain pests may prove effective, if used in appropriate manner, time and space. However, for biological methods to reach their full potential, an increased research effort is required.

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