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Management of Biopesticides to Control Infestation of Insect Stored Grain Pest *Triboloium castaneum* (Herbst) (Coleoptera: Tenebrioide): A Review

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Abstract: Pulses and Cereals have great nutritional value in the daily human diet. Infestation of Stored grain is a serious issue since different life stages of several types of insects can cause it. Insect degrade the quality of stored grains and product, resulting in economic losses. The storage of grains has been linked to a high number of insect infestations. Almost all stored grain insect pests have remarkably high multiplication rates and may destroy 10-15 % of grains. The major pest of stored grains includes Weevil (*Sitophilus oryzae, Sitophilus zeamais, Sitophilus granaries), Tribolium* species (*Tribolium castaneum* and *Tribolium confusum*), Khapra beetles (*Trogoderma granarium*), lesser grain borer (*Rhyzopertha dominica*), Pulse beetles (*Callosobruchus maculatus)*, Rice moth (*Corcyra cephalonica)*, etc. Continuous and indiscriminate over use of insecticides are responsible for the development of resistance against these insect pesticides. Accumulation of synthetic chemical pesticide residues on pulses and cereals are unfortunately consumed by human. Recently, in agricultural practices in different areas of the world, attention has been given towards the exploitation of plant biochemical as a new approach in stored grain protection. Various scientific literature already documented the efficacy of plant derivatives against storage grain pests. Biopesticides kill and repel the insect pests, affect insect growth, development and metamorphosis. Farmers have used higher plants, medicinal plants, various herbs and traditional spices for stored grain insect pest management, but majority of farmer use chemical insecticide to increase productivity but it causes adverse effect on environment and non-target animal including human also, so there is more need for scientific research regarding the plant Biopesticides efficacy against stored grain pests.

Keywords: *Triboloium castaneum*, Infestation, Stored grain pests, Biopesticides, Phytochemicals

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Introduction

Agriculture is crucial sector in world, because economy of nation depends on agriculture sector. Most of the income generated from this sector, but agriculture faces many different problems. One of

the prime problems is insect pest damage. Insect pest create huge loss of production, on other side population increases continuously which also create pressure on agriculture to increase food production. Post-harvest losses of stored food grains are caused by a variety of reasons, the most serious of which are Pulses and Cereals infested with insects. According to reports, insect infestation alone on stored food grains range from 5 to 30 per cent of global agriculture production. Improper storage of stored grains results in high losses in grains. The capital value of losses is more than fifty thousand crores per year (Singh, 2010)

Farmers use a variety of chemical pesticides on the crop to reduce the pest's damages. This pesticide chemical residue accumulates in the environment and causing negative effects on non-target organisms. Stored grain pests damage the grains and infested more stored grains than they consume. The contaminated products are not suitable for consumption. It is recorded that about 10-30% of food grain losses are due to the stored grain infestation by pests. Third world reported as Insect and rodents are responsible for damaging as well as create infestation up to 10 to 25 per cent of the total harvested food (Matthews, 1993).

Tissue of higher plants contains arrays of biochemical, known as 'secondary plant chemicals' which are defensive in function. They include alkaloids, steroids, phenolic, saponins, resin, essential oils, various organic acids and other compounds. Insects, rodents and microorganisms destroy the edible, non-edible part of the stored grain and lead to postharvest deterioration causing economic losses due to decay as well as changes in the odour, taste, appearance, and nutritional value. In this context, the improvement of grain storage conditions is the first step in this direction. Majority of farmer use chemical pesticides to increase productivity but it causes adverse effect on environment and non-target animal including human also, hence natural pesticides (Biopesticides) are required to control pests and is essential for maintaining the good quality of grains during storage and production. In many circumstances, a minor change in storage methods can result in significantly greater preservation of the stored product and as a result, reduced loss. Therefore, the eco-friendly chemicals non-toxic to a man having biodegradable properties are required to control the stored grains pests and plants only can provide such chemicals. The need is to screen the plants and their parts for the proper phytochemicals.

Triboloium castaneum (Herbst) (Coleoptera: Tenebrioidae):

As per research data number of Coleoptera and Lepidoptera insect pests have been observed and noted to be associated with stored grains. Most of insect pests belong to the order Coleoptera and Lepidoptera. *Triboloium castaneum* is considered as a most important and major insect pest of stored food grains (Howe, 1965). *Triboloium castaneum* commonly known as red flour beetle, is harmful and destructive insect pest which belongs to order Coleoptera. The adult of *Triboloium castaneum* is flat, 5 mm to 6 mm long and body is reddish-brown in colour. Head, thorax, abdomen are distinct and antennae are well developed, of which the last segment is abruptly much more significant than preceding ones. The individual female lays 400-450 eggs in their whole life. Eggs are sticky in nature. Adults lay eggs on the grains and debris. Eggs are small round and cylindrical at both ends and whitish in colour. Incubation period is 5-10 days to hatch. The larva is very active, cylindrical and pupates after 3-4 weeks. Pupation takes place on the grain surface, which last for 6-8 days. Adult and larva of *Triboloium castaneum* cause damage. *Triboloium castaneum* (Herbst) is a vital insect pest for food grains; it is considered a major pest of stored grains, leading to a considerable loss of quality and viability of grain.

Host Range and Damage:

Triboloium castaneum (Red flour beetle) is a most destructive insect pest of grains and its products. Adult and larva of *Triboloium castaneum* feeding on many different kinds of food i.e., polyphagous feeding habit. Both adult and larva of *Triboloium*

castaneum cause damage, loss of stored grains and its product like wheat and wheat flour, biscuits, corn flakes, dried fruits, nuts, beans, pasta (Hussain, 1994; Devi and Devi, 2015). All the above manifestation of damage usually leads to the loss of overall gain due to the loss of price and the extra cost needed for control from pesticides and expensive pest-proof packaging. The need to find cheaper and safer methods for this pest can be a long way in enhancing food security, especially in subsistent families with little resources to afford the prohibitive costs of insecticides and other protective measures.

Management Practices Against Control Infestation of Stored Grain Pest Triboloium castaneum (Herbst):

Physical Control:

Physical control includes light, temperature, moisture, humidity, mechanical methods and different structural methods. Temperature is a most important abiotic factor for survival of life. Temperature treatment for storage of Pulses and Cereals are very effective, priceless and responsible to kill the different life stages i.e. larval, pupal and adult stages of insect at a time. Generally stored grain insect pest cannot tolerate extreme temperature (cooling as well as heating). They show high mortality ratio at 55-56 C for 10 to 12 h duration and can effectively kill the different life stages i.e. larval, pupal and adult of stored grain insect pest species. Low temperature less than 12 C also reduces insect growth, development and metamorphosis (Carrillo *et al*., 2006). The red flour beetle (*Triboloium castaneum*, Herbst) has a developed chemosensory organ (Barrer, 1983). *T. castaneum* adults do not prefer light and high as well as low temperature. Thus, if storage areas were lid covered with these sources, *Triboloium castaneum* (Red flour beetle) could be managed without use of insecticide.

Sorting and Dividing:

Food grains displaying insect infestation, mould, mechanical damage or any other inferior quality must be removed and processed as soon as possible. This will prevent contamination of the healthy grains and maintain the overall quality of the product. Another way is that products meant for storage be divided into two parts, one for short-term storage. Generally, no losses are caused by insects for up to 3-4 months. Therefore, food grains intended for consumption during this period need not be treated, whereas long-term storage requirements require proper treatment.

Chemical Control:

The breakthrough discovery of Dichloro diphenyl trichloroethane (DDT), the use of chemical pesticides was at that time very popular in all pest management system all over the world. DDT and BHC should be avoided for seed treatment since their toxicity may persist in making them toxic; also, BHC tends to reduce the germinating quality of the seeds. At present many synthetic chemicals are used for chemical control of insect pest.

Farmers use a variety of chemical pesticides on the crop to reduce the pest damages. The residue of these synthetic chemical pesticide accumulates in the environment and cause negative effects on non-target living organisms like human and biodiversity (Kaur *et al*., 2019). The chemical methods of exposing pests to pesticides cannot be applied for store grain pests; therefore, it is necessary to find safe Biopesticides that can protect the store grains from the beetle but will be harmless to man. The only way to protect grains is to screen many plants for their biopesticidal properties to control store grain pests.

Biological Control:

Biological control is a pest control that necessitates the use of other biological species to control the pests. In this method different biological species or agents are used for suppression of population of pest. The use of natural enemies for the control of *T. castaneum* has long been proven to be very effective. Most commonly Hymenoptra (parasitoids) insects are used to reduce the infestation and damage stored grain insect pest.

Biopesticidal Control:

Biopesticides are plant-based chemicals commonly called as phytochemicals prepared from different plant parts which can control insect pest by the eco-friendly mechanism. Phytochemicals are non-toxic to a human and possess biodegradable properties so they reduce agricultural toxicity (Patel *et al*., 2021).

Phytochemicals are naturally occurring having defensive function and used for controlling insect pests. Biopesticides (Phytochemicals) are most useful and important as alternative to synthetic chemical pesticides. Different phytochemicals from plant sources have been reported as having insecticidal activity against all life stages of insect pests. These factors suggest a need for finding a new approach to pest management. The present review discuss the biopesticides from plant origin to be effectively used to control *T. castaneum* infestation. Presently Botanicals/Biopesticides occupy a tiny niche in the world of synthetic pesticides. Still, the increasing environmental concern had led to a surge in the use of environmentally sustainable and friendly "green" alternatives. Biopesticides are advantageous in many ways as they naturally occur, particularly to target pests, with little or no adverse effect on beneficial insects, no unknown environmental hazards, less residual activity. Botanicals are effective against insecticide resistance species of insects.

Some Biopesticides with Their Mode of Action for Control of Stored Grain Insect Pest Triboloium castaneum (Red Flour Beetle):

- Ethanol extracts of *Myristica fragrans* and *Curcuma longa* were found to be most effective biopesticides against *Triboloium castaneum* (Red flour beetle) (Thuraya, 2017).
- Petroleum ether and diethyl extract of *Curcuma longa* showed noticeable reduction in F1 progeny of *Triboloium castaneum* (Matter *et al*., 2008).
- *Piper nigrum* and *Zingiber officinale* extract on *Triboloium castaneum* has been tested by different concentration for 7 days (2.5 ml concentration) and it was found that the *Triboloium castaneum* mortality rate was high (Mary and Durga, 2017).
- Essential oils from leaves of *Eucalyptus globulus* and *Ocimum bacilicum* showed repellent efficacy against adult stage of *Triboloium castaneum* (Mishra *et al*., 2012).
- Ethanol extract of *Ceriops tagal* stem and twig showed significant feeding deterrent activity against *Triboloium castaneum* (Du *et al*., 2011).
- Powder effect of *Tephrosia purpurea*, *Prosopis juliflora* and *Alfaroa mexicana* were tested against *Triboloium castaneum,* all these plants showed repellent activity (Pugazhvendan *et al*., 2009).
- Leaf Powder of *Annona squamosa* and *Balanites aegyptieca* caused high mortality against *Triboloium castaneum* (Sule and Ahemad, 2009).
- Seed extract of *Sapium indicum, Thevetia neriifolia* and *Jatropa gossypifolia* affected fecundity and fertility of *Triboloium castaneum* and *Tribolium confusum* (Khanam *et al*., 2008)
- *Nigella sativa* showed insecticidal activity against stored grain pest *Triboloium castaneum* (Chaubey, 2007)
- Leaf extract of *Clerodendron viscosum* showed repellent activity against larva and adult of *Triboloium castaneum*(Husain and Rahman, 2006).
- *Nicotiana tabacum* leaf powder contains phytochemical alkaloid which acts as anti-feedant against *Triboloium castaneum* as well as insecticidal effect on larva of *Triboloium castaneum*(Tiwari *et al*., 1995).
- Extract of early immature berries of *Azadirachta indica* is toxic to insect pest *Triboloium castaneum* and *Sitophilus oryzae*

(Ahmed *et al*., 2000).

- *Azadiraacta indica* and *Vitex negundo* showed antifertility and antiovipositional effect against *Triboloium castaneum* (Amin, 2000).
- Seed extract of *Aphanamixis polystachya* showed insecticidal activity against *Triboloium castaneum* (Pandin *et al*., 2000).

Conclusion

Triboloium castaneum is a significant insect pest of food grains, considered as a major pest of stored grains. *Triboloium castaneum* stored grain pest management broadly depends on synthetic pesticides. Synthetic chemical pesticides are very toxic having long residual value and are thus very harmful to human. Accumulation of chemical residues may result in the loss of food and food products. Overuse of synthetic chemical pesticide cause harmful impact on the ecosystem and biodiversity. Biopesticides can be the best means of the control of the stored grain pests. Many plants have a defense mechanism to protect themselves against the attack of insect pests. And for this they possess phytochemicals such as terpenoids, alkaloids, phenolic acids, ecdysterone hormone-like chemicals, which alter the metamorphosis or are toxic to insects. Botanical pesticide is a most effective method to control insect pest because they neither harm the farmers nor the natural enemies of pest and maintain eco-friendly environment.

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