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Eco-friendly management of lesser grain borer *Rhizopertha dominica* (F) in cereal grains

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Abstract
Lesser grain borer, *Rhizopertha dominica* (F). is a serious pest of stored wheat and distributed in all the countries of the world? It is a very destructive pest of wheat, buckwheat, rice, maize, sorghum, barley, rye, millets etc. Both the adults and grubs of *R. dominica* cause serious damage to the grains by feeding inside them and reducing them to more shells with many irregulars' holes. Presently, insect manage procedures mostly rely on synthetic insecticides and fumigants. Theses Insecticides have wide and unsystematic application causes natural imbalance opposition to insect, insect recovery and epidemic of secondary insect and creates Phytotoxicity. Insecticide residues in diet and nourish. Furthermore, non-stop use of insecticides is harmful for insect pollinators, biological agent like different Predators, parasitoids and also causes the ecological contamination. Owing to these drawbacks, substitute and safe approaches for management of lesser grain borer by using plants products, essential oils, animal products and entmopathogenic fungi has been reviewed.

Keywords: lesser grain borer, cereal grains, plant extracts, entmopathogic fungi, essential oils

Introduction

Cereal grains are the main sources of human diets. In India, annual storage losses have been estimated about 14 million Tones worth of Rs. 7,000 crores in which insects alone account for nearly Rs. 1,300 crores (2015). Out of these post-harvest losses storage -insects alone account for 2.0 to 4.2 per cent. The major economic loss caused by storage insect pests is not always by consumption but also by the amount of contamination. About 600 species of insects have been associated with stored grain products. Nearly 100 species of insect pests of stored products cause economic losses. Among various pests of stored grain, lesser grain borer, *Rhyzopertha dominica* (F). (Coleoptera: Bostrichidae) infests the cereal crops like paddy, sorghum and maize (Menon *et al*., 2002) [25] and was considered as the main pest. Lesser grain borer is one of the smallest beetles, infesting wheat grain, coupled with the fact that *R. dominica* has been surrounded in diverse environments, including woodlands substantial distances from grain stores led us to suspect movement of this pest between potentially natural habitats and grain storage facilities. Lesser grain borer, *Rhizopertha dominica* (F). is a serious pest of stored wheat (Jaipal *et al*., 1984) [16] and distributed in all the countries of the world (Zakladnoi and Ratanova 1987; Hill 1990) [40]. It not only causes quantitative loss but also qualitative losses like nutritive loss, germination losses and make the wheat unfit for marketing as well as for human consumption. Quantitative and qualitative loss of grain is caused by insects can reach 50 per cent of the total harvest during storage in cereal grains (Fornal *et al*., 2007) [12]. This insect pest attacks grain both externally and internally. Both grubs and adults of this insect feed on sound grains and cause extensive damage (Rees, 2007). Lesser grain borer, *R. dominica* is a field to store pest and this may cause economic damage in the store (Adedire 2001) [2]. The adults of *R. dominica* causes fresh infestation in the stored wheat, when the infestation is severe, the adults produce a considerable amount of frass. The flour, so produced, serves as nourishment for the young grubs until they are ready to bore into the grain. The flour, so produced, is not fit for human consumption; even by animal. *R. dominica* had completed 5 to 6 generations per year (Lin 1958) So, it destroys the stored grain all over the year. Rabbi and Begum 1986 reported that in Bangladesh it destroys 60.0% stored rice and reduced viability 53.7% annually. Today pest control is a serious problem of developing countries (Dwivedi and Shekhawat 2004) [8]. Generally, management of stored pro*duct pests are done through fumigation (Page and Lubatti 1963) [28] as well as synthetic insecticides has also been considered the most effective and accessible means to control (Huang and Subramanyam 2005). But use of insecticides have many limitations and undesirable side effects. If it has been used for a long time it may cause serious health hazards as well as destruction of beneficial insects and increasing costs of application (Kavadia *et al*., 1984; Desmarchelier 1986; Fishwick 1988; Singh *et al* 2001; Passino *et al*., 2004) [19, 6, 9, 37, 29]. Hence, there is a need to develop alternative safe and economical non-chemical methods for controlling insect pests of stored products at small scale grain storage.

Ambika Devi and Mohandas 1982, in their studies on assessment of relative efficacy of eleven antifeedants and deterrents against *R. dominica* and *S. cerealella* infestation in stored paddy found neem extract at 1.0 and 0.5 per cent, neem and coconut oils at 1.0 per cent as the highly effective to provide more protection against *R. dominica* for up to 180 DAT.

Pereira and Wohlgemuth 1982, reported neem oil at 1.0 per cent (v/w) as the highly effective grain protectant against stored grain insect pests like *R.dominica*, *S. oryzae*, *T. castaneum and C. chinensis.*

Ketkar 1986 [21], in their studies on use of tree derived non-edible oils as surface protectants revealed neem kernel powder at 1.0-2.0 per cent (w/w) effective to reduce population and oviposition rate of *R. dominica* Flinn and Hagstrum, 2001; Menon *et al*., 2002

[11, 26] stated that *Rhyzopertha dominica* coexists with several predaceous bugs, mites, and parasitoids that invade grain storages. At least five parasitoids belonging to the families Bethylidae and Pteromalidae, two Hemipterans in the family Anthocoridae, and four mite's species belonging to the families Acarophenacidae, Pediculoidae, and Cheyletidae have been recorded as attacking R. dominica in grain storage or in the laboratory. All parasitoids recorded attacks the larval or more rarely the pupal stage.

Biradar, 2000; Channabasanagowda *et al*., 2008; Sandeep *et al*., 2013) [5, 36] reported that Rhizome powder of *Acorus calamus* against Rhizopertha dominica.

Khan and Marwat, 2004 [22] stated that Leaves, bark and seeds powder of *Melia azadarach, Calotropis procera* against *Rhizopertha Dominica.*

Mamta Arya and Ruchira Tiwari 2013 [24] reported that different bio products evaluated against lesser grain borer in wheat like neem leaf powder, jatropha seed powder, mustard oil, cow dung powder and cow dung ash powder and cow urine @ 2% were found superior with less adult emergence, seed damage and weight loss with higher adult mortality, seed germination, vigour index and significance of viability in comparison to other treatments and untreated control.

Jyothi *et al*., 2014 founded that Interactions of entomopathogenic fungi against *R. dominica* at 15 DAT, revealed that the grains treated with *Beauveria* + *Metarhizium* have recorded the highest adult mortality of 96.30% followed by *Beauveria* + *Metarhizium* + *Lecanicillium* (92.13%) when compared to *Beauveria* (89.17%), *Metarhizium* (84.63%) and *Lecanicillium* (62.22%) tested alone. At 180 DAT, *Beauveria* + *Metarhizium* + *Lecanicillium* and *Beauveria* + *Metarhizium* recorded less per cent weight loss of 17.68 and 18.75 per cent when compared to control (51.27%).

Abdul Ahad *et al*., 2016 [1] worked on N-hexane extracts of 10 weeds such as Clerodendrumviscosum, *Xanthium indicum*, *Mimosa pudica*, *Polygonum hydropiper*, *Argemone mexicana*, *Croton bonpalandianum*, *Leucus aspara*, *Dryoptrisfilix-max*, *Cassia tora*, *Blumea lacera* were used. All the weeds extract showed more or less performance for the protection of *Rhizopertha dominic*a. However, the lowest seed damage was found in the extract at 1.5% in Polygonum hydropiper followed by *Clerodendrum viscosum*; *Cassia tora*; *Argemone mexicana*; *Blumea lacera*; *Leucus aspara*. In respect of adult emergence, the lowest number of *Rhizopertha dominica* was found in the extract at 1.5% in *Polygonum hydropiper* followed by *Cassia tora*. All the plants at 0.50% and 1.0% gave 100% protections up to 32 days.

Ishtiaq *et al*., 2016 [15] study showed that among all medicinal plant extracts, maximum mortality was observed (67.81%) in case of *P. nigrum* after 120 hours of application. Percent weight loss and progeny development was also zero when *P. nigrum* was applied at 20% concentration. Overall, *P. nigrum* was observed effective against *R. dominica* and could be integrated into stored insect's management system.

Subash *et al*., 2016 [39] stated that three indigenous plant oils, viz. neem oil, eucalyptus oil, and castor oil each at 0.10, 0.15 and 0.20 per cent (v/w) were tested against lesser grain borer, *Rhyzopertha dominica* (Fabricius) by direct mixing with wheat seed. On overall basis, neem oil at 0.20 per cent had minimum adult emergence (22.58 adults/100g grain sample), grain damage (4.79%), weight loss (2.60%) and maximum inhibition rate (88.92%). It was followed by eucalyptus oil (32.75 adults, 6.37 and 3.48%) and castor oil (36.50 adults, 7.53 and 4.18%) over the untreated control with highest adult emergence (146.30 adults), grain damage (28.58%) and weight loss (18.39%).

Jyothi *et al*., 2014 research findings stated that Compatibility of entomopathogenic fungi with vegetable oils revealed that the highest adult mortality of *R. dominica* was recorded with *Metarhizium* + Groundnut oil (81.57%) followed by *Beauveria* + groundnut oil (78.54%) at 15 DAT. Progeny build up recorded at 180 DAT was found to be less with *Beauveria* + Groundnut oil (118.33) followed by *Metarhizium* + Groundnut oil (121.33) when compared to control (517.00) and were superior over all other treatments. At 180 DAT, less per cent weight loss was recorded with *Beauveria* + Groundnut oil (17.59%) followed by *Metarhizium* + Groundnut oil (19.01%) when compared with control (50.09 %).

Sunda *et al*., 2018 found that the maximum mortality of *Rhyzopertha dominica* (F.) in Barley Grains was recorded in higher dose (1.5%) of neem, mustard, castor and taramira oil. The maximum protection was provided with the higher doses of malathion 50 EC (0.075%) and neem oil (1.5%) as adult emergence, grain damage and weight loss were not observed up to 150 days, followed by higher doses of castor, taramira and mustard oil up to 120 days of storage.

Rajat *et al*., 2018 evaluated Nine protectants against *Rhyzopertha dominica* (F) including control (untreated) viz. Neem oil, Mentha leaf powder, Neem cake and Neem dry leaf powder and Deltamethrin were evaluated as seed protectant, all the protectants were found effective over untreated for control of 3 months of storage and Deltamethrin 40.0 mg seed was observed the best (0.33% damage) and followed neem oil (1% damage). 6 months of storage and Deltamethrin40.0 mg seed was observed the best (1.33% damage) and fallowed neem oil (2% damage).

Rahul Kumar *et al*., 2019 evaluated the fumigation toxicity and repellent action of Eucalyptus, globulus and Labill essential oil against adults of *R. dominica*. GC/MS analysis showed the major components of E. globulus essential oil as 1,8-cineole (22.35%), α-pinene (12.58%) limonene (4.01%), aristolene (3.35%), p-cymene (3.25%), transverbenol (3.02%), isosativene (2.85%), α-myrcene (2.15%) and terpinen-4-ol (2.10%). Fumigation toxicity and repellent activity showed that as the concentration and exposure time increased the mortality and repellency also increased. Maximum repellency of 62.0% was observed at 0.32µl/cm2 concentration after 36 hours of exposure.

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