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Research Article

MANAGEMENT OF LESSER GRAIN BORER IN WHEAT GRAINS BY USING COMMERCIALLY AVAILABLE MICROBIAL PESTICIDE

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Abstract – Wheat is the third largest food crop of the world, and Pakistan is the eighth largest wheat producing country globally. The lesser grain borer is a primary pest of stored grains in many regions of the world. It is injurious to cereals; breeds in corn, rice, wheat, and in other substrates containing starch. The highest reduction in fecundity of this pest was observed when grains were treated with concentrations of 0.5 ml and 0.75 ml resulting 5.22 and 5.26 eggs per grain, respectively. With the increasing concentration of Tracer, the emergence rate of F1 adults decreased as compared to the control. The maximum number (21.46 F1 adults) was recorded when we applied 0.25 ml of concentration in the wheat grains. On the other hand, the least number of newly emerged adults (18.06) reported in the jar that was treated with concentration of 0.75 ml. All the concentrations were statistically different from each other and resulted in effective virulence against this insect except the control, where 84.65% weight loss was reported. Among concentrations, the highest percent weight loss (21.47%) was caused by the concentration (0.25 ml) whereas concentration of 0.75 ml was the most effective, with less than 10% weight loss to wheat grains. The mortality of the insect was increased with the increase in concentration of bio-pesticide. The highest mortality was observed in concentration of 0.75 ml with 4, 7 and 8.5 dead adults, after 24, 48 and 72 hours, respectively.

Keywords – Lesser Grain Borer, Tracer, Weight Loss, Mortality, Management.

I. INTRODUCTION

Wheat has third position among food crops all over the world and Pakistan is the eighth largest country in wheat production (Shuaib et al., 2007). About 65-75% of the overall obtained wheat is stored in godowns for different purpose not only for food as well as for seed production (Chaudhry & Anwar, 1988). Generally storage up to a period of maximum three months is considered safe and afterwards there starts infestation by insect pests. Among the biotic factors, insect pests are the main factor causing storage losses (Latif, Ahmad, Khan, & Hassan, 1991) including quantitative as well as qualitative.

Damage of stored grains due to attack of stored grain insect pests is estimated by 5-10 % in the worldwide production. In certain tropical states these damage of stored grain are 30% which is high percentage. Insect pest of stored commodities are expected 20% or more in developing countries and 9%

in developed countries (Phillips & Throne, 2010). Lesser grain borer is one of the most important stored insect pests of grains all over the world. Corn, rice, wheat and other stored products which contain starch are preferred hosts of this economic pest (Chittenden, 1911).When compared with other stored product insect pests, *Rhyzopertha dominica* is the most challenging pest and their control with grain protectant is of significance. Presently it developed resistance to grain protectants (Lorini & Galley, 1999); grain protectants and numerous pyrethroid based insecticide developed the phosphine resistance (Collins, 2006) and all accepted insecticides like organophosphates(Edde, 2012). To control *R. dominica*, Phosphine fumigation has been most effective method (Ruiu, Satta, & Floris, 2013).

This economic pest is found in storage places, where female of lesser graın borer laids eggs between grain kernels and other developmental stages (larvae and pupae) develop inside the kernels. Its larvae go through 45 instars, and 25 -65 days to attain maturity (Eddie, 2012). The adults of this economic pests has life span of more than four months. Larvae and adult both cause damage to the grains and production of Fras can severely decrease grain quality. *R. dominica.* larvae injure unbroken wheat kernel greater than any other store product pest (Edde, 2012).

Grain protectants are used worldwide for management of this insect pest (Zettler & Cuperus, 1990) and it has developed resistance against synthetic pesticides (Edde, 2012). Phosphine is used as fumigant (Price & Mills, 1988) but resistance is also reported in this pest in United States of America (Zettlera& Cuperus, 1990; Opit, Phillips, Aikins, & Hasan, 2012), Brazil and Australia (Collins, 2006).

Now biologists are focusing on non-chemical alternative including use of natural products, predators, parasitoids and microbes for the development of well incorporated pest management (IPM) approaches to meet the demands of HACCP (Hazard Analysis and Critical Control Points) (Quiniones, 1990; Copping & Menn, 2000). It took another 20 years to use *B. thuringiensis* as biopesticide on commercial scale in the United States for the first time in 1958 (Ghassemi et al., 1981).

The spinosad is obtained from actinomycete bacterium *Saccharopolyspora spinosa* Mertz (Mertz & Yao, 1990). It is a broad spectrum and has potential to manage the stored insect pests (Subramanyam & Krishnan, 2003). Spinosad is said to be extremely efficient against a broad spectrum of insect species in grain commodities, at very low dose rates, which do not exceed from 1 ppm (Daglish&Nayak, 2006).

R. dominica is specifically vulnerable to spinosad (Fang, Subramanyam& Arthur, 2002; Towes&Subramanyam, 2003).In Pakistan, spinosad is commercially available as Tracer, manufactured by Dow Agri sciences (Alvi, Sayyed, Naeem & Ali, 2012). Similar tospinosad, botanigard is other microbial insecticide which is being used commercially. Unlike spinosad, botanigard has *Beauveriabassiana,* and entomopathogenic fungus. It is being use in the management of whitefly in the greenhouses (Ayalew, 2016). Botanigard has also been used in the control of different Bostrichidae beetle like as larger grain borer *Prostephanustruncates* in maize grain **(**Popoola, Osipitan, Afolabi&Oke, 2015).

Among all pests of stored grains products, lesser grain borer is of high importance causing quantitative and qualitative losses of grains. The chemical based pesticides cause many problems like resistance to insect pests, environmental pollution and non target effects. Therefore, biopesticides are being used as safe alternative to manage this economic pest. The finding of the study will help to make microbial control as the part of one effective IPM strategy against this economic pest. This study was executed with the objective of determination of pathogenicity of commercially available fungal and bacterial microbial biopesticides against *Rhyzopertha dominica*.

II. MATERIALS AND METHOD

Collection of *Rhyzopertha dominica* Infested Samples and Maintenance of Insect Culture

Infested samples of stored wheat grains were collected from different godowns/storages in different areas of the province Punjab. *R dominica* culture was sustained in the 'Stored Product

Entomology Laboratory' of the University in an incubator at 70 ± 5 % RH and 30 ± 2 °C temperature. Male and female were identified based on slight change the sternite of female, in last abdominal ventral part which was seento be pale yellow as related to the males which were consistently brown.

Insect Bioassays Using Different Concentrations of Commercially Available Biopesticides Formulation Based on *Bacillus thuringiensis* at Different Concentrations

The biopesticide to be used in the experiment were purchased from the market. In each plastic jar, 25g of grains were placed and enclosed with tightened muslin cloth and kept at 30°C temperature and 70% RH in incubator. Three pairs (3 males and 3 females) of *R. dominica* were released into each jar. Different concentrations (in ml) of biopesticides were prepared for the experiment. Different replications were done for each treatment. A separate control treatment was done in which grains were treated with distilled water. Data was taken at first hours and then thrice at 24hours intervals i.e. at 24 hours, 48 hours, and 72 hours. The wheat grains stored at 30°C temperature and 70% RH.

The insecticidal aptness of different concentrations of biopesticides against *R. dominica* was studied according to the following parameters:

i. Eggs Number

Average numbers of *R. dominica*eggswere counted to determine influence of different treatments on its egg laying capacity (fecundity). From each jar grains were randomly selected and number of eggs were counted. Finally, to check the eggs number on grains in every jar, average was calculated.

ii. Number of F_1 Adults Emerged

Number of F_1 (freshly developed) matures in every jar were counted to check inhibition of *R.dominica* development by changed concentrations of all the microbial pesticides.

iii. Percent Weight Loss (%)

Weight loss percentage was counted through following formula:

$$\text{Weight loss (\%)} = \left(\frac{\text{Initial weight} - \text{weight of sound \& damaged grains}}{\text{Initial weight}}\right) \times 100$$

iv. Mortality of *Rhyzopertha dominica*

Mortality of *R dominica* was determined in treated and untreated grains in each petri plate. Different concentrations of microbial pesticides were applied to grains. Each treatment had 3 replications. The death rate of *R.dominica*due to diverse concentrations of microbial pesticides was observed after 24, 48 and 72 hours. Six beetles of *R.dominica*were released. Petri-plates were placed in an incubator at 30ºC with 70 ± 5% RH.

Statistical Analysis

The recorded data were subjected to statistical analysis by using appropriate statistical packages like SPSS 22 for Windows in addition to MS Excel Program.

III. RESULTS

Insectıcıdal Aptness of Tracer Agaınst Lesser Graın Borer

Mean Number of Eggs (Mean ± SEM) Per Grain Laid by Lesser Grain Borer in Wheat Grains Treated with Different Concentrations of Tracer

According to Table 1, statistically all the treatments were different from others except concentration of 0.5 ml and 0.75 ml. The highest reduction in fecundity of Lesser Grain Borer was observed when grains were treated with the concentrations of 0.5 mland 0.75 ml with 5.22 and 5.26 eggs per grain, respectively. The maximum numbers of eggs (5.87 eggs) were recorded in the concentration (0.25ml). All treatments proved better in reducing fecundity rather than the control.

Mean Number of F_1Adults Emerged (Mean ± SEM) of Lesser Grain Borer in Wheat Grains Treated with Different Concentrations of Tracer

It could be seen from Table 2, as the concentration of Tracer was increased the emergence rate of F_1 adults decreased as compared to the control and all the concentrations were significantly different from other. The maximum number (21.46 F_1 adults) recorded when we applied 0.25 ml of concentration in the wheat grains. On the other hand, the least number of newly emerged adults 18.06 reported in the jar that was treated with concentration of 0.75 ml.

Table 1: Mean number of eggs (Mean ± SEM) per grain laid by lesser grain borer in wheat grains treated with different concentrations of tracer

Sr. No.	Concentrations of Tracer	Number of eggs per grain (Mean ± SEM)
1	0.25 ml	5.87 ± 0.05 b
2	0.50 ml	5.22 ± 0.03 a
3	0.75 ml	5.26 ± 0.02 a
4	Control	16.77 ± 0.04 c

Mean followed by the same letters are statistically alike; DMRT ($P \leq 0.05$), Duncan, 1951.

Table 2: Mean number of F_1 adults emerged (Mean ± SEM) of lesser grain borer in wheat grains treated with different concentrations of tracer

Sr. No.	Concentrations of Tracer	Number of F_1 adults emerged (Mean ± SEM)
1	0.25 ml	21.46 ± 0.06 c
2	0.50 ml	19.43 ± 0.03 b
3	0.75 ml	18.06 ± 0.03 a
4	Control	46.64 ± 0.05 d

Mean followed by the same letters are statistically alike; DMRT ($P \leq 0.05$), Duncan, 1951.

Percent Weight Loss (Mean ± SEM) Caused by Lesser Grain Borer in Wheat Grains Treated with Different Concentrations of Tracer

According to Table 3, all the concentrations were statistically different from other and resulted in effective virulence against PB except the control as 84.65% weight loss was reported. Among concentrations, the highest percent weight loss (21.47%) was caused by LGB when the concentration (0.25 ml) was applied to grains whereas concentration of 0.75 ml was the most effective with less than 10% weight loss to wheat grains.

Table 3: Percent weight loss (Mean ± SEM) by lesser grain borer in wheat grains treated with different concentrations of tracer

Sr. No.	Concentrations of Tracer	Percent weight loss (Mean ± SEM)
1	0.25 ml	21.47 ± 0.05 c
2	0.50 ml	17.44 ± 0.03 b
3	0.75 ml	9.07 ± 0.05 a
4	Control	84.65 ± 0.05 d

Mean followed by the same letters are statistically alike; DMRT (P ≤ 0.05), Duncan, 1951.

Adult Mortality (Mean ± SEM) of Lesser Grain Borer in Wheat Grains Treated with Different Concentrations of Tracer

Table 4 showed that mortality of insect was increased with the increase in concentration of the biopesticide. The highest mortality was observed in concentration of 0.75 ml with 4, 6.67 and 9dead adults, after 24, 48 and 72 hours, respectively. There was significant difference among mortalities due to different concentrations of Tracer as compared to that of the control.

Table 4: Mean adult mortality of lesser grain borerin wheat grains treated with different concentrations of tracer

S. No.	Concentrations of Tracer	Adult mortality ± S.E		
		24h	48h	72h
1	0.25 ml	3.33±0.33 ab	5.33±0.31 ab	8.0±0.56 b
2	0.50 ml	3.67±0.33 ab	6.00±0.33 ab	7.66±0.33 b
3	0.75 ml	4.0±0.33abc	6.67±0.33 bc	9.0±0.57 c
4	Control	3.0±0.57 a	4.66±0.66 a	6.0±0.57 a

Means followed by the same letters within columns and rows are significantly similar (P ≤ 0.05); DMRT, Duncan, 1951.

IV. DISCUSSION

The findings of the studies are in conformity with the work done by different entomologists. Ruiu, Satta, & Floris (2013) studied the entomopathogenic bacteria in the management of insect pest with the combination of pesticides .The result indicated that entomopathogenic bacteria were eco-friendly practice as compared to chemical pesticides. Mahdneshin, Safaralizadah, & Ghosta (2009) evaluated the efficacy of *Beauveriabassiana*and *Metarhiziumanisopliaeas* against*Rhyzoperthadominica*on stored wheat by using high and low concentration. The results of current study indicated that efficacy of tested fungi increased with increased concentration and applied interval.Chaston et al. (2011) study the efficacyof*Beauveriabassiana* was increased when mix with diatomaceous earth increases the mortality, mycosis and sporulation of *Rhyzoperthadominica* in the stored wheat under laboratory conditions by using 200 and 400 ppm. Chaston et al. (2011) as well as Ekesi, Egwurube, Akpa, & Onu (2001) reported the efficacy of the entomopathogenic fungus, *Metarhizium anisopliaeas* against the groundnut bruchid, *Caryedonserratus* on the groundnut under laboratory condition. The finding of the current study indicated that *Metarhiziumanisopliae* (5 isolates) fatal to adult *C.serratus* in the laboratory condition.

Fang & Subramanyam (2003) studied the efficacy of spinosad, against the adults of the lesser grain borer, *R dominica* (F.), on 12.5 or 14.5% moisture wheat stored at 22, 28, and 34^{o}C.Adults of *R. dominica* were showing for 14 days to the untreated wheat and wheat treated with the spinosad at the 0.1 and 1 mg (AI)/kg every month for the four months. Mortality of adult exposed to the untreated wheat range from 0 to 39%. All *R. dominica* adults expose to the spinosad treated wheat were killed. Activity of the spinosad during four-month test period was not affect by the three temperatures and two moisture levels tested.Athanassiou et al. (2008) studied that the insecticidal effect of the spinosad dust, a formulation that contain 0.125% spinosad. It was evaluating against the adults of *Sitophilusoryzae* (L.) In addition, *Rhyzoperthadominica* (F.) at three different temperature level (20, 25, and 30C) and the four commodities. The result indicted that for both species, mortality improved with increases in the concentration, applied interval, and the temperature.

Chintzoglou, Athanassiou, Markoglou, & Kavallieratos (2008)evaluated the insecticidal effect of the spinosad dust against the two major store grain species, *R. dominica* (F.) and the *S.oryzae*(L.), in the wheat, maize and barley. Spinosad was applied at four different dose rates: 20, 100, 500 and 1000 ppm of the formulation, resultant to 0.025, 0.125, 0.625 and 1.25 ppm of the active ingredient, correspondingly. The result of the current study indicated that reduced mortality of *S. oryzae* in maize is almost certainly due to the high degree of pesticide degradation.Daglish & Nayak (2006), determined the resolution and efficiency of spinosad against the *R. dominica* (F.) in the wheat stored for 9 months at 30˚C and 55±70% relative humidity under laboratory conditions. Result shows that spinosad is likely to be effective grain protectant against the *R. dominica* in wheat store in the warm climate.Daglish, Head, & Hughes (2008) reported that in the silo-scale check on the wheat stored in the Victoria Australia. *R. dominica*. The finding of the current study indicated that wheat sample over 7.5 month cause 100% adult mortality after the 2 weeks exposure and no live progeny were formed.

V. CONCLUSION

The lesser grain borer, *R. dominica* is a primary pest of stored grain in many regions of the world. It is injurious to cereals; breeds in corn, rice, wheat, and in other substrates containing starch. Statistically all the treatments were different from others except concentration of 0.5 ml and 0.75 ml. The highest reduction in fecundity of Lesser Grain Borer was observed when grains were treated with the concentrations of 0.5 ml and 0.75 ml with 5.22 and 5.26 eggs per grain, respectively. The maximum numbers of eggs (5.87 eggs) were recorded in the concentration (0.25 ml). All treatments proved better in reducing fecundity rather than the control. With the increasing concentration of Tracer the emergence rate of F_1 adults decreased as compared to the control. The maximum number (21.46 F_1 adults) was recorded when we applied 0.25 ml of concentration in the wheat grains. On the other hand, the least number of newly emerged adults 18.06 reported in the jar that was treated with concentration of 0.75 ml. All the concentrations were statistically different from other and resulted in effective virulence against thıs pest except the control as 84.65% weight loss was reported. The mortality of the insect was increased with the increase in concentration of the biopesticide. The highest mortality was observed in concentration of 0.75 ml with 4, 7 and 8.5 dead adults, after 24, 48 and 72 hours, respectively. Among concentrations, the highest percent weight loss (21.47%) was caused by Lesser Grain Borer when the concentration (0.25 ml) was applied to grains whereas concentration of 0.75 ml was the most effective with less than 10% weight loss to wheat grains.

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