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Management of lesser grain borer *Rhyzopertha dominica* (Fabricius) associated with stored cereals

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Abstract
The studies on Management of lesser grain borer *Rhyzopertha dominica* (Fabricius) associated with stored cereals were carried out to know the impact of phyto extracts and bio rationals on the mortality of the pest and germination response of treated seeds. The research was carried out at Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, U.P. in Department of Entomology 2022-2023. This experiment was conducted under Complete Randomized block Design (CRD). The experiment was conducted on effect of phyto extracts and bio rationals on the mortality of adult *Rhyzopertha dominca* (Fabricius) at 3,7 and 10 days of exposure. In Rice, results proved that 100 percent mortality was observed after 10 days of exposure to spinosad 45SC followed by Emamectin benzoate, sweet flag rhizome powder, cinnamon bark oil, mentha leaf oil, clove bud oil and eucalyptus oil. In wheat, 100 percent mortality was observed after 10 days exposure to spinosad 45SC followed by sweet flag rhizome powder, emamectin benzoate, cinnamon bark oil, mentha leaf oil, clove bud oil and eucalyptus oil. In maize, 100 percent mortality was observed after 10 days exposure to Spinosad 45SC followed by emamectin benzoate, mentha leaf oil, sweet flag rhizome powder, clove bud oil, cinnamon bark oil and eucalyptus oil. Experiments conducted on germination of treated seeds have resulted in no adverse effects on germination percent. The germination of treated grains with spinosad 45SC in most effective followed by emamectin benzoate, sweet flag rhizome powder, clove bud oil, mentha leaf oil, cinnamon bark oil and eucalyptus oil. Therefore, present laboratory studies clearly showed that phyto extracts and bio rationals were found quite effective against *Rhyzopertha dominica* (Fabricius) without causing any deleterious effect. Hence, it may be concluded that these eco-friendly and cost-effective products can easily be made available and used for management of *Rhyzopertha dominica* in stored cereals without impairing the quality of seeds for 3 months of storage period.

Keywords: Germination, lesser grain borer, maize, mortality, rice, spinosad, wheat

Introduction
Cereal grains are grown in greater quantities worldwide than any other type of crop and provide more food energy to the human race than any other crop.

Wheat (*Triticum aestivum* L.) is the worlds most important crop in relation to production and consumption (Ileke K.D., 2011) [6]. It can be used to make various human consumable products like biscuits, noodles, bakery products, *etc*. It has high calorie and protein intake for most of the people of India. Major wheat-producing states in India are Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, and Rajasthan.

Rice *(Oryza sativa)* is the major food crop in the world belongs to the family (Poaceae). Major rice producing states in India are West Bengal, UP, Andhra Pradesh, Punjab and Tamil Nadu. However, during storage of rice grains are destroyed during the storage period by many stored insect pests that are responsible loss up to 10-40% annually in the world(Ahman *et al*., 2013) [1].

Maize (*Zea mays* L.) belongs to the family (Poaceae) and is the world's leading crop and is widely cultivated as cereal grain that was domesticated in Central America. The predominant maize growing states are Andhra Pradesh, Karnataka, Rajasthan, Maharashtra, Bihar, Uttar Pradesh, Madhya Pradesh, Himachal Pradesh. Among these, post-harvest loss is the most serious problem in the context of food security as about 60% of maize grain is lost during this period (Alam *et al*, 2014) [2].

Lesser grain borer *Rhyzopertha dominica* (Fabricius), (Coleoptera: Bostrychidae) is a destructive and cosmopolitan insect pest of stored grain (Edde *et al.*, 2005) [4]. It is present both in field at harvesting time and in godown, granaries and other storage structures (Nadeem *et al.*, 2011) [10]. In the recent years, synthetic pesticides and fumigants were used to control stored-product pest and it has increased the problems related to toxic synthetic pesticides,

such as development of pest resistance, adverse effect on non-target organisms and humans and their surroundings. Botanical insecticides composed of essential oils may be a sound alternative to the more persistent synthetic pesticides for managing the major insect-pests due to the presence of rich source of bioactive molecules (Rajashekhar *et al.,* 2012) [12]. Essential Oils (EOs) are obtained by steam distillation of plant species beloning to the families Myrtaceae, Lauraceae, Lamiaceae and Asteraceae (Roger *et al.,* 2012) [13].

Materials and Methods

Studies on the "Management of lesser grain borer *Rhyzopertha dominica* (Fabricius) associated with stored cereals" were conducted at Entomology Department SHUATS, PRAYAGRAJ, to assess the effect of phytoextracts and bio rationals on percent mortality and germination percentage of cereal grains.

Collection and rearing of test insect *Rhyzopertha dominica*

The cultures of *R. dominica* were gathered from a few local Godowns and homes. Stock culture was maintained separately. Insects were raised in plastic containers with a 1 kg capacity. Each container contained 500 g of grains, and separately, 600 adult beetles were released. The container's mouth was covered with muslin cloth and secured with a rubber band. Thus, preserved culture was employed throughout the period of the research. The experiments were conducted on wheat variety (Sharbati) under laboratory conditions. Treatments include sweet flag rhizome powder, clove bud oil, mentha leaf oil, cinnamon bark oil, eucalyptus oil, spinosad and emamectin benzoate.

Mixing of grain protectants

100g of rice, wheat and maize was taken into different containers to replicate the treatments for three times. Ten pairs of freshly emerged adults were released in each replication. Percent Mortality and germination percentage were noted.

Observations to Be Recorded

Mortality Studies

Different phytoextracts and biorationals were evaluated in separate transparent plastic containers having 500gm capacity. The required amounts of phyto extracts and bio rationals were mixed thoroughly with 100 g of rice, wheat and maize grains. Ten pairs of freshly emerged adults were released into each container and the containers were capped. The numbers of dead beetles were recorded after 3, 7 and 10 days of treatment respectively. Adult percent mortality was calculated by using the following formua employed by Zeng *et al.* (2010) [15]

$$\text{Adut mortality (\%)} = \frac{\text{Number of dead insects}}{\text{Total number of insects released}} \times 100$$

Percent seed germination

Germination of the seeds was tested by paper towel method by maintaining three replications of each treatment. 50 wheat and maize seeds were kept in paper towel and allowed to germinate. Percentage of germination was calculated by using the formula employed by Padmasri *et al.* (2021) [11].

$$\text{Percentage of seed germinated} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds}} \times 100$$

Statistical Analysis

The data averaged into respective parameter requisite will be subjected to suitable transformation. After analysis, data will be accommodated in the table as per the needs of objectives for interpretation of results. The standard procedures in agriculture statistics given by Gomez and Gomez (1976) [5] were consulted throughout. The interpretation of data will be done by using the critical difference value calculated at 0.05 probability level.

Results and Discussion

Adult mortality (%) in rice

The data pertaining to overall mean mortality of *Rhyzopertha dominica* adults release with different intervals *i.e*. 3,7 and 10 days after treatment are present in (Table 1). The results revealed that, T_6 spinosad @2ppm was found to be effective and gave significantly highest adult mortality (100.00 %) over rest of the treatments. The minimum adult mortality (31.11%) was found with T_5 eucalyptus oil @ 2ml/100g. Rest of the treatments were intermediate as T_7 emamectin benzoate @ 2ppm (65.55%) followed by T_1 sweet flag rhizome powder @ 2gm (57.77%) followed by T_4 cinnamon bark oil @ 0.3ml (48.88%) T_3 mentha leaf oil 1ml (47.77%) and T_2 clove bud oil @ 0.2ml (41.10%). Whereas negligible mortality of 4.44 percent was observed in T_8 untreated control.

Table 1: Effect of phyto extracts and biorationals on adult mortality of *Rhyzopertha dominica* in stored Rice

Sl. No	Treatments	Dosage per 100g of grains	Mortality%			
			3DAT	7DAT	10DAT	Mean
T_1	Sweet flag rhizome powder	2g	46.66	56.66	70.00	57.77
T_2	Clove bud oil	0.2ml	33.33	43.33	46.66	41.1
T_3	Mentha leaf oil	1ml	43.33	46.66	53.33	47.77
T_4	Cinnamon bark oil	0.3ml	43.33	50.00	53.33	48.88
T_5	Eucalyptus oil	2ml	23.33	33.33	36.66	31.1
T_6	Spinosad45SC	2ppm	100.00	100.00	100.00	100.00
T_7	Emamectin benzate 5SG	2ppm	56.66	66.66	73.33	65.55
T_8	Untreated control	-	0.00	3.33	10.00	4.44
	S.Em(±)	-	1.66	2.04	2.25	2.30
	C.D (p=0.05)	-	8.655	10.6	11.719	11.954
	C.V	-	11.538	12.247	12.217	13.929

DAT: Days After Treatments

All the treatments were found to be significantly superior to control in enhancing adult mortality of test insect (*Rhyzopertha dominica*) in treated rice. From results of adult mortality in rice the maximum adult mortality was recorded in

spinosad 45SC results are similar to Ajaykumara *et al.* (2018) [3]. Among all the treatments emamectin benzoate 5SG (2ppm/100g) mortality after 10 days of treatment, Sweet flag rhizome powder (2gm/100g) was found to be the next. The results of emamectin benzoate 5SG were supported by Ajaykumara *et al.* (2018) [3] and sweet flag rhizome powder (2gm/100g) were supported by Swetha *et al.* (2023) [14]. The next best treatments were cinnamon bark oil (0.3ml/100g) were supported by Mahmoud *et al.* (2023) [9] followed by mentha leaf oil (1ml/100g) as supported by Latif and Moajel (2004) [8] followed by clove bud oil (0.2ml/100g) were supported by Zeng *et al.* (2010) [15]. Eucalyptus oil showed least effect when compared with all other treatments.

Adult mortality (%) in wheat

The data pertaining to overall mean mortality of adult *Rhyzopertha dominica* release with different intervals *i.e.* 3,7 and 10 days after release are depicted in (Table 2). The results revealed that T_6 spinosad @ 2ppm was found to be effective and gave significantly highest adult mortality 100.00 percent over rest of the treatments. Minimum adult mortality (38.88%) was found with T_5 eucalyptus oil @ 2ml. Rest of the treatments were intermediate as T_1 sweet flag rhizome powder @ 2g with 77.77 percent, followed by T_7 emamectin benzoate 5SG @ 2ppm with 68.88 percent, T_4 cinnamon bark oil @ 0.2ml with 68.88 percent, T_3 mentha leaf oil @ 1ml with 57.77 percent and T_2 clove bud oil @ 0.3ml with 54.44 percent. Mortality of 8.88 percent was observed in T_8 untreated control.

Table 2: Effect of phyto extracts and bio rationals on adult mortality in wheat

Sl. No.	Treatments	Dosage per 100g seeds	Mortality%			
			3DAT	7DAT	10DAT	Mean
T_1	Sweet flag rhizome powder	2gm	73.33	76.66	83.33	77.77
T_2	Clove bud oil	0.2ml	50	50	63.33	54.44
T_3	Mentha leaf oil	1ml	53.33	56.66	63.33	57.77
T_4	Cinnamon bark oil	0.3ml	63.33	66.66	76.66	68.88
T_5	Eucalyptus oil	2ml	36.66	36.66	43.33	38.88
T_6	Spinosad45SC	2ppm	100	100	100	100
T_7	Emamectin benzoate 5SG	2ppm	63.33	70	73.33	68.88
T_8	Untreated control	-	0	10	16.66	8.88
	SEm(±)	-	1.92	2.45	2.15	1.93
	C.D (p=0.05)	-	9.994	12.74	11.173	10.062
	C.V.	-	10.497	12.617	9.931	9.779

DAT: Days After Treatments

All the treatments were found to be significantly superior to control in enhancing adult mortality of test insect (*Rhyzopertha dominica*). From results of adult mortality in wheat the maximum was recorded in spinosad 45SC results are similar to Ajaykumara *et al.* (2018) [3]. Among all the treatments sweet flag rhizome powder (2gm/100g) followed by emamectin benzoate 5SG (2ppm/100g) was found to be next. The results of sweet flag rhizome powder (2gm/100g) were supported by Swetha *et al.* (2023) [14] and emamectin benzoate 5SG (2ppm/100g) were supported by Ajaykumara *et al.* (2018) [3]. The next best treatments were cinnamon bark oil (0.3ml/100g) were supported by Mahmoud *et al.* (2023) [9] followed by mentha leaf oil (1ml/100g) were supported by Latif and Moajel (2004) [8] followed by clove bud oil (0.2ml/100g) were supported by Zeng *et al.* (2010) [15]. Eucalyptus oil showed least effect when compared with all other treatments.

Adult mortality (%) in maize

The data pertaining to overall mean mortality of *Rhyzopertha dominica* adult release with different intervals of *i.e.* 3,7 and 10 days are presented in (Table 3). The results revealed that T_6 spinosad @ 2ppm was found to be effective and gave significantly high mortality (100.00%) over rest of the treatments. The minimum adult mortality (17.77%) was recorded in T_5 eucalyptus oil @ 2ml. Rest of the treatments were intermediate as T_7 emamctin benzoate @ 2ppm (53.33%) followed by T_3 mentha leaf oil @ 1ml (52.21%) which is followed by T_1 sweet flag rhizome powder @ 2gm (48.88%) followed by T_2 clove bud oil @ 0.2ml (43.33%) and T_4 cinnamon bark oil @ 0.3ml (41.10%). Where as negligible mortality of 1.11 percent was observed in T_8 untreated control.

Table 3: Effect of phyto extracts and bio rationals on adult mortality in maize

Sl. No.	Treatments	Dosage per 100g grains	Mortality%			
			3DAT	7DAT	10DAT	Mean
T_1	Sweet flag rhizome powder	2gm	43.33	50.00	53.33	48.88
T_2	Clove bud oil	0.2ml	36.66	43.33	50.00	43.33
T_3	Mentha leaf oil	1ml	46.66	53.33	56.66	52.21
T_4	Cinnamon bark oil	0.3ml	33.33	43.33	46.66	41.10
T_5	Eucalyptus oil	0.2ml	13.33	16.66	23.33	17.77
T_6	Spinosad45SC	2ppm	100.00	100.00	100.00	100.00
T_7	Emamectin Benzoate 5SG	2ppm	46.66	53.33	60.00	53.33
T_8	Untreated control	-	0.00	0.00	3.33	1.11
	SEm(±)	-	1.66	1.92	1.92	1.74
	C.D.	-	8.655	9.994	9.994	9.048
	C.V.	-	12.5	12.83	11.743	11.689

DAT: Days After Treatments

All the treatments were found to be significantly superior to control in enhancing adult morality of test insect (*Rhyzopertha dominica*). From results of adult mortality the maximum adult mortality was recorded in spinosad 45SC are similar to Ajaykumara *et al.* (2018) [3]. Among all the treatments emamectin benzoate 5SG (2ppm/100g) and mentha leaf oil (1ml/100g) was found to be next. The results of Emamectin benzoate 5SG (2ppm/100g) were similar to Ajaykumara *et al.* (2018) [3] followed by mentha leaf oil (1ml/100g) were supported by Latif and Moajel (2004) [8]. The next best treatments are sweet flag rhizome powder (2gm/100g) were supported by Swetha *et al.* (2023) [14] followed by clove bud oil (0.2ml/100g) were supported by Zeng *et al.* (2010) [15]. Eucalyptus oil showed least effect when compared with all other treatments.

Germination percentage

Germination percentage of wheat grains

The data on effect of various phyto extracts and bio rationals on germination of treated grains is presented in Table 4. The results revealed that, highest seed germination of 97.33 percent was found with T_6 spinosad @ 2ppm which is followed by T_7 emamectin benzoate5SG @ 2ppm with 90.00percent, T_1 sweet flag rhizome powder @ 2g with 86.33percent, T_2 clove bud oil @ 0.2ml with 83.33 percent, T_3 mentha leaf oil @ 1ml with 79.66 percent and T_4 cinnamon bark oil @ 0.3ml with 76.66 percent resepctively. However lowest seed germination (65.66%) was found in the T_5 eucalyptus oil @ 2ml. Where as 62.33 percent of germination was observed in T_8 untreated control.

Table 5: Effect of phyto extracts and bio rationals on germination percentage of wheat

Sl. No.	Treatments	Dosage	90DAT
T_1	Sweet flag rhizome powder	2g	86.33
T_2	Clove bud oil	0.2ml	83.33
T_3	Mentha leaf oil	1ml	79.66
T_4	Cinnamon bark oil	0.3ml	76.66
T_5	Eucalyptus oil	0.2ml	65.66
T_6	Spinosad45SC	2ppm	97.33
T_7	Emamectin benzoate 5SG	2ppm	90.00
T_8	Untreated control	-	62.00
	SEm(±)	-	0.39
	C.D.	-	2.06
	C.V.	-	1.485

DAT: Days After Treatment

All the treatments did not affect the germination percentage, all treatments significantly superior over control spinosad, emamectin benzoate and sweet flag rhizome powder showed highest germination percentage followed by clove bud oil, mentha leaf oil, cinnamon bark oil. Eucalyptus oil showed least mortality as supported by Kakde *et al.* (2014) [7].

Germination percentage of maize grains

All the treatments did not affect the germination percentage, all treatments significantly superior over control spinosad, emamectin benzoate and sweet flag rhizome powder showed highest germination percentage followed by clove bud oil, mentha leaf oil, cinnamon bark oil. Eucalyptus oil showed least mortality as supported by Kakde *et al.* (2014) [7].

Conclusion

On the basis of lab experiment, it can be concluded that spinosad 45SC @ 2ppm/100gm, emamectin benzoate @ 2ppm/100gm and sweet flag rhizome powder @ 2gm/100gm in treated rice, wheat and maize were found effective against major insect pest (*Rhyzopertha dominica*) as being cost effective, eco- friendly and easy to adopt by small scale farmers which can also be used as an alternative to synthetic insecticides under storage conditions. Since the findings are based on the laboratory experiment done for one time it may be repeated for further confirmation and recommendation.

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