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Safe and eco-friendly pest management techniques against lesser grain borer (*Rhyzopertha dominica* Fab.) under *in vitro* condition

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Abstract
The present investigations entitled "Studies on biology and eco-friendly management of lesser grain borer (*Rhyzopertha dominica* Fab.) under laboratory conditions" in Eastern part of Uttar Pradesh" was carried out at Students' Instructional Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad during *Rabi*, 2015. revealed that the Nine protectants 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).

Keywords: Lesser grain borer, eco-friendly, *in vitro* and management

1. Introduction
India is one of the principal wheat production and consuming country in the world. Importance of wheat in Indian agriculture is second next to rice. Nearly 55% of the world population depends on wheat for intake of about 20 % of food calories. Globally, wheat is being grown in 122 countries and occupies an area of 222.22 million ha. With an annual production of nearly 729.0 million tonnes DAC&FW (2015) [6]. India stands second in wheat production in the world with annual production of 93.4 million hectare land with productivity of 88.4 tonnes per ha. And yield 2872 Kg./ha. Wheat contributes about 35% of total food grain production of the country. Agricultural Statistics at a glance (2015) [1].

Among these Lesser grain borer (*Rhyzopertha dominica* Fab.) is the major pest of all cereals and also known as Australian wheat weevil. It was described in 1972 from specimen of South America. The original home of Lesser grain borer is said to be India (Pruthi and Singh 1950) [8]. The beetle is a strong flier and may spread rapidly and often found attacking wheat in field (Cotton, 1938 and Dean, 1947) [4, 5]. The young one also feeds on paddy and turns it to chaff. This species also feeds on flour and maida etc.

India has attained the distinction as the second largest wheat producer in the world, from an area of about 27 million hectare with record production of over 76 million metric tones during the 1999-2000 crop season. During 2002-03, estimated production of wheat in India was about 70.26 million tones from an area of 24.23 million hectares with productivity of 2.9 t/ha. About 90 % of total wheat production is contributed by five states *viz*., U.P., Punjab, Haryana, M.P., and Rajasthan (Solmon *et al*., 2004) [10]. Among these states U.P. contributes ample share and have first position in respect of acreage (9.50 m ha) and production (27.70).

2. Method and Materials
Field experiments were carried out during *Rabi* season in 2015-16 at Students' Instructional Farm (SIF), at Narendra Deva University of Agriculture and Technology, Narandra Nagar, (Kumarganj), Faizabad (U.P.) in a complete randomized block design with 9 treatments and three replications. Disinfested seed of PBW-154 was packed in jute bags of 1 kg capacity in 3 replication weighing 500 gm each after mixing the protectants as per schedule.

The newly emerged *R. dominica* were taken from culture already maintained for this purpose were released @ 5 pairs/bags. After releasing adults, the mouth of bags were tied with the help of rubber and kept on racks at ambient temperature in the laboratory of Entomology department. The germination per cent, per cent moisture content, per cent damage grain and weight loss were recorded as per technical programme.

2.1 Preparation of neem cake powder and Neem oil.
The neem cake purchased from the local market was grinded, to find out the fine powder. The grinded cake was also sieved with 20 no. mesh. The neem oil purchased from the local market.

2.2 Preparation of dry neem leaf powder
The mature green leaves of neem were plucked from the neem tree, cleaned and grinded after drying in shadow. To find out the fine powder from such grinded leaves was sieved with 20 no. mesh.

2.3 Preparation of Calotropis leaf powder
The mature green leaves of Calotropis were plucked from Calotropis plant, cleaned and grinded after drying in shadow. To find out the fine powder from such grinded leaves was sieved with 20 no. mesh.

2.4 Preparation Mentha leaf powder
The mature green leaves of menthe were plucked from mentha plant, cleaned and grinded after drying in shadow. To find out the fine powder from such grinded leaves was sieved with 20 no. mesh.

3. Results and Discussion
The results clearly indicated that all the protectants showed better performance at significant level over control in relation to per centages of grain moisture content, germination, damage and weight loss at different storage period (3 and 6 months).
At 3 months of storage Deltamethrin (2.5 WP) @ 40mg/kg 0.33 per cent, Neem oil @ 10 ml/kg seed with 1 per cent grain damage, Mentha leaf powder @ 10gm/kg seed with 1.33 per cent grain damage. The least effective treatment was the Neem cake @ 15 gm/kg seed, Neem dry leaf powder @ 15 gm/kg seed with 1.66 per cent grain damage followed by Calotropis leaf powder @ 10 gm / kg seed, Turmeric powder @ 10 gm/kg seed with 2.33 per cent grain damage and Brick furnace ash @ 10gm/kg seed with 2.66 per cent grain damage.

Table 1: Grain moisture per cent, Damage per cent and germination per cent of various eco-friendly grain protectants before storage against *R. dominica* under laboratory condition.

Treatments	Protectants	Dose/kg Seed	Moisture Content (%)	Germination (%)	Damage (%)
T_1	Neem cake	15.0g	10.80	93.66 (1.97)	0.00
T_2	Neem dry leaf powder	15.0g	10.80	93.33 (1.97)	0.00
T_3	Neem oil	10.0 ml	10.80	93.66 (1.97)	0.00
T_4	Calotropis leaf powder	10.0g	10.80	94.00 (1.97)	0.00
T_5	Mentha leaf powder	10.0g	10.80	94.66 (1.98)	0.00
T_6	Turmeric powder	10.0g	10.80	93.33 (1.97)	0.00
T_7	Brick field furnace ash	10.g	10.80	94.33 (1.97)	0.00
T_8	Deltamethrin (2.5wp)	40.0 mg	10.80	94.66 (1.98)	0.00
T_9	Control	Untreated	10.80	93.33 (1.97)	0.00
SEm±		-	-	0.002	-
CD at 5%		-	-	0.007	-

Mean of three replications.
Value in parentheses are angular transformed values.

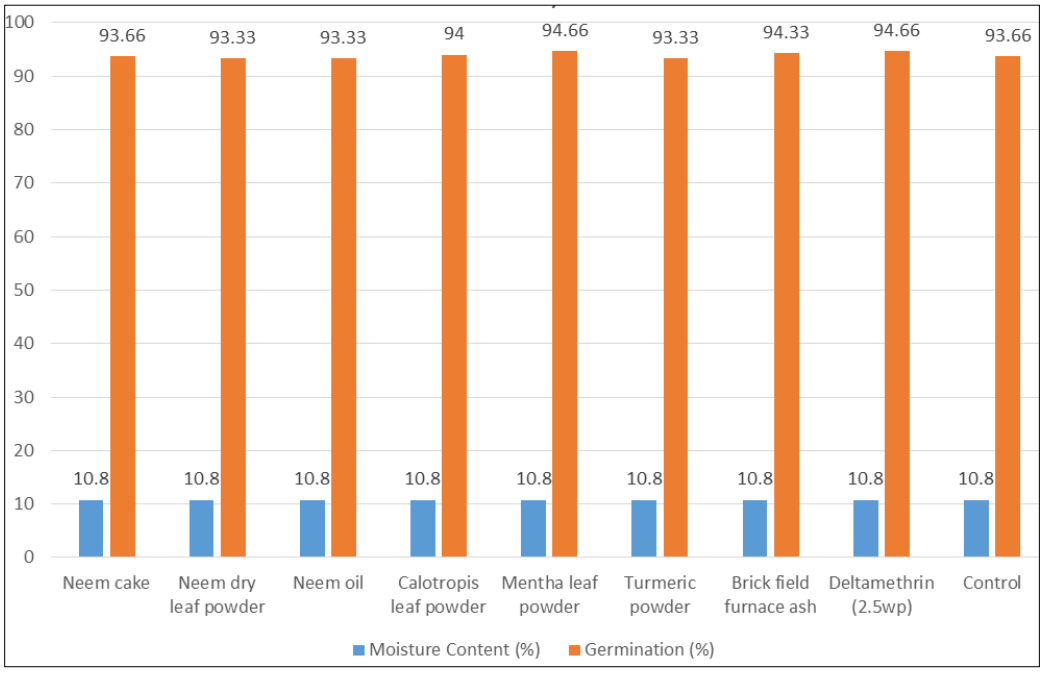

Fig 1: Eco-friendly grain protectants before storage against R. dominica under laboratory condition. Title

Table 2: Effect of protectants on the grain moisture per cent, germination, grain damage and weight loss against *R. dominica* at 3 months of storage.

Treatments	Protectants	Dose/kg Seed	Moisture Content (%)	Germination (%)	Damage (%)	Weight loss (%)
T_1	Neem cake	15.0g	11.36 (1.06)	93.33 (1.97)	1.66 (0.42)	2.00 (0.48)
T_2	Neem dry leaf powder	15.0g	11.30 (1.05)	92.00 (1.96)	1.66 (0.42)	2.00 (0.48)
T_3	Neem oil	10.0 ml	11.20 (1.05)	93.33 (1.97)	1.00 (0.30)	1.33 (0.36)
T_4	Calotropis leaf powder	10.0g	11.23 (1.05)	93.00 (1.97)	2.33 (0.52)	1.66 (0.42)
T_5	Mentha leaf powder	10.0g	11.23 (1.05)	93.00 (1.97)	1.33 (0.36)	2.66 (0.56)
T_6	Turmeric powder	10.0g	11.33 (1.05)	93.00 (1.97)	2.33 (0.52)	1.33 (0.36)
T_7	Brick field furnace ash	10.g	11.30 (1.05)	93.00 (1.97)	2.66 (0.56)	3.00 (0.60)
T_8	Deltamethrin(2.5wp)	40.0 mg	11.20 (1.05)	94.33 (1.97)	0.33 (0.10)	1.00 (0.30)
T_9	Control	Untreated	11.36 (1.06)	88.66 (1.96)	3.33 (0.63)	7.00 (0.90)
SEm±			0.002	0.002	0.058	0.040
CD at 5%			0.007	0.007	0.171	0.120

Mean of three replications.
Value in parentheses are angular transformed values.

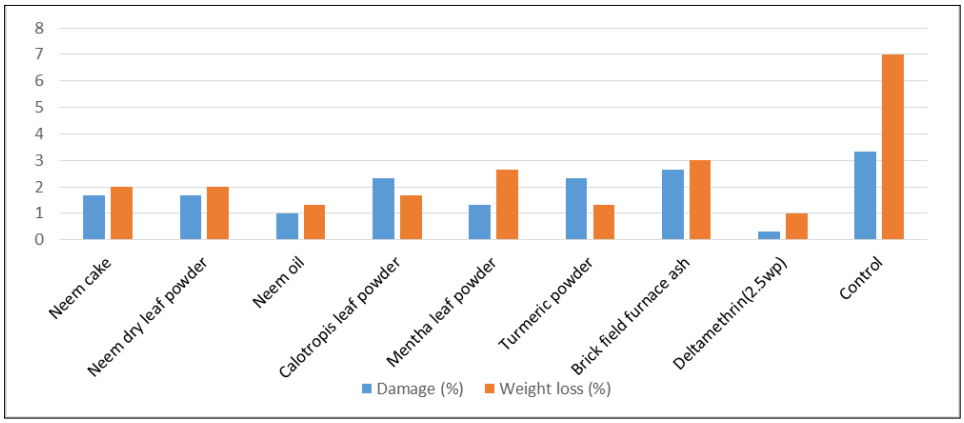

Fig 2: Effect of protectants on the grain moisture per cent, germination, grain damage and weight loss against *R. dominica* at 3 months of storage

Table 3: Effect of protectants on the grain moisture content, germination, grain damage and weight loss against *R. dominica* at 6 months of storage.

Treatments	Protectants	Dose/kg Seed	Moisture Content (%)	Germination (%)	Damage (%)	Weight loss (%)
T_1	Neem cake	15.0g	11.46 (1.06)	92.33 (1.97)	2.66 (0.56)	6.00 (0.85)
T_2	Neem dry leaf powder	15.0g	11.40 (1.06)	91.00 (1.96)	2.66 (0.56)	6.00 (0.84)
T_3	Neem oil	10.0 ml	11.30 (1.05)	92.33 (1.96)	2.00 (0.48)	3.00 (0.59)
T_4	Calotropis leaf powder	10.0g	11.33 (1.05)	92.00 (1.97)	3.33 (0.63)	5.00 (0.76)
T_5	Mentha leaf powder	10.0g	11.33 (1.05)	92.00 (1.96)	2.33 (0.52)	8.00 (0.95)
T_6	Turmeric powder	10.0g	11.43 (1.06)	92.00 (1.96)	3.33 (0.63)	4.00 (0.68)
T_7	Brick field furnace ash	10.g	11.40 (1.06)	92.00 (1.96)	3.66 (0.67)	8.00 (0.95)
T_8	Deltamethrin(2.5wp)	40.0 mg	11.30 (1.05)	93.33 (1.97)	1.33 (0.36)	2.66 (0.56)
T_9	Control	Untreated	11.46 (1.05)	86.66 (1.94)	4.33 (0.73)	14.00 (1.17)
SEm±			0.002	0.002	0.039	0.053
CD at 5%			0.007	0.007	0.117	0.156

Mean of three replications.
Value in parentheses are angular transformed values.

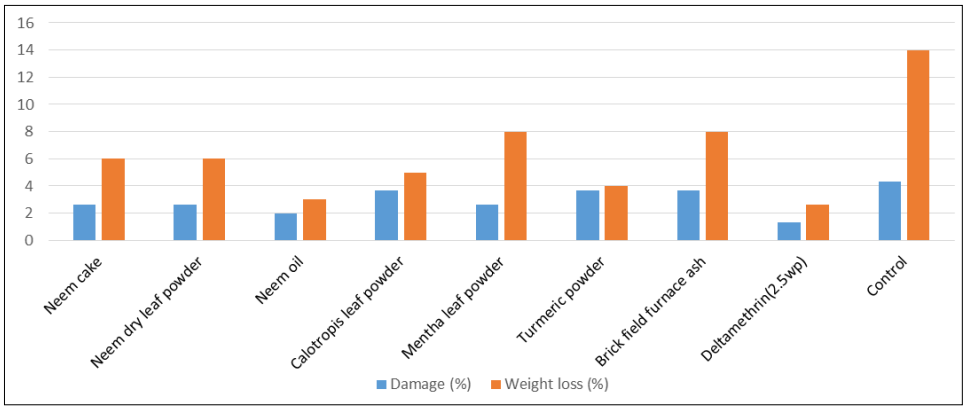

Fig 3: Effect of protectants on the grain moisture content, germination, grain damage and weight loss against *R. dominica* at 6 months of storage

At 6 months of storage Deltamethrin (2.5 WP) @ 40mg/kg seed with 1.33 per cent grain damage followed by Neem oil @ 10 ml/kg seed with 2 per cent grain damage, Mentha leaf powder @ 10gm/kg seed with 2.33 per cent, Neem cake @ 15gm/kg seed and Neem dry leaf powder @ 15gm/kg seed with 2.66 per cent grain damage, respectively. While, the least effective treatment were Brick furnace ash @ 10gm/kg seed with 3.66 per cent grain damage followed by Calotropis leaf powder @ 10gm/kg seed and Turmeric powder @ 10gm/kg seed with 3.33 per cent grain damage caused by *R. dominica.* More or less similar work also reported by Singh *et al.* (2012), Arya *et al.* (2013) [2], Manzoor *et al.* (2013) [7] and Badshah *et al*. (2015) [3] tested several safe and eco- friendly protectants against *R. dominica.*

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