The Pharma Innovation Journal 2023; 12(2): 1801-1804

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(2): 1801-1804

www.thepharmajournal.com
Received: 01-11-2022
Accepted: 05-12-2022

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Efficacy of indigenous plant products and cow dung powder on lesser grain borer, *Rhyzopertha dominica* (Fabricius) in stored wheat

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DOI: https://doi.org/10.22271/tpi.2023.v12.i2v.18632

Abstract
Studies on the efficacy of indigenous plant products and cow dung powder on the lesser grain borer, *Rhyzopertha dominica* (Fabricius) in wheat (*Triticum aestivum*), were conducted to determine the effects of the aforementioned plant products and cow dung powder on Percent Mortality, Adult Emergence, and Percent Weight loss. This experiment was carried out using a Completely Randomized Design (CRD). *Rhyzopertha dominica* orientation was found to be maximum in control and minimum in Mustard oil treatments. Mustard oil treated wheat grains showed the minimum amount of Adult Emergence and Weight loss when compared to control. The wheat treated with Mustard oil (100.00%) had the maximum percentage mortality rate. As a result, the current laboratory investigations amply demonstrated the practically complete efficacy of native plant products and cow dung powder on wheat. Accordingly, it can be said that these products were affordable, convenient, and eco-friendly. It's indeed simple to implement for controlling the stored pest in wheat.

Keywords: *Rhyzopertha dominica*, survey, life cycle, wheat, mustard oil, neem leaf powder, curry leaf powder, sweet flag rhizome powder, cow dung powder, completely randomized design (CRD), eco-friendly

Introduction
Agriculture is the primary occupation of the majority of people worldwide. Over 70% of Indians rely on agriculture as their primary source of income (Chandrasekar *et al.*, 2005, Jeeva *et al.*, 2005 and Kiruba *et al.*, 2005) [3, 11, 13, 13]. The most frequently grown crop in the world is wheat, *Triticum aestivum* (L.). It is a poaceae family crop and is known as rabi. Nearly 55% of the carbs come from this source, making it a significant one. Wheat has roughly 8–15% protein, although that protein is of rather poor quality for delivering critical amino acids. It is a source of numerous nutrients and dietary fiber in addition to being a staple food for people throughout.

Wheat is heavily infested with a variety of insect pests while in storage, including the Lesser grain borer, *Rhyzopertha dominica* (Fabricius), rice weevil, *Sitophilus oryzae* (Linnaeus), red rust flour beetle, *Tribolium casteneum* (Herbst), granary weevil, *Sitophilus granarius* (Linnaeus), maize weevil, *Sitophilus zeamais* (Motschulsky), Angoumois grain moth, *Sitotroga cerealella* (Olivier) and rice moth, *Corcyra cephalonica* (Stainton) (Fornal *et al.*, 2007, Ileke 2011) [6, 8].

The lesser grain borer, *Rhyzopertha dominica* (Fabricius) (Bostrichidae: Coleoptera), is one of the many pests of storage insects. It mostly affects stored grains including paddy, wheat, maize, and sorghum, but it can also infest other products like pulses and dried cassava root. *R. dominica* belongs to subfamily Dinoderinae and family Bostrichidae. *Rhyzopertha* only only one species in its whole genus. It is also known as a powder post beetle or an auger beetle (Fisher, 1950) [5]. *R. dominica* was first described by Fabricius in 1792 as *Synodendron dominicum* using samples from imported Indian nuts and roots (Chittenden, 1911) [4]. The beetle was called *R. dominica* by Lense in 1896.

For a long time, pests in stored grains have been managed using synthetic chemical insecticides (Salem *et al.*, 2007) [17]. Because the storage facilities are not airtight, farm-level fumigation of food grains with harmful gases is not practical.

In addition, using insecticides to control insects has serious drawbacks, including toxic residues left on grains that have been stored, target species developing resistance, pests resurging, and lethal effects on non-target organisms in addition to direct toxicity to users and health risks (Adedire and Lajide 2003, Adedire *et al.*, 2011, Ileke and Olotuah 2012) [1, 2, 9].

This situation demonstrates the need for natural insecticides that are safe but nonetheless efficient for pest control in storage and have no hazardous side effects on non-target organisms. Natural insecticides that come from plants are called botanical insecticides (Golob *et al.*, 2000; Isman, 2000) [7, 10]. These formulations have been tested for their insecticidal activity, including their effectiveness as repellents, anti-feedants, and insect development regulators. Botanical insecticides are employed in a variety of forms, including powders, solvent extracts, essential oils, and whole plants (Weaver and Subramanyam, 2000) [19]. Keeping these points in mind the present study "Efficacy of indigenous plant and animal products on lesser grain borer, *Rhyzopertha dominica* (Fabricius) in stored wheat" was undertaken.

Materials and Methods

The experimental procedures for "Efficacy of indigenous plant products and Cow dung powder on lesser grain borer, *Rhyzopertha dominica* (Fabricius) in stored wheat" were carried at Department of Entomology, SHUATS, PRAYAGRAJ, U.P to assess the efficacy of treatments on percent mortality of the insect, adult emergence, and percent weight loss of wheat grains.

Collection and rearing of test insect *Rhyzopertha dominica*

In the Vizianagaram district of Andhra Pradesh, 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 Neem leaf powder, Curry leaf powder, Jatropha leaf powder, Sweet flag rhizome powder, Mustard oil, Rice husk and Cow dung cake powder.

Collection of plant and indigenous products

The tested plant products i.e., Neem leaves, (*Azardiracta indica* L.), Curry leaves (*Murraya koenigii*) and the inert material i.e., Rice husk was collected from our houses, rhizome of Sweet flag and Mustard oil were bought from the local markets and Jatropha leaf powder from the online store. Cow dung was collected from desi breed cow from the nearby houses domesticating cows. The Neem and Curry leaves were washed with water and sun dried to mix with wheat in a powdered form. The Cow dung cake and Sweet flag rhizome were powdered in pestle and mortar. To prepare the required quantity @ 2% concentration of the treatments, 20 grams of each powder and 20 ml of Mustard oil were added separately to 1 kg of wheat grains.

Mixing of grain protectants

100 g wheat 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, Percent Weight loss and Adult Emergence were noted.

Observations to Be Recorded

Mortality Studies

Different botanicals were evaluated at doses of 0 (control) and in Sweet flag rhizome powder, curry leaf powder, Jatropha leaf powder, Neem leaf powder, Cow dung powder, Rice husk, Mustard oil in separate transparent plastic containers having one kg capacity. The required amounts of botanicals were mixed thoroughly with 100 g of seeds of wheat. 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.

$$\text{Adult mortality (\%)} = \frac{\text{n in T after treatment}}{\text{n in Co after treatment}} \times 100$$

Where; n = Insect population, T = treated, Co = control - (Abbott's formula)

Adult Emergence (Progeny Development):

The observation on progeny development was recorded by sieving the grains and counting the total number of adult beetles at 30, 60 and 90 days after treatment.

Effect on Weight loss (%)

The observation on percent weight loss was recorded by counting the numbers of un infested seeds and infested seeds.

$$\text{Percent weight loss} = \frac{\text{Initial weight of grains} - \text{Final weight of grains}}{\text{Total weight of grains}} \times 100$$

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) [20] were consulted throughout. The interpretation of data will be done by using the critical difference value calculated at 0.05 probability level. The level of significance will be expressed at 0.05 probability. The F-test will used to determine the significant difference.

Results and Discussion

Percent Mortality

From the data obtained (table 1), we could observe that the percent mortality of the released adults in treated wheat after 3, 7, 10 DAT was found significantly superior in Mustard oil (90.00**,** 98.33 & 100.00%) followed by Neem leaf powder (78.33, 83.33 & 95.00%) respectively, while the results are significantly as par with each other in Sweet flag rhizome powder (46.67, 63.33 & 78.33%), Jatropha leaf powder (36.67, 60.00 & 68.33%), Cow dung cake powder (25.00, 36.67 & 58.33%) and Rice husk (15.00, 26.67 & 36.67%). The Curry leaf powder (10.00, 20.00 & 25.00%) recorded to produce least percent mortality, while negligible in Untreated Control (0.00%).

All the treatments were found to be significantly superior to control the percent mortality of test insect (*Rhyzopertha dominica*) in treated wheat. The results were in accordance with Mamta Arya and Ruchira Tiwari (2013) [15] reported among different bio products evaluated, Neem leaf powder, Jatropha seed powder, Mustard oil, Cow dung powder and Cow dung ash powder and Cow urine @ 2% were found superior with higher adult mortality. Narayana Swamy, K. C. (2019), *Acorus calamus* rhizomes @ 2 percent (91.11% and 76.67%) found to be significantly superior among botanicals with highest adult mortality. Kathirvelu (2003) [12] stated that Neem leaf powder @ 30 percent (w/w) gave 50.90 percent mortality of adults of *R. dominica*.

Table 1: Percent Mortality

S. No	Treatments	Percent Mortality		
		3 DAT	7 DAT	10 DAT
1.	Neem Leaf Powder (T_1)	78.33 (62.265)	83.33 (65.927)	95.00 (79.528)
2	Curry Leaf Powder (T_2)	10.00 (18.428)	20.00 (26.554)	25.00 (29.988)
3.	Jatropha Leaf Powder (T_3)	36.67 (37.243)	60.00 (50.769)	68.33 (55.747)
4.	Sweet flag Rhizome Powder (T_4)	46.67 (43.070)	63.33 (52.721)	78.33 (58.906)
5.	Mustard Oil (T_5)	90.00 (71.536)	98.33 (85.683)	100.00 (90.000)
6.	Rice Husk (T_6)	15.00 (22.777)	26.67 (31.058)	36.67 (37.243)
7.	Cow dung cake Powder (T_7)	25.00 (29.988)	36.67 (37.243)	58.33 (46.894)
8.	Untreated Control (T_8)	0.00 (0.000)	0.00 (0.000)	0.00 (0.000)
Sem ±		1.021 (0.632)	1.667 (1.809)	1.559 (2.062)
CD (P = 0.05)		3.086 (1.912)	5.040 (5.469)	4.714 (6.235)
CV (%)		4.688 (3.070)	5.947 (7.162)	4.783 (7.174)

*Figures in parenthesis are angular transformed values

Adult Emergence

From the obtained data we could observe that all the tested products were found highly effective against *Rhyzopertha dominica* on stored wheat after 30, 60 and 90 days after treatment respectively. As given in table 2 significantly least mean number of adults emerged in Mustard oil (0.67, 1.00 & 3.00), Neem leaf powder (2.00, 3.33 & 4.00) treated grains followed by Sweet flag rhizome powder (3.00, 4.00 & 5.00), Jatropha leaf power (4.00, 6.00 & 7.00) and maximum number of adult emergence was observed in Cow dung cake powder (5.00, 6.00 & 8.00), Rice husk (6.00, 8.33 & 10.00) and Curry leaf powder (7.00, 9.00 & 12.33) as compared to Untreated Control (11.00, 13.33 & 15.33).

The present studies were being supported by Mamta Arya and Ruchira Tiwari, 2013 [15].

Percent weight loss

From the obtained data we could observe that all the tested products were found highly effective against *Rhyzopertha dominica* on stored wheat after 30, 60 and 90 days after treatment respectively. As given in table 2 significantly least weight loss% was observed in Mustard oil (0.00, 0.67 & 0.67%), Neem leaf powder (1.67, 1.67 & 2.00%) treated grains followed by Sweet flag rhizome powder (0.67, 1.67 & 4.33%), Jatropha leaf power (2.00, 2.67 & 6.33%) and significantly superior weight loss% was observed in Cow dung cake powder (1.67, 6,67 & 12.67%), Rice husk (2.33, 8.00 & 14.33%) and Curry leaf powder (3.67, 13.00 & 17.00%) as compared to Untreated Control (5.33, 17.33 & 27.00%).

The results were more or less significant to the results of Singh and Singh *et al.*, (2005) [18] found that Grain weight loss and damage was also prevented by *A. indica* and *J. curcas* leaf powders applied for three months post infestation, this might be because of the presence of anti-feeding properties in the parts of the plants used.

Table 2: From the obtained data we could observe that all the tested products were found highly effective against *Rhyzopertha dominica* on stored wheat after 30, 60 and 90 days after treatment respectively

S. No	Treatments	Adult Emergence			Percent Weight Loss		
		30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
1.	Neem Leaf Powder (T_1)	2.00 (8.127)	3.33 (10.491)	4.00 (11.532)	1.67 (7.422)	1.67 (7.422)	2.00 (8.127)
2	Curry Leaf Powder (T_2)	7.00 (15.336)	9.00 (17.451)	12.33 (20.548)	3.67 (11.040)	13.00 (21.126)	17.00 (24.340)
3.	Jatropha Leaf Powder (T_3)	4.00 (11.532)	6.00 (14.173)	7.00 (15.336)	2.00 (8.127)	2.67 (9.401)	6.33 (14.563)
4.	Sweet flag Rhizome Powder (T_4)	3.00 (9.970)	4.00 (11.532)	5.00 (12.916)	0.67 (4.693)	1.67 (7.388)	4.33 (11.982)
5.	Mustard Oil (T_5)	0.67 (3.825)	1.00 (5.737)	3.00 (9.970)	0.00 (0.000)	0.67 (4.693)	0.67 (4.693)
6.	Rice Husk (T_6)	6.00 (14.173)	8.33 (16.766)	10.00 (18.428)	2.33 (8.765)	8.00 (16.423)	14.33 (22.234)
7.	Cow dung Powder (T_7)	5.00 (12.916)	6.00 (14.173)	8.00 (16.423)	1.67 (7.422)	6.67 (14.961)	12.67 (20.843)
8.	Untreated Control (T_8)	11.00 (19.362)	13.33 (21.405)	15.33 (23.041)	5.33 (13.343)	17.33 (24.590)	27.00 (31.294)
Sem ±		0.118 (0.676)	0.204 (0.241)	0.167 (0.138)	0.060 (0.115)	0.103 (0.186)	0.168 (0.217)
CD (P = 0.05)		0.356 (2.004)	0.617 (0.730)	0.504 (0.418)	0.180 (0.349)	0.310 (0.563)	0.507 (0.657)
CV (%)		4.223 (9.836)	5.546 (2.995)	3.571 (1.494)	4.767 (2.627)	2.751 (2.435)	2.753 (2.181)

*Figures in parenthesis are angular transformed values

Conclusion

On the basis of lab experimentation, it can be concluded that, Mustard oil @ 2 ml/100 g and also Neem leaf powder @ 2 g/100 g treated rice wheat grains were found effective against major insect pest (*Rhyzopertha dominica*) of stored wheat as being cost effective, eco-friendly and easy to adopt by small-scale farmers which also can be used as an alternative to synthetic insecticides under storage conditions for shorter

duration. 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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