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Effect of indigenous natural and plant products on storability of redgram (*Cajanus cajan*) seeds

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Abstract

Redgram (*Cajanus cajan*) is an important pulse crop widely cultivated in India and serves as a major source of dietary protein. However, its storability is severely affected by insect pests, particularly bruchids, leading to significant quantitative and qualitative losses. The present study was conducted to evaluate the effectiveness of indigenous natural and plant products on the storability of redgram seeds under laboratory conditions. The experiment consisted of twelve treatments, including combinations of red earth slurry, ash, neem leaf paste, sweet flag powder, and sand, arranged in a Completely Randomized Design (CRD) with four replications. Observations on seed damage, number of eggs laid, and adult emergence were recorded at 20, 40, and 60 days of storage. The results revealed that treatment T₆ (red earth slurry + neem leaf paste) was the most effective in reducing seed damage, egg laying, and adult emergence as compared to other treatments. Combination of treatments performed better than individual treatments due to their synergistic effects. The control recorded the highest level of infestation. The study concludes that indigenous practices, particularly neem-based combinations, are eco-friendly, cost-effective, and efficient alternatives for managing storage pests in redgram seeds.

Keywords: Redgram, Indigenous Technical Knowledge, Storability, Neem, Bruchids, Seed damage

Introduction

Redgram (*Cajanus cajan* L.), commonly known as pigeonpea, is one of the most important pulse crops cultivated in India and other tropical countries. It serves as a major source of dietary protein, particularly for the vegetarian population, and plays a crucial role in ensuring nutritional security and improving soil fertility through biological nitrogen fixation (Saxena *et al.*, 2018; Varshney *et al.*, 2012) [16, 19]. Despite its importance, redgram is highly susceptible to storage losses, which significantly affect both seed quality and market value. Post-harvest losses in pulses are mainly caused by storage insect pests, especially bruchids (*Callosobruchus* spp.), which infest seeds during storage and cause severe quantitative and qualitative damage (Deshpande *et al.*, 2011; Kumar & Kalita, 2017) [3, 11]. These pests reduce seed weight, germination percentage, and nutritional quality, leading to economic losses for farmers. Storage pests can cause up to 25–40% losses in pulses under traditional storage conditions (Kumar & Kalita, 2017; Food and Agriculture Organization [FAO], 2019) [11]. The use of synthetic insecticides is a common method to control storage pests; however, their indiscriminate use has resulted in pest resistance, environmental pollution, toxic residues in food grains, and health hazards to humans and livestock (Isman, 2020; Pavela & Benelli, 2016) [8, 13]. Therefore, there is an increasing need for eco-friendly and sustainable alternatives. Indigenous Technical Knowledge (ITK) provides valuable, locally adapted solutions. Farmers traditionally use materials such as neem leaves (*Azadirachta indica*), ash, red earth, sand, and sweet flag (*Acorus calamus*) for protecting stored grains (Kedia *et al.*, 2015; Mishra *et al.*, 2018) [9, 12]. These materials act as repellents, antifeedants, or physical barriers. Neem-based products are particularly effective due to the presence of bioactive compounds such as azadirachtin, which interfere with insect growth, reproduction, and feeding behavior (Isman, 2020; Campos *et al.*, 2019) [8, 2]. Similarly, sweet flag (*Acorus calamus*) contains β -asarone, which exhibits insecticidal properties against storage pests (Pavela, 2016) [13]. Materials such as ash and red earth create unfavorable conditions for insect survival by causing desiccation and restricting movement. Although these indigenous

practices are widely used due to their low cost and easy availability, there is limited scientific validation regarding their comparative effectiveness, particularly when used in combination. Therefore, the present study was undertaken to evaluate the effect of different indigenous natural and plant products on the storability of redgram seeds under controlled conditions.

Research Gap

There is limited scientific validation of indigenous storage practices used by farmers for redgram. Most studies focus on individual plant products, with very few evaluating their combined effects. Standardized dosages and application methods are not well established. Comparative data on seed damage, egg laying, and adult emergence are also inadequate. Hence, systematic evaluation is required.

Research Objectives

1. To evaluate the effect of indigenous natural and plant products on the storability of redgram seeds.
2. To assess their effectiveness in reducing seed damage, egg laying, and adult population of storage pests.

Materials and Methods

Experimental Material

Clean and healthy redgram seeds were procured and used for the experiment. The seeds were properly cleaned and dried before treatment application.

Experimental Design

The experiment was conducted in a Completely Randomized Design (CRD) with twelve treatments, including a control, and four replications. The study was carried out at room temperature ($27 \pm 2^\circ\text{C}$) and relative humidity ($65 \pm 5\%$). Seeds (100 g per treatment) were stored in plastic containers.

Preparation of Treatments

Treatment	Description	Dosage/Ratio
T ₁	Mixing with Red earth slurry	15 g
T ₂	Mixing with Ash	15 g
T ₃	Mixing with Neem leaf paste	15 g
T ₄	Mixing with Sweet flag powder (<i>Acorus calamus</i>)	15 g
T ₅	Mixing with Sand	15 g
T ₆	Red earth slurry + Neem leaf paste	1:1 ratio
T ₇	Ash + Neem leaf paste	1:1 ratio
T ₈	Red earth slurry + Sweet flag powder	1:1 ratio
T ₉	Neem leaf paste + Sweet flag powder	1:1 ratio
T ₁₀	Red earth slurry + Sand	1:1 ratio
T ₁₁	Combination of all treatments (T ₁ + T ₂ + T ₃ + T ₄ + T ₅)	Equal proportion
T ₀	Control (untreated seeds)	—

Storage Procedure

After treatment application, the seeds were shade-dried and stored under laboratory conditions. Observations were recorded at 20, 40, and 60 days of storage.

Observations Recorded

- Percentage of seed damage
- Number of eggs laid per 100 seeds
- Number of live adults

Statistical Analysis

The data were subjected to analysis of variance (ANOVA) to determine the significance of treatments. Mean separation was performed using Tukey's HSD test at the 5% level of significance using SPSS software (Version 25).

Results and Discussion

Effect of Indigenous Natural Plant Products on Seed Damage in Stored Redgrams.

1. Damage of Seeds: The percentage of seed damage was observed and recorded at 20, 40, and 60 days of storage and compared with control. The lowest seed damage was recorded in treatment T₆ (Red earth slurry + Neem leaf paste) on 20th day (32.33; 0.00), 40th day (29.33; 0.33), and 60th day (22.66; 0.33), followed by T₁ (Red earth slurry) and T₃ (Neem leaf paste) during both the years. The maximum seed damage was observed in control (T₀). There was a significant difference among the treatments.

Table 1: Effect of indigenous natural and plant products on reducing the damage of seeds under storage in Redgram

Treatments/ Year/ Days	I Year			II Year		
	20	40	60	20	40	60
T ₁	38.33	32.00	24.33	1.00	2.00	1.33
T ₂	50.33	46.33	42.00	1.33	4.66	4.00
T ₃	42.00	33.00	27.66	0.00	0.33	2.33
T ₄	48.66	43.66	43.33	0.00	3.33	3.66
T ₅	51.33	43.33	39.33	2.60	3.33	5.66
T ₆	32.33	29.33	22.66	0.00	0.33	0.33
T ₇	51.66	40.66	30.33	5.66	16.33	17.33
T ₈	51.66	41.66	38.33	0.00	3.00	4.00
T ₉	45.00	41.33	36.66	1.00	21.00	22.33
T ₁₀	53.60	47.66	42.00	6.60	17.30	19.30
T ₁₁	52.33	46.00	41.00	3.30	14.33	14.66
T ₀	64.66	62.00	55.66	1.33	15.00	16.66
Sed	6.01	5.62	4.12	2.26	6.45	6.45
CD (5%)	12.47	11.67	8.56	4.70	13.39	13.39

2. Number of Eggs Laid

The total number of eggs laid on 100 seeds was recorded at 20, 40, and 60 days. Minimum number of eggs was observed in T₆ (Red earth slurry + Neem leaf paste) on 20th day (70.00; 0.00), 40th day (63.66; 3.33), and 60th day (57.00; 6.66), followed by T₁ and T₃ during both the years. The control (T₀) recorded the maximum number of eggs. There was a significant difference among treatments.

Table 2: Effect of indigenous natural and plant products on reducing the number of eggs laid under storage in Redgram

Treatments/ Year/ Days	I Year			II Year		
	20	40	60	20	40	60
T ₁	80.00	72.00	66.00	0.66	54.00	0.00
T ₂	180.66	160.00	141.00	0.00	3.33	6.66
T ₃	104.33	99.00	84.33	0.66	54.00	0.00
T ₄	164.33	141.66	120.33	0.00	14.00	6.00
T ₅	135.33	121.66	102.66	0.00	23.66	15.00
T ₆	70.00	63.66	57.00	6.00	0.00	0.00
T ₇	172.33	156.00	131.00	0.33	0.00	33.00
T ₈	108.33	98.33	88.66	4.00	6.33	0.00
T ₉	167.66	149.66	137.33	9.66	45.00	35.00
T ₁₀	184.66	175.00	157.00	21.66	27.33	35.00
T ₁₁	182.00	161.66	145.00	3.33	39.66	25.00
T ₀	192.33	182.66	175.33	8.00	40.66	61.66
Sed	7.07	4.40	5.38	4.67	8.56	8.98
CD (5%)	14.68	9.14	11.16	9.69	17.79	18.64

3. Number of Alive Adults

The number of alive adults was recorded up to 60 days at 20-day intervals. Minimum population of adults was observed in T₆ (Red earth slurry + Neem leaf paste) on 20th day (38.66; 0.00), 40th day (31.66; 0.66), and 60th day (22.00; 0.66), followed by T₁ and T₃. Control (T₀) recorded the maximum number of adults. Significant differences were observed among treatments.

Table 3: Effect of indigenous natural and plant products on reducing the number of a live adults under storage in Redgram

Treatments/ Year/ Days	I YEAR			II YEAR		
	20	40	60	20	40	60
T ₁	63.33	56.00	47.66	1.66	4.00	0.66
T ₂	104.66	97.33	88.33	0.00	6.00	0.00
T ₃	93.00	85.00	72.00	5.00	0.33	0.00
T ₄	111.33	103.00	94.33	0.33	0.00	0.00
T ₅	90.00	80.00	72.00	2.66	1.66	0.00
T ₆	38.66	31.66	22.00	0.00	0.66	0.66
T ₇	87.66	79.33	70.00	0.33	6.00	1.00
T ₈	101.33	92.00	74.00	0.00	6.00	0.00
T ₉	116.33	104.33	91.66	4.33	2.30	3.33
T ₁₀	107.66	96.66	91.00	5.60	1.00	2.66
T ₁₁	103.66	93.00	86.66	0.00	5.00	2.66
T ₀	116.33	114.00	101.00	10.00	10.33	3.66
Sed	3.46	2.95	4.22	0.62	1.46	0.89
CD (5%)	7.17	6.12	8.77	1.29	3.03	1.15

Discussion

The study revealed significant differences among treatments. Treatment T₆ (red earth slurry + neem leaf paste) consistently recorded the lowest seed damage, egg laying, and adult emergence. Neem-based treatments were highly effective due to the presence of azadirachtin, which disrupts insect growth and feeding (Isman, 2006) [7]. The red earth slurry has likely enhanced protection by forming a coating over the seeds, thereby restricting insect movement and oviposition (Golob *et al.*, 1999) [6].

Combination of treatments performed better than individual treatments, indicating a synergistic effect between physical and botanical components, as reported by Dubey *et al.* (2008) [4]. Treatments involving ash and sand showed moderate effectiveness due to their physical action in causing desiccation and limiting insect activity (Khaire *et al.*, 1992) [10]. However, these treatments were less effective compared to neem-based combinations.

The control treatment recorded the highest seed damage and insect population, confirming severe infestation under untreated conditions (Ahmed *et al.*, 2000) [1]. Overall, the findings suggest that indigenous practices, particularly combined treatments, offer an eco-friendly, cost-effective, and sustainable solution for managing storage pests in redgram seeds (Rajapakse & Van Emden, 1997) [15].

Conclusion

The study demonstrated that the combination of red earth slurry and neem leaf paste (T₆) was the most effective treatment in reducing seed damage, egg laying, and adult population of storage pests in redgram seeds. This treatment significantly improved seed storability compared to other treatments. Indigenous practices, particularly neem-based combinations, can be recommended as eco-friendly, low-cost, and sustainable alternatives for managing storage pests.

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