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Efficacy of Two Indigenous Plant Extracts, *Acacia auriculiformis* and *Azadirachta indica* Against Rice Weevil, *Sitophilus oryzae* L.

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Abstract: Efficacy of neem (*Azadirachta indica*) and acacia (*Acacia auriculiformis*) extract was assessed on the basis of toxicity and repellency effects on rice weevils. The study followed a completely randomized design with three replications and six treatments: 5%, 7.5%, 10% concentrations of neem and 5%, 7.5%, 10% concentrations of acacia leaf extracts. The results revealed that neem leaf extract, particularly at 10%, exhibited the highest efficacy, showing 58.56% adult mortality and 58.67% repellency against rice weevil. In contrast, 5% acacia leaf extract demonstrated the lowest mortality (26.43%) and repellency (27.33%). The effectiveness of both extracts increased with higher concentrations, neem showing superior activity compared to acacia. These findings suggest that neem leaf extract, especially at higher concentrations, could serve as a promising, eco-friendly alternative for controlling rice weevil infestations in stored grains.

Keywords: Efficacy of neem extract; Acacia extract; Rice weevil.

INTRODUCTION

The rice weevil is a serious insect pest not only of paddy and rice but also of all cereals and their products worldwide. In fact, it is the commonest pest that one encounters in all kinds of stores. Bhuiya *et al*., (1992) reported 11-16% weight loss of husked rice during 4 months of storage in the laboratory. Some studies indicate that potential losses range from 6-18% annually and in maize, even up to 80% within 5-6 months of storage (Alam *et al.* 2019). These losses point out the need for effective pest management strategies, including improved storage practices to ensure food security and economic stability.

Traditionally, chemical insecticides and fumigants have been the primary means of controlling storage pests. Synthetic pesticides such as phosphine, malathion and pyrethroids have been widely applied to protect stored grains from insect infestations (Rajendran & Sriranjini, 2008). However, prolonged and indiscriminate use of these chemicals has led to serious issues, including pesticide resistance, environmental pollution, toxic residues in food and adverse health effects (Pimentel, 2005; Arthur, 2016). Additionally, the rising costs of synthetic insecticides have made them less accessible to farmers, particularly in developing countries (Subramanyam & Hagstrum, 2012). Botanical pesticides have gained attention as biodegradable, environmentally safe and non-toxic alternatives to synthetic chemicals, offering a sustainable approach to pest management (Mordue & Nisbet, 2000; Pavela & Benelli, 2016). Botanicals of various kinds have been noted for their insecticidal efficacy and they are being regarded as better alternatives to synthetic chemical insecticides (Scott et al. 2003). Therefore, many researches have been done to screen many plant species for their insecticidal potential because they are believed to contain numerous phytochemicals that could have antifeedant and considerable toxicity against insects (Berenbaum and Zangerl 1996; Zibaee 2011; Ashamo *et al* 2013). Despite the effectiveness of many botanicals there is still a wide gap between them and synthetic chemical insecticides, as many of them lose their potency over time (Forim *et al.* 2012; Begum *et al.* 2013). So, there is a need to evaluate other botanicals that could comparably contend with synthetic chemical insecticides. The purpose of the study was to find out the effectiveness of locally available plants, namely acacia, *Acacia auriculiformis* A. cunn. Ex. Benth and neem, *Azadirachta indica* A. Juss. against rice weevil, *Sitophilus oryzae* L. for their insecticidal properties

MATERIALS AND METHODS

Insect rearing

The test insect species, the rice weevil, *Sitophilus oryzae* *L*. was collected from Kamal-Ranjeet (K.R) market at a food shop in Mymensingh and was maintained in the laboratory condition of the Department of Entomology, Bangladesh Agricultural University, Mymensingh, at 27-30°C and 70-75% RH.

Plate 1. Rearing of rice weevil

Collection and preparation of plant sample

Fresh leaves of acacia, *Acacia auriculiformis* and neem, *Azadirachta indica* were washed in running water and then they were dried under sun for fine dust. Sun dried leaf dust was prepared by pulverizing the dried leaves in a magnetic stirrer. A sieve was used to obtain fine & uniform dust and preserved them in an air tight plastic jar, till their use in extract preparation.

Preparation of extraction

At first 50g of each category of dust were taken in a 500 ml beaker and separately mixed with 300 ml of 70% methanol solvents. Then the mixture was stirred for 15 minutes by a magnetic stirrer and was kept standing for the next 24 hours. The mixture was then filtered through a fine cloth and again through filter paper (Whatman No. 1). The filtered materials were taken into a round bottom flask and then condensed by evaporation of solvent in a water bath at 55℃ temperature. After the evaporation of solvent from filtrate, the condensed extracts were preserved in tightly corked-labeled bottles and stored in a refrigerator until their use for insect bioassays.

Plate 2. Preparation and filtration of extracts

Direct mortality test

Ten insects per treatment were treated and each treatment was replicated 3 times. In addition, the same numbers of insects were treated with solvent only for control. Insects were examined daily and those that did not move or respond to gentle touch were considered dead. Insect mortalities were recorded at 24, 48 and 72 hours after treatment (HAT).

Plate 3. Mortality test of rice weevil at different dose of plant extracts

Observed mortalities of the insects were corrected by Abbott's formula (1987):

Corrected mortality (%) = (Observed mortality–Control mortality/100 - Control mortality) x 100.

Repellency Test

A nine-centimeter diameter petri dish was divided into three portions, treated and untreated grain portion 3.5 cm each and neutral center portion (without grain) 2 cm. Two grams of rice grain were taken in each side portion of petri dishes for rice weevils. 1 ml of solution of different doses of each plant extract was applied to a side portion as uniformly as possible with a pipette i.e. treated grain side portion and the other side was control side. Ten insects were released at the central portion of each petri dish and a cover was placed on the petri dish. There were three replications for each plant leaf extract and for each dose. In the control side portion of the petri dish the grains were treated with solvent only. Then the number of insects on each portion was counted at hourly intervals up to the 5th hour.

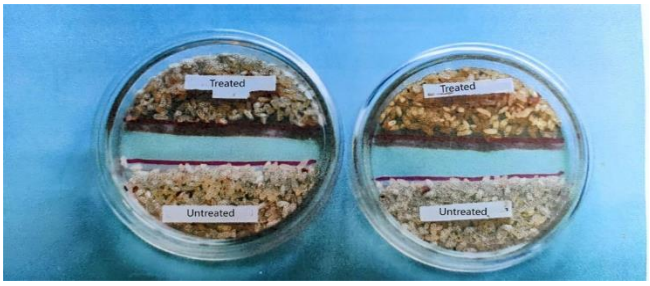

Plate 4. Repellency test of plant extracts to *Sitophilus oryzae* adults using treated rice grain

The data were converted to express percent repulsion (PR) by the following formula (Talukdar and Howse, 1994).

$$PR\ (\%) = (Nc\text{-}50) \times 2$$

Where, Nc= the percentage of insect present in the control half.

Positive values express the degree of repellency and negative values for the level of attractancy. Data PR (%) were analyzed using ANOVA. The average values were then categorized into classes (McDonald *et al.,* 1970) viz., 0=>0.01-0.1%, I=0.1-20%, II=20.1- 40%, III=40.1- 60%, IV=60.1- 80% and V=80.1-100% repellency rate.

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Results And Discussion

Leaf extracts from two native plants were tested against the rice weevil, *Sitophilus oryzae*. Under the following subheadings, the findings from a variety of experiments carried out during the research period (March-October'24) are shown and discussed.

Effects of Mortality test on Rice Weevil

The adult mortality of rice weevil, *S. oryzae* following treatment with methanol extracts of neem, *Azadirachta indica* and acacia, *Acacia auriculiformis,* at different concentrations is presented in Table 1. It illustrates the effects of plant leaf extract, dosage and time. Mortality rates at 24 HAT showed that the 10% neem leaf extract had toxicity (42.96%) on rice weevils, followed by the acacia extract (35.55%). Similar pattern results were observed at 48 and 72 HAT. Neem extract showed the highest toxicity effect (72.95%) at 72 HAT than acacia (56.06%). The 7.5% neem leaf extract exhibited moderate toxicity (31.85%) on rice weevils, with acacia extract showing 21.11% mortality at 24 HAT. The 5% neem leaf extract showed the lowest toxicity (23.70%) followed by the acacia extract (16.67%) at 24 HAT, with the same pattern observed at 48 and 72 HAT. The percentage of mortality was directly correlated with the time that passed after treatment. Both plant leaf extracts were toxic to rice weevils in the following order: Neem > Acacia.

Table 1. Effects of two plant leaf extracts at different Dose level on the mortality of rice weevil, *Sitophilus oryzae.*

Name of the extracts	Dose (% Concentration)	Adult mortality (%)		
		24 HAT	48 HAT	72 HAT
Neem	5	23.70	36.43	46.29
	7.5	31.85	42.75	56.22
	10	42.96	59.76	72.95
Acacia	5	16.67	26.39	36.23
	7.5	21.11	29.29	42.76
	10	35.55	46.29	56.05
Sx̄		5.21	3.60	1.96
Probability level		NS	NS	NS

NS= Not significant
HAT= Hour after Treatment

The average mortality (Figure 1) further supports this conclusion, with neem at 10% achieving the highest average mortality (58.55%) and acacia at 5% yielding the lowest mortality (26.43%). The order of toxicity observed was neem > acacia, aligning with previous studies that highlighted the insecticidal properties of neem-based formulations.

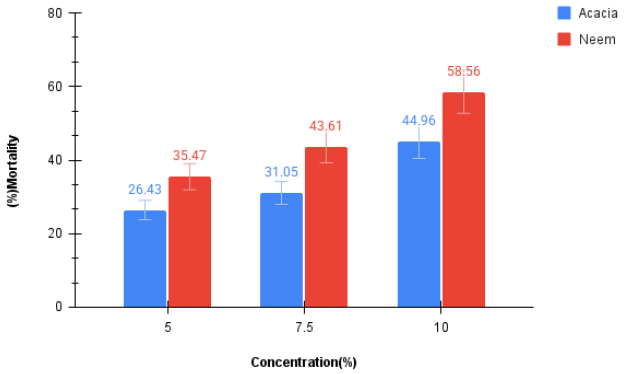

Fig 1. Effects of neem and acacia leaf extracts at different dose level on % mortality of rice weevil, *Sitophilus oryzae.*

These findings are strongly supported by the research of Akter *et al.* (2015) who confirmed that neem extracts are highly effective in decreasing the infestation of *S. oryzae*, suggesting their potential as an eco-friendly and sustainable solution for managing pests in stored rice. Similarly, Singh P. & Singh R. (2015) and Hassan & Drees (2005) found neem-based formulations to significantly deter *S. oryzae*, with a clear dose-dependent relationship.

Although acacia was less effective in this trial, previous research has demonstrated its significant insecticidal potential. For instance, Buss *et al.* (2013) and Mugisha & Birikorang (2019) observed high weevil mortality due to tannins in acacia.

Repellent Effect on Sitophilus oryzae

The repellency rates of methanol leaf extracts of acacia, *A. auriculiformis* and neem, *A. indica* on rice weevils are presented in (Table 2). The repellency effects of both acacia and neem leaf extracts demonstrated that the two plant extracts possess repellent properties. The repellent capacity of the different plant extracts at varying treatment times significantly differed from one another. Among the two, neem exhibited higher repellency (58.67%) compared to acacia (50%). The repellency class for both plant extracts was classified as III. The lowest repellency rate (27.33%) was recorded for acacia leaf extract, while neem showed a higher rate (Table 2).

In most cases, the repellency rate decreased over time. The rate of repellency also varied depending on the specific type of extract. The repellency effects of the plant extracts at different dosage levels on rice weevils are further shown in Table 2. The highest mean repellency was observed in the

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10% neem extract (58.67%), while the lowest was found in the 5% acacia extract (27.33%). The repellency rate of neem extracts at all dosage levels was consistently higher than that of acacia extracts at the same concentrations. The repellency rates of the plant extracts increased with higher concentrations, regardless of the plant material.

Table 2: Repellent effect of different plant leaf extracts in different dose levels on Rice weevil, *Sitophilus oryzae* using treated grain.

Name of the plant leaf extracts	Dose (%Concentration)	Repellency rate (%)					Mean repellency rate (%)	Repellency class
		1HAT	2HAT	3HAT	4HAT	5HAT		
	5	36.67	53.33	46.67	50	56.67	48.67	iii
Neem	7.5	40	58.67	53.33	46.67	63.33	52.4	iii
	10	53.33	63.33	53.33	56.67	66.67	58.67	iii
	5	20	26.67	26.67	30	33.33	27.33	ii
Acacia	7.5	30	33.33	36.67	36.67	43.33	36	ii
	10	46.67	43.33	50	53.33	56.67	50	iii
Sx̄		4.61	3.23	3.84	4.30	3.04		
Probability level		NS	NS	NS	NS	NS		

HAT=Hours after treatment

The repellency rates of methanol leaf extracts of acacia and neem indicated that both plant extracts exhibited notable repellent properties. The results presented in Table 3 show that neem exhibited the highest repellency (58.67%) at 10% concentration, while acacia followed with 50%. The repellency class for both neem and acacia was classified as Class III. The lowest repellency was recorded for the 5% acacia extract (27.33%). A general repellency over time was also observed. The repellency rates increased with concentration for both plant extracts. Neem extracts showed consistently higher repellency across all tested doses compared to acacia. These findings align closely with those of Kamruzzaman *et al*. (2005), who reported that *A. indica* exhibited strong repellency against *S. oryzae*. Similarly, Roy (2020) also confirmed the significant repellency of *A. indica*-based botanical mixtures in stored rice and wheat.

The relatively lower repellency of acacia is still notable. The rate of 50% suggests moderate activity, consistent with the findings of Mugisha and Birikorang (2019), who recorded significant repellency using 5% acacia extract.

CONCLUSIONS

Botanical products are effective, easy to handle and low cost to prepare and plants are available around us. Each year Bangladesh imports a huge quantity of insecticides to minimize the severe damage caused by insect pests. As our farmers are poor, they cannot spend a huge amount of money on synthetic insecticides to protect their stored products. So, they can use botanical materials as insecticides, which will benefit our agricultural sector as these substances are not only of low cost but also have less environmental impact in terms of insecticidal hazards. The findings of the present study indicated that *A. auriculiformis* and *A. indica* can be utilized as effective insect-controlling agents in storage conditions, provided they are used at appropriate concentrations and doses. The results demonstrated the potential of these two plant products in managing insect pests during storage. In comparison, the experimental findings, supported by extensive literature, confirm that neem leaf extract is a superior botanical pesticide, particularly when compared to acacia, showing higher efficacy in terms of both mortality and repellency against S. oryzae. Neem's effectiveness is attributed to its rich phytochemical profile, especially azadirachtin, which disrupts insect physiology, feeding, and reproduction.

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Conflict of Interest

The authors declare that there is no conflict of interest among authors regarding the submission and publication of this manuscript.

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