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Bioefficacy of neem, mahogoni and their mixture to protect seed damage and seed weight loss by rice weevil in storage

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Abstract

The research work aimed to evaluate the efficacy of some locally available botanicals namely Neem (*Azadirachta indica*), Mahogoni (*Swietenia mahagoni*) and their mixture at 0%, 1%, 2% and 3% concentrations on rice weevil, *Sitophilus oryzae* L. to protect seed from damage and weight loss caused by the insects. The experiments were laid out in factorial CRD with 12 treatments in Entomology Laboratory, Agrotechnology Discipline, Khulna University. The three botanicals were very effectual to reduce seed damage and weight loss in storage condition, caused by insects. In case of seed damage and seed weight loss Neem and mixture showed more or less similar effect to protect seed damage and weight loss of grains by the weevil followed by Mahogoni. The seed damage and seed weight loss were inversely proportionally to the level of concentration of botanicals. In all cases 3% concentration of botanicals showed highest protective efficiency followed by 2% and the lowest was found in control (0%) preceded by 1% concentration. All the botanicals especially Neem and mixture were found very promising in protecting of unhusked stored rice both in household and commercial purposes in eco-friendly way.

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Introduction

Now-a-days half of the world's population subsists wholly or partially on rice. Ninety percent of the world crop is grown and consumed in Asia (FAO, 2009).

Rice is the most important cereal crop and staple food in Bangladesh. The farmers of Bangladesh after harvest of grains store the seeds throughout the year for cultivation, consumption and also for sell in future to get more economic benefits. The ways the rice grains they store are very prone to the attack of the insect pests particularly the rice weevils which cause the heavy losses in the storage.

Preserving the harvested crop having loss or damage in storage condition is a serious threat to our national economy. In every year 5-8 percent of the food grains, seeds and different stored products are lost due to insect pests which would be up to 10 percent (Alam, 1971). Rice weevil *Sitophilus oryzae* L. (Coleoptera; curculionidae) is a major storage pest of economic importance throughout the world and decline the food value in stored cereal grains (Bourne, 1977). About 15 percent rice is lost in Bangladesh due to Storage pests (Khan, 1991). About 13 species have been reported as such insect pests on stored rice in Bangladesh among which rice weevil, *S. oryzae* L. is one of the most important damaging pests (Alam, 1971).

The pest not only damages the grain but also deteriorates the weight and quality of it. It also infests oats, barley, cotton seed, linseed and cocoa. The females lay eggs in tiny hole which is created by females and sealing the hole with a special waxy secretion. Pupa takes place inside the grain and the young adult has conspicuous a dark patch under the testa. The larva feeds within the kernel and consumes the endosperm excavating a tiny hole. The adult leaves a large, ragged exit hole in the kernel and feeds on damaged kernels. The rice weevil adult gathers and reproduces in stored grains (Atwal and Dhaliwal, 2005). This produces heat and moisture which can lead to mould development and invasion by other insect species. The damage in storage is more crucial than in the field (Hill, 1987).

In order to preserve the grain it is necessary to make a constant war with stored grain pests which inflict considerable damage to the cereal. Many preventive measures have been reported to minimize the loss due to rice weevil. Among these, chemical insecticides can be used for effective control but they have some serious drawbacks such as undesirable side effects, toxic residues, costly application and finally health hazards to consumer (Human and Animal). It also pollutes air, water, soil that means whole environment become in threat. Continuous use of chemical insecticides develops cross and multiple resistant strains in many important insect species (Ahmed *et al*., 1981).

As a result, a worldwide interest in the development of alternative strategies of chemicals that involves the search for new types of botanicals insecticides and use of age old traditional pest control agents are noticeable. At the present time, agricultural scientists priorities the use of botanicals insecticides to control the insect pest both in storage and field conditions because botanicals insecticides have no or less side effects and toxic residues which are non-hazardous to human and other vertebrates. Moreover, it can easily be produced by farmers that are less expensive and safe and amenable to apply.

That is why, the present study was carried out to determine the efficacy of some locally available botanicals against rice weevil to prevent or reduce seed damage and seed weight loss caused by rice weevil.

Materials and methods

The present study was undertaken to determine the bio-effect of Neem, Mahogany oil and their mixture against rice weevil to protect grain damage and its weight loss by the weevil. The experiments were done in the Entomology Laboratory, Agrotechnology

Discipline, Khulna University, Khulna maintaining temperature and humidity of 25±3°C and 73±5% respectively.

Test Materials

Two available plants' seed oils (Neem and Mahogany) were selected for this experiment. These were collected from Regional Agricultural Research Station (RARS), Jessore. The morphology, distribution and uses of Neem and Mahogany seed oils are briefly described below:

Neem

Scientific name : *Azadirachta indica* A. Juss.
Family : Meliaceae

Usage

All most all parts of Neem tree, especially its seeds kernel and leaves are very important culturally and economically because of insecticidal, amoebicidal, antiallergic, antidermatic, antifuruncular, antigingivitic, antieczemic, anti-inflamatory, antiperiodontitic, antipyrrhoeic, antiscabic, antitubercular, antiviral, bactericide, antifeedant, antifungal, larvicidal, nematicidal, spermicidal and other biological activities, of its derivatives. The active ingredient of Neem is Azadirachtin which is isolated from the seed. Bitter Neem leaves also contain useful compounds like nimbin, nimbinene, nimbandiol, nimbolide, 6-deacetylnibinene and quercetin which are useful for pest and disease control. When the powdered kernel is mixed with wheat and rice, protects seeds from the attack of rice weevil, lesser grain borer and grubs of khapra beetle for about 9, 11 and 13 months respectively. The extract of seed acts as a gustatory repellent against rice weevil and red flour beetle of wheat (Das and Alam, 2001).

Mahogoni

Scientific name : *Swietenia mahagoni* L.
Family : Meliaceae

Usage

A magnificent deciduous tree widely distributed throughout the world. It has significant pesticidal usage to control the insect pests in agriculture. Now a days, the leaves and seed extracts of Mahogany are maximally used as bio-control agent in the management of insect pests both in field and storage. (Das and Alam, 2001).

Mixture

Mixture was prepared manually in Laboratory by mixing equal quantity of both Neem and Mahogoni in together. It plays significant role in controlling pests both in field and storage condition.

Collection and Rearing of Test Insects

Rice weevils were collected from stock culture of the Entomology Laboratory, Agrotechnology Discipline, Khulna University, Khulna.

Rice weevils were reared in a big plastic jars (radius 34 cm and height 22 cm) in which sterile rice was given in jar for insect feeding and the jar was kept in the Laboratory maintaining temperature and humidity of 25±3°C and 73±5% respectively for two month to multiply insect number. One hundred insects were taken in the jar mating freely and reproduce rapidly. To ensure continuous supply of adequate adult, the rearing procedure was repeated with different batches of insects.

Treatment and Design

The experiments were laid out in accordance with factorial CRD in the laboratory maintaining twelve treatments each of which replicated thrice. The treatments consisted of factor A and factor B where factor A involved some locally available botanicals namely Neem, Mahogany seed extracts and their mixture, and factor B comprised different concentrations viz. 1.0%, 2.0%, 3.0% and an untreated control (0%) of the botanicals. Thus, the number of treatments was shown as 3 botanicals x 4 concentrations.

Disinfestations of Unhusked Unboiled Rice

The unhusked unboiled rice was spread on news paper and sun-dried from 10.00 A.M. to 2.30 P.M. in

direct sun light ranging temperature from 25°C - 30°C for five consecutive days. Sun-dried rice was kept in the Laboratory for few hours and then packed in an air tight plastic jar to avoid further infestation.

Seed Damage

The seeds kept in each petridish, were infected with holes by insects were considered as damaged seed. To evaluate the damage percentage of rice grain, 50 treated seeds were taken in petridish in which ten insects were released and finally the number of holed seeds were counted and finally expressed as percentage. The percentage of damaged seed was calculated by the following formula:

$$\text{Damaged seed (\%)} = \frac{\text{No.of damaged seed}}{\text{No. of total seed}} \times 100$$

Seed Weight Loss

The seed weight loss was caused by the feeding of weevils. Ten gram (10g) unhusked unboiled treated rice were taken in each petridesh and ten insects were taken ten insects in each petridesh after air drying of treated seeds. The weight of grains was taken periodically after every 24 hours till five consecutive days. The percentage of seed weight losses were evaluated by the following formula:

$$\text{Seed weight loss (\%)} = \frac{A-B}{A} \times 100$$

Where, A=Initial weight

B= Final weight

Data Analysis

The recorded data were analyzed statistically for ANOVA with the help of computer package program MSTAT-C and the mean differences were adjudged by Duncan's New Multiple Range Test (Duncan, 1955).

Result and discussion

The bio-effect of Neem, Mahogoni and their mixture was evaluated against major stored grain pest of rice, *Sitophilus oryzae* L to shield seed damage and seed weight loss. The results of experiments conducted during the study period were discussed below:

Seed Damage

Effect of botanicals, their concentrations (1%, 2%, 3% and 0%) and both botanicals and different concentrations at different days after treatment (DAT) on the seed damage caused by rice weevil until their death were assessed in this experiment and presented in Table 1 and 2, and Fig. 1.

Table 1. Effect of botanicals on seed damage by the test insects (*S. oryzae*).

Name of botanicals	Seed Damage (%)	
	Seed Damage/Day	Total Seed Damage
Neem	3.47	17.33
Mahogoni	3.70	18.50
Mixture	3.37	16.83
LS	NS	NS
Mean	3.51	17.55
SE±	0.10	0.49

LS = Level of significance
NS = Non significance
SE = Standard error

Table 2. Effect of different concentrations of botanicals on seed damage by the test insects (*S. oryzae*).

Conc. (%)	Seed Damage (%)	
	Seed Damage/Day	Total Seed Damage
1	1.47 b	7.33 b
2	0.89 b	4.44 b
3	0.49 b	2.45 b
0	11.20 a	56.00 a
LS	* *	* *
Mean	3.51	17.55
SE±	2.57	12.85

LS = Level of significance

* * = Significant at 1% level

SE = Standard error

Conc. = Concentration

Within table different letter(s) in same column indicate that they are significantly different by DMRT.

Effect of botanicals on seed damage

The effect of botanicals (Neem, Mahogoni and the mixture of Neem and Mahogoni) on the seed damage by the rice weevil *S. oryzae* until death was

statistically insignificant (Table 1). But numerically, the highest total seed damage (18.50%) was recorded in the seeds treated with Mahogoni followed by damage (17.33%) treated with Neem and the lowest damage (16.83%) was in the seeds treated with mixture of Neem and Mahogoni.

Again, the highest average daily seed damage (3.70%) was found in seeds treated with Mahogoni and the lowest (3.37%) in seeds treated with mixture of Neem and Mahogoni.

The order of botanicals to protect the damage of seed by the rice weevil, *S. oryzae* L. could be expressed as mixture (Neem+Mahogoni)>Neem>Mahogoni.

It was notable that the treated seed damage percentage caused by rice weevil was more or less similar because the toxic and repellent effect of two botanicals (Neem and Mahogoni) and their mixture did not vary significantly from each other resulting in almost alike protection.

Effect of different concentrations of botanicals on seed damage

Different concentrations (1%, 2%, 3% and 0%) of botanicals had statistical significant effect on seed damage by the rice weevil *S. oryzae* (Table 2). The result indicated that the highest total seed damage (56.00%) was measured in 0% concentration i.e. untreated seed followed by damage (7.33%) treated with the lowest concentration (1%), and the lowest total damage (2.45%) found in seeds treated with high concentration (3%) preceded by seed damage (4.44%) treated with medium concentration (2%).

Similarly, the highest average daily seed damage (11.20%) was observed in untreated seeds (0%) and the lowest (0.49%) in seeds treated with high concentration (3%) of botanicals.

Therefore, the damage percentage of unhusked grain caused by the insect was decreased with the increase of concentration level. But the striking fact was that in case of control insect caused seed damage more than eight times compared to treated seed.

According to efficacy to protect the damage of seed by the rice weevil, *S. oryzae* L. the concentrations of the botanicals could be arranged as 3%>2%>1%>0% (control).

Overall, the significant variation of total and average daily seed damage by insects might be resulted from distinct difference in concentration levels along with disparate composition, amount and functioning of toxic ingredients of the concentrations.

Effect of both botanicals and their different concentrations on seed damage

The effect of both botanicals (Neem, Mahogoni and mixture of Neem and Mahogoni) and their different concentrations (1%, 2%, 3%) with control (0%) on seed damage by the rice weevil *S. oryzae* was found statistically insignificant (Fig. 5). But numerically, the highest total seed damage (54.67%) was observed in untreated seed i.e. 0% of mixture and the lowest total damage (1.34%) was found in seeds treated with mixture having concentration of 3%.

The highest average daily seed damage (11.33%) was observed in case of the control, untreated with botanicals and the lowest average seed damage (0.27%) was observed in 3% concentration of mixture.

Thus, the efficacy of both botanicals and their concentrations to protect seed damage by the rice weevil, *S. oryzae* L. could be categorized as mixture(3%)>Neem(3%)> mixture(2%)> Mahogoni(3%)> Neem(2%)> Mahogoni(2%)> Neem(1%)> mixture(1%) /Mahogoni(1%)> control.

The result showed that seed damage percentage is inversely proportional to the level of concentration.

However, the dissimilarity of seed damage caused by insects (rice weevil) might be due to variation in the level of concentrations (0%, 1%, 2%, and 3%) of

different botanicals having different toxic ingredients and functioning.

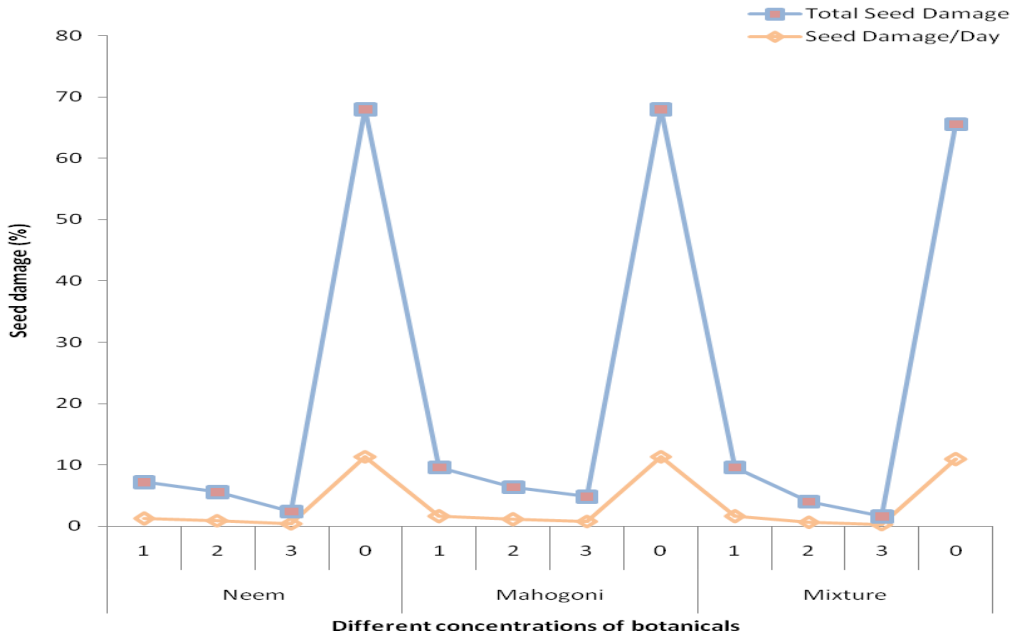

Fig. 1. Effect of both botanicals and their different concentrations on seed damage by the test insects (*S. oryzae*).

Seed Weight Loss

Effect of botanicals (Neem, Mahogoni and the mixture of Neem and Mahogoni), their different concentrations (1%, 2%, 3% and 0%) and both botanicals and concentrations at different hours after treatment on the percentage of seed weight loss caused by rice weevil were evaluated in this experiment and presented in Table 2 and 3, and Fig. 2.

Table 3. Effect of different concentrations of the botanicals on seed weight loss by the test insects (*S. oryzae*).

Concentration (%)	Seed Weight Loss (%)	
	Seed weight loss per day	Total seed weight loss until death
1	0.39 b	1.97 b
2	0.30 b	1.51 b
3	0.22 b	1.13 b
0	8.43 a	42.16 a
LS	* *	* *
Mean	2.34	11.69
SE±	2.03	10.15

LS = Level of significance
* * = Significant at 1% level
SE = Standard error
Conc. = Concentration
Within table different letter(s) in same column indicate that they are significantly different by DMRT.

Effect of botanicals on seed weight loss

Effect of botanicals (Neem, Mahogoni and the mixture of Neem and Mahogoni) on the seed weight loss caused by the rice weevil till five consecutive days was statistically insignificant (Fig. 2). But numerically, it was very apparent that the highest total seed weight loss (12.66%) was found in seed treated with Neem and the lowest (11.21%) was recorded against Mahogoni and mixture.

Likewise, the lowest average seed weight loss (2.24%) was observed in seed treated with both Mahogoni and the mixture and the highest average seed weight loss (2.53%) was observed in seed treated with Neem.

The efficacy order of botanicals (Neem, Mahogoni and the mixture of Neem and Mahogoni) to protect the seed weight loss by the rice weevil, *S. oryzae* L. could be arranged as Mahogoni = mixture (Neem+Mahogoni) > Neem.

The little difference in seed weight loss percentage caused by rice weevil might be owing to little insignificant variation in toxic effect, composition and functioning of three botanicals (Neem and Mahogoni)

on the test insects, resulting in almost alike reduction of weight loss of the grains, damaged by the insects.

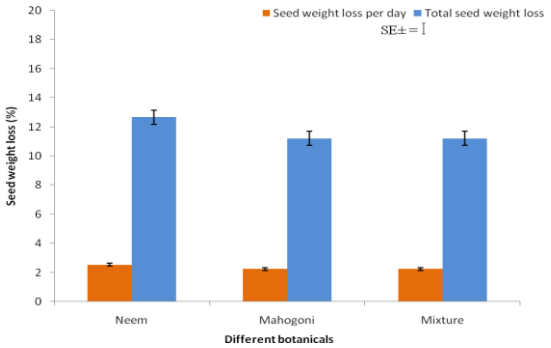

Fig. 2. Effect of botanicals on seed weight loss by the test insects (*S. oryzae*).

Effect of different concentrations of botanicals on seed weight loss

Effect of different concentrations (1%, 2% and 3% with control, 0%) of the botanicals on the seed weight loss caused by the rice weevil *S. oryzae* was observed statistically significant (Table 3). The result represented that the highest total seed weight loss (42.16%) was recorded in untreated seed (0%) followed by 1% concentration (1.97%) and the lowest total seed weight loss (1.13%) was found in seeds treated with high concentration (3%) preceded by 2% concentration (1.51%).

Similarly, the highest average seed weight loss (8.43%) was recorded in untreated seed (0%) for no toxicity and the lowest average seed weight loss (0.22%) was recorded in seed treated with high concentration (3%) for high toxicity.

Therefore, the order of three concentrations and control to protect the weight loss of seed by *S. oryzae* L. could be ranked as 3%>2%>1%>control (0%).

However, the significant variation in seed weight loss caused by rice weevil might be resulted from disparate presence of toxic chemical elements at different concentrations of botanicals along with their dissimilar functioning that prevent the seed weight loss to different degree.

Effect of both botanicals and their concentrations on seed weight loss

The effect of both botanicals (Neem, Mahogoni and the mixture of Neem and Mahogoni) and their different concentrations (1%, 2%, 3% and control, 0%) on the seed weight loss done by rice weevil was statistically insignificant (Table 4). But numerically, the highest total seed weight loss (45.92%) was estimated in 0% concentration (control) of Neem followed by its 1% concentration (2.08%) and the lowest total seed weight loss (1.08%) was also observed in 3% concentration of Neem.

Table 4. Effect of both botanicals and their different concentrations on seed weight loss by the test insects (*S. oryzae*).

Name of the botanicals Neem	Conc. (%)	Seed Weight Loss (%)	
		Seed weight loss per day	Total seed weight loss until death
Neem	1	0.42	2.08
	2	0.32	1.58
	3	0.21	1.08
	0	9.18	45.92
Mahogony	1	0.37	1.88
	2	0.29	1.46
	3	0.22	1.10
	0	8.08	40.38
Mixture	1	0.39	1.96
	2	0.30	1.50
	3	0.24	1.21
	0	8.03	40.17
LS		NS	NS
Mean		2.34	11.69
SE±		1.06	5.32

LS = Level of significance

NS = Non significance

SE = Standard error

Conc. = Concentration

on the same way, the highest average seed weight loss (9.18%) was observed in 0% concentration (control) of Neem and the lowest average seed weight loss (0.21%) was found in 3% concentration of Neem.

Hence, the efficacy of both botanicals and their concentrations with control on protection of seed from damage by *S. oryzae* were hierarchally ranked as Neem(3%) >Mahogoni(3%) >mixture(3%)> Mahogoni(2%)> mixture(2%) >Neem(2%)>

Mahogoni(1%)> mixture(1%) > Neem(1%)> control (0%).

Moreover, the result proved that seed weight loss percentage is inversely proportional to the level of concentrations of botanicals.

Finally, the dissimilarity observed in seed weight loss percentage occurred because the botanicals contained different concentration levels (0%, 1%, 2% and 3%) that functioned against rice weevil in different degree to protect the seeds from weight loss caused by them.

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