Efficacy of two plant extracts on rice weevil, S*itophilus oryzae* L.

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Abstract: The efficacy of nishinda (*Vitex negundo* L.) and bitter gourd leaf (*Momordica charantia* L.) extract was assessed on the basis of toxicity, repellency and antifeedant effects by rice weevil. Both the botanicals had repellent and antifeedant effects but nishinda leaf extract showed more toxic effect on the mortality (21.22%) for rice weevil. Comparing the extracts, the higher repellency was observed in bitter gourd leaf extract on rice weevil (48.13%). The results also showed that nishinda leaf extract had the higher antifeedant effects on rice weevil having total coefficient of deterrency 125.49. The ethanol leaf extract was more effective than those of water solvent. Insect mortality percent, coefficient of deterrency and in most of the cases, repellency rate increased proportionally with doses. Mortality percentage increased with the progress of time considering all the concentration.

Key words: Efficacy of Nishinda, bitter gourd, rice weevil.

Introduction

Rice weevil *Sitophilus oryzae* L. is the most common pest in all types of rice stores in Bangladesh but loss estimates due to this pest are scanty. Bhuiya *et al*., (1992) reported 11-16% weight loss of husked rice during 4 months of storage in the laboratory. The uses of chemical insecticides are the most potent technology, but it has ultimately fallen into disrepute both by farmers and traders. Chemical control of insects in storage has been used with serious draw breaks (Saharayaj, 1998). The synthetic insecticides are expensive and have in many cases only produced moderate results along with major ecological damage (Franzen, 1993).

In contrast, the low toxicity of botanical insecticides makes the processing and application of the product inexpensive. In many cases, the materials are locally available and affordable (Childs *et al*., 2001). Botanicals are a promising source of pest control compounds. The pool of plants possessing insecticidal substances is enormous (FAO, 1992). These have generated extraordinary interest in recent years as potential sources of natural insect control agents.

The use of locally available plants and their products as a bio-degradable component in the control of the storage pests is an ancient technology in many parts of the world. There is an urgent need for safe, effective and biodegradable pesticides with no toxic effects on non-target organisms. This has created a world wide interest in the development of alternative strategies including the search for new types of insecticides and use of age-old traditional botanical pest control agents (Heyde *et al*., 1983. The purpose of the study was to find out the effectiveness of locally available plants namely, Nishinda (*Vitex negundo* L.) and Bitter gourd (*Momordica charantia* L.) against Rice weevil for their insecticidal properties.

Materials and Methods

The rice weevil was collected from the stock culture of the laboratory of the Entomology Division, BINA, Mymensingh. The test insects were maintained in rice grain in the laboratory at 27-30^{0}C temperature and 70-75% relative humidity. Fresh leaves of Nishinda (*Vitex negundo* L.) and Bitter gourd (*Momordica charantia* L.) were washed in running water and then they were dried in the oven at 60^{0}C to prepare fine dust. Oven dried plant materials were prepared by pulverizing the dried leaves in a magnetic stirrer. A 25-mesh diameter sieve was used to obtain fine & uniform dust and preserved them into air tight plastic jar, till their use in extract preparation. At first twenty grams of each category of dust were taken in a 600 ml beaker and separately mixed with 200 ml of different solvents (distilled water and ethanol). Then the mixture was stirred for 30 minutes by a magnetic stirrer (at 6000 rpm) and left to stand for 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 80^{0}C and 55^{0}C temperature for water and ethanol extracts respectively. 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.

Direct Toxicity Test

The adult insects were chilled for a period of 10 minutes. Then the immobilized insects were picked up individually by using a small suction tube. One µl solutions of different concentrations (7.5, 10.0, 12.5 and 15.0%) were applied to the dorsal surface of the thorax of each insect using a fine micro-pipette. After treatment, the insects were transferred into 9 cm diameter Petri dish @ 10 insects per Petri dish containing food. Insects were examined daily and those that did not move or respond to gentle touch were considered as dead. Insect mortalities were recorded at 24, 48 and 72 hours after treatment (HAT). Observed mortalities or the insects were corrected by Abbott's formula (Abbott, 1987)

$$\text{Corrected mortality} = \frac{\text{observed mortality} - \text{control mortality}}{100 - \text{control mortality} \times 100} \times 100$$

Thirty insects, in 3 replicates of 10 insects each, were treated at each dose. In the control, same number of insects was treated with solvent only. The mean values were separated by DMRT (Duncan, 1951). The corrected mortality data were analysed by probit analysis (Finney, 1964) using MSTAT programme.

Repellency Test

Fifteen centimeter diameter Petri dish was divided into three parts, treated and untreated grain portion 5.5 cm each and neutral centre portion (without grain) 4 cm. Five grams of rice grain was taken in each side portion of Petri dishes for rice weevil. 0.5 ml of solution of difference dose 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 portion. 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 extract and for each dose. In the control side portion of Petri dish the grains were treated with solvent only. Then the number of insects on each portion (treated and untreated) was counted at hourly intervals up to the fifth hour. The data were converted to express percent repulsion (PR) by the following formula (Talukder and Howse, 1994).

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

Where, Nc = Percent insects in the untreated side portion of the Petri dish.

Positive values expressed the degree of repellency and negative values for the level of attractancy. Data (PR %) were analysed using ANOVA. The average values were then categorized into the following classes as outlined by (McDonald *et al.*, 1970).

Repellency rate	Class
>0.01-0.1%	0
0.1-20%	I
20.1-40%	II
40.1-60%	III
60.1-80%	IV
80.1-100%	V

Antifeedant Test

The feeding deterrent effects of Nishida and Bitter gourd on rice weevil, *S. oryzae* was determined by the method originally described by (Nawrot *et al*., 1986) and later modified by Talukder and Howse, 1994.

Results and Discussion

Two indigenous plant leaf extracts were evaluated against rice weevil, *Sitophilus oryzae*. The results of various experiments conducted during the study period are presented and discussed under the following subheadings.

Direct Toxicity Effects on Rice Weevil

The results of the direct toxicity effects of Nishida and Bitter gourd leaf extracts on rice weevil *S. oryzae* are presented in Tables 1. Average mortality percentage of rice weevil at 24, 48 and 72 hours after treatment (HAT) indicated that Nishida leaf extract (21.22%) possessed more toxic effect comparing Bitter gourd leaf extract (10.44%). The order of toxicity of the two plant leaf extracts on rice weevil was: Nishinda>Bitter gourd. Mortality percentages were directly proportional to the time after treatment.

The effects of different plant leaf extracts of different solvents on the mortality of insects are presented in Table 1. It was observed that the toxicity of different plant leaf extracts was influenced by the solvents. The highest toxic effect was observed in ethanol extract of Nishinda (46.00%) and the toxic effect was found in water extract of Bitter gourd (14.67%) at 72 HAT. Average mortality percentage was also found directly proportional to the level of doses of plant leaf extracts (Table 1). Akhter (1997) reported that the extract of Nishinda showed moderate toxic effects on red flour beetle.

Table 1: Mean mortality percentage of *Sitophilus oryzae* treated with plant leaf extracts, solvents and different doses by topical application method at different HAT

Name of the plant leaf extracts		Mortality percent			
		24 HAT	48 HAT	72 HAT	Average value
Nishinda		6.00e	21.67b	36.00a	21.22a
Bitter gourd		4.33e	9.33d	17.67c	10.44b
Name of the plant leaf extracts	Name of the solvents used in extract				
Nishinda	Water	5.33ef	16.00d	26.00b	15.78b
	Ethanol	6.67ef	27.33b	46.00a	26.67a
Bitter gourd	Water	4.00f	8.67ef	14.67d	9.11c
	Ethanol	4.67f	10.00e	20.67c	11.78bc
Name of the plant leaf extracts	Doses (%)				
Nihinda	7.5	5.00	21.67	38.33	21.67
	10.0	8.33	26.67	43.67	26.22
	12.5	8.33	28.33	43.33	26.67
	15.0	8.33	28.33	45.00	27.22
Bitter gourd	7.5	3.33	5.00	13.33	7.22
	10.0	3.33	10.00	18.33	10.55
	12.5	6.67	11.67	25.00	14.45
	15.0	6.67	18.33	28.33	17.78

Data were evaluated by using Abbott's formula, HAT= Hours after treatment

Table 2. Relative toxicity (by probit analysis) of two plant leaf extracts treated against rice weevil, *S. oryzae* at different hours of treatment

Name of the extracts	Hours after treatment	No. of insect used	LC_{50} value %	95% fiducial limit	χ^2 value	Slope ± SE
Nishinda	24 HAT	240	21.37	$0.48\text{-}9.5\times10^4$	0.47	0.89 ± 0.06
Bitter gourd		240	62.53	8.59-454.94	0.74	2.15 ± 0.08
Nishinda	48 HAT	240	19.92	7.95-49.84	0.33	1.02 ± 0.04
Bitter gourd		240	23.51	15.06-36.67	0.50	3.13 ± 0.06
Nishinda	72 HAT	240	3.79	0.63-22.72	1.82	0.87 ± 0.04
Bitter gourd		240	15.85	12.06-20.83	0.09	2.39 ± 0.04

The repellency rates of insects were influenced by the concentrations of extracts shown in Table 3. Repellency rate did not increase proportionally with the doses. The highest mean repellency effect was found with 15% Bitter gourd extract (60.67%). Islam (2001) reported that the leaf extract of Bitter gourd showed moderate repellent effects on granary weevil and the leaf extract of Nishinda had moderate repellent effect on red flour beetle (Akhter, 1997). From the above results, it was found that Bitter and Nishinda extracts have moderate repellent effects against rice weevil and agreed with the previous findings.

Table 3. Repellent effect of different plant leaf extracts in different solvent and dose level on rice weevil, *S. oryzae* using treated rice grains

Name of the plant leaf extracts		Repellency rate (%)					Mean repellency rate %	Repellency class
		1HAT	2HAT	3HAT	4HAT	5HAT		
Nishinda		26.67b	30.00b	52.00a	53.33a	56.67a	43.67b	III
Bitter gourd		22.67b	54.67a	57.33a	54.00a	52.00a	48.13a	III
Name of the plant leaf extracts	Name of the solvents used in extract							
Nishinda	Water	36.00c-f	30.67ef	36.00c-f	41.33c-f	45.33cd	37.87c	II
	Ethanol	17.33g	29.33f	68.00ab	65.33ab	68.00ab	49.60b	III
Bitter gourd	Water	29.33f	33.33d-f	44.00cd	48.00c	42.67c-e	39.47c	II
	Ethanol	16.00g	76.00a	70.67ab	60.00b	61.33b	56.80a	III
Name of the plant leaf extracts	Doses (%)							
Nishinda	7.5	33.33	23.33	56.67	46.67	56.67	43.33	III
	10.0	36.67	36.67	53.33	60.00	63.33	50.00	III
	12.5	30.00	36.67	53.33	63.33	53.33	47.33	III
	15.0	20.00	40.00	60.00	60.00	66.67	49.33	III
Bitter gourd	7.5	16.67	53.33	53.33	56.67	50.00	46.00	III
	10.0	33.33	63.33	60.00	56.67	60.00	54.67	III
	12.5	23.33	63.33	70.00	56.67	60.00	54.67	III
	15.0	36.67	60.00	63.33	70.00	73.33	60.67	IV

From the interaction of plant leaf extract, dose and time, the mortality percentage at 72 HAT indicated that the Nishinda 15% leaf extract possessed the highest toxic effect (45.00%) on rice weevil. Same trend was also observed at 24 and 48 HAT. Average values indicated that mortality percentage differed significantly between plant leaf extracts, solvents and doses. The interaction effects of plant leaf extract-time and plant leaf extract-solvent-time were found to be significant at 1% level of probability. But the interaction effects of plant leaf extract-dose-time showed no significant effect on insect mortality.

Probit analysis for direct toxicity

The results the probit analysis for the estimation of LC_{50} values and their 95% fiducial limits and the slope of regression lines at 24, 48 and 72 HAT for the mortality of rice weevil showed in Table 2. The LC_{50} values of Nishinda at 24, 48 and 72 HAT were 21.37%, 19.92% and 3.79% respectively and for Bitter gourd were 62.53%, 23.51% and 15.85% respectively. Between two plant leaf extracts, LC_{50} values at 72 HAT indicated that the Nishinda extract (3.79%) was highly toxic.

Table 4. Antifeedant effect of different plant leaf extracts in solvent and different dose level on rice weevil, *S. oryzae*

Name of the plant leaf extracts		Co-efficient of deterrency (%)			Efficacy of extracts
		Absolute	Relative	Total	
Nishinda		60.93a	64.56a	125.49a	+++
Bitter gourd		49.40b	52.85b	102.25b	+++
Name of the plant leaf extracts	Name of the solvents used in extract				
Nishinda	Water	58.30c	61.37c	119.67c	+++
	Ethanol	63.55a	67.75a	131.30a	+++
Bitter gourd	Water	36.97d	40.25d	77.22d	++
	Ethanol	61.83b	65.44b	127.27b	+++
Name of the plant leaf extracts	Doses (%)				
Nishinda	7.5	45.63e	50.00e	95.63e	++
	10.0	55.92d	59.75d	115.67d	+++
	12.5	66.72b	69.88b	136.60b	+++
	15.0	75.42a	78.64a	154.06a	++++
Bitter gourd	7.5	36.37f	39.47f	75.84f	++
	10.0	44.46e	48.68ef	93.14e	++
	12.5	55.22d	59.49d	114.71d	+++
	15.0	61.55c	63.74c	125.29c	+++

Within column values followed by different letter(s) are significantly different by DMRT

Antifeedant effect on rice weevil

The results of antifeedant effects of Nishinda and Bitter gourd plant leaf extracts on rice weevil are presented in Table 4. All the extracts had moderate inhibitory effects on the feeding activities of rice weevil. Between the two plant leaves extracts tested, Nishinda had the higher absolute deterrency (60.93) and Bitter gourd had the lower effect (49.40). In case of relative deterrency, Nishinda also showed the higher effect (64.56) followed by Bitter gourd (52.85).

Considering the total effects, the Nishinda possessed the higher feeding deterrent effect (125.49), whereas Bitter gourd possessed the deterrent effect (102.25). Talukder and Howse, (1994) reported that the plant extracts had feeding deterrent effects on *Tribolium castaneum*. The absolute and relative coefficients represented the no choice and choice tests respectively. When the insects had no opportunity to choice between treated and control disks (no choice test), adults consumed either a small amount of the treated disks or a large amount of the control disks, which gave low absolute coefficient values. But, when they had the opportunity to choose between treated and control disks (choice test), the adults directed their feeding activity to control ones, which produce high relative coefficient values. The differences of coefficient deterrent values

among different plant extracts were found to be significant at 1% level of probability.

The results of present investigation on antifeedant effect influenced by solvents are presented in Table 4. Among the two solvents, the ethanol extract of Nishinda possessed the higher total feeding deterrent effect (131.30) and water extract of Bitter gourd possessed lower total feeding deterrent effect (77.22). The interaction of antifeedant effects of plant leaf extract and solvent were significant at 1% level of probability and Nishinda leaf extract had strong antifeedant effect on red flour beetle.

Mean antifeedant effect of different plant leaf extracts in different dose level on rice weevil is shown in Table 4. The coefficient of deterrency increased proportionally with the increase of doses. The highest total coefficient of deterrency occurred in 15% concentration of Nishinda leaf extract (154.06) and the lowest in 7.5% of Bitter gourd leaf extract (75.84). The coefficient of deterrency values of different doses of plant leaf extracts was statistically significant at 5% level of probability.

It was observed that the Nishinda leaf extract possessed the higher toxic effect on rice weevil than Bitter gourd and the LC_{50} value of Nishinda extract for rice weevil at 72 HAT indicated that Nishinda was more toxic plant for this insect. Ethanol extract of plant was more efficient than that of water extract. Insect mortality percentage, coefficient of deterrency and in most the cases, repellency rate increased proportionally with doses. Mortality percentage increased but the repellency effect decreased with the progress of time. The use of botanical materials as insecticides will benefit our agricultural sector. They are not only of low cost, but have no environmental impact in term of insecticidal hazard. Therefore, the findings of the present experiment will of immense importance to screen out botanical materials/extracts in controlling our storage pest successfully and will enable us to save precious foreign currency from importing synthetic insecticides in this regard.

References

Abbott, W.S. 1987. A method of computing the effectiveness of an insecticide. *J. American Mosquito Control Assoc.* 3(2): 302-303.

Akhter, S. 1997. Repellent, Toxic and Antifeedant effects of Bishkatali, Nishinda and Pithraj on red flour beetle and lesser grain borer of stored grains. M. S. Thesis, Dept. of Entomology, Bangladesh Agril. Univ., Mymensingh. pp. 38-73.

Bhuiya, M.I.M, Alam, S. and Karim ANMR. 1992. Losses to stored rice caused by rice weevil and angoumois grain moth, and their control in Bangladesh. *Bangladesh. J. Agric. Sci.* 19 (1): 13-18.

Childs, F.J, Chamberlain, J.R and Antwi, E.A. 2001. Improvement of neem and its potential benefits to poor farmers. Department of International Development. UK. pp. 32.

Duncan, D.B. 1951. A significance test for differences between ranked treatments in an analysis of variance. *Virginia. J. Sci.* 2: 171-189.

FAO, 1992. Pesticide residues in food. Report no. 116. Rome.

Finney, D.J. 1964. Statistical method in Biological Assay (2nd edition). Charles Griffin & Co., London. 668p.

Franzen, H. 1993. Need for development of new strategies for locust control. In: New strategies for locust control. Ed: Rembold, H. ATSAF. Bonn; 89. pp. 9-13.

Heyde, J.V.D, Saxena, R.C. and Schmutterer, H. 1983. Neem oil and neem extracts as potential insecticides for control of Hemipterous rice pests. Proc. 2nd Int. Neem Conf. Rauischholzhausen. pp. 377-390.

McDonald, L.L, Guy, R.H. and Speirs, R.D. 1970. Preliminary evaluation of new candidate materials as toxicants, repellents and attractants against stored product insects. Marketing Res. Report No. 882. Agric. Res. Serv., U. S. Dept. Agric. Washington, D. C.8 p.

Nawrot, J., Bloszvk, E., Harmatha, J., Novotny, L. and Drozdz, H. 1986. Action of antifeedants of plant origin on beetles infesting stored products. *Acta Entomol. Bohemoslovaca*. 83: 327-335.

Sahayaraj, K. 1998. Antifeedant effect of some plant extracts on the Asian armyworm, *Spodoptera litura* (Fabricius). *Current Science*, India. 74(6): 523-525.

Talukder, F.A. and Howse, P.E. 1994. Laboratory evaluation of toxic and repellent properties of pithraj, *Aphanamixis polystachya* Wall and Parker, against *Sitophilus oryzae* L. *Int. J. Pest Management*. 40 (3): 274-279.