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Evaluation of Botanical Product as Grain Protectant Against Grain Weevil, *Sitophilus granarius* (L.) on Wheat

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Abstract: The present study was carried out to evaluate the botanical products viz. leaf powder and extract of Nishinda (*Vitex negunda* Linn.), eucalyptus (*Eucalyptus macrorhyncha* F.muell.), Bankalmi (*Ipomoea* sp.), ash of babla wood (*Acacia arabica* Willd), oil of neem (*Azadirachta indica* A. Juss.), sesame (*Sesamum indicum*) and safflower (*Carthamus tinctorius*) against the attack of grain weevil (*Sitophilus granarius*) on wheat. The results showed that the higher concentration of oil (0.25-1.0%) indicated the lower infestation, less emergence of adults, less seed damage, less weight loss and higher inhibition rate. Neem oil was most effective in checking the insect infestation and allowing the least number of F₁ adults emerged from the seed. The wood ash was found highly effective in prohibiting the adult emergence (F₁) with higher inhibition rate and showed reduction in seed damage and weight loss(%) over other treatment. It was concluded that botanical product acted as insect antifeedant and the order of toxicity of three plant leaf extracts on grain weevil were : nishinda> eucalyptus> bankalmi.

Key words: Botanical product, grain protectant, *Sitophilus granarius*, toxicity effect, antifeedant

Introduction

The grain weevil, *Sitophilus granarius* (L.) is a major problem in storage causing significant annual losses of wheat all over the world (Khanam *et al.*, 1990). Grain weevil can cause losses to wheat in storage either directly through consumption of the grain or indirectly producing 'hot spots' causing migration of moisture and thereby making grain more suitable for other pests (Chowdhury and Pathak, 1990). The damaged wheat grain become unfit for consumption and planting. The use of chemical pesticides to protect cereal crops against the attack of grain weevil in storage may cause serious health hazards (Bhaduri *et al.*, 1989; Talukder and Howse, 1994). In developing countries, the indiscriminate, regular and routine use of synthetic pesticides for the control of insect pest has led to a number of problems, such as insect pest resistance, resurgence, environmental pollution, ecological imbalance and residues in market produce. On the other hand, botanical pesticides are safe, less hazardous and biodegradable (Talukder and Howse, 1993, 1995). These facts have drawn researcher's interest in plant and plant products as source of pesticides and during the last few years, a number of investigators isolated and identified chemical compounds from leaves and seeds of many plant species as insect antifeedants. The potential antifeedant activities of neem oil have been reported for several insect pests, both in storage and field (Ramzan, 1994; Seck, 1994; Xu-Hanhony and Zhao-

Shanhuan, 1994). This study was undertaken to evaluate the efficacy of botanical products as grain protectants on the feeding response and survival of *Sitophilus granarius*.

Materials and Methods

An experiment was conducted in the laboratory of the Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh. The grain weevil, *Sitophilus granarius* (L.) were collected from the LSD godown of Jamalpur and reared on a diet of wheat (var. Balaka) grain in jar. Wheat grains were collected from villages near Bangladesh Agricultural University, Mymensingh Campus. Grain weevils were reared in the laboratory at 27-30°C temperature with 70-75% relative humidity. Fifty pairs of adult grain weevil (2-6 days old) were introduced in jar containing the rearing media of wheat grain. The jars were sealed and a maximum of 7 days were allowed for free mating and oviposition. Then the parent stocks were removed and the egg containing media were transferred to pre-conditional media of wheat grain in the breeding jar. The jars were covered with muslin cloth secured with rubber bands to prevent the contamination and escape of insects. Seeds of neem, safflower and sesame and leaf of nishinda, eucalyptus and bankalmi were collected from BAU campus for oil, powder and extract preparation. Babla wood was also collected for preparation of ash.

Table 1: Surface protectant effect of different oils (v/w) on grain weevil, *Sitophilus granarius* L.

Oils	No. of F1 adult emerged (%)				Seed damage (%)			
	0.25	0.50	0.75	1.00	0.25	0.50	0.75	1.00
Neem	34.50c	29.00b	7.50c	3.25b	13.25c	11.50b	4.75c	2.50b
Safflower	37.25bc	31.00b	8.50c	3.50b	14.25bc	12.25b	5.75c	3.00b
Sesame	42.50b	35.25b	16.00b	4.50b	17.75b	13.25b	11.00b	3.25b
Control	71.00a	71.00a	71.00a	71.00a	31.00a	31.00a	31.00a	31.00a
S ⁻ x value	1.54	1.54	1.54	1.54	1.09	1.09	1.09	1.09
	Weight loss (%)				Inhibition rate (%)			
	0.25	0.50	0.75	1.00	0.25	0.50	0.75	1.00
Neem	3.98b	3.46b	1.53b	0.76b	51.16a	58.36a	89.42a	95.40a
Safflower	3.82b	3.73b	1.81b	0.64b	47.60ab	56.40a	88.10a	95.03a
Sesame	5.83b	4.23b	3.11b	1.11b	40.18b	50.20a	77.50b	93.70a
Control	9.98a	9.98a	9.98a	9.98a	-	-	-	-
S ⁻ x value	0.82	0.82	0.82	0.82	2.24	2.24	2.24	2.24

Values followed by different letters within a column are significantly different at the 5% level of probability (DMRT)

Table 2: Residual toxicity of different leaf powders and wood ash on grain weevil, *Sitophilus granarius* L.

Powders	No. of F ₁ adult emerged (%)		Seed damage (%)		Weight loss (%)		Inhibition rate (%)	
	2	3	2	3	2	3	2	3
Nishinda	77.75c	61.00d	29.25bc	23.75bc	7.19c	6.59b	32.56b	47.16a
Eucalyptus	83.00c	71.00c	31.00bc	26.50bc	8.88bc	6.86b	27.92b	38.54b
Bankalmi	104.75b	93.75b	37.25b	27.25b	10.88b	7.30b	9.29c	18.73c
Ash	63.00d	56.50d	25.75c	18.75c	7.14c	5.02b	45.32a	51.05a
Control	115.50a	115.50a	46.00a	45.00a	15.51a	14.53a	-	-
S ⁻ x value	1.85	1.85	2.69	2.69	1.16	1.16	2.69	2.69

Values followed by different letters within a column are significantly different at the 5% level of probability (Duncan's multiple range test)

Table 3: Direct toxicity effect (by dipping method) of different leaf extracts on grain weevil, *Sitophilus granarius* L.

Leaf extracts	Dose (%)	% Insect mortality rate (HAT)		
		24	48	72
Nishinda	2	13.06ab	29.72a-d	41.66c-e
	4	21.11a	27.78a-c	61.11ab
	6	20.83a	43.05a	72.22a
Eucalyptus	2	10.28bc	26.67b-d	36.11de
	4	18.06ab	34.72a-c	49.99b-d
	6	15.82ab	40.5ab	52.77bc
Bankalmi	2	5.00c	18.89d	30.55e
	4	10.28bc	24.17cd	36.11c-e
	6	15.56ab	29.43a-d	41.66c-e
S ⁻ x value		3.05	3.05	3.05

*Values followed by different letters within a column are significantly different at the 5% level of probability (Duncan's multiple range test).

*HAT = Hour after treatment

Oil, Powder, Ash and Extract preparation: Thousand g seeds each of neem, sesame and safflower were ground separately in blender and soaked overnight in water. The soaked seeds were boiled for 2 h and cooled. Scums formed over the liquid was collected carefully keeping the residue below. The collected scum was boiled for extraction of oils.

Approximately 500 g of leaves of nishinda, eucalyptus and bankalmi were separately washed after their collection and then air-dried in the shade. Then they were ground in an electric grinding machine and passed through a 25-mesh sieve to obtain fine dust.

Babla wood was dried in the sun. Then the babla wood was burnt, ash was cleaned and collected from the oven. After cooling, the ash was put in the jar and covered it

air-tight to prevent the absorption of air moisture. A 25 diameter sieve was used to obtain fine ash.

Ground leaves (10g) of nishinda, eucalyptus and bankalmi were separately mixed with 50 ml acetone and the mixture was then stirred for 30 min. in a magnetic stirrer and left to stand for next 24 h. The mixture was then filtered through a fine cloth. The filtered solution was then boiled for solvent evaporation at 80-85°C in a water bath until the constant weight of extract was gained. Extracts were preserved in tightly corked bottles and stored in a refrigerator until their uses for insect bioassay.

Bioassays

Surface protectant effects: Oil of neem, sesame and safflower were mixed separately with wheat grain @ 2.5, 5.0, 7.5 and 10.0 ml kg⁻¹ seeds. The oils were diluted with petroleum ether. Conical flasks containing 40 g grains and oil mixture were shaken manually to ensure uniform application of oils with the wheat grain. After proper shaking, the seeds were taken out and air-dried for 1 h at room temperature. Treated wheat grains (10 g) were kept in each plastic pot. There were 15 treatments, each being replicated thrice. Five pairs of grain weevil (5 female and male) were then released in each pot and were closed with lid for next 7 days.

Residual toxicity test: Leaf powders of nishinda, eucalyptus, bankalmi and babla wood ash were mixed with wheat grain (rearing media) @ 2 and 3% by weight

and kept overnight. Treated wheat grain (10 g) was put into separate plastic pot (3.5×4 cm). Control pots contained normal food only. Ten adult grain weevils were introduced at the centre of plastic pot containing food and closed with lid for next 7 days to allow them for oviposition.

Direct toxicity by dipping method: Leaf extracts of nishinda, eucalyptus and bankalmi were diluted with acetone to make 2, 4 and 6% solution. Five pairs of adult grain weevil (3–5 days old) were taken at the centre of the filter paper and they were dipped for 3–5 s in diluted extract solution. Then the insects were returned to the petri dishes containing insect food (5 g wheat grain). Mortality were observed at 24, 48 and 72 h after treatment (HAT).

Weight loss and inhibition rate (%) were calculated using the following formulae:

$$\text{weight loss(\%)} = \frac{(\text{Und}) - (\text{DNu})}{\text{U}(\text{Nd} + \text{Nu})} \times 100$$

Where U = Weight of undamaged seed
D = Weight of damaged seed
Nd = Number of damaged seed
Nu = Number of undamaged seed

$$\text{Inhibition rate(\%)} = \frac{\text{Cn} - \text{Tn}}{\text{Cn}} \times 100$$

Where, Cn = Number of insects in control pot and
Tn = Number of insects in treated pot

Results and Discussion

Surface protectant effects: Surface protectant effect against grain weevil has been evaluated by comparing the number of F_1 adult emerged, seed damage percentage, weight loss percentage and inhibition rate in the food treated with 0.25, 0.50, 0.75 and 1.00% plant oils (Table 1). The least number of F_1 adults were emerged from the food were 34.50, 29.00, 7.50 and 3.25 respectively. Seed damage was also lower and significantly differed for the food treated with 1.00% neem oil than other in all concentration. The weight loss(%) was not significantly different at various concentration of oil. But the lowest was 0.64 in safflower oil at 1% concentration identical to neem (0.76) and sesame oil (1.11). The inhibition rate was significantly differed at 0.25 and 0.75% concentration. From this study it was observed that in all the parameters, the higher concentration of oil showed the lower

infestation i.e., least number of F_1 adult emergence for which the seed damage and weight loss and inhibition rate were less and higher, respectively. This finding was in strong agreement of Jood *et al.* (1993) who observed that the oil of neem acted as surface protectant of wheat grain against the larvae of *Trogoderma granarium* by reducing hatching (%) of grain.

Residual toxicity: Leaf powders and wood ash acted as seed protectant of wheat grain were evaluated by comparing the number of F_1 adult emerged, seed damage rate, weight loss (%) and inhibition rates (Table 2). Residual toxicity showed that the lowest number of F_1 adult emergence (63.00), seed damage rate (25.75%) followed by nishinda and eucalyptus, weight loss (7.14%) identical to nishinda and the maximum inhibition rate (45.32%) were found from wheat grain treated with 2% wood ash. In case of 3% mixture similar observations in F_1 adult emergence, seed damage rate, percentage weight loss and inhibition rate were observed. The lowest number of F_1 adult emergence (56.50), least seed damage rate (18.75%) followed by nishinda and eucalyptus, weight loss percentage (5.02%) identical to nishinda, eucalyptus and bankalmi and the maximum inhibition rate (51.05%) identical to nishinda were observed from the wheat treated with 3% wood ash. Between the two treatment rates, emphasis was given on lower rate (2%) because it might be economically profitable. The present findings agrees with the report of Gonzalez and Lagunes (1986) who stated that leaf powder and wood ash were effective for reducing seed damage rate.

Direct toxicity effect: Direct toxicity effects of three different plant leaf extract (2, 4 and 6%) were evaluated through mortality data at 24, 48 and 72 h after treatment (Table 3). It was found that the nishinda extract revealed the highest toxic effect and bankalmi extract showed the lowest toxic effect on grain weevils at 2, 4 and 6% rate of leaf extract. The order of toxicity of three extracts on grain weevils were as such nishinda > eucalyptus > bankalmi. Mortality(%) showed their proportional relation to the level of concentration with time. De-pedro and De-pedro (1994) observed that crude plant extracts were toxic to corn weevil and their findings are in accordance of the present results.

The botanical products are not only of low cost, but also have less hazardous effect. It is easy to process by farmers at village level using very simple methods. Therefore, the application of plant products will be ideally suited by farmers and consumers in developing countries like Bangladesh in storage pest management systems without using costly methods or expertise.

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