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REPELLENT EFFECT OF PLANT EXTRACTS FOR MANAGEMENT OF RICE WEEVIL, *Sitophilous oryzae* L.

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ABSTRACT

The leaf and seed/fruit extracts of karanja, *Pongamia pinnata* (L.); mahogany, *Swietenia mahogani* Jacq.; neem, *Azadirachta indica* and urmoi, *Sapium indicum* Willd. @ 2.0, 4.0, 6.0, 8.0 and 10.0% (w/v) concentrations were evaluated for their repellent effect against rice weevil, *Sitophilus oryzae*. Among the four extracts tested, urmoi showed the highest mean repellent effect (53.04%). The rate of repellency differed with the extract type. The repellency effects of fruit extracts were higher than that of leaf extracts i.e. mean repellency of urmoi fruit extract was 56.17% and leaf extract was 49.86%. Among three solvents neem n-hexane extract showed the highest repellency effect (59.86%). The repellency rates of insects were influenced by concentrations of the extracts. Repellency rate increased proportionally with the increase of doses. The results indicated the possibility of further use of 10% urmoi extracts as an alternative control measure for rice weevil instead of using the costly and hazardous synthetic insecticides.

Key words: Plant leaf extract, seed extract, repellent effect, rice weevil.

Introduction

Insect pests cause considerable losses to stored rice, which may affect the food availability of a large number of people, particularly in the developing countries like Bangladesh. The rice weevil, *Sitophilus oryzae* (Linnaeus) (Coleoptera: Curculionidae), is one of the most widespread and destructive major insect pests of stored product throughout the world (Plague *et al.*, 2010; Khani *et al.*, 2011). Bhuiyan *et al.* (1992) reported 11-16% weight loss of husked rice during 4 months of storage in the laboratory. The poor storage facilities of the farmers in developing countries, which are unsuitable for effective conventional chemical control (Tapondjou *et al.*, 2002), emphasize the necessity of new and effective methods for insect pest control of stored products. Thus, there is an urgent need to develop safe alternatives to conventional insecticides and fumigants for the protection of grain products against insect infestations. The repellents are desirable chemicals as they offer protection with minimal impact on the ecosystem, as they drive away the insect pest from the treated materials by stimulating olfactory or other receptors. Repellents from plant origins are considered safe in pest control; minimize pesticide residue; ensure safety of the people, food, and environment (Talukder, 2006; Maia and Moore, 2011). The plant extracts, powders, and essential oil from the different bioactive plants were reported as repellent against stored grain insect pests (Talukder *et al.*, 2004; Koul *et al.*, 2008).Therefore, the present research work was undertaken with four indigenous plants to evaluate their repellent effect to serve as basis for development of new strategies for rice weevil, *S. oryzae* management in storage conditions, particularly for use in small-holder farms.

Materials and Methods

The study was conducted to know the most effective repellent plant extract for management of rice weevil in the laboratory of the Entomology Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh.

Insect rearing: The rice weevil was collected from the stock culture of the Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh-2202. The rice weevil was reared in round plastic jars (12 x 23 x 6.5cm in size) with rice grains (13 to 14% moisture) in growth chamber at 28±5°C temperature and R.H. 75±5% in the Entomology laboratory of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh.

Collection and preparation of plant sample: Fresh leaves and fruits of karanja *(Pongamia pinnata* L.); mahogany, *Swietenia mahogani* Jacq. and neem, *A. indica* were collected from BAU. Leaves and fruits of urmoi, *Sapium indicum* Willd. were collected from Chalna under the District of Khulna. After collection, all fresh leaves of the test plants were washed with water and kept in the shade up to 15 days for air-drying. Mature seeds were collected from fresh fruits of karanja, mahogany, neem and mature fruits were collected from urmoi. The dried plant materials were then ground separately with electrical grinder and sieving through 60 micron diameter sieve to obtain fine powder. The powder was preserved into plastic pot at low temperature (4˚C) till their use in extract preparation.

Extraction of plant materials: Prepared leaf, seed and fruit powder were used for preparation of plant extract following the method of Tikum *et al.* (2008). The dried plant powders (50 g) were taken into a 400 ml beaker. The powder of leaves, seeds and fruits were extracted with n-hexane, dichloromethane (DCM) and methanol, respectively. The extract was collected after 24 hours, filtered by fine cloth and concentrated by a rotary vacuum evaporator. The residual solvent was removed by high vacuum pump. Each of the extract was stored in a freezer until use.

Preparation of concentration: Stock solutions (20% w/v) of plant extracts were prepared by diluting the condensed extracts with respective solvent. Different concentrations (2.0, 4.0, 6.0, 8.0 and 10.0% w/v) of each category of plant extracts were prepared by dissolving them in the same solvent prior to insect bioassay.

Repellency Test: The experiment was conducted according to the method of Talukder and Howse (1995) with certain modification. Nine centimeter diameter Petri dish was divided into three parts, treated and untreated grain portion 3.5 cm each and neutral centre portion (without grain) 2 cm. Two grams of rice grain were taken in each side portion of Petri dish. 0.2 ml of each plant extracts at different doses (2.0, 4.0, 6.0, 8.0 and 10.0% w/v) was applied to a side portion of Petri dish as uniformly as possible with a pipette i.e. treated grain side portion and the other side is untreated side portion (control). The treated grain was then air-dried to evaporate the solvent completely. Ten (5 ♂ + 5 ♀) insects (1-2 weeks old) were released at the central portion of each Petri dish and a cover was placed on the Petri dish. Then the number of weevils on each portion (treated and untreated) was counted at hourly intervals up to the fifth hour. The data were converted to express per cent repulsion (PR) by the following formula as described by Talukder and Howse (1995): PR (%) = (Nc - 50) x 2; Where, Nc= Per cent 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 by ANOVA and significant mean values compared with DMRT. 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.

Results and Discussion

The repellency effects of different plant extracts are presented in Tables 1-4 and Figs. 1-3. Among the four extracts tested, urmoi showed the highest mean repellent effect (53.04%) followed by neem (47.20%), mahogany (44.13%) and karanja (41.02%). However, these differences were statistically significant. On the basis of mean repellency rate, it was found that all the plant extracts were in the same repellency class i.e. class III. karanja, mahogany, neem and urmoi extracts showed medium repellent effect on rice weevil. The rate of repellency differed with the extract type. The interaction effect of plant part and time was significant on rice weevil at 1-5 HAT. The repellency effects of seed/fruit extracts were higher than that of leaf extracts i.e. mean repellency of seed/fruit extract was 52.82% and leaf extract was 39.86% (Fig. 1). Repellent rate of different plant, plant parts and time is presented in Table 2. The interaction of mean repellent effect of plant, plant part and time was significant on rice weevil. The urmoi fruit extract showed the highest repellent effect (56.17%) whereas karanja leaf extract possessed least repellent effect (31.82%).

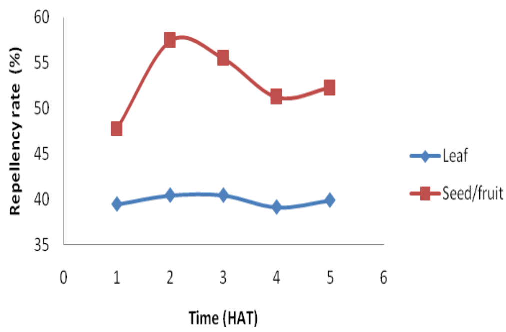

Fig.1. Repellent effect of different plant part extracts on rice weevil, *S. oryzae* using treated rice grains at different hours after treatment (HAT)

Table 1. Repellent effect of different plant extracts on rice weevil, *S. oryzae* using treated rice grains at different hours after treatment (HAT)

Plant extracts	Repellency rate (%)					Mean repellency (%)	Repellency class
	1 HAT	2 HAT	3 HAT	4 HAT	5 HAT		
Karanja	38.89 b	40.89 c	42.67 b	42.00 b	40.67 b	41.02	III
Mahogany	45.33 ab	44.00 bc	45.33 b	41.78 b	44.22 ab	44.13	III
Neem	40.44 ab	52.22 ab	48.67 ab	45.78 ab	48.89 a	47.20	III
Urmoi	49.78 a	58.67 a	55.11 a	51.22 a	50.45 a	53.04	III
$S_{\bar{X}}$	2.4894	2.3700	2.4544	2.5687	2.7754	-	-
Probability level	0.01	0.01	0.01	0.05	0.05	-	-

Table 2. Repellent effect of plant part extracts of different plants on rice weevil, *S. oryzae* using treated rice grains at different HAT

Plant extracts	Plant parts	Repellency rate (%)					Mean repellency (%)	Repellency class
		1 HAT	2 HAT	3 HAT	4 HAT	5 HAT		
Karanja	Leaf	33.78	32.00d	34.22	31.11b	28.00c	31.82	II
	Seed	44.00	49.78bc	51.11	52.89a	53.33a	50.22	III
Mahogany	Leaf	44.44	35.56d	36.00	32.44b	40.00b	37.69	III
	Seed	46.22	52.44b	54.67	51.11a	48.44ab	50.77	III
Neem	Leaf	32.44	38.22cd	41.33	44.44ab	44.00ab	40.08	III
	Seed	48.44	66.22a	56.00	47.11a	53.78a	54.31	III
Urmoi	Leaf	47.11	56.00ab	50.22	48.44a	47.56ab	49.86	III
	Fruit	52.44	61.33ab	59.99	53.78a	53.33a	56.17	III
$S_{\bar{X}}$		3.5205	3.3516	3.4711	3.6327	3.9250	-	-
Probability level		NS	0.01	NS	0.01	0.05	-	-

NS= Not significant. Within column values followed by different letter(s) are significantly different by DMRT.

On the basis of mean repellency rate, it was found that all the plant parts extracts were in the same repellency class i.e. class III except karanja leaf extract, which was in class II. The mean repellency rate of different plant extracts influenced by the different solvents is presented in Fig. 2. Among three solvents n-hexane extract showed the highest repellency effect (49.06%) and it was significantly different from dichloromethane extract (47.83%) and methanol extract (42.13%). The mean repellency rate of different plant extracts influenced by the different solvents is presented in Table 3. The highest mean repellency was observed in n-hexane extract of urmoi (59.86%) and the lowest in methanol extract of karanja (31.87%). The interaction effects of plants, solvents and time had significant effects on repellency rate of *S. oryzae*. Mean repellent effect of different plant extracts at different dose level on rice weevil is presented in Fig. 3.

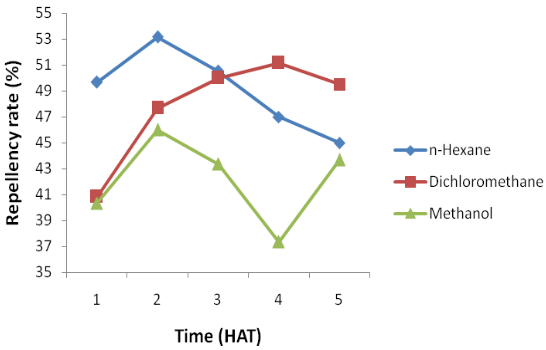

Fig. 2. Repellent effect of different solvents used in preparing different plant extracts on rice weevil, *S. oryzae* using treated rice grain at different HAT

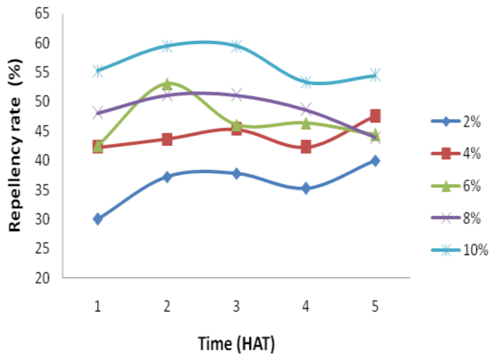

Fig. 3. Repellent effects of doses of different plant extracts on rice weevil, *S. oryzae* using treated rice grain at different HAT

Table 3. Repellent effect of plant extracts of different solvents on rice weevil, *S. oryzae* using treated rice grains at different HAT

Plant extracts	Solvents	Repellency rate (%)					Mean repellency (%)	Repellency class
		1 HAT	2 HAT	3 HAT	4 HAT	5 HAT		
Karanja	n-Hexane	37.33 bd	42.67bc	44.67a-c	42.67a-e	40.00bc	41.47	III
	DCM	46.67a-d	50.00ab	50.00a-c	52.67ab	49.33a-c	49.73	III
	Methanol	32.67d	30.00c	33.33c	30.67de	32.67c	31.87	II
Mahogany	n-Hexane	53.33a-c	48.67ab	44.67a-c	34.00c-e	36.00bc	43.33	III
	DCM	42.67a-d	40.00bc	46.67a-c	53.99ab	55.33ab	47.73	III
	Methanol	40.00a-d	43.33bc	44.67a-c	37.34b-e	41.33a-c	41.33	III
Neem	n-Hexane	53.33a-c	65.33a	60.66a	59.33a	60.67a	59.86	III
	DCM	36.00cd	46.00bc	48.00a-c	50.00a-c	46.67a-c	45.33	III
	Methanol	32.00d	45.33bc	37.33bc	28.00e	39.33bc	36.39	II
Urmoi	n-Hexane	54.66ab	56.00ab	52.00ab	52.00a-c	43.33a-c	51.60	III
	DCM	38.00b-d	54.67ab	55.00a	48.00a-d	46.67a-c	48.47	III
	Methanol	56.66a	65.33a	58.00a	53.00ab	61.33a	58.84	III
$S\bar{X}$		4.3117	4.1049	4.2512	4.4491	4.8072	-	-
Probability level		0.01	0.01	0.01	0.01	0.01	-	-

NS= Not significant. Within column values followed by different letter(s) are significantly different by DMRT.

The repellency rates of insects were influenced by concentrations of the extracts. Repellency rate increased proportionally with the increase of doses. The interaction effects of doses and time had significant effects on repellency rate**.** The repellency effects of different plant extracts at different dose level on rice weevil are shown in Table 4. The highest mean repellency was observed in 10% extract of urmoi (66.22%) and the lowest in 2% extract of mahogany (30.67%)**.** Among four plants, the mean repellency rates of 10% of all extracts were in class III except urmoi, which was in class IV. Repellency rate of urmoi extracts in different dose level was always higher than all other plant extracts of the same level. The interaction effects of plants, doses and time had no significant effects on repellency rate of S. *oryzae* except 5 HAT.

Table 4. Repellent effect of different plant extracts at different dose level on rice weevil, *S. oryzae* using treated rice grains at different HAT

Plant extracts	Dose (%)	Repellency rate (%)					Mean repellency (%)	Repellency class
		1 HAT	2 HAT	3 HAT	4 HAT	5 HAT		
Karanja	2.0	17.78	30.00	36.67	42.22	42.22a-d	33.78	II
	4.0	36.67	34.45	37.78	33.33	32.22cd	34.89	II
	6.0	36.67	40.00	32.22	40.00	31.11cd	36.00	II
	8.0	42.22	45.56	47.78	45.55	48.89a-d	46.00	III
	10.0	61.11	54.44	58.88	48.89	48.89a-d	54.44	III
Mahogany	2.0	37.78	35.56	34.44	21.11	24.44d	30.67	II
	4.0	45.55	42.22	46.67	42.22	52.22a-c	45.77	III
	6.0	43.33	48.89	44.44	50.00	51.11a-d	47.55	III
	8.0	47.78	41.11	48.89	42.22	40.00b-d	44.00	III
	10.0	52.22	52.22	52.22	53.33	53.33a-c	52.66	III
Neem	2.0	32.22	33.33	41.11	40.00	47.78a-d	38.88	II
	4.0	38.89	45.56	40.00	41.11	45.56a-d	42.22	III
	6.0	38.89	63.33	54.44	52.22	55.55a-c	52.88	II
	8.0	42.22	57.77	53.33	46.67	47.78a-d	49.55	III
	10.0	50.00	61.11	54.44	48.89	47.78a-d	52.44	III
Urmoi	2.0	32.22	50.00	38.89	37.78	45.56a-d	40.89	III
	4.0	47.78	52.22	56.67	52.22	60.00ab	53.77	III
	6.0	51.11	60.00	53.33	43.33	40.00b-d	49.55	III
	8.0	59.99	60.00	54.44	60.80	38.89b-d	54.82	III
	10.0	57.78	71.11	72.22	62.22	67.78a	66.22	IV
$S\bar{X}$		5.5664	5.2994	5.4882	5.7437	6.2060	-	-
Probability level		NS	NS	NS	NS	0.01	-	-

NS= Not significant. Within column values followed by different letter(s) are significantly different by DMRT.

It is evident from the results that all solvents are not equally effective for all plants and no solvent is found to perform well for all plants. So, it can be suggested that before making extract from plant, the type of solvent to be used should be determined first because it cannot be generalized that a particular solvent will be useful for all plants. Repellency rate did not increase proportionally with the doses. Islam *et al.* (2002a) reported that the urmoi plant extract showed moderate repellent effects on granary weevil and Kamruzzaman *et al.* (2004) showed that the urmoi plant extract had moderate repellent effect on rice weevil. From the above results, it was found that urmoi extracts have moderate repellent effects against rice weevil and agreed with the previous findings of Talukder and Howse (1994 a, b, 1995), Shahjahan *et al.* (2003), Mamun *et al.* (2008), Khanam *et al.* (2008) and Akther *at al.* (2013). Overall the study noted that urmoi extracts have moderate repellent effects on adult rice weevils. This study also confirms the validity of traditional use of urmoi against stored grain pests.

References

Akhtar, M., Arshad, M., Raza, A.B.M., Chaudhary, M.I., Iram, N., Akhtar, N. and Mahmood, T. 2013. Repellent effects of certain plant extracts against rice weevil, *Sitophilus oryzae* (Coleoptera: Curculionidae)**.** *Inter. J. Agril. Appl. Sci.* 5(1): 69-73.

Bhuiyan, M. I. M., Alam, S. and Karim, A. N. M. 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.

Islam, M.S., Shahjahan, M., Motaleb, M.A., Alam, M.M. and Das, A.K. 2002a. Repellency and antifeedant property of some indigenous plant extracts against granary weevil. *Bangladesh J. Envir. Sci.,* 8(1): 136-139.

Kamruzzaman, M., Shahjahan, M., Chowdhury, S. and Islam, M.F. 2004. Repellent effects of some indigenous plant extracts against rice weevil, *Sitophilus oryzae* (L.). *Bangaldesh J. Envir. Sci.,* 10: 271-275.

Khanam, M.L.A., Khan, A.R., Khalequzzaman, M. and Rahman, S.M. 2008. Effect of *Sapium indicum*, *Thevetia neriifolia* and *Jatropha gossypifolia* seed extract on the fecundity and fertility of *Tribolium castaneum* and *Tribolium confusum. Bangladesh J. Scient. and indust. Res.* 43(1): 55-66.

Khani, M., Awang, R. M., Omar, D., Rahmani, M. and Rezazadeh**,** S. 2011. Tropical medicinal plant extracts against rice weevil, *Sitophilus oryzae* L. *J. Medicinal Plants Res.,* 5(2): 259-265.

Koul, O., Walia, S., Dhaliwal, G.S. 2008. Essential oils as green pesticides: potential and constraints. *Biopesticide International,* 4(1): 63–88.

Maia, M.F. and Moore, S.J. 2011. Plant-based insect repellents: a review of their efficacy, development and testing. *Malaria Journal,* 10(1): 1–15.

Mamun, M.S.A., Shahjahan, M. and Ahmad, M. 2008. Laboratory evaluation of some indigenous plant extracts as repellent against red flour beetle, *Tribolium castaneum* Herbst. *Bangladesh J. Entom.* l8 (1): 91-99.

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.

Plague, G. R., Voltaire, G., Walsh, B. E. and Dougherty, K. M. 2010. Rice Weevils and Maize Weevils (Coleoptera: Curculionidae) Respond Differently to Disturbance of Stored Grain. *Annal. Entomol. Soc. of America,* 103(4):683-687.

Shahjahan, M., Kamruzzaman, M. and Diba, F. 2003. Evaluation of some indigenous plant extracts as toxicant against lesser mealworm, *Alphitobius diaperinus* Panz. and rice weevil, *Sitophilus oryzae*L. J. Bangladesh Agril. Univ., 1 (1): 19-27.

Talukder FA, Howse PE 1994b: Repellent, toxic and food protectant effects of pithraj, *Aphanamixis polystachya* (Meliaceae) against pulse beetle, *Callosobruchus chinensis* L. in storage. *J. Chem. Ecol.,* 20(4): 899-908.

Talukder, F. A. and Howse, P. E. 1995. Evaluation of *Aphanamixis polystachya* as a source of repellents, antifeedants, toxicants and protectants in storage against *Tribolium castaneum* (Herbst). *J. Stored Prod. Res.,* 31(1): 55-61.

Talukder, F.A. 2006. Plant products as potential stored product insect management agents a mini review. *Emirates J. Agricul. Sci.,* 18(1): 17-32.

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

Talukder, F.A., Islam, M.S., Hossain, M.S., Rahman, M.A. and Alam, M.N. 2004. Toxicity effects of botanicals and synthetic insecticides on *Tribolium castaneum* (Herbst) and *Rhyzopertha dominica* (F.). *Bangladesh J. Envir. Sci.,* 10(2): 365-371.

Tapondjou, L. A., Adler, C., Bouda, H. and Fontem, D. A. 2002. Efficacy of powder and essential oil from *Chenopodium ambrosioides* leaves as post-harvest grain protectants against six-stored product beetles. *J. Stored Prod. Res.,* 38: 395-402.

Tikum, N., Pitiyon, B. and Visetson, S. 2008. Partially isolation of Non Thai Yak extraction against beet army worm *(Spodoptera exigua* Hubner*).* Proceedings of the 46th Kasetsart University Annual Conference, Kasetsart, Plants. pp. 253-261.