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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 5 (7): 763-766, 2002

Laboratory Evaluation of Some Indigenous Plant Extracts Against Granary Weevil, *Sitophilus granarius* L. (Coleoptera:Curculionidae)

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Abstract: The acetone, ethanol, methanol and water extracts of bitter gourd, karanja, mehedi, and urmoi, leaf and seed/bark were evaluated for their growth inhibition, and grain protection effect against granary weevil, *Sitophilus granarius* L. The highest reduction in number of adults was in urmoi followed by karanja, bitter gourd and mehedi extracts. Extracts of all the four plants showed grain protective effects up to 30 DAT, though the effects of different plant extracts lost gradually with the increase in duration. In most of the cases the extracts of ethanol were more effective than those of other three solvents. The seed extracts were more effective than leaf. Efficacy of the extracts increased proportionally with the increase in doses and decreases proportionally with the increase in time. The extracts did not show any adverse effect on germination capability of wheat seeds even after 3 months of treatments.

Key words: Growth inhibition, grain protectant, germination, *Sitophilus granarius*, extracts

Introduction

Wheat plays a vital role in the diet of common people of developing countries, including Bangladesh. About 600 species of insects belonging to different families have been identified from stored products in various parts of the world (Hinton, 1945). Among them granary weevil, *S. granarius* is highly destructive and cosmopolitan (Munro, 1966). Granary weevil attacks all types of grain (Jones and Jones, 1974) such as wheat, maize, rice, oat, sorghum, barley and perhaps the most destructive pest insect in the world (Metcalf and Flint, 1962; Lamb, 1974). It causes loss to grain in storage, either directly through consumption of the grain or indirectly by producing 'hot spot' causing increase in moisture and thereby making grains more suitable for other stored grain pests (Longstaff, 1986).

Fumigation of stored food grains with toxic gases is effective but not applicable at the farm level because the storage structure is not suitable for fumigation. Application of different pesticides contribute to a stable supply of agricultural production, but their continuous use causes serious environmental pollution (soil, air and water) and health hazards to all living beings (Bhaduri *et al.*, 1989). Moreover, due to indiscriminate use of synthetic pesticides, pest resurgence, secondary pest out break and pesticides resistance are now common phenomena (Bartlet and Ewart, 1951; McClure, 1977; Heinrichs *et al.*, 1982). This situation dictates the need for safe, locally available and less expensive materials for pest control in storage. Therefore, four indigenous plant extracts were tested for their effect on seed viability and growth inhibition & grain protection against the adults *S. granarius.*

Materials and Methods

An experiment was carried out in the laboratory of the Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh during the period from April 2000 to February, 2001. *Sitophilus granarius* were obtained from a laboratory culture maintained at 27± 3°C and 70-75% relative humidity. Urmoi, available only in the coastal region of Bangladesh was collected from the district of Patuakhali and the rest of the three plants were collected from different places of BAU campus, Mymensingh. The fine and uniform dusts were prepared by pulverizing the dried leaves and seeds/bark (bark extract, instead of seed, was used in case of mehedi) with the help of grinder. Plant extracts were prepared by evaporating the filtrates of stirred mixture of dusts and solvents (acetone, ethanol, methanol and water were used as solvents). Four different concentrations 2.5, 5.0, 7.5 and 10.0% (v/v) of each plant extract were prepared with the respective solvents.

Growth inhibition test: The rearing media (wheat) were treated with different plant extracts at doses of 2.5, 5.0, 7.5 and 10.0%. Different petri dishes were filled up with treated and untreated (control) food (10 g/petridish). Five pairs of newly emerged adult insects were released in each pot at 7, 14 and 21 days after treatment (DAT). Three replications were made for each dose. All the pots were kept in the growth chamber at 27-33°C and 70-75% RH. The adult insects from each petridish were removed after 7 days of releasing insects for each treatment. On subsequent days the number of adults emerged per day from each petridish were recorded from 30 to 42 days after setup. Then the inhibition rate (IR%) was calculated by the formula of Talukder and Howse (1994).

Grain protection efficacy test: Different leaf, seed/bark extracts of urmoi, karanja, bitter gourd and mehedi were mixed with the rearing media (wheat) at he doses of 2.5, 5.0, 7.5 and 10.0%. Petri dishes were filled with treated and untreated food. Three replications were made for each dose. Petri dishes containing 70 g of wheat and extracts mixture were shaken manually to ensure uniform coating or uniform distribution of extracts on the grains. Petri dishes were arranged in the laboratory following the completely randomized design (CRD). Then the number of insects in each petridish was counted at 5 days interval up to 30 days.

Seed viability test: Wheat seeds of the variety 'Sonalika' popular at farmer's level, were collected from Wheat Research Centre (WRC), Bangladesh Agricultural Research Institute. Wheat for seed purpose was treated with different plant extracts at the doses of 2.5, 5.0, 7.5 and 10.0% and preserved for three months. Control was maintained by taking only solvent with no extract. The seeds were taken to test their viability. Fifty seeds for each treatment were placed on petri dishes (90 mm diameter) containing water soaked blotting paper. The well germinating seeds were counted in all petri dishes after 7 days of setting and the data were recorded. Each dose of individual extract was replicated three times. The petri dishes containing treated and untreated (control) grains were arranged in completely randomized design (CRD). The mean values were separated by Duncan's multiple range test (DMRT) (Duncan, 1957).

Results and Discussion

Growth inhibition effect: It was found that all the treated plant extracts reduced the progeny adult emergence of *S. granarius* in comparison to control and the effects, in general, was done dependent. The reduction of adults (inhibition rate) was the

Table 1: Adult emergence and inhibition rate of granary weevil, *S. granarius* treated with extracts of different plants at different DAT

Name of the plants	Number of adults emerged			Inhibition rate (%)		
	7 DAT	14 DAT	21 DAT	7 DAT	14 DAT	21 DAT
Bitter gourd	77.22 b	95.52 b	131.81	47.81 b	35.50 c	11.03
Karanja	74.54 c	88.91 c	132.47	48.07 b	40.48 b	11.74
Mehedi	85.71 a	101.46 a	131.91	40.52 c	32.90 d	13.09
Urmoi	67.98 d	81.14 d	130.62	53.53 a	45.11 a	13.51
S$\bar{x}$	0.4180	0.6378	1.331	0.7010	0.6378	0.9036
Probability level	0.01	0.01	NS	0.01	0.01	NS

Table 2: Adult emergence and inhibition rate of granary weevil, treated with leaf and seed/bark extracts of different plants at different DAT (Interaction of plant and plant parts)

Name of the plants	Name of the plant parts	Number of adults emerged			Inhibition rate (%)		
		7 DAT	14 DAT	21 DAT	7 DAT	14 DAT	21 DAT
Bitter gourd	Leaf	80.06 b	101.73 b	135.63 a	45.83 de	30.87 cd	8.92 c
	Seed	74.38 cd	89.31 d	127.98 c	49.80 b	40.13 b	13.14 ab
Karanja	Leaf	77.98 bc	98.68 bc	135.40 ab	46.83 cd	32.81 e	10.29 bc
	Seed	71.10 d	79.15 e	129.55 c	49.31 bc	48.15 a	13.18 ab
Mehedi	Leaf	87.56 a	106.48 a	132.81 a-c	37.56 f	27.65 d	10.74 bc
	Bark	83.86 a	96.43 c	131.01 a-c	43.47 e	38.15 b	15.44 a
Urmoi	Leaf	70.56 d	86.81 d	131.73 a-c	51.72 b	40.26 b	11.23 bc
	Seed	65.40 e	75.46 e	129.51 bc	55.35 a	49.96 a	15.80 a
S$\bar{x}$		1.353	1.206	1.883	0.9914	0.9020	1.278
Probability level		0.05	0.01	0.05	0.01	0.01	0.05

Table 3: Adult emergence and inhibition rate of granary weevil, treated with leaf and seed/bark extracts of different solvents at different DAT (Interaction of plant and plant parts)

Name of the solvents	Number of adults emerged			Inhibition rate (%)		
	7 DAT	14 DAT	21 DAT	7 DAT	14 DAT	21 DAT
Acetone	74.96 b	91.10 bc	131.79	47.24 ab	38.55 b	13.15
Ethanol	76.40 ab	88.30 c	132.53	49.07 a	42.67 a	12.74
Methanol	79.75 a	94.41 a	131.84	45.64 b	37.21 bc	11.71
Water	74.36 b	93.22 ab	130.66	48.01 ab	35.82 c	11.79
S$\bar{x}$	0.9568	0.8531	1.3312	0.701 0	0.6378	0.9036

Table 4: Adult emergence and inhibition rate of granary weevil, treated with leaf and seed/bark extracts of different solvents at different DAT (Interaction of plant and plant parts)

Doses (%)	Number of adults emerged			Inhibition rate (%)		
	7 DAT	14 DAT	21 DAT	7 DAT	14 DAT	21 DAT
0.0	148.08 a	150.59 a	150.73 a	-	-	-
2.5	73.84 b	91.07 b	134.07 b	46.87 c	38.89 d	10.60 c
5.0	63.35 c	80.88 c	129.56 bc	56.56 b	45.24 c	14.00 bc
7.5	49.40 d	70.92 d	126.00 c	66.10 a	52.10 b	16.19 b
10.0	47.16 e	65.33 e	118.17 d	67.90 a	56.27 a	20.94 a
S$\bar{x}$	1.0697	0.9538	1.4883	0.7837	0.7131	1.0100

Table 5: Protectant effect of different plant extracts on granary weevil, at different DAT

Name of the plants	Number of insects in wheat grain						
	5 DAT	10 DAT	15 DAT	20 DAT	25 DAT	30 DAT	Mean
Bitter gourd	0.0	1.70 b	2.21 a	2.88 a	3.20 ab	4.07 a	2.34
Karanja	0.0	1.43 a	2.17 a	2.61 ab	2.84 b	5.52 b	2.06
Mehedi	0.0	1.80 b	2.33 a	2.80 a	3.46 a	3.76 ab	2.35
Urmoi	0.0	1.42 a	2.40 a	2.40 b	2.98 b	3.32 b	2.02
S$\bar{x}$	0.00	0.09372	0.1020	0.1047	0.1027	1.1193	-
Probability level	NS	0.05	0.05	0.01	0.01	0.01	-

DAT= Days after treatment. NS= Not significant.
Within column values followed by different letter(s) are significantly different by DMRT. S$\bar{x}$ = Standard error.

Table 6: Protectant effect of extracts of different plant parts on granary weevil *S. granarius* at different DAT (Interaction of plant and plant parts)

Name of the plants	Plant parts	Number of insects in wheat grain						
		5 DAT	10 DAT	15 DAT	20 DAT	25 DAT	30 DAT	Mean
Bitter gourd	Leaf	0.0	1.83 ab	2.40 ab	3.00 ab	3.31 a	4.26 a	2.46
	Seed	0.0	1.56 bc	2.01 b	2.76 a-c	3.08 a	3.88 a	2.21
Karanja	Leaf	0.0	1.33 c	2.01 b	2.45 bc	2.36 b	2.98 b	1.81
	Seed	0.0	1.51 bc	2.31 ab	2.76 a-c	3.31 a	3.65 a	2.20
Mehedi	Leaf	0.0	2.03 a	2.53 a	3.13 a	3.60 a	3.83 a	2.52
	Bark	0.0	1.48 bc	2.13 ab	2.46 bc	3.30 a	3.66 a	2.16
Urmoi	Leaf	0.0	1.33 c	2.05 b	2.28 c	2.43 b	2.71 b	1.87
	Seed	0.0	1.50 bc	2.03 b	2.51 bc	3.51 a	3.91 a	2.29
S$\bar{x}$		0.0	0.1325	0.1442	0.1430	0.1707	0.1686	-
Probability level		NS	0.05	0.05	0.01	0.01	0.01	-

Table 7: Protectant effect of extracts at different doses on granary weevil *S. granarius* at different DAT (Interaction of plant and plant parts).

Dose	Number of insect in wheat grain						
	5 DAT	10 DAT	15 DAT	20 DAT	25 DAT	30 DAT	Mean
0.0	0	1.78 a	2.46 a	2.99 a	2.47 a	3.92 a	2.27
2.5	0	1.68 a	2.25 ab	2.62 b	3.13 ab	3.50 b	2.20
5.0	0	1.57 ab	2.06 b	2.56 b	3.03 b	3.35 b	2.10
7.5	0	1.51 ab	2.19 ab	2.57 b	2.85 b	3.70 ab	2.14
10.0	0	1.33 b	1.98 b	2.63 b	3.10 ab	3.59 ab	2.11
S$\bar{x}$	-	0.1048	0.1140	0.1170	0.1349	0.1333	-

DAT= Days after treatment. NS= Not significant.
Within column values followed by different letter(s) are significantly different by DMRT. S$\bar{x}$ = Standard error

Table 8: Germination rate of wheat seeds treated with extracts of different plants at different doses (Interaction of plant and dose)

Name of plants	Germination percentage				
	0.0%	2.5%	5.0%	7.5%	10.0%
Bitter gourd	96.08 a	95.41 a-c	95.16 a-d	93.91 b-e	93.00 e
Karanja	96.25 a	95.83 ab	94.41 a-e	93.66 b-e	93.91 b-e
Mehedi	95.58 a	b95.26 a-d	93.58 c-e	94.16 b-e	93.33 de
Urmoi	96.25 a	94.08 b-e	95.00 a-d	94.33 a-e	93.33 de
S$\bar{x}$	0.5783				

DAT= Days after treatment,

Table 9: Germination rate of wheat seed treated with different plant extracts of different solvents (Interaction of plant and solvent)

Name of plants	Germination percentage			
	Acetone	Ethanol	Methanol	Water
Bitter gourd	94.00 ab	94.13 ab	94.46 ab	94.93ab
Karanja	94.93 ab	94.40 ab	94.86 ab	94.86ab
Mehedi	95.40 a	94.53 ab	95.20 a	93.26 b
Urmoi	94.26 ab	93.80 ab	95.53 a	95.26 a
S$\bar{x}$	0.5172			

Within column values followed by different letter(s) are significantly different by DMRT at $p< 0.05$.
S$\bar{x}$ = Standard error.

highest in urmoi (53.53%) followed by karanja (48.07%), bitter gourd (47.81%) and mehedi (40.52%) at 7 DAT. Almost similar trend was observed in 14 and 21 DAT (Table 1). There was a significant difference between leaf and seed/bark extract at 7, 14 and 21 DAT (Table 2). Performance of seed extracts was observed better than that of leaf extracts. Different solvents also possessed significant influence on the number of adult emergence and IR% at 7 and 14 DAT (Table 3). Number of adults emerged was inversely and inhibition rate was directly proportional to doses (Table 4). In almost all cases highest number of adults was emerged from untreated grain.

Shelke *et al.* (1985) found to afford 91.96-100% oviposition deterrence of karanja oil against *Aulocophora foveicollis.* Babu *et al.* (1989) observed karanja oil to reduce oviposition of bruchics over 18 months of storage. Khaire *et al.* (1992) adult emergence of pigeon peas was prevented by karanja for up to 100 days. Doharey (1983) found that *Dacus cucurbitae* preferred bitter gourd among pumpkin, bitter gourd and squash gourd. The life cycle was shorter on it than the others.

Here it is found from previous studies that efficacy of the same plant varied in different insect. So the result of the present study, may be justifiable.

Grain protection effect: The efficacy of bitter gourd, karanja, mehedi and urmoi leaf and seed/bark extract as protectants for wheat against granary weevil was evaluated by comparing the number of insects found in treated grains. All the plant extracts effectively protect wheat grain from granary weevil up to 5 DAT. Infestation started from 10 DAT and the infestation was found very high up to 30 DAT for all the plant extracts. The mean highest number of insects (2.34) was observed in bitter gourd treated seed and the lowest (2.02) in urmoi treated seed (Table 5). The persistent effect of all the four plant leaf and seed/bark extracts is more or less same (Table 6). Dose had slight influence on persistent effect (Table 7). The highest number of insects was always recorded in untreated grain. Number of insects increased with the increase in days.

Sangappa (1977) reported that karanja could be effective in checking the infestation of *Callosobruchus chinensis* in red gram. Sighamony *et al.* (1986) found to have provided good protecting action of karanja against the *S. oryzae* for up to 60 days of exposure.

Effect on germination: Always highest percentage of seed germination was recorded in control treatment. Germination percentage of wheat seeds decreased gradually with the increase in doses (Tables 8, 9, 10 & 11). The present findings are in agreement with the view of Singh *et al.* (1987), Sighamony *et al.* (1986) and Kalinovic *et al.* (1997), who reported that seeds treated with plant materials did not adversely affect the seed germination.

Table 10: Germination rate of wheat seeds treated with plant extracts of different solvents at different doses (Interaction of solvent and dose)

Name of solvents	Germination percentage				
	0.0%	2.5%	5.0%	7.5%	10.0%
Acetone	95.83 ab	94.83 a-e	95.16 a-e	93.83 c-e	93.58 de
Ethanol	96.25 a	95.41 a-e	93.91 b-e	93.75 de	91.75 f
Methanol	95.75 a-c	95.50 a-d	94.66 a-e	94.41 a-e	94.75 a-e
Water	96.33 a	94.58 a-e	94.41 a-e	94.08 b-e	93.50 e
$S\bar{x}$			0.5783		

Table 11: Germination rate of wheat seeds treated with extracts of different plant parts at different doses (Interaction of plant part and dose)

Name of plant parts	Germination percentage				
	0.0%	2.5%	5.0%	7.5%	10.0%
Leaf	96.16 a	94.87 b-d	94.79 b-d	94.62 c-e	93.75 d-f
Seed/Bark	95.91 ab	95.29 a-c	94.29 c-e	93.41 ef	93.04 f
$S\bar{x}$			0.4089		

DAT= Days after treatment.
Within column values followed by different letter(s) are significantly different by DMRT at $p< 0.05$. $S\bar{x}$ = Standard error.

Low cost technique of extraction: Four types of extract e.g, acetone, ethanol, methanol and water were used. It was observed that ethanol extract of plants were more efficient than that of other extracts. The efficiency of acetone and water extracts was more or less similar. Researchers can use ethanol extract though its cost is high. On the other hand, our farmers are faced with the high costs of insecticides. Most of them can no longer afford synthetic insecticides to protect the stored products. So, farmers can use water extract because they require less money to prepare extracts in comparison with ethanol extracts.

Efficacy of different plant extracts was evaluated for their growth inhibiting and grain protecting action against rice weevil. Effect on germination of wheat seed and low cost technique of extraction was also evaluated. The extracts could protect the adult emergence for up to 21 days. Protecting action was found up to 30 days but at that time it was very low. Considering the cost of extraction water is recommended for farmer use.

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