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Evaluation of two plant materials for the management of pulse beetle, *Callosobruchus chinensis* L.

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Abstract: An investigation was carried out with acetone and water extracts of leaf and seed of castor, *Ricinus communis* and urmoi, *Sapium indicum* for their direct toxic and residual effects on the pulse beetle, *Callosobruchus chinensis* using different (7.5, 10, 12.5 and 15%) concentrations. Both urmoi and castor seed extract was found toxic for pulse beetle having 34.44% and 34.33% mortality respectively. The seed extract was more effective than that of leaf extract. Again the acetone extracts of leaf and seed were more effective than those of water extracts.

Key words: Plant extract, Toxicity, Residual effect, Pulse beetle.

Introduction

Stored grain food Particularly pulses suffers seriously from the attack by a number of insect pests. Approximately one third of global agricultural products are reportedly destroyed each year by more than 20,000 species of insect pests. The production of pulses in Bangladesh is very low as compared to total national requirements. Recently, pulse production is gradually decreasing day by day. One of the major hindrances to increase pulse production is the loss of seed viability due to damage of pulse grains from insect infestation in storage. Among the insect pests, bruchids are known to cause both quantitative and qualitative losses to pulses (Kulkarni *et al.*, 1985) which lead to a reduction of commercial value and seed germination. The genus *Callosobruchus* includes a number of economically important species that attack stored pulses throughout the world but *C. chinensis* L. and *C. maculatus* Fab. have been recorded in Bangladesh and are commonly known as pulse beetles (Atwal, 1976).

The adult beetles do not feed on seeds but they oviposit on seeds. The grub is solely responsible for major damage. They destroy seeds by feeding inside partly or completely and making them unfit for human consumption (Atwal, 1976). Pulse beetle breeds throughout the year in stored pulses. But it is generally found that the intensity of infestation is higher in summer than winter mainly due to high temperature and relative humidity.

Control of storage pests by using synthetic chemicals has become a common practice among the farmers and stockholders. In Bangladesh, insect pest control practice after 1970 constraint of dwindling foreign exchange (Maniruzzaman, 1981) and it got many limitations and undesirable side effects.

In this alarming situation, now a days the search for alternative methods of the insect control utilizing botanical products is being pursued in many countries. These plant products include oil, extracts, dried leaves, fruits, seeds, rhizomes etc. A number of botanicals and their derivatives have been tested in Bangladesh and other developing countries particularly against the pulse beetle (*C. chinensis*) and have shown promising results (Das, 1987; Soedomo and Sunaryono, 1988).

The present investigation was carried out using two plant (Castor, Urmoi) extracts for the management of pulse beetle.

Materials and Methods

The effects of leaf and seed extracts of two plants viz. castor and urmoi against pulse beetle, *Callosobruchus chinensis* L. were conducted during the period from May to October, 2006.

Collection and rearing of insect

The test insect, *C. chinensis* were collected from the pulse godown of Mymensingh town and were reared in the laboratory to get sufficient number of adult beetles for conducting the whole experiment.

Collection and preparation of plant extract

Fresh leaves and seeds of urmoi were collected from rural areas of Phatuakhali, and from Boira and Sutiakhali villages of Mymensingh district. After collection, fresh leaves and seeds were washed in running tap-water and air dried in the shade for 15 days and then oven dried at 60^0C to make dust.

Oven dried leaves and seeds were ground to powder in an electric grinder. A 25 mesh diameter sieve was used to obtain fine dust. Twenty gm of each category of dust were taken in a 600 ml beaker and separately mixed with 200 ml of selected solvents (distilled water and acetone). 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 filter paper (Whatman No.1).

Direct toxicity test (by topical application method)

A laboratory test for direct toxicity by topical method was conducted according to the method of Talukder and Howse (1993). Different concentrations of each plant extracts (7.5%, 10%, 12.5% and 15%) were prepared with respective solvents. The adult insects were chilled for a period of 10 minutes. Then the immobilized insects were picked up individually by using a camel hair brush. Two μl solution of different concentrations were applied to the dorsal surface of the thorax of each insect using a fine micropipette. Ten insects per replication were treated and each treatment was replicated 3 times. In addition, the same number of insects were treated with respective solvent only for control. After treatment, the insects were transferred into 9 cm diameter petridishes (10 insects/petridish) containing food.

Insect mortalities were recorded at 24, 48 and 72 hours after treatment (HAT). Observed mortalities of the insects were corrected by Abbott's formula (1987): Corrected mortality = (observed mortality–control mortality/100-control mortality) × 100, then it was analyzed by ANOVA. The mean values were separated by DMRT. The corrected mortality data were analyzed by probit analysis designed by Finney (1964).

Residual toxicity test

Two ml plant extracts of different concentrations (7.5, 10.0, 12.5 and 15.0%) were used for treating each 10g seed. Then each 10g treated seeds were placed into different petridish. The untreated petridish contain normal food only. Three replications were made for each dose. Ten adult pulse beetles (5male and 5 female) were introduced at the centre of each petridish to give them a free choice to oviposit. They were left for a 7 day period and then the adult beetles were sieved out and removed from the petridish. The following observations were recorded:

i. Number of F_1 adults emerged from each pots (from 27 to 42 days)
ii. Seed damage rate from the random sample of 50 seeds at the end of the experiment.
iii. The inhibition rates (IR %) were calculated as follows-

$$IR\% = \frac{Cn - Tn}{Cn} \times 100$$

Where,
C_n = Number of insects on control dish and
T_n = Number of insects on treated dish

iv. Percentage weight loss was determined by the following formulae-

Weight loss percentage =

$$\frac{(UNd) - (DNu)}{U \times (Nd + Nu)} \times 100$$

Where,
U = Weight of undamaged grain
D = Weight of damaged grain
Nd = Number of damaged grain
Nu = Number of undamaged grain

Statistical analysis

The experimental data were statistically analyzed by Completely Randomized Design using MSTAT statistical software in a micro computer. The mean values were separated by Duncan's Multiple Range Test (DMRT).

Results and Discussion

Direct Toxic Effect of Plant Extracts

It was observed that the seed extracts of both the tested plants inflicted higher mortality of *C. chinensis* than that of leaf extract (Table 1). Toxicity increased proportionately with time. Among the seed extracts, both of the plants caused highest mortality (44.33%) at 72 HAT. In case of leaf extract, urmoi showed the highest mortality (42.00%) then castor (34.67%) at 72 HAT. No significant difference was found among different plant extracts regarding the mortality of pulse beetle.

Effect of solvent

It was observed that the toxicity of different plant extracts were influenced by the solvents and the solvents are not equally effective for both the plants (Table 2). For castor, the acetone extract had the highest mortality of pulse beetle (53.67%) at 72 HAT, which was followed by water extract (23.33%). For urmoi, acetone extract was found to be highly effective in causing mortality of insect (54.33%) at 72 hour after treatment followed by the water extracts (32.00%). The difference among various solvents utilized for the extraction was found to be significant statistically within each plant.

Stomach poisoning

Results revealed that the urmoi seed extracts @ 15mg/ml of acetone caused the highest mortality of 70% after 72 hours (Table 3). The percentage of insect mortality at 24, 48 and 72 hours after treatment indicated that the urmoi plant extract possessed the highest toxic effect than castor plant extract at all dose levels. The difference among different dosages and extracts were not significant statistically. Mortality percentage was found directly proportional to the level of doses and time after treatment.

Probit analysis for direct toxicity

The results of 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 pulse beetle are presented in Table 4.

The LC_{50} values of castor (8.44%) and urmoi (6.34%) at 24 HAT (Table 4) indicated that urmoi plant extract was more toxic than that of castor plant extract. Comparing LC_{50} values at 48 HAT, results showed that urmoi plant extract possessed highest toxic effect (3.95%). Between two plant extract, LC_{50} values at 72 HAT showed that urmoi plant extract (2.64%) was highly toxic, whereas, castor plant extract possessed least toxic (3.99%) effect. From the above probit results it is clear that urmoi plant extract will be more effective for controlling the pulse beetle.

Table 1. Direct toxic effect of plant extracts on pulse beetle, *C. chinensis*.

Name of the plants	Name of the plant parts	Mortality percentage		
		24 HAT	48HAT	72HAT
Castor	Leaf	11.67	23.67	34.67
	Seed	22.00	36.67	44.33
Urmoi	Leaf	17.33	32.67	42.00
	Seed	22.00	37.00	44.33
$S\bar{X}$	1.0929			
Probability level	NS			

Table 2. Mean mortality percentage of pulse beetle, *C. chinensis* treated with plant extracts of different solvents at different HAT

Name of the plants	Solvents used	Mortality percentage		
		24 HAT	48HAT	72HAT
Castor	Acetone	21.67 ef	41.67b	53.67a
	Water	12.00 g	18.67f	25.33de
Urmoi	Acetone	26.33 d	44.00b	54.33a
	Water	13.00 g	25.67de	32.00c
$S\bar{X}$	1.0929			
Probability level	0.01			

HAT = Hour after treatment
NS= Not significant
Within table values followed by different letters(s) are significantly different by DMRT.

Table 3. Mean mortality percentage of pulse beetle, *C. chinensis* treated with different plant extracts of different doses at different HAT

Name of the plants	Dose (%)	Mortality percentage		
		24 HAT	48HAT	72HAT
Castor	7.5	10.00	20.83	27.50
	10.0	12.50	30.00	40.83
	12.5	27.50	40.00	52.50
	15.0	29.17	49.17	58.33
Urmoi	7.5	10.00	25.83	30.83
	10.0	15.83	32.50	41.67
	12.5	33.33	50.00	61.67
	15.0	35.00	55.83	70.00
$S\bar{X}$	1.7280			
Probability level	NS			

Table 4. Relative toxicity (by probit analysis) of different plant extracts treated against pulse beetle, *C. chinensis* at 24, 48 and 72 HAT

Name of the plant	No. of insect used	LC_{50} value (%)	95% fiducial limits	χ2 value	Slope ± SE
24 HAT					
Castor	480	8.44	4.67-15.49	2.51	1.90±0.006
Urmoi	480	6.34	4.27-9.33	2.40	2.02±0.003
48 HAT					
Castor	480	5.34	3.63-7.94	0.37	1.70±0.003
Urmoi	480	3.95	3.01-5.01	1.85	1.73±0.002
72 HAT					
Castor	480	3.99	3.09-5.01	0.12	1.98±0.002
Urmoi	480	2.64	2.27-3.05	1.98	2.11±0.001

HAT = Hours after treatment.
Values were based on two plant parts, two solvents, four concentrations and three replications of 10 insects each.
χ2 = Goodness of fit
The tabulated value of χ2 is 5.99 (d.f = 2 at 5% level)

Table 5. Residual toxicity of different plant extracts of different doses on pulse beetle, *C. chinensis*

Name of the plants	Plant parts	Doses (%)	No. of F_1 adults emerged	Seed damage rate (%)	Weight loss (%)	IR (%)
Castor	Leaf	7.5	36.83	45.00	32.27	8.16
		10.0	34.50	43.33	29.93	12.96
		12.5	31.17	40.33	25.42	23.00
		15.0	28.33	34.00	21.60	29.99
	Seed	7.5	35.17	45.67	29.45	9.39
		10.0	32.33	40.67	25.19	16.98
		12.5	28.67	38.00	21.74	26.89
		15.0	25.67	33.33	17.35	34.52
Urmoi	Leaf	7.5	34.00	39.00	27.18	11.35
		10.0	30.50	37.67	23.42	22.32
		12.5	27.00	33.67	20.34	30.12
		15.0	22.50	28.33	16.19	42.50
	Seed	7.5	32.33	36.33	24.67	15.54
		10.0	28.67	33.67	22.36	25.40
		12.5	25.17	28.67	17.18	34.50
		15.0	20.00	25.00	12.56	48.58
Probability level			NS	NS	NS	NS

NS = Not significant
IR = Inhibition rate

The chi-square ($\chi 2$) values of different plant extracts at different hours after treatment were insignificant at 5% level of probability and did not show any heterogeneity of the mortality data. From the above probit results it is clear that the tested two plants would be effective for controlling pulse beetle. The present study revealed the reduction of pest population due to use of plant extracts and agreed with the previous findings of Islam and Shahjahan (2000), Islam *et al.* (2001) and Shahjahan *et al.* (2003).

Probit regression lines

The calculated probit regression lines for two plant extracts on pulse beetle at 24 HAT were: Y= 3.3733+ 2.029X and Y= 3.2467+ 1.890X for castor and urmoi extracts, respectively. Comparing between two lines, the regression line for urmoi plant extract showed highest probit mortality.

The calculated probit regression lines for two plant extracts on pulse beetle at 48 HAT were: Y= 3.7717+1.688X and Y= 3.9561+1.732X for castor and urmoi extracts, respectively. In this case, urmoi plant extract showed highest mortality effect.

The calculated regression equations for the effects of two plant extracts on pulse beetle at 72 Hat were: Y=3.799+1.989X and Y= 4.131+2.088X for castor and urmoi plant extract, respectively. Between two lines, the regression line for urmoi plant extract also showed the highest probit mortality.

Residual toxicity effects on pulse beetle

Table 5 showed the effects of plant, plant parts at different doses. Among the plant parts, urmoi seed extracts was more effective. The lowest number of F_1 progeny (20.00) emerged from the pulses treated with urmoi seed extracts followed by urmoi leaf extract (22.50) and castor seed extracts (25.67). The least seed damage rate (25.00%) and the lowest weight loss percentage (12.56%) and the highest inhibition rate (48.58%) were also found in pulses treated with urmoi seed extract. The interaction of plant, plant parts and doses showed no significant residual toxic effect.

From the above findings, all plant extracts reduced F_1 adult emergence, seed damage rate, weight loss percentage and gave higher inhibition rate. The results of the present investigations were quite in agreement with the previous findings of Mhgoub (1998) and Ram *et al.* (2001). They found the residual toxic effects of plant materials on stored grain pests. All of them were found that botanical plant materials reduced the adult emergence, seed damage rate and percentage of weight loss which is similar with this study.

References

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

Atwal, A.S. 1976. Agricultural pests of India and South East Asia. Kalyani Publisher, Delhi, India. pp. 389-415.

Das, G.P. 1987. Effect of different concentrations of neem oil on the adult mortality and oviposition of *Callosobruchus chinensis* Linn. (Coleoptera: Bruchidae). Indian J. Agric. Sci. 56(10): 743-744.

Finney, D.J. 1964. Statistical method in biological assay (Second edition). Charles Griffin & Co., London. 668p.

Islam, M.S. and Shahjahan, M. 2000. Insecticidal effects of some plant extracts against rice weevil, *Sitophilus oryzae* L. and red flour beetle, *Tribolium castaneum* Herbst. Progress. Agric. 11 (1 & 2): 123-129.

Islam, M.S., Shahjahan, M. and Motaleb, M.A. 2001. Toxic effect of some plant extracts against granary weevil, *Sitophilus granarius* L. (Coleoptera: Curculionidae). Progress. Agric. 12 (1&2): 99-104.

Kulkarni, S. G., Harobe, H., Deshpande, A.D., Boridar, P.S. and Puri, S.N. 1985. Damages and losses caused by *C. chinensis* L. to different legumes stored in selected containers. Agril. Sci. Digest, India. 5 (2): 108-110.

Maniruzzaman, F.M. 1981. Plant protection in Bangladesh. Nation Book Centre, 67/A , Purana Paltan. pp. 270-276.

Mhgoub, S.M.1998. Efficacy of *Ricinus communis* extracts in different solvents as protectants against the cowpea weevil, *Callosobruchus maculatus* F. (Coleoptera: Bruchidae). Egyptian J. Agric. Res. 76 (1): 77-83.

Ram, S., Basant, S., Verma, R.A., Singh, R. and Singh, B. 2001. Efficacy of different indigenous plant products as grain protectant against *C. chinensis* L. on pea. Indian J. Entomol. 63(2): 179-181.

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.

Soedomo, P. and Sunaryono, H.1988. Seed storage of bushitao with several kinds of plant pesticide treatments. Bull. Penelitian Hort., Indonesia.16 (1): 24-28.

Talukder, F.A. and Howse, P.E. 1993. Deterrent and insecticidal effects of extracts of pithraj, *Aphanamixis polystachya* against *Tribolium castaneum* in storage. J. Chem. Ecol. 19 (11): 2463-2471.