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Research Article

Evaluation of Some Botanicals as Seed Protectant Against Pulse Beetle (*Callosobruchus chinensis* L.) on Stored Gram Seed

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Abstract

The pulse beetle, *Callosobruchus chinensis* (L.) is one of the major pests of pulses in storage. In the present study an attempt was made to screen and compare the efficacy of four botanicals viz., sesame oil, groundnut oil, garlic powder and mahogany powder on gram seed, *Cicer arietinum* (L.) as protectant against pulse beetle. The efficacy was evaluated by considering oviposition, adult emergence, seed infestation and weight loss caused by the insect. All the tested botanicals were found effective significantly to check the oviposition, adult emergence, seed infestation and weight loss as compared to control. However sesame oil provided the best protection of gram seed against the pulse beetle followed by mahogany powder. The results suggest considering oviposition performance, developmental performance, seed damage and weight loss, sesame oil (2.00%) could be recommended as remedies against pulse beetle infestation.

Keywords: Botanicals; Gram Seed; Pulse Beetle; Oviposition; Adult Emergence; Seed Infestation and Weight Loss

Introduction

Pulses are leguminous crops under the family Leguminosae and sub-family of Papilionaceae. A large number of pulses are grown in Bangladesh such as lentil (*Lens culinaris* M.), chick pea (*Cicer arietinum* L.), black gram (*Vigna mungo* L.), Grass pea (*Lathyrus sativus* L.), mungbean (*Vigna radiata* L.) and cow pea (*Vigna unguiculata* L.) etc. In Bangladesh, after harvest the pulse crops are mostly stored by the traders. The farmers also stored pulse crops for the next year for using as planting materials. All growers and traders stored the grain in the warehouses. But it is unfortunate that the grains suffer enormous losses due to attack of bruchid. According to Southgate (1979) there are 100 species of bruchids which belong to 56 genera and 5 sub-families. In Bangladesh two bruchid species *Callosobruchus chinensis* (L.) and *C. maculatus* (Fab.) are most abundant and commonly known as pulse beetle. This insect comes originally from East Asia and now has a cosmopolitan distribution. Preservation of reserve food grain stock is necessary to ensure a continuous supply at stable price. About 10,000 years ago, agricultural practices began and that of storing food grain started about 4,500 years ago as a safeguard against poor harvests and famines. Losses due to insect infestations are serious problems in grain storage, particularly in villages and towns of Bangladesh. The losses during growing of crops and postharvest handling, processing, storage and distribution system vary between 20 and 60%

in some of the countries of the world. It has been estimated that about 15-20% of the world agricultural production is lost every year. Out of this 8% production is lost every year due to insect infestation alone.

Pulse is one of the best sources of plant protein and plays an important role in the diet of common people of Bangladesh. The cultivated area under pulse crops in Bangladesh coverage 356607.043 hectares (903261 acres) with annual production of 313251 mt tons [1]. Most of the pulses have to be stored by the producer in their home and by the traders and the Governmental agencies in go-downs for one year or more for future use. Pulses are more difficult to store than cereals, because pulse grain suffer comparatively more damage during the storage due to insect pest and microorganisms.

In Bangladesh, 50 species of the insects are considered injurious to food grains and their products. Several species of pulse beetle are reported to attack pulses in storage. These are *Callosobruchus chinensis* (L.), *Callosohruchus maculates* (F.) and *Callosobruchus analis*. Among these, the pulse beetles Callosobruchus spp. is the major pests in stored pulse [2]. *C. chincnsis* L. is one of the most destructive pests of almost all kind of pulses in storage and to some extent in the field. Pulse beetle, *Callosobruchus chinensis* is a major economically important pest of all pulses and causes 40 - 50% in losses of pulses storage. The pulse beetle may cause 10 - 95% loss in seed weight and 45.5 - 66.3% loss in protein content of the seeds under normal condition and the, severity of damage increases with the duration of storage [3,4].

Generally, management of stored product pest is done through fumigation and also is controlled by synthetic insecticides, which have many limitations and undesirable side effects. Insecticides have been used for a long time with serious drawbacks. Indiscriminate use of insecticides to protect pulse beetle in storage may cause serious health hazard as well as destruction of beneficial insect and increasing costs of application. Alternative methods of insect control, utilizing botanical products are being used in many countries. Botanical insecticides are biodegradable, relatively specific in the mode of action and easy to use and are environmentally safe, less hazardous, less residual effect, less expensive and readily available. Many workers at home and abroad studied on the insecticidal properties of plant materials. The main advantage of botanical insecticides is that these can be easily produced in small scale by the farmers and small industries.

Scientific research works have been done in Bangladesh to explore our locally available plant materials for the control of harmful insect pests in storage and field level. Considering problems of synthetic insecticides and benefits of botanical insecticides, the present research work was undertaken by four botanicals such as sesame oil, groundnut oil, garlic powder, mahogany powder (fruit). These botanicals are available and well distributed in Bangladesh.

Most of the farmers are marginal and they haven`t ready hand cash round the year. The damage caused by insect attack worsens the financial crisis of the farmers. Despite the availability of synthetic pesticides in the market, the farmers are not able to purchase in view of cost factor. They dream to prepare botanical pesticides by using different plant parts which is readily available within their home yard. The present study was undertaken to study the insecticidal activity of four botanicals such as, sesame oil, groundnut oil, garlic powder and mahogany powder (fruit) against the pulse beetle, *Callosobruchus chinensis* on stored gram seeds.

Methods and Materials

Experimental materials

The major stored pulse insect, pulse beetle (*Callosobruchus chinensis* L.) and four different Botanicals (sesame oil, groundnut oil, garlic powder and mahogany powder) were collected Department of Entomology, Bangladesh Agricultural University, Mymensingh. The gram seed (*Cicer arietinum* L.) popularly known as 'chick pea' were collected from local market for this study.

Mass culture of test insect

Collected 1kg gram seed were allowed to oviposit in a large glass container that was then covered with nylon cloth and was allowed for free mating and oviposition for a maximum period of 7 days. After oviposition, the beetles were removed and seeds along with eggs were left in the container. Newly emerged adults were again allowed for oviposition on new seeds added in different container to maintain a stock culture.

Preparation of different botanicals treatments

Three different concentrations (2.0, 1.0 and 0.5%) of sesame oil and groundnut oil were prepared by addition of distilled water. To prepare 2.0% concentration, 2 ml of sesame oil was added to 98 ml

of distilled water in a glass bottle and mixed properly. For preparing 1.0% concentration, 50 ml of this concentration 2.0% was then added to 50 ml of distilled water and mixed properly. In the same way 0.50% concentration of sesame oil was prepared by dilution method. In the same way three concentrations of groundnut oil were prepared by dilution method. Another two botanicals, garlic powder and mahogany powder were prepared for three different concentrations (1.0g, 1.5g and 2.0g) by addition of distilled water.

Seed treatment

Randomly 30g seeds were taken in pot and 0.5 ml of each prepared three concentration of sesame oil and groundnut was added on seeds by dropping. Then pots were properly mixed and kept some time for air-drying. Another two botanicals garlic powder and mahogany powder were also properly mixed with seeds. Distilled water was applied only on control. Three replications were done for each concentration.

Oviposition performance of pulse beetle

Four pair of newly emerged pulse beetles were taken in each pot for each treatment and covered with net. The pots were kept in a table to maintain darkness and left undisturbed for 7 days. Male and female insects were always maintained as 1:1 ratio. Control treatment was performed side by side. After 7 days of release, adult beetles were removed and the eggs laid on gram seeds of each treatment in the pots were counted individually using hand lens. Data on number of eggs bearing seeds, number of egg(s) per seed and total number of eggs were recorded. After counting, both the egg bearing and non- egg bearing seeds were returned to their respective pots and covered with lid and left undisturbed for further development.

Developmental performance of pulse beetle

Developmental performance was assessed by recording the number of adults emerged. The adults started emerging after 21 days of egg laying. The emerged beetles were counted and removed every day from the pots. The numbers of dead insects were also recorded. After adult emergence the seeds were examined to assess the damage done to the grain seeds as a result of feeding during larval period. Seeds with whole(s) were considered as damaged seeds. The cleaned seeds in each pot were weighed separately. The weight losses were expressed in percentage and calculated with the following formula:

$$\% \text{ Weight loss} = \frac{A-B}{A} \times 100$$

Where,

A= Initial weight of grain

B= Grain weight after adult emergence

Statistical analysis

The observed data were statistically analyzed in accordance with one factor Completely Randomized Design (CRD) and treatment mean values were compared by Duncan's Multiple Range Test (DMRT). All statistical analysis was done through a package programmed namely, MSTAT-C.

Results

Effect of botanicals on the oviposition performance of *C. chinensis*

Significant variation was observed on mean number of eggs bearing seeds due to use of different doses of botanicals (Table 1). In case of sesame oil, significantly the highest numbers of eggs bearing seeds 86.67% were found in control pots followed by the treatment with 0.5% concentration 68.33%. Significantly the lowest numbers of eggs bearing seeds 62.00% were found in 2.0% concentration. In use of 1% concentration the egg bearing seeds were found 26.33% which was statistically significant. In the event of groundnut oil, significantly the highest numbers of eggs bearing seeds 91.00% were found in control pots followed by the treatment with 0.5% concentration 72.67%. Significantly the lowest numbers of eggs bearing seeds 34.67% were found in 2.0% concentration. In use of 1% concentration the egg bearing seeds were found 61.67% which was statistically significant.

Garlic powder, the highest numbers of eggs bearing seeds 78.00% were found in control pots followed by the treatment with 1.0g dose 66.67%. Significantly the lowest numbers of eggs bearing seeds 28.33% were found in 2.0g dose. In use of 1.5g dose the egg bearing seeds were found 54.67% which was statistically significant. Subject to mahogany powder, significantly the highest numbers of eggs bearing seeds 83.00% were observed in control pots followed by the treatment with 1.0g dose 72.33%. Significantly the lowest numbers of egg bearing seeds 27.67% were found in 2.0g dose. In use of 1.5g dose the egg bearing seeds were found 48.00% which was statistically identical.

Botanicals	Dosages	Number of egg bearing seeds/30g seeds	Number of eggs laid/30g seeds	Number of adult emergence/30g seeds
Sesame oil	0% (Control)	86.67 a	183.30 a	112.00 a
	0.5%	68.33 b	130.70 b	48.00b
	1.0%	62.00 b	100.30 c	32.67bc
	2.0%	26.33 c	18.33 d	17.67 c
LSD(0.05)		6.66	13.78	21.97
Level of sign.		**	**	**
SE (±)		2.04	4.23	6.74
Groundnut oil	0% (Control)	91.00 a	181.70a	138.70 a
	0.5%	72.67 b	134.30 b	68.33 b
	1.0%	61.67 b	98.67 c	36.00 c
	2.0%	34.67 c	41.00 d	19.33 d
LSD(0.05)		12.84	13.25	7.76
Level of sign.		**	**	**
SE (±)		3.94	4.06	2.38
Garlic powder	0g (Control)	78.00 a	185.00 a	139.70 a
	1.0g	66.67 b	146.00 b	80.33 b
	1.5g	54.67 c	106.00 c	50.33 c
	2.0g	28.33 d	43.00 d	24.00 d
LSD(0.05)		5.15	15.67	18.59
Level of sign.		**	**	**
SE (±)		1.58	4.80	5.70
Mahogany powder	0g (Control)	83.00 a	183.00 a	146.00 a
	1.0g	72.33 b	130.30 b	63.00 b
	1.5g	48.00 c	96.67 c	31.67 c
	2.0g	27.67 d	23.33 d	19.17 c
LSD		4.77	14.91	13.03
Level of sign.		**	**	**
SE (±)		1.46	4.57	3.99

Table 1: Number of eggs bearing seeds, eggs laid and adult emergence due to oviposition of pulse beetle after treatment with botanicals
** = Significant at 1% level of probability.

The mean number of eggs per 30g seeds significantly differed among the treated and untreated control (Table 1). Subject to sesame oil, the highest numbers of eggs 183.30% were found in control treatment. Significantly the lowest numbers of eggs 18.33% were recorded in 2.0% concentration. In the event of groundnut oil, the highest numbers of egg 181.70% were found in control treatment. Significantly the lowest number of egg 41.00% were observed in 2.0%concentration.

In case of garlic powder, the highest numbers of eggs 185.00% were found in control treatment. Significantly the lowest numbers of eggs 43.00% were recorded in 2.0g dose. On condition of ma-

hogany powder, the highest numbers of eggs 183.00% were found in control treatment. Significantly the lowest numbers of eggs 23.33% were noted in 2.0g dose.

Developmental performance of *C. chinensis* was assessed by recording the number of adult emerged from treated and untreated seeds and presented in Table 1. In case of sesame oil, the highest adult emergence was recorded from control treatment having mean 112.00%. This value was significantly higher than all other treatment. The lowest number of adult emergence 17.67% was obtained in 2.0% concentration, which was statistically different from 1.0% (32.67%). Subject to groundnut oil, the highest adult emergence was observed from control treatment having mean 138.70%. The lowest value 19.33% was obtained in 2.0% concentration, which was significantly different from 1.0% (36.00%).

In the event of garlic powder, the highest adult emergence was counted from control treatment having 139.70%. This value was statistically higher than all other treatments. The lowest number of adult emergence 24.00% was obtained in 2.0g dose, which was statistically different from 1.5g (50.33%). On condition of mahogany powder, the highest adult emergence was calculated from control 'treatment having mean 146.00%. The lowest number of adult emergence 19.17% was obtained in 2.0g dose, which was statistically different from 1.5g (31.67%). Numbers of dead insects on the stored gram seeds after treatment with different botanicals were presented in table 1.

Effect of botanicals on developmental performance of *C. chinensis*

Contingent upon sesame oil, the highest number of dead insect 6.53% was observed in 2.0% concentration. The lowest number of dead insects 3.00% was found in control treatment. In case of groundnut oil, the highest number of dead insect 6.00% was founded in 2.0% concentration.

The lowest number of dead insects 2.00% was recorded in control treatment. Given garlic powder, the highest number of dead insect 5.00% was recorded in 2.0g dose. The lowest number of dead insects 1.00% was calculated in control treatment. On these terms of mahogany powder, the highest number of dead insect 6.43% was observed in 2.0g dose. The lowest number of dead insects 4.00% was found in control treatment (Table 2).

Botanicals	Dosages	Number of dead insects	Number of damaged seeds/30g seeds	Weight losses of seed after infestation
Sesame oil	0% (Control)	3.00 b	71.67 a	2.33 a
	0.5%	4.00 a	54.00 b	1.57 b
	1.0%	5.67 a	20.00 c	0.67 c
	2.0%	6.53 a	13.00 d	0.33 c
LSD(0.05)		1.54	5.60	0.61
Level of sign.		**	**	**
SE (±)		0.47	1.72	0.19
Groundnut oil	0% (Control)	2.00 b	58.00 a	2.47a
	0.5%	5.00 a	64.33 a	1.00 b
	1.0%	4.67 a	31.00 b	0.67 b
	2.0%	6.00 a	17.67 c	0.43 b
LSD(0.05)		1.96	13.27	1.31
Level of sign.		**	**	**
SE (±)		0.60	4.07	0.40
Garlic powder	0g (Control)	1.00 b	77.33 a	2.43 a
	1.0g	4.67 a	66.33 b	2.00 ab
	1.5g	3.00 a	54.00 c	1.33 b
	2.0g	5.00 a	21.67 d	0.35 c

LSD(0.05)		1.72	7.53	0.94
Level of sign.		**	**	**
SE (±)		0.53	2.31	0.29
Mahogany powder	0g (Control)	4.00 c	73.33 a	2.67 a
	1.0g	3.33 bc	57.67 b	1.67 ab
	1.5g	5.33 ab	35.33 c	1.00 ab
	2.0g	6.43 a	16.67 d	0.33 b
LSD(0.05)		2.04	6.67	1.62
Level of sign.		**	**	*
SE (±)		0.63	2.05	0.50

Table 2: Number of dead insects, damaged seeds and weight losses of seed done by pulse beetle after treatment with botanicals ** = Significant at 1% level of probability, * = Significant at 5% level of probability.

The larvae of pulse beetle feed on the internal content of the seeds for their growth and development and finally emerged as adults from the seeds leaving hole(s) on the seed coat. It was observed that percentage of damaged seeds were significantly different among the treatments (Table 2). In case of sesame oil, Mean number of damaged seeds ranged from 13.00% to 71.67% per 30g of seeds (Table 2).The highest number of damaged seeds 71.67% was found in untreated gram seeds, which was significantly higher than all other treatments. The lowest number of damaged seeds 13.00% as recorded in 2.0% concentration. Given groundnut oil, the numbers of damaged seeds were recorded from 17.67% to 64.33% per 30g of seeds (Table 2). The highest number of damaged seeds 64.33% was observed in untreated gram seeds, which was statistically higher than all other treatments. The lowest number of damaged seeds 17.67% as calculated in 2.0% concentration.

Subject to garlic powder, the numbers of damaged seeds were found from 21.67% to 77.33% per 30g of seeds (Table 2). The highest number of damaged seeds 77.33% was recorded in untreated gram seeds, which was significantly higher than all other treatments. The lowest number of damaged seeds 21.67% as recorded in 2.0g dose. In the event of mahogany powder, the number of damaged seeds observed from 16.67% to 73.33% per 30g of seeds (Table 2). Highest number of damaged seeds 73.33% was founded in untreated gram seeds, which was statistically higher than all other treatments. The lowest number of damaged seeds 16.67% as calculated in 2.0g dose.

Just after hatching the larva entered into the seeds and completed its immature stages inside seeds. Feeding of larvae caused seed weight losses. Data of weight losses were also recorded both in treated and untreated gram seeds. It was found that damage occurred to the gram seeds at different treatments and those were differed significantly (Table 2). Contingent upon sesame oil, significantly the highest loss 2.33% was recorded in control treatment and significantly the lowest weight loss 0.33% was observed in 2.0% concentration. Given groundnut oil, statistically the highest loss 2.47% was calculated in control treatment and significantly the lowest weight loss 0.43% was recorded in 2.0% concentration.

Subject to garlic powder, significantly the highest loss 2.43% was observed in control treatment and identically the lowest weight loss 0.35% was founded in 2.0g dose. In the event of mahogany powder, statistically the highest loss 2.67% was founded in control treatment and significantly the lowest weight loss 0.33% was recorded in 2.0g dose.

Discussion

Effect of botanicals on the oviposition performance of *C. chinensis*

The results on oviposition performance of *C. chinensis* showed that botanicals (sesame oil, groundnut oil, garlic powder and mahogany powder) significantly inhibited oviposition on the gram seeds as compared to untreated seeds. Sesame oils at 2.0% concentration caused the highest reduction 26.33% of oviposition of *C. chinensis* than control. The numbers of eggs bearing seeds were also affected by sesame oil. The highest numbers of eggs bearing gram seeds 86.67% were observed in control treatment. Groundnut oils at 2.0% concentration caused the highest reduction 34.67% of ovi-

position of *C. chinensis* than control. The highest numbers of eggs bearing gram seeds 91.00% were observed in control treatment.

Garlic powder at 2.0g dose caused the highest reduction 28.33% of oviposition of *C. chinensis* than control. The highest numbers of eggs bearing seeds 78.00% were observed in control treatment. Mahogany powder at 2.0g dose caused the highest reduction 27.67% of oviposition of *C. chinensis* than control. The highest numbers of eggs bearing seeds 83.00% were observed in control treatment whereas less egg bearing seeds 28.67% in 2.0g dose.

Botanicals especially sesame oil might have anti-ovipositional effect against pulse beetle. The present result on oviposition performance were consistent with the results reported by Das [5] who found that the oviposition of *C. chinensis* was completely inhibited when stored seeds were treated with neem, sesame and coconut oil. Ahmed., *et al*. [6] also reported that neem, linseed, safflower, sunflower and sesame oils significantly reduced oviposition of *C chinensis*. They [7] further reported that neem and sesame oil treated beans were less preferred for oviposition of adults of *C. maculatus*.

Effect of botanicals on developmental performance of C. chinensis

Observations on developmental performance of *C. chinensis* assessed by adult emergence were directly proportional with concentrations of botanicals used in the experiment. Botanicals had significant effect on the decrease of adult emergence.

The highest number of adults 112.00% emerged in control treatment and the lowest 17.67% were at 2.0% concentration of sesame oil. The highest number of adults 138.70% emerged in control treatment and the lowest 19.33% were at 2.0% concentration of groundnut oil. The highest number of adults 139.70% emerged in control treatment and the lowest 24.00% were at 2.0g dose of garlic powder. The highest number of adults 146.00% emerged in control treatment and the lowest 19.17% were at 2.0g dose of mahogany powder.

The highest number of dead insect 6.53% was found in 2.0% concentration and the lowest number of dead insect 3.00% was recorded in control treatment of sesame oil. The highest number of dead insect 6.00% was found in 2.0% concentration and the lowest number of dead insect 2.00% was recorded in control treatment of groundnut oil. The highest number of dead insect 5.00% was found in 2.0g dose and the lowest number of dead insect 1.00% was recorded in control treatment of garlic powder. The highest number of dead insect 6.43% was found in 2.0g dose and the lowest number of dead insect 4.00% was recorded in control treatment of mahogany powder.

Botanical used in the experiment effectively controlled adult emergence probably by inhibiting oviposition and also by adversely affecting on the growth and development of the stages of *C. chinensis*. The supposed to be positive relation between the egg laid and number of adult emergence. It was found that sesame oil significantly reduced the fecundity of *C. chinensis* and therefore, the number of adult emergence reduced. Reduction of adult emergence might also associate with larval mortality. Botanicals might cause larval mortality in their early development stage. The results were in agreement with the findings of Ahmed., *et al*. [7] who reported that neem and sesame oils completely inhibited adult emergence. The oils also cause delay in larval development and the protective properties involved chemical rather than physical tactics. Dohary., *et al*. [8] also stated that reduction of adult emergence was more at higher concentration than lower concentration of sesame oil. Reported by Hussain., *et al*. [9] the fecundity of the pulse beetle was greatly reduced by sesame oil and completely inhibited the adult emergence.

It was evident that the mean numbers of damaged seeds recorded in control treatment were significantly higher than that of all other treatments. The highest mean damaged seeds 71.67% were found in control condition and lowest 13.00% in 2.0% concentration of sesame oil. The highest mean damaged seeds 64.33% were found in control condition and lowest 17.67% in 2.0% concentration of groundnut oil. The highest mean damaged seeds 77.33% were found in control condition and lowest 21.67% in 2.0g dose of garlic powder. The highest mean damaged seeds 73.33% were found in control condition and lowest 16.67% in 2.0g dose of mahogany powder.

The highest mean weight loss 2.33% was recorded in control treatment and lowest 0.33% in 2.0% concentration of sesame oil. The highest mean weight loss 2.47% was recorded in control treatment and lowest 0.43% in 2.0% concentration of groundnut oil. The highest mean weight loss 2.43% was recorded in control treatment and lowest 0.35% in 2.0g dose of garlic powder. The highest mean weight loss 2.67% was recorded in control treatment and lowest 0.33% in 2.0g dose of mahogany powder.

Similar results were observed by Ahmed., *et al*. [7]. They found that neem and sesame oils were effective protectant of seeds against pulse beetle in the storage.

The quantitative losses resulted in gram seeds by the attack of *C. chinensis* were observed in the experiment. From the observations it was evident that the highest weight loss in control treatment was related to severe damage caused by pulse beetles and due to the absence of any protectant in seeds against pulse beetle. The percentage of weight loss by pulse beetle decreased gradually following the increase of doses of botanicals (sesame oil, groundnut oil, garlic powder and mahogany powder). This result was consistent with the findings of Choudhury [10] who observed that neem, groundnut, castor, soybean and sesame oils reduced seed damage by *C. chinensis*. Similar findings also observed by Singh [11,12] and reported that sesame oil can serve as promising alternative method of protection of pulse seeds in storage and highly effective in protecting the seed damage in storage and weight loss of pulses.

Conclusion

The findings of the present investigations indicated that botanicals (sesame oil, groundnut oil, garlic powder and mahogany powder) might be useful as insect control agent for the management of pulse beetle in storage because of low cost, effective, easy handling, availability and relief from environmental degradation. Among those botanicals sesame oil and Mahogany powder performed well against pulse beetle. Therefore considering oviposition performance, developmental performance, seed damage and weight loss sesame oil (2.00%) could be recommended as potential protectant against pulse beetle.

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