CONTROL OF PULSE BEETLE, *Callosobruchus chinensis* (L.) In Stored Gram Seed Using Sesame Oil

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Accepted: 21 November, 2017

Abstract

Evaluation of sesame oil as seed protectant against pulse beetle, *Callosobruchus chinensis* (L.) was carried out in the Laboratory of the Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh. Efficacy of sesame oil was assessed at 0.5, 1.0, 2.0 and 4.0% concentration on oviposition performance, development performance, seed damage and weight loss done by *C. chinensis*. The results indicated that sesame oil at all the doses tested had significant effects on all the parameters observed and the effects were dose-dependent. Significantly the lowest numbers of egg bearing seeds (17.00) were found in 4.0% concentration followed by 34.67 in 2.0%, 61.64 in 1.0% and 72.67 in 0.5% concentrations compared to 91.00 in control. Similarly, significantly the lowest number of eggs/100 seeds (18.00) was found in 4.0% concentration but the highest number of eggs (185.00) was found in control. The highest adult emergence (139.67) was recorded in control but the lowest (12.00) at 4.0% concentration. The maximum damaged seeds were observed in control (77.33 seeds/100seeds) followed by 0.5% (67.01seeds/l00 seeds). 1.0% (54.00 seeds/l00 seeds) and 2.0% (20.00 seeds/l00 seeds). The lowest seed damaged (11.00/100 seeds) was found in 4.0% concentration. The highest weight loss (16.24%) was recorded in control but the lowest (3.67%) at 4.0% concentration. Sesame oil might possess anti-ovipositional, insecticidal and seed protectant properties against pulse beetle. Therefore, sesame oil may be useful for protection of pulse seeds against infestation of *C. chinensis* in gram seed storage.

Keywords: Pulse beetle, Callosobrucuss chinensis, gram seed, damage, control, sesame oil

Introduction

Pulses are important crops in Bangladesh because they are good source of protein (20-30%), vitamins, minerals and fiber content. People who cannot afford for animal protein, they include it in their diet. But it is unfortunate that the grains suffer enormous losses due to attack of bruchid both stored and in field condition. According to Southgate (1979) there are 100 species of bruchids which belong to 56 genera and 5 subfamilies. In Bangladesh, two bruchid species *Callosobruchus chinensis* (L.) and *C. maculatus* (Fab.) are most abundant and commonly known as pulse beetle. It causes both qualitative and quantitative losses in pulses. Rahman (1971) reported 12% loss due to pulse beetle in stored condition leads to commercial value and germination percentage. But controlling pulse beetle with chemical insecticides is not safe due to its residual effects. In this alarming situation, controlling pulse beetle with botanical products is being pursued in many countries as they are biodegradable, relatively specific in the mode of action and easy to use. Plant products are environmentally safe, less hazardous, less expensive and readily available. Due to problems such as health hazards, undesirable side effects and environmental pollution caused by the continuous use of synthetic chemical pesticides (Nas, 2004), there is renewed interest in the application of botanical pesticides for crop protection. Scientists are now experimenting and working to protect insect infestation by indigenous plant materials (Roy et al., 2005). The use of such plant extracts to control pests is not a new innovation, as it has been widely used by small scale subsistence farmers.

According to Roy et al. (2005) the use of locally available plants in the control of pests is an ancient technology in many parts of the world. Most of these botanical pesticides are nonselective poisons that target a broad range of pests. Botanical pesticides are biodegradable (Delvin and Zettel, 1999) and their use in crop protection is a practical sustainable alternative. It maintains biological diversity of predators and reduces environmental contamination and human health hazards. Research on the active ingredients, pesticide preparations, application rates and environmental impact of botanical pesticides are a prerequisite (Buss and Park-Brown, 2002) for sustainable agriculture. Botanical pesticides are unique because they can be produced easily by farmers and small industries (Roy et al. 2005). As consumer demand for organically produced foods increase, scientific research on the use of botanical pesticides is now gaining momentum (Nas, 2004). The present research work was undertaken to determine the effect of sesame oil on the oviposition performance, development, seed damage and weight loss that is done by *C. chinensis.*

Materials and Methods

An experiment with the efficacy of sesame oil as seed protectant against pulse beetle on stored grain in BAU Entomology laboratory. For conducting the experiment pulse beetle *Callosobruchus chinensis* and gram seeds and sesame oil were collected.

Mass culture of C. chinenis

One thousand (1000g) gram of fresh gram seed are collected from the local market and kept in a glass container. *C. chinensis* were obtained from the laboratory culture. Laboratory of Entomology, BAU, Mymensingh where culture had been maintained for several generations. The beetles were released in a glass container for mating and oviposition upto maximum in 7 days. The head of the container was covered with nylon cloth. After oviposition, the adult beetles were removed and fresh seeds were poured in the jar. The newly emerged beetles were again allowed to oviposit on fresh seeds in different container to maintain stock culture throughout the study period.

Preparation of sesame oil doses

Four different doses of sesame oil such as 4.0, 2.0, and 1.0 and 0.5% were prepared. To prepare 4% concentration, 4 ml of sesame oil was taken in conical flusk with the help of pipette then 96 ml of distilled water was added. In this way 2 ml in 98 ml, 1 ml in 99 ml and 0.5 ml sesame oil in 99.5 ml distilled water were added to prepare 2%, 1% and 0.5% concentration.

Seed treatment with different doses of sesame oil

One thousand seeds were randomly taken from the collected sample, weighted and kept in a petridish. From each prepared concentration 0.5 ml was taken then applied on seeds by dropping. Later on they were properly mixed and kept sometime for air drying. Distilled water was applied only on control. Each concentration was replicated three times.

Oviposition performance

Four pairs of newly emerge pulse beetle were kept in each petridish for egg laying for each concentration and then covered. The adult beetles were removed after 4 days and the eggs laid on gram seeds were counted. Number of egg bearing seeds, eggs per seed and total number of eggs were recorded and left undisturbed for further development.

Developmental performance

After completion of larval development inside the seed, adult emergence occurred. The adult emerged after 21 days of egg laying and continued for several days.

Assessment of damage and weight loss

After adult emergence the seeds were examined to assess the damage done in gram seeds after the feeding during larval stages. All the seeds were examined carefully to observe the number of holes on the surface made by C. *chinensis.* Seeds with holes were considered as damaged seeds and were counted and recorded. To asses weight loss gram seeds were separated from dust and body parts of pulse beetle by sieving and winnowing. The cleaned seeds in each petridish were weighed separately. Weight loss of gram seeds calculated by subtracting the final weight from the initial weight before releasing the pulse beetle. The weight losses were expressed in percentage and calculated by the following formula (Abbott,1987):

$$\text{Weight loss (\%)} = \frac{(A-B)}{A} X\ 100$$

Where,

A = Initial weight of the gram seed
B = Final weight of gram seed after adult emergence

Statistical analysis

Data were statistically analyzed in one factor Completely Randomized Design and treatment mean values were compared by Duncan's Multiple Range Test (DMRT).

Results and Discussion

Oviposition

The highest number of egg bearing seeds were found in control petridish (91.0) followed by the treatment with 0.5% concentration (72.67) and the lowest mean number of 17.0 egg bearing seeds were found in 4% concentration. In use of I% and 2% concentration the egg bearing seeds were found 61.67 and 34.67 respectively (Table 1). The results on oviposition performance of *C. chinensis* showed that sesame oil significantly inhibited oviposition on the gram seeds as compared to untreated seeds ($p < 0.01$). Sesame oil at 4.0% concentration caused the highest reduction (10.27 times) of oviposition of *C. chinensis* than control (Table 2). Sesame oil might have anti-ovipositional effect against pulse beetle. The result on oviposition performance was consistent with the results reported by Das and Karim (1986) who found that oviposition performance was completely inhibited when stored seeds were treated with neem, sesame and coconut oil. Ahmed *et al.* (1993) also reported that neem, linseed, safflower, sunflower and sesame oils significantly reduced oviposition of *C. chinensis.* Neem and sesame oil treated beans were less preferred for oviposition by adult of *C. maculatus* (Ahmed *et al.,* 1999).

Adult emergence

The highest number of adult emergence was found in control (Table 1). The 12 adultswere developed inform gram seed where seds were treated with 4% concentration and sigficantly different from all other concentrations ($p < 0.05$). The second highest adult emergence (80.33%) was observed in 0.50% concentration followed by 1.0% concentration and the results were statistically significant ($p < 0.01$) (Table 3). Sesame oil used in the experiment effectively controlled adult emergence by inhibition of oviposition and also adversely affecting the growth and development of *C. chinensis.* Positive relation between the egg laid and number of adult emergence was observed. It was found that sesame oil significantly ($p < 0.01$) reduced the fecundity of *C. chinensis.* Reduction of adult emergence might also associate with larval mortality. Dohary *et al.* (1988) stated that reduction of adult emergence was more at higher concentration than lower concentration of sesame oil. The fecundity of the pulse beetle was greatly reduced by sesame oil and completely inhibited the adult emergence (Hussain *et al.,*1992).

Table 1. Number of egg of *C. chinensis* per 100 seeds in sesame oil treated gram seeds

Concentration	Number of egg bearing seeds per 100 seeds			
	R_1	R_2	R_3	Mean ± S.E.
Control	85	92	96	91.00±3.2Ia
0.5	72	75	71	72.67± 1.201b
1.0	65	50	70	61.67±6.009 c
2.0	28	35	41	34.67±3.576 d
4.0	19	15	17	17.00±1.l54 e

Values followed by different letters within column differed significantly as per DMRT ($p < 0.05$)

Table 2. Number of egg laid by *C. chinensis* per 100 seeds in sesame oil treated gram seeds

Concentration	Number of egg bearing seeds per 100 seeds			
	R_1	R_2	R_3	Mean ± S.E.
Control	178	185	192	185.00±4.041a
0.5	135	148	155	146.00±5.859b
1.0	108	98	112	106.00±4.163c
2.0	35	42	52	43.00±4.932d
4.0	25	18	12	18.00±3.75e

Values followed by different letters within column differed significantly as per DMRT ($p < 0.05$)

Table 3. Number of adult emergence of *C. chinensis* per 100 seeds in sesame oil treated gram seeds

Concentration (%)	Number of egg bearing seeds per 100 seeds			
	R_1	R_2	R_3	Mean ± S.E.
Control	142	121	156	139.67±10.170a
0.5	78	75	88	80.33±3.929b
1.0	52	46	53	50.33±2.185c
2.0	22	21	29	24.00±2.516d
4.0	12	11	13	12.00±0.577e

Values followed by different letters within column differed significantly as per DMRT ($p < 0.05$)

Seed damage and weight loss

It was evident that the mean number of damaged seeds recorded in control treatment was significantly higher than those of all other treatments (Table 4). The highest damaged seeds (77.33) were found in control condition and lowest (11.00) in 4.0% concentration (Table 4). Ahmed *et al.* (1999) 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 present experiment. The highest weight loss was 16.24% in control and the lowest (3.67) in 4.0% concentrations (Table 5). It was evident that the highest weight loss in control was related to severe damage caused by pulse beetles. The percentage of weight loss decreased gradually with increasing of doses of sesame oil. The result was consistent with the findings of Choudhury (1990) who observed that neem, ground nut, castor, soybean and sesame oils reduced seed damaged by *C. chinensis.* Similar findings also observed by Singh (2003) 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. The present findings suggested that sesame oil can serve as promising alternative method for protection of gram seeds in storage. The results encourage peoples of our country to use this botanical agent in storage pest management system because of low cost, effective, easy handling, availability and relief from environmental degradation.

Table 4. Number of damaged seed caused by *C. chinensis* per 100 seeds in sesame oil treated gram seeds

Concentration (%)	Number of egg bearing seeds per 100 seeds			
	R_1	R_2	R_3	Mean ± S.E.
Control	77	72	83	77.33±3.179a
0.5	69	67	65	67.00±1.154b
1.0	58	51	53	54.00±2.081c
2.0	20	17	23	20.00±1.732d
4.0	10	11	12	11.00±0.577e

Values followed by different letters within column differed significantly as per DMRT ($p < 0.05$)

Table 5. Weight loss of gram seeds by infestation of *C. chinensis* after treated with sesame oil

Concentration (%)	Initial wt. of seed (g)	Final wt. of seed (g)	Mean wt. loss (g)	Wt. loss (%)
Control	19.27	16.13	3.13	16.24a
0.5	20.22	17.98	2.24	11.07a
1.0	21.26	19.21	2.05	9.64ab
2.0	21.40	20.15	1.25	5.84b
4.0	21.53	20.74	0.79	3.67b

Values followed by different letters within column differed significantly as per DMRT ($p < 0.05$)

Conclusion

Since currently, store grain insect pests management solely depends on chemical insecticide that has tremendous impact on environment, biodiversity, animal as well human health, the findings of this study can be used to explore more effective botanical oils as biopesticide for store grain insect pests in Bangladesh. Based on this report, neem oil would be an effective biopesticide for controlling pulse beetle in stored products in house or other store godowns.

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