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Bio efficacy of *Eruca sativa* oil against *Callosobruchus chinensis* on chickpea

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Abstract

Pulse beetle, *Callosobruchus chinensis* L. responsible for destroying qualitative and quantitative losses to most stored grains. Once the damage done by the beetle, the grains lose their nutritional and germination capacity and become unfit for either consumption. Seed treatment still mainly relies on heavy synthetic chemicals which cause residual effect and threaten public health. However, the natural plant products containing insecticidal activity have recently displayed a great scope as they tend to come up with low mammalian toxicity, less effect on environmental and broad public adoption. Therefore, an experiment was conducted with variable doses of *Eruca sativa* L. seed oil (0.5 ml, 1 ml, and 1.5 ml) against *C. chinensis*. The data were recorded for corrected mortality, repellent effects, and seed protectant at different intervals (24, 48, 72 hrs and 1 week). We found the higher corrected mortality (32.65%) at 1.5ml after 24 hrs. Later, the mortality percentage decreased at different intervals but remained higher at maximum dose of *E. sativa*. However, the overall highest mortality of *C. chinensis* was 50.00% at 1.5 ml and the lowest 41.00% at 0.5 ml. Meanwhile, the index showed repellent effect with R.I value <1 in all treatments at different intervals. The seed protectant data showed that the minimum number of 1.66±0.33 eggs laid on treated seeds at 1.5 ml and 8.00±1.15 eggs on untreated seeds in choice experiment. In total, maximum number of 17.33±4.93 eggs laid at 0.5 ml in choice experiment and minimum 4.83±1.51 eggs at 1.5 ml. However, in no choice experiment, the maximum number of 51.00±4.58 eggs on control treatment and minimum 0.33±0.33 eggs on 1.5 ml were laid by pulse beetle. The most effective dose of 1.5ml caused maximum mortality, repellent and seed protectant.

Key words: *Callosobruchus chinensis*, Chickpea, *Eruca sativa*, Repellent, Mortality.

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1. INTRODUCTION

Chickpea (*Cicer arietinum* L.*)* is one of the major leguminous crops belonging to the family Fabaceae. It holds fourth position in the world among legume crops and cultivated on an area of 10.2 m ha with an average yield of 11 mm tons[1]. It provides calories and proteins to the significant population of the world and keeps food security of billions people[2]. It is also an imperative drought tolerant crop grown in semi-arid and arid areas and plays a vital role in providing food for the poor people of the world where there is shortage of water[3,4]. In Pakistan, chickpeas have been cultivated over 0.96 m ha with the production of 399 to 484 m tones[5]. Although, a rise in production was witnessed for chickpeas in Pakistan but the major issue of pulse beetle *C. chinensis* still exists which destroy quality and quantity of stored grains[6]. It has been recorded that this beetle causes heavy losses in seed weight (50- 60%) and protein content (45-65%) in godowns[7, 8]. Once damaged by the beetle, the grains lose their nutritional and germination capacity and become unfit for either consumption[9]. Treatment of most stored grains to protect from insects still mainly relies on heavy synthetic chemicals such as methyl bromide, pirimiphos-methyl, phosphiner and permethrin[10]. However, widespread exploitation of these insecticides has largely enhanced the pesticides' defiant strains, handling hazards, increased costs, insecticide residues that causes threats to public health and pollute the environment[11]. In the public domain, understanding the threat and risk regarding synthetic chemicals recently aroused which pushed them to seek for safer insecticides or other alternatives to save the stored-produce from noxious attack of stored grain pests[12]. In this regard, the utility of natural plant products that possess insecticidal activity have recently displayed a great scope as they tend to come up with low mammalian toxicity, less effect on environmental and broad public adoption[13].

Essential oils of plants are explosive volatile mixtures that continue living at stumpy concentrations and frequently found in fragrant plants[14,15]. Numerous transplant derivatives have been reported quite effective against stored grain insect pests. The neem *Azadirachta indica* A. Juss. is one of the most traditional plants used against several pests[16]. [17]Identified the principal part of citrus lubricate as limonene which was found to be vastly operative insecticide. These oils do not only help the farmers to kill and repel the insects but also helpful to inhibit the oviposition of these bruchid beetles. *Eruca sativa* L. is commonly known as rocket plant and it is a member of the mustard (Brassicaceae) family. The plant is used as a medicinal remedy for various diseases and insect pests[18]. As, this plant contains a high amount of erucic acid and glucosinolates which provide ideal protection to plant from several pests during field and in godowns against stored grain pests[19]. During the recent years, formulation of plants and their products as powders, volatile oils, nonvolatile oils, and extracts could be effectively used against pulse beetles and another store grain pest[20]. Therefore, this study has been carried out to observe the lethal and repellent effects along with seed protectant efficiency of *E. staiva* oil against *C. chinensis* for egg laying.

2. MATERIALS AND METHODS

2.1 Studied Area

The experiment was performed at post graduate laboratory, Department of Entomology, Faculty of Crop Protection, Sindh Agriculture University, Tando jam.

2.2 insect collection

The culture of *C. chinensis* was obtained from grain Pulse Section, Agriculture Research Institute (ARI) Tando jam.

2.3 Experimental observation

Botanical oil of *E. staiva* was purchased from local market near Tando jam and three different doses i.e. 0.5ml, 1ml and 1.5ml were used to observe the mortality, repellence and seed protectant efficiency against *C. chinensis*.

2.4 Mortality assessment

In each container, 20 freshly emerged beetles (10 pairs) of *C. chinensis* were transferred to plastic jar having treated seed of different doses inside it. The opening of all plastic jars was protected with ventilated muslin cloth and tautens with elastic band to avoid escaping of beetles. The corrected mortality of insects due to poured of *E. staiva* oil was recorded after 24, 48, 72 hrs and one-week intervals through counting the number of alive and dead insects.
The mortality assessment was observed using[21] formula as mentioned below.

$$Pt = \frac{Po-P_c}{100-P_c} \times 100$$

Po= observed mortality (%) and Pt= corrected mortality (%)

2.5 Repellence Index Test

The repellence index (IR) was calculated using the area preference procedure as mentioned by[22]. A filter paper was used and divided into two portions, one portion was dipped in prepared concentration of oil and reaming portion left untreated. In the same way, all replications from different treatments were made and these filter papers were dried for few hours before keeping inside the petri dish. Later, 20 beetles randomly selected and were released on treated grains and repellent effect was observed by using formula given by[23]. The repellence index was observed based on if value < 1 shows repellent effect, if value > 1 shows attractant and if value =1 shows neutral.

IR= 2G/G + P

2.6 Seed protectant against egg laying

The seed protectant for egg laying was recorded with two different experiments i.e. choice and no choice experiments. In choice experiment, five treated and five untreated chickpea seeds were taken and kept in a petri dish (9.0 cm^2) on which a virgin pair (male and female) of beetle was released. However, in no choice experiment, similar procedure was followed but all seeds were treated, and untreated seeds were kept in control treatment. The seeds were treated with similar different doses as used in first experiment Fig.1.

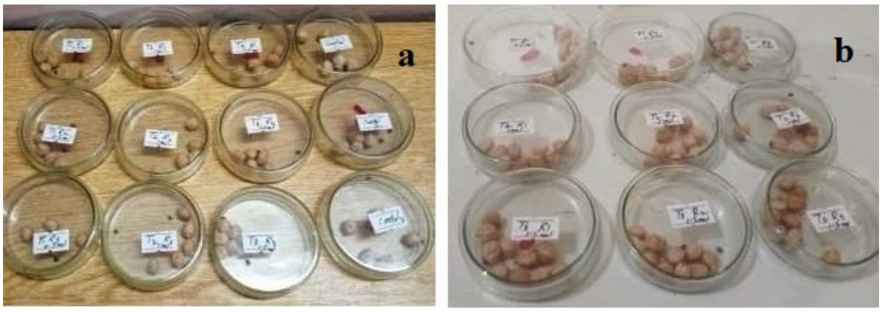

Fig.1. Experimental setup (a) No choice experiment (b) Choice experiment

2.7 Statistical analysis

The collected data were analyzed through ANOVA test using statistics 8.1 computer software package. The differences among the treatment means were compared by Least Significant Difference (LSD) at $p<0.05$.

3. RESULTS AND DISCUSSIONS

3.1. Effect of E. sativa oil on corrected mortality of C. chinensis at 24, 48, 72 hrs and one week

The *E. sativa* oil on corrected mortality of *C. chinensis* at different doses of *E. sativa* oil under laboratory condition was recorded and presented in Table-1. The results indicated maximum corrected mortality (32.65%) at 1.5 ml after 24hrs followed by (9.27%) at 48hrs and minimum. Overall, the highest value for corrected mortality of *C. chinensis* was noted (50%) also at 1.5ml followed by (46.25%) at 1 ml and the lowest (41.00%) at 0.5ml, respectively.

Table 1. Corrected mortality of *C. chinensis* at different doses of *E. sativa* oil

Doses	24	48	72	1week	Overall %
0.5ml	23.46%	7.21%	4.21%	-1.11%	41.25%
1ml	28.57%	8.24%	5.26%	-4.21%	46.25%
1.5ml	32.65%	9.27%	6.31%	-7.77%	50.00%

3.2. Repellent effect of different doses of E. sativa oil on C. chinensis at 24, 48 and 72 hrs

After corrected mortality, the effect of *E. sativa* was also observed as repellent Table-2. The results showed that the maximum number of insects repelled **(**12.33±1.20) at 1.5ml followed by (10.33±0.33) at 1ml after interval of 24 hrs and the lowest (9.66±0.88) at 0.5ml. After 48 hrs of application, the highest number of insects repelled (4.0±0.57) at 1ml and the lowest (2.0±0.00) at 1.5ml. The highest number of insects (1.00±0.57) repelled at 0.5ml and the lowest (0.66±0.33) at 1ml and 1.5ml. The index value for 24, 48 and 72 hrs showed all treatment repellent after 72 hrs. Meanwhile, repellent index showed that all treatments were repellent.

Table 2. Repellent effect of different doses of *E. sativa* oil against *C. chinensis* on chickpea seed

Treatment	Mean± S.E	GValue%	PValue%	RIndex	Remarks/Effect
			24 hrs		
0.5ml	9.66±0.88b	42.00	58.00	0.84	Repellent
1ml	10.33±0.33ab	35.41	64.59	0.70	Repellent
1.5ml	12.33±1.20a	21.28	78.72	0.04	Repellent
			48 hrs		
0.5ml	3.66±0.33a	47.62	52.38	0.95	Repellent
1ml	4.00±0.57a	29.42	70.58	0.58	Repellent
1.5ml	2.00±0.00b	40.00	60.00	0.80	Repellent
			72 hrs		
0.5ml	1.00±0.57a	25.00	75.00	0.50	Repellent
1ml	0.66±0.33a	33.34	66.66	0.66	Repellent
1.5ml	0.66±0.33a	0.00	100	0.00	Repellent

Means followed by different letters within the same column are significantly different (P <0.05) R. I< 1 shows repellent effect, if value > 1 shows attractant and if value =1 shows neutral IR= 2G/G + P (Mazzonetto 2002)

3.3. Seed protectant efficiency of E. sativa oil against C. chinensis for egg laying

The seed protectant for egg laying was recorded with two different experiments i.e. choice and no choice Table-3.

3.3.1. Choice experiment

In results, the minimum number of 1.66±0.33 eggs laid on treated seeds of 1.5 ml and 8.00±1.15 on untreated seeds in similar treatment. However, the maximum number of 28.00±1.52 eggs laid on untreated seeds and 6.66±2.33 on treated seeds of 0.5ml. In total maximum number of 17.33±4.93 eggs laid on treated and untreated seeds of 0.5ml. However minimum total number of 4.83±1.51 eggs laid on treated and untreated seeds of 1.5ml.

3.3.2. No Choice experiments

In results, the minimum number of 0.33±0.33 eggs laid on 1.5ml and maximum 51.00±4.58 in control treatment.

Table 3. Seed protectant efficiency of *E. staiva* oil against *C. chinensis* for egg laying

Treatments	Choice			No Choice
	Treated Mean ± S. E	Untreated Mean ± S. E	Total Mean ± S. E	Mean ± S. E
0.5ml	6.66±2.33a	28.00±1.52a	17.33±4.93a	4.33±0.33b
1ml	3.66±0.33ab	19.33±3.52b	11.50±3.84ab	1.66±0.33b
1.5 ml	1.66±0.33b	8.00±1.15c	4.83±1.51b	0.33±0.33b
Control				51.00±4.58a

Means followed by different letters within the same column are significantly different (P <0.05)

Due to toxicity of most pesticides and their residual effects alternative control measures are highly required to eradicate store grain pest. In this concern, the use of botanical oil as pesticide is an apex site of attraction. The *E. sativa* are well appreciated and documented for their performance as a mortality, repellent seed protectant and toxic against many store grain pests. In present study seed treatment with *E. sativa* oil against *C. chinensis* in chickpea grains were observed regarding mortality, repellent and seed protectant as this oil has great potency being a mortality and toxic to many store grains pests[24].

The present results showed maximum mortality of *C. chinensis* on 1.5 ml (50.00%) and the lowest on (41.00%) on 0.5 ml which showed that an increase rate of botanical pesticides also increased the mortality percent of stored pest. These results are in line with[25] who conducted a trail on eco-friendly management of pulse beetle on chickpea. They observed death ratio of adult bruchids among six pesticidal materials was significantly higher in chickpea treated by *C. camphora* followed by *A. callamus*. No grain damage was recorded in chickpea. The adult emergence and mortality in chickpea were found ineffective among the botanicals (*A. indica*), leaf and (*X. armatum*) fruit dust. Meanwhile, adult's emergence recorded maximum in F2 generation. However, in comparison of two storage structure, the jute bag with plastic lining performed much better in maintaining less grain damage, low moisture and higher generation. Thus, the better storage structure and botanical materials was found in *A. calamus* rhizome dust, sesamum-oil and *C. camphora* balls in jute bag with plastic lining and was also found as effective safe alternatives in management of *C. chinensis* for storage of chickpea. Mortality of adult bruchids was obtained significantly in chickpea treated by sesamum oil (24.50%) and which enhanced when doses were increased.

Moreover, the repellent effect of different doses of *E. sativa* oil on *C. chinensis* also observed effective and their potency remained high at 24 hours with maximum number of repellent (12.33±1.20) on 1.5ml. These results are in line with[26] who observed that the highest repellent activity for *Schyzygium aromaticum* (essential oil) against *Sitophilus oryzae* was higher at maximum doses and highest repellent found at 24 hours of application. [24]evaluated 13 different indigenous plants used N-hexane solvent extracts of which tested for screening of their pesticide's activity against pulse beetle. Affecting through mortality inhibition by extracts showed insecticidal activity, reduced as seed damage and adult emergence, fecundity inhibition. In plant extracts *Annona reticulate* and *Emblica officinalis* and showed 100% mortality within 72 hours, *Nerium oleander* indicated 90% mortality in 2 to 3%. Furthermore, *Polygonum hydropiper* (9.33%) and *A. reticulate* (2%) extract also reduced the seed damage, respectively. However, repellence to classes varied (II to IV) but *P. hydropiper* displayed better results as related to other plant extracts.

In last part of the study, seed protectant efficiency of *E. staiva* oil against *C. chinensis* for egg laying was observed. The results showed that the minimum number of eggs was observed in no choice experiment at the dose of 1.5 ml and maximum in control treatment. [27]conductedan experiment in which *E. sativa* oil was tested against *Callosobruchus sp.* In their results, they mentioned that the *E. sativa* oil was the most effective in low egg laying and reduced adult emergence followed by mustard oil. [28,29]also studied different formulations against the pulse beetle *C. chinensis* on grains of *Vigna radiata*. The plants were *Jatropha gossypiifolia*, *Phyllanthus amarus* and *Euphorbia hirta* and the main object of the study was to inhibit egg laying percentage of pulse beetle and they found successful results in order to inhibit egg laying capacity of pulse beetle on all plant extract more or less but maximum on *J. gossypiifolia*.

4. CONCLUSION

It was concluded that the *E. sativa* oil found effective at all selected doses. However, the mortality and repellent effect of pest increased as doses of this oil was increased. The most effective dose of 1.5ml caused maximum mortality, repellent and seed protectant.

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6. CONFLICT OF INTEREST

The authors declare no conflict of interest.

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