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Bio-insecticidal activity of *Delonix regia* oil extracts on maize weevil *Sitophilus zeamais* (Motschulsky, 1855) (Coleoptera: Curculionidae)

O. M. Obembe

Department of Plant Science and Biotechnology, Plant Resources Management Programme, Ekiti State University, P.M.B 5363, Ado Ekiti, Nigeria

E-mail address: obembemike01@yahoo.com

ABSTRACT

The maize weevil, *Sitophilus zeamais* (Coleoptera: Curculionidae) is one of the major pest infesting stored grains world wide. Experiments were conducted to study the efficacies of *D. regia* oils on mortality and adult emergence of *S. zeamais* Motschulsky. The long time storage and viability of the treated maize grains were also investigated. Results obtained showed that *D. regia* oil at every concentration was lethal on *S. zeamais*. At 1.0%, 1.5%, and 2.0% concentration, there was 100% mortality of *S. zeamais* at 96 h of exposure. The least potent extract was 0.5% concentration. The extracts drastically reduced adult emergence to 0.0% in grains treated with 1.5% and 2.0% oil extracts concentration. Grains treated with 1.0%, 1.5% and 2.0% *D. regia* seed oil completely prevented infestation and subsequence damage of the treated maize grains for a period of three Months. Thereafter, 20.04% damage was observed in grains treated with 0.5% oil extract. The oil extracts at all concentrations in this experiment hardly affected germination as there was no significant difference between percentage germination in the treated grains and the control. The results obtained reveal that oil extracts of *D, regia* seeds are effective in controlling *S. zeamais* and could serve as alternative to the controversial convectional chemical insecticides

***Keywords*:** *Sitophilus zeamais, Delonix regia*, Mortality, Lethal, Bio-insecticide

1. INTRODUCTION

Grain storage in Nigeria and other Africa countries has been faced mostly by insect pests such as weevils, beetles and moth. These have led to weight loss and reduction in seeds quality [1-3] Adult weevils and larvae feed on wholesome grains and reduce them into powdering form. Infestation by maize weevils may commence from the field just before harvest and the weevils continues to reproduce and destroy the grains in the store [4-6]. The larvae develop and pupate within the grains. The adult emerge through characteristic circular hole made on the grain. The developmental activities of weevil often lead to severe powdering and tainting of the grains with their extrements. The infested grains are often rendered susceptible to caking and mould infection thereby reducing their market values.

Figure 1. Insects on maize (*Sitophilus zeamais*).

To prevent such loses however, the use of synthetic insecticides have been the major insect control method, but these chemical insecticides have significant setbacks, such as the development of strain resistance to insecticides [7], increased cost, problem of handling, residual toxicity and environmental pollution [8]. The aforementioned shortcomings of the chemical insecticides have led researchers to look for insect control strategy to serve as substitutes to the dangerous synthetic chemical insecticides [9-11]. Researchers have been able to discover botanicals that are ecologically safer, economical, readily affordable, and environmentally friendly pest control techniques [12-14].

Several plant oils have been screened for preventing post harvest losses due to insects [5,15]. Oils of coconut, groundnut and African palm at dosage rates of 5 and 10ml/ kg were found to effectively control *Sitophilus oryzae* by reducing oviposition and larva development [16]. Plant oils are toxic to young larva, adult and egg. Neem seed oil and powder are affective in repelling and killing maize weevil [17]. The powders and oil extacts of pepper fruit, *Dennettia tripetala* have been reported effective against *S. zeamais* [18,19]. The purpose of the present research was to evaluate the bio-insecticidal activity of *Delonix regia* (Fig. 1 & 2) oil extract on maize weevil, *Sitophilus zeamais* (Fig. 1).

Fig. 1. *Delonix regia* (flower).

Figure 2. *Delonix regia* (tree).

2. MATERIALS AND METHODS

2. 1. Insect rearing

Parent stock of *Sitophilus zeamais* were obtained from naturally infested maize grains from Oba market, Omuo Ekiti, Nigeria. The insects were reared in the laboratory on cleaned maize grains at 28±2 degree centigrade and relative humidity of 75 ±5% following the method described by Adedire *et al.* (2011) [8]

2. 2. Collection and preparation of Oil Extracts

Dry pods of *Delonix regia* were collected from the Faculty of Science, Ekiti State University, Ado Ekiti, Nigeria. The pods were split opened and the seeds were removed. The seed coats were then crushed to remove the cotyledons. The cotyledons were air-dried in the laboratory for two weeks in order to reduce the moisture content, so as to prevent moldiness. The air-dried cotyledons were milled into fine powder using an electric Binatone blender (Model BLG 400). The powder was stored in black cellophane bag until ready needed. The powders were measured separately into beakers and packed into thimbles and extracted with 250 ml 70% ethanol in a Soxhlet apparatus at 60 degree centigrade. The oil was concentrated by removing the solvent using rotary evaporator and thereafter exposed to slow blowing fan to remove traces of ethanol. The oil was poured into a bottle and stored in a refrigerator until the commencement of the experiment.

2. 3. Toxicity bioassays

Twenty grams of un-infested maize grains were measured into 9 cm diameter Petri-dish. Oil extracts of volume 0.5, 0.1, 0.15 and 0.2 ml were added to 10 ml of ethanol to give 0.5%, 1.0% 1.5% and 2.0% v/v respectively. Oil dosage of 1 ml was pipetted from each concentration into each replicate.

The mixture was thoroughly agitated to ensure uniform coating of the oil on the maize grains. The Petri-dishes were exposed to air for about 45 minutes to allow the traces of the solvent (ethanol) to dry off. Thereafter, 20 newly emerged adult maize weevils were introduced into the Petri-dishes and then covered with the lid. Solvent treated and untreated grains were set up as the control experiment.

All treatments were replicated four times in a Complete Randomized Design (CRD). Mortality of the insect was observed and recorded at 24 h interval for 96 h. Thereafter, all dead and life insects were removed and the set-up was kept for another 6 weeks to assess the effectiveness of the treatment on adult emergence of *S. zeamais*. After 6 weeks the number of adult that emerged was recorded. The number of damaged seeds and weight loss were calculated and expressed as percentage of the total number of seeds in the Petri-dish [8].

Percentage seed damage was determined thus:

$$\%\text{ damage of seed damage} = \frac{\text{No of seed damaged}}{\text{Total no of seeds}}$$

Seed damage was also assessed after 90 days using the weevil perforated index (WPI) as described by Fatope *et al.* (1995) [20]. WPI index exceeding 50 was regarded as enhancements of infestation by the weevil or negative ability of the extract tested.

2. 4. Viability bioassays

Clean and wholesome maize grains were used for the experiment. Twenty grams of maize grains were weighed into transparent plastic containers and mixed with 0.5, 1.0, 1.5 and 2.0% oil extracts concentration with the aid of a glass rod to allow for uniform coating of the extracts on the grains.

The seeds were treated with Apron plus (2.5g/ Kg seed) to prevent fungal growth, air-dried and then covered with muslin clothes to prevent the escape of weevils and entry of other insects. The experiment was replicated four times.

The control experiment consists of samples that were not treated with any extract and one treated with ethanol. The treatment and control were left in a wooden cage in the laboratory for 90 days. Fifty seeds were randomly selected from each treatment and the control and planted on a moistened filter paper in Petri-dishes. The germination process lasted for a period of seven days after which the number of germinated seeds in each Petri-dish was counted and recorded.

2. 5. Data analysis

Data obtained were subjected to analysis of variance and where significant differences existed, means were separated using Tukey's test.

3. RESULTS

3. 1. Effect of Oil extract of *D. regia* seed on mortality of adult *S. zeamais*

The mortality of adult *Sitophilus zeamais* treated with oil extract of *D. regia* seed is presented in Table 1. The result showed that *S. zeamais* mortality increased with an increased in oil concentration and exposure period. Mortality recorded was 8.50%, 32.80%, 43.30% and 84.20% by 0.5, 1.0, 1.5 and 2.0% v/v concentration respectively at 24 h post treatment. At 96 h post treatment 100% adult mortality was recorded by 1.0%, 1.5% and 2.0% treatment concentration of the oil. There was zero mortality in the control experiments. The effect of the oil differed significantly (P< 0.05) across the various extract concentrations

Table 1. Toxicity of oil extracts of *D. regia* seed on *Sitophilus zeamais*

Treatment (%)	% mortality at lows post treatment			
	24h	48h	72h	96h
0.5	8.50b	30.00b	55.20b	65.20b
1.0	32.80c	55.20c	80.80c	100.00a
1.5	43.30c	68.40d	92.40c	100.00a
2.0	84.20d	92.00c	100.00d	100.00a
Untreated	0.00a	0.00a	0.00a	000.00a
Ethanol	0.00a	0.00a	0.00a	000.00a

Each value is the mean of 4 replicates. Mean in each column followed by the same alphabet(s) are not significantly different (p>0.05) by Tukey's test

Table 2. Effect of different oil extract of *D. regia* seed on adult emergence of *S. zeamais* after 7 weeks in maize grains

Conc. (%)	Mean adult emergence
0.5	20.40b
1.0	15.20b
1.5	0.00a
2.0	0.00a
Untreated	125c
Ethanol	123c

Each value is the mean of 4 replicates. Mean in each column followed by the same alphabet(s) are not significantly different (p>0.05) by Tukey's test

Table 3. Effect of *D. regia* seed oil on long term storage of maize grains.

Conc. (%)	Total no of seeds	Percentage damage	weight loss	Weevil perforator index
0.5	195	20.04±1.45b	10.20±1.20b	8.10±2.00b
1.0	200	0.00±0.00a	0.00±0.00a	0.00±0.00a
1.5	198	0.00±0.00a	0.00±0.00a	0.00±0.00a
2.0	194	0.00±0.00a	0.00±0.00a	0.00±0.00a
Untreated	196	85.04±2.20c	25.02±1.90a	50.00±0.00c
Ethanol	195	80.02±2.02c	23.10±0.10c	50.00±0.00c

Each value is the mean of 4 replicates. Mean in each column followed by the same alphabet(s) are not significantly different (p>0.05) by Tukey's test

Table 4. Effect of *Delonix regia* seed oil on germination of maize that were previously protected for 90 days.

Concentration (%)	Mean percentage germination
0.5	100.00±0.00a
1.0	95.00±2.20a
1.5	95.00±1.25a
2.0	10.00±1.42a
Untreated	100.00±0.00a
Ethanol	100.00±0.00a

3. 2. Effect of *Delonix regia* seed oil on adult emergence of *S. zeamais.*

D. regia seed oil extracts effectively reduced the number of adult that emerged after a period of seven weeks as revealed in Table 2. The ability of adults *S. zeamais* to emerged increased with decrease in concentration of the oil extracts. With 0.5% and 1.0% oil extracts concentration, there was no significant difference in the number of adult that emerged (P>0.05). No weevil survived in 1.5% and 2.0% oil extracts concentration. In all cases the number of adult that emerged is significantly lower than that of the control.

3. 3. Protectant ability of *D. regia* seed oil extracts on maize grains

The ability of the *D. regia* seed oil extracts to protect maize grains from damaging is concentration dependant as revealed in Table 3. The oil extracts concentration of 1.0%, 1.5% and 2.0% completely prevented infestation and damage of the maize grains. There was neither seed damage nor weight loss recorded in the maize grains and WPI was zero for the above concentrations. However, there was 20% damage, 10% weight loss and 8.10 Weevil Perforation Index with grains treated with 0.5% to oil extract concentration. In the untreated and ethanol control there was 85% and 80% damage respectively as revealed by emergent holes of the weevils. The weight of the control was significantly reduced compared to the treated grains.

3. 4. Effect of *D. regia* seed oil extract on grain viability

The percentage germination of the grains was generally high (Table 4). There was 100% germination in grains treated with 0.5% oil extract and those of the control experiment. Also 95% germination was recorded in grains treated with 1.0% and 1.5% oil extract concentration while 90% germination was recorded in grains treated with 2.0% oil extract concentration.

4. DISCUSSION & CONCLUSIONS

Result from this study showed that oil extracts of *Delonix regia* seeds caused high mortality of adult *S. zeamais* in treated maize grains with the concentration of 2.0%.the most toxic. This results suggest that *D. regia* could be successfully used for the control of *S. zeamais* and may serve as alternative to the synthetic insecticides. *Delonix regia* extracts is also believed to be easily biodegradable and environmentally friendly just like other botanical insecticides and very effective for the control of storage beetles [21,22]. The present results agree with those obtained by Adedire *et al.* (2011) [8] where the effectiveness of oil extracts of Cashew kernel for the protection of cowpea from *C. maculatus* was reported.

The insecticidal effect of *D. regia* oil on *S. zeamais* in the treated maize grains might be as a result of contact toxicity. The oil extract might have blocked the spiracles of the insects, thereby leading to suffocation and death of the insect [23; 8, 24]. Adult emergence of *S. zeamais* was significantly lower ($P<0.005$) in oil treated grains as against the adult emergence in the untreated and ethanol treated maize grains after 6 weeks of exposure to the *D. regia* oil extracts. The low adult emergence may be ascribed to low oviposition or the toxicity of the oil on the eggs laid. Also the *D. regia* oil extracts possibly inhibited locomotion, hence, inhibiting the free movement of insect and thereby affecting mating activities and fecundity [8].

The potency of some plant oil to protect maize grains from damage by beetle over a long storage period had been tested with positive results. The oil extracts at 1.0%, 1.5% and 2.0% completely prevent infestation and damage of the maize grains in the sense that they offered 100% protection of the treated maize grain except that of 0.5% where 20.04% grain damage was recorded. Several workers have proven that coating legume seeds with oils extracted from plants is effective in the protection of *C .maculatus* during storage [25-27]. The vegetable oils which have been tested include oils from African palm, groundnut, soybean cotton seed, coconut, neem, sesame, sunflower mustard among others.

There were no significant differences between the percentage germination in the treated maize grain compared to the untreated and the ethanol treated maize grains. This result is in agreement with Adedire *et al*., 2011 [8] who recorded 100% Protection of maize grain treated with n-hexane, pet- ether and acetone oil extracts of cashew kernel after three months of storage. In conclusion, *D. regia* seed oils can be recommended as cheap approach, easily applicable, environmentally friendly methods in management of *S. zeamais* and can be used as alternative to the convectional chemical insecticides in the control of insect pests.

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