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INSECTICIDAL ACTIVITY OF GARLIC (*Alium sativum* (L.)) OIL ON *Callosobruchus maculatus* (F.) IN POST-HARVEST COWPEA (*Vigna unguiculata* (L.) WALP.)

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Abstract

Studies were conducted to determine the effect of garlic oil on Callosobruchus maculatus (F.) in three cowpea varieties (Borno brown, Mubi white and Iron beans). Ten grams in 3 replicates for untreated (check) and 4 levels of garlic Alium sativum (L.) seed oil treatments (0.1, 0.2,0.4 and 0.6 ml) were infested with 3 pairs of 0 - 3 days old C. maculatus for pre and post oviposition. Experiments were conducted under ambient conditions of 25- 30oC and 27 - 56% relative humidity. Data on number of eggs laid and progeny emergence were subjected to analysis of variance (ANOVA). Significantly different means were separated using the Least Significant difference at 5% level of probability. Result showed that the number of eggs laid and adults that emerged from untreated grains of the varieties were each significantly ($p<0.05$) different from the number of eggs that were laid and adults that emerged from all treated grain of the varieties. The study also showed that cowpea grains infested with 1 - 5 day old eggs of C. maculatus can be prevented from damage by the bruchid. Grain treatment with garlic oil before oviposition drastically suppressed oviposition, egg-hatch and development by the cowpea bruchid consequently the emergence of few to zero adults. Both pre and post oviposition grain treatments were effective in the management of the beetle. However, treatment before oviposition appeared to be more effective in protecting cowpea grains against infestation and damage.

Key words: Damage, *C. maculatus*, garlic oil, varieties, pre-oviposition, post-ovipotion

INTRODUCTION

Callosobruchus maculatus (F.) has attracted great attention because it is widely distributed throughout the tropical and sub-tropical regions. It is an important pest of several pulses including cowpea (*Vigna unguiculata* (L.) Walp) (Mahfuz and Khalaquzzaman, 2007). Reports by IITA (1989) showed that *C. maculatus* consumeed 50 - 90% of cowpea in storage annually throughout tropical Africa. The bruchid infestation also affected seed quality, market value and reduced cowpea seed viability to 2% after 3 months of storage (Caswell, 1980; Caswell, 1981; Ofuya and Credland, 1995). Synthetic pesticides are currently the method of choice to protect stored grains from insect damage (Mahfuz and Khalequzzman, 2007; Mbata *et al*., 2005). Their use is so desired because of the quicker and sometimes the complete protection it offers against diverse storage insect pests. However, the indiscriminate use of pesticides, especially by grain merchants and farmers to protect grains in storage with its adverse effects on man, the environment, non-target organisms as well as the evolution of resistant strains of insect pests, has been a serious draw back. One alternative to synthetic insecticides is the use of botanical pesticides, such as essential oils that result from secondary metabolites of plants (Mahfuz and Khalequzzaman, 2007). Botanical insecticides are of great interest to many because they have historically been in use longer than any other group with the possible exception of sulphur, tobacco, pyrethrum, derris, hellebore, quassia, comphor and turpentine, which were some of the more important plant products in use before the organised search for insecticides began (Alberto *et al*., 2005). Plant essential oils and their constituent insecticidal action have been well demonstrated against stored product insect pests by several authors (Boateng and Kusi 2008; Bamaiyi *et al*., 2006; Maina, 2006; Maina and Lale, 2005; Papachristos and Stamopoulos 2003; Lale and Mustapha, 2000). However, the use of garlic oil in the management of pre and especially post infestation has not been sufficiently reported in the literature. The objective of this study was to determine the insecticidal activity of garlic (Alium sativum (L)) oil on *C. maculatus* oviposition and development in stored cowpea.

MATERIALS AND METHODS

Source of cowpea grains and garlic (*Alium sativum* (L.)) oil

Grains of cowpea varieties namely: Borno brown, Mubi white and Iron beans were purchased from a local market in Maiduguri, while variety banjaram was obtained from the Department of Crop Production, University of Maiduguri. Garlic oil was purchased from a dealer in Monday Market, Maiduguri. Pristine cowpea grains were each sorted out and cleaned from dirt and kept in a refrigerator until required for use.

Culturing of *Callosobruchus maculatus*

Callosobruchus maculatus culture was raised on 500g grain of variety banjaram infested with 50 pairs of *C. maculatus* 0 - 3 day old in a Kitner jar. *C. maculatus* stock was obtained from house-hold infested cowpea. The bruchids were sieved and removed after 5 days. The kilner jar was covered with a nylon mesh tied with a rubber band to prevent contamination and escape of the beetles. Adult progeny that emerged from this culture was used to set up experiments.

Experimental Procedure

Experiment was conducted in two batches in Entomology Laboratory, Department of Crop Protection, University of Maiduguri. Ten grams of each variety in three replicates were weighed into a 200ml bottle, for untreated (check) and four levels of garlic oil treatments (0.1, 0.2, 0.4 and 0.6ml).

Grain treatment with garlic oil before oviposition

Grains of each replicate of the three varieties for the four levels of treatments were treated with 0.1, 0.2, 0.4 and 0.6ml of garlic oil respectively. Afterward the untreated (check) and all the treated grains were infested with three pairs of 0 - 3 day old *C. maculatus*. The bruchids were removed after five days and the number of eggs laid counted. The experiment was left until adult emergence. Adults that emerged were counted and recorded daily throughout the first filial generation (F_1).

Grain treatment with garlic oil after oviposition

Three pairs of 0 - 3 day old *C. maculatus* were used to infest grains of each replicate for untreated (check) and for four levels of grains to be treated with garlic oil after oviposition. The bruchids were removed after five days and the number of eggs laid counted. Four levels of garlic oil (0.1, 0.2, 0.4 and 0.6 ml) in three replicates were applied on the eggs laid on grains. Adults that emerged were counted daily throughout the first filial generation (F_1). All experiments were conducted under ambient conditions of 25 - 30^{o}C and 27 - 56% relative humidity.

Data analysis

Data obtained on the number of eggs laid and progeny emergence were subjected to the analysis of variance (ANOVA). Significantly different means were separated using the least significant difference (LSD), at 5% level of probability.

RESULT

Results

Effect of garlic oil on C. maculatus eggs and development (Grain treatment after oviposition)

The mean number of adults that emerged from the untreated (check) grains of the varieties were each significantly ($P < 0.05$) different from all treated grains of the varieties. There was however, no significant ($P > 0.05$) difference in the mean number of adult emergence from treated grains of the three varieties with various dosage of garlic oil. Significant ($P > 0.05$) difference was recorded in the mean number of adult *C. maculatus* that emerged from all untreated grains of the varieties. Variety Mubi white and Iron bean had the highest and lowest means respectively (Table 1).

Table 1: Mean number of adult *C. maculatus* that emerged from 10 g grains treated with garlic oil after oviposition

Garlic oil dose (ml)	Cowpea Varieties			
	Borno brown	Mubi white	Iron bean	Means
0	16.55	19.11	14.78	16.81
0.1	0.33	0.22	0.33	0.29
0.2	0.00	0.00	0.00	0.00
0.4	0.00	0.00	0.33	0.11
0.6	0.00	0.00	0.00	0.00
Means	3.26	3.84	3.08	

SE ± 0.20, LSD ($P < 0.05$) = 0.41 (variety)
SE ± 0.26, LSD ($P < 0.05$) = 0.53 (Garlic oil)
SE ± 0.45, LSD ($P < 0.05$) = 0.92 (Interaction)

Effect of garlic oil on oviposition and development by *C. maculatus* (Grain treatment before oviposition)

Results in Table 2 show a significant ($P < 0.05$) difference in the mean number of eggs laid on untreated and treated grains of all the three varieties. There was also a significant difference in the mean number of eggs laid on grains treated with 0.1ml garlic oil, where Iron beans had the highest number of eggs laid. The number of eggs laid on variety Mubi white grains treated with 0.1ml garlic oil and those laid on the three varieties treated with 0.2 ml, 0.4 ml and 0.6 ml garlic oil were not significantly ($P < 0.05$) different from one another. Significant ($P < 0.05$) difference was observed in the mean number of eggs laid on untreated grains of Iron beans compared to Borno brown and Mubi white, which were not significantly ($P > 0.05$) different from each other.

Table 2: Mean number of eggs laid on 10 g treated cowpea grains by *C. maculatus* (Grain treatment before oviposition

Garlic oil dose (ml)	Cowpea varieties					
	Borno brown	Mubi white	Iron bean	Means		
0	20.33	20.19	15.33	18.62		
0.1	7.55	1.11	11.44	6.70	0.89	1.37
0.2	3.11	0.11	0.33	0.26		
0.4	0.11	0.33	0.00	0.00		
0.6	0.00	0.00	5.56			
Means	6.22	4.25				

SE ± 0.64, LSD ($P < 0.05$) = 1.30 (variety)
SE ± 0.82, LSD ($P < 0.05$) = 1.68 (Garlic oil)
SE ± 1.42, LSD ($P < 0.05$) = 2.90 (Interaction)

The number of progeny emergence from untreated grains of the cowpea varieties were each significantly ($P < 0.05$) different from all the treated grains of the varieties. Mean number of adults that emerged from untreated cowpea grains also shows a significant ($P < 0.05$) difference in all the three varieties with Mubi white having the highest number of adult emergence. Mean number of adult emergence from treated grains were not significantly different ($P > 0.05$) from one another (Table 3).

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Table 3: Mean number of adult *C. maculatus* that emerged from 10g treated cowpea grains (Grain treatment before oviposition)

Garlic oil dose (ml)	Cowpea varieties			
	Borno brown	Mubi white	Iron bean	Means
0	16.55	19.11	14.78	16.81
0.1	0.22	0.67	0.00	0.30
0.2	0.00	0.11	0.00	0.03
0.4	0.00	0.00	0.11	0.03
0.6	0.00	0.00	0.00	0.00
Means	3.35	3-98	2.98	

SE ± 0.32, LSD (P < 0.05) = 0.65 (variety)
SE ± 0.41, LSD (P < 0.05) = 0.84 (Garlic oil)
SE ± 0.71, LSD (P < 0.05) = 1.45 (Interaction)

DISCUSSION

Effect of garlic oil on *C. maculatus* eggs and development (Grain treatment after oviposition)

The results showed that cowpea grain treatment with garlic oil after oviposition had adverse effect on *C. maculatus* emergence. The effect appeared to be ovicidal and or inhibition of larval instar development. This implied that cowpea grains of these varieties infested with 1 - 5 days old *C. maculatus* eggs could be salvaged from damage by the cowpea bruchid. Similar report was made by Boateng and Kusi (2008) which showed that Jatropha seed oil was hightly toxic to the eggs of *C. maculatus*, resulting in significant reduction in number of adults that emerged. Earlier report also showed that cowpea grain treated with *Khaya senegalensis* seed oil either prevented egg-hatch or the larvae from completing their development (Bamaiyi *et al*., 2006). In insect development, the eggs tend to be more tolerant to chemical treatment (Giga and Smith, 1987). In this study however, garlic oil significantly inhibited egg-hatch and development of *C. maculatus*. This was also observed by (Boateng and Kusi, 2008; Adebowale and Adedire, 2006) when *Jatropa curcas* seed oil was used. Untreated grains of the variety, Mubi white had higher risk of incurrinig damage by the beetle, as it had the highest adult emergence.

Effect of garlic oil on oviposition and development of *C. maculatus* (Grain treatment before oviposition

The result showed that garlic oil had an oviposition deterrent or inhibitory effect on *C. maculatus* development, as relatively few to zero eggs were laid on treated grains of all the varieties. This reduced the risk of infestation and damage by the cowpea bruchid. In addition, that the effect of garlic oil appeared to be dose dependent, as the dose increased severity of its effect also increased in all the varieties.

According to Lale and Mustapha (2000) successful infestation is determined by the number of eggs that hatch as well as the number of first instar larvae that are able to penetrate the cotyledons, interfering with any of those processes leads to a reduction in the population of the bruchid and degree of damage. Don-pedro (1989) also showed that eggs laid on oil treated seeds are less firmly attached, suggesting that the oil may inhibit successful egg-hatch and larval penetration into the seed. Similarly, grain treatment with all garlic oil dosages had a drastic significant reduction of *C. maculatus* emergence in all the varieties, as few to zero emergences were recorded. The study has shown that control of the cowpea bruchid was achieved mainly through reduced oviposition and adult emergence in all the cowpea varieties. Garlic oil therefore offers promising potential in the management of *C. maculatus* in cowpea grains, Borno brown, Mubi white and Iron beans under the conditions they were screened. Both pre and post oviposition grain treatment suppressed oviposition and development of the beetle, however, treatment before oviposition appeared to be more effective in reducing infestation and damage risk. It is important to note that while the use of plant essential oil as a biopesticide is being advocated, the use of plant oils which are medicinal should be cautiously considered.

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