Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 3, No. 1, p. 54-60, 2013
http://www.innspub.net

INNSPUB

RESEARCH PAPER
OPEN ACCESS

Effect of *Callosobruchus maculatus* (FAB.) (Coleoptera: Chysomelidae) infestation level on control using different particle sizes of Eugenia aromatic and piper guineense powders

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Article published on January 21, 2013

Key words: Botanical powders, *Callosobruchus maculatus, Eugenia aromatic*, insect density, *Piper guineense*, particle size

Abstract

Number of eggs population was used to measure initial infestation of Callosobruchus maculatus on cowpea seeds treated with Piper guineense and Eugenia aromatic powder. The treatment involves the use of P. guineense and E. aromatic of particle sizes of 150µm and 300 µm at the rate of 0.4g per 20g of cowpea seeds infested with different insect densities (0, 1, 3, 5, 8 and 10 pairs). The eggs laid on the seeds increased with increase in insect density. Significantly more eggs were laid on untreated seeds compared to seeds treated with botanical powder. Adult emergence increased significantly with increase in insect density on the seeds with P. guineense, irrespective of the particle size of powder applied. In E. aromatic treated seeds there were no adult emergence in seeds treated with 150µm particle size, except in the seeds with highest insect population treated with 300µm. seeds treated with 10 pairs of insect with 300µm also had low number of adult emergence irrespective of the particles size. The percentage weight loss of the treated and untreated seeds increased with increase in insect population in P. guineense treated seeds. However, no seed weight loss was recorded in 150 µm and 300µm particle sizes of E. aromatic except in the seeds infested with 10 pairs. Also the seed weight loss was significantly higher than that of seeds infested with different levels of insect population. This study shows the dependent of insect population and botanical particle size on control of C. maculatus.

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Introduction

Due to the low availability and consumption of animal protein in tropical and subtropical regions of the world, cowpea serves as a major source of dietary protein (Ofuya, 1986). In storage, cowpea grains suffer greatly from *Callosobruchus maculatus* (F.) which is a cosmopolitan pest of stored grains in the tropics and subtropics (Ofuya, 2001). Severely damaged seeds are disfigured with eggs and riddled with adult exit holes and consequently reduced the nutritional and economic values of the grains (Ogunkoya and Ofuya, 2001).

Throughout tropical Africa, *C. maculatus* causes substantial loss of cowpea in storage annually (IITA, 1989). It accounts for over 90% of the damage done to stored cowpea seeds by insects (Caswell, 1981). Because of its high incidence and associated damage, synthetic insecticides have been considered the most effective and accessible means of control. Resistance and toxicity problems of the synthetic insecticides have resulted in the necessity of finding more effective and healthier alternatives.

There are alternative methods to manage pests, which, in the economic context, are effective without presenting the risks associated with the use of conventional pesticides. One method consists of using plants with insecticidal properties that can be used as powder, extracts or oils (Mazzonetto and Vendramim, 2003). Given the array of selective pressures that pests exert on plant, it is obvious that the plant kingdom offers a tremendous diversity of bioactive phytochemicals that can serve as complementary or alternative to the conventional synthetic pesticides. Botanic insecticides have been used traditionally in developing countries to control pests of stored grains, such as Coleoptera (De Oliveira, 2003). Consequently, the objective of the study is to assess the different levels of insect infestation on control of *C. maculatus* using different particle sizes of *P. guineense* and *E. aromatic* leaves powder.

Materials and methods

Study area

The study was carried out in the Pest Management Laboratory of Crop, Soil and Pest Management Technology Department , Rufus Giwa Polytechnic, Owo, Ondo State Nigeria (Latitude 5° 12' N and Longitude 5° 36' E).

Culturing of insects

Initial insects (*C. maculatus*) used for the study were obtained from established culture from Entomology Laboratory of Crop, Soil and Pest Department of Federal University of Technology, Akure, Ondo State, Nigeria. The insects were sub-cultured on Sokoto white local cowpea cultivar (Susceptible variety) in Kilner jar at ambient conditions (32±0.64°C and 68±3% R.H.) in the Pest Management Laboratory of Crop, Soil and Pest Management Technology Department, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria.

Source of cowpea seeds

The Ife brown cowpea cultivar used for the study was obtained from International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. Prior to use, the cowpea seeds were disinfested by keeping in deep freezer for 2 weeks and left to equilibrate at room temperature for 12-24 hrs and thereafter 20g of cowpea seeds were weighed using digital weighing balance into small plastic containers.

Effect of initial C. maculatus infestation on control by Eugenia aromatic and piper guineense powders

Freshly (0-2 days old) emerged adults of *C. maculatus* from laboratory culture were introduced into 20g clean Ife brown cowpea seeds treated separately with 0.4g of *Eugenia aromatic* and *piper guineense* powders sieved to particle sizes of 150µm and 300µm at 1, 3, 5, 8 and 10 insect pairs respectively. The morphology of the insect proboscis was used for sexual differentiation, that of the male is rough and of a higher caliber than that of the female (Halstead 1963).

The powders were thoroughly mixed with the grains to ensure proper coating of the seeds. The insects were allowed 8 days to oviposit and dead insects were removed. Thereafter, eggs laid by female beetles on cowpea seeds were counted and recorded. The various treatments were left on the laboratory workbench and examined daily for adult emergence. The emerged adults were removed and counted daily for 15 days

Experimental design

The experiment was laid out in Completely Randomized Design (CRD) and all the treatments were replicated 4 times. Control experiment was also set up with no insect and plant powder.

Data collection and analysis

Data were collected after sieving the insects through a 3 mm sieve. The data collected include the number of eggs laid, adult emergence and percentage weight loss and were subjected to analysis of variance (ANOVA) with the Statistical Analysis System (SAS) program (SAS, 1989). Data on percentage weight loss, egg count and adult emergence were arcsine transformed and square root transformed before subjecting it to analysis. Treatment means were separated using Turkey's test at 5% level of probability.

Table 1. Mean number of eggs laid on cowpea seeds infested with different level of *C. maculatus* population.

Pairs	P. guineense	E. aromatica			Control
	150µm	300µm	150µm		300µm
0 pair	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}
1 pair	1.6^{b}	2.9^{b}	0.8^{b}	1.8^{b}	3.6^{b}
3 pairs	5.2^{c}	5.6^{c}	1.9^{c}	2.5^{c}	9.5^{c}
5 pairs	6.1^{d}	7.1^{d}	2.1^{d}	2.7^{d}	15.6^{d}
8 pairs	8.5^{e}	8.5^{e}	6.7^{e}	9.4^{e}	18.7^{e}
10 pairs	11.0^{f}	11.4^{f}	9.2^{f}	12.3^{f}	16.8^{f}

Mean in each column, the same letters are not significantly different at 5% level of probability by Turkey's test

Rable 2. Mean number of emerged adults from cowpea seeds infested with different level of *C. maculatus* population.

Pairs	P. guineense		E. aromatica		Control	
	150µm	300µm		150µm	300µm	
0 pair	0.0^{a}		0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}
1 pair	1.6^{b}		2.2^{b}	0.0^{a}	0.0^{a}	2.8^{b}
3 pairs	4.4^{c}		5.5^{c}	0.0^{a}	0.0^{a}	4.9^{c}
5 pairs	4.7^{d}		6.1^{d}	0.0^{a}	0.0^{a}	6.9^{d}
8 pairs	7.2^{e}		7.5^{e}	0.0^{a}	0.0^{a}	8.3^{e}
10 pairs	8.5^{f}		9.5^{f}	0.0^{a}	3.6^{b}	9.8^{f}

Mean in each column, the same letters are not significantly different at 5% level of probability by Turkey's test

Table 3. Mean percentage weight loss from cowpea seeds infested with different level of *C. maculatus* population.

Pairs	P. guineense		E. aromatica		Control
	150µm	300µm		150µm	300µm
0 pair	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}
1 pair	0.1^{b}	0.9^{b}	0.0^{a}	0.0^{a}	3.9^{b}
3 pairs	2.3^{c}	2.4^{c}	0.0^{a}	0.0^{a}	4.8^{b}
5 pairs	2.7^{d}	3.0^{d}	0.0^{a}	0.0^{a}	5.7^{b}
8 pairs	3.9^{e}	4.5^{e}	0.0^{a}	0.0^{a}	8.3^{b}
10 pairs	4.9^{f}	5.6^{f}	0.0^{a}	2.6^{b}	8.7^{b}

Mean in each column, the same letter are not significantly different at 5% level of probability by Turkey's test

Results

Mean number of eggs laid on cowpea seeds treated with different particle sizes of *E. aromatic* and *P. guineense* plant powder showed significant (P <0.05) increase with increase in the level of insect population (Table 1). . In comparison, plant powders applied at 150 µm particle size significantly (P <0.05) inhibits oviposition by female beetles compared to plant powder applied at 300µm.

The number of emerged adult was presented in Table 2. The number of emerged adults increased significantly (p < 0.05) with increase in number of *C. maculatus* population in cowpea seeds treated with *P. guineense* and control treatment; while in cowpea seeds treated with various particle sizes of *E. aromatic* completely suppressed adult emergence except treatment involving 10 pairs of *C. maculatus* and 300µm particle size (3.6). Meanwhile, *P. guineense* applied at 150µm shows promising effect than 300µm in suppressing adult emergence.

Table 3 shows the mean percentage weight loss on cowpea seeds infested with different levels of *C. maculatus* and particle sizes of plant powders. Similar trend which was observed in adult emergence was also recorded for percentage weight loss. The mean percentage weight loss on cowpea seeds treated with different particle sizes of *P. guineense* and insect population increased significantly (P < 0.05) with increase in number of *C. maculatus* population used to infest the cowpea seeds and a similar observation was also recorded in the control. However, in cowpea seeds treated with 150µm particle size of *E. aromatica* there was no weight loss recorded irrespective of insect population, but in cowpea seeds treated with 300µm particle size of *E. aromatica*, seed weight loss was significantly higher at 5 pairs insect population (2.6%). It was generally observed that seed weight loss was significantly (P < 0.05) higher in control than on treated cowpea seeds.

Discussion

The result from this study has shown that oviposition and adult emergence by *C. maculatus* differ significantly with insect density. An increase in insect density significantly caused an increase in the seed weight loss. Percentage damage and weight loss were in positive correlation with the total number of bruchids because treatments with high total number of bruchids inflicted more damage and caused weight loss. These results are in accordance with other reports on a positive relationship between bruchid density and damage on cowpea (Schoonhoven, 1978; Busungu and Mushobozy, 1991; Swella and Mushobozy 2007; Ramzan, 1994). At the highest insect density, *C. maculatus* laid significantly more eggs on cowpea seeds and a similar observation was reported by Jackai and Asante (2001) when different densities of *C. maculatus* were used to screen cowpea seeds. It was also observed that percentage adult emergence increased with increase in insect density. It was also observed that the number of eggs laid, adult emergence and seed weight loss were higher in control treatment compared to treated seeds.

The result equally showed that particle size had significant effect on the insecticidal activity of *E. aromatica* and *P. guineense* in the control of *C. maculatus* and damage to stored cowpea. *E. aromatica* and *P. guineense* powder of particle size 150µm generally showed greater insecticidal activity against *C. maculatus* than when the particle size was 300µm. Adult beetles were more rapidly killed which might have led to significant reduced oviposition. This was consistent with the findings of Olotuah *et al.*, (2007) and Olotuah *et al.*, (2010). Ogunwolu and Idowu (1994) reported that the more finely ground powder (Particle size 150µm) of root bark of *Zanthoxylum zanthoxyloides* (Lam) Watern and seed of *Azadirachta indica* A. Juss. was more active insecticidally to *C. maculatus* than more coarse (particle size 2mm) powder. Ofuya and Dawodu (2002) similarly reported that the most finely ground powder (particle size 212µm) of *P. guineense* was more active insecticidally to *C. maculatus* than the most coarse (particle size 1mm) powder. Particle size affect dispersion and the finer the particles, the more uniformly the dust will coat treated grains and storage container thus enhancing contact with targeted insects. This shows that *E. aromatica* and *P. guineense* may have some insecticidal properties which might have significantly reduced the number of eggs laid and adult emergence from cowpea seeds, correspondingly leading to a decrease in seed weight loss. Similar to this observation, many workers have reported the efficacy of the plant powder for insecticidal activity on *C. maculatus* (Adedire and Lajide, 2001). The reduction in oviposition by *C. maculatus* may be due to inhibition of oviposition or deterrence (Boeke *et al.*, 2001; Lale, 1995; Ofuya, 2003). It was generally observed that irrespective of particle size of *E. aromatica* and *P. guineense*, the number of eggs laid, adult emergence and percentage seed weight loss as a result of feeding activities by larvae of *C. maculatus* increased significantly with increase in insect population density on the cowpea seeds. Meanwhile, the reduction in adult emergence could either be due to egg mortality or larval mortality or even reduction in the hatching of the eggs, as a result of the ovicidal or larvicidal properties of the plant powders. It has been reported that larvae hatched from the eggs of *C.maculatus* species must penetrate the seeds to survive (FAO, 1999).

Conclusion

Results obtained from this study show that eggs laid, adult emergence and seed weight loss were insect population dependent and *E. aromatica* plant powder applied at 0.4g/20g of cowpea can be used for effective control of *C. maculatus,* irrespective of infestation level. Also, the toxicity of tested plant powder increased as the particle size decreased.

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