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EVALUATION OF BIO-NIMBECIDINE BOTANICAL POWDER IN THE CONTROL OF *Callosobruchus maculatus* (F.) (COLEOPTERA: BRUCHIDAE) INFESTATION IN STORED GRAIN LEGUMES

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ABSTRACT
The effect of Bio-nimbecidine botanical powder on *Callosobruchus maculatus* (F.) infestation was investigated in the laboratory at (30 - 35^{o}C and 55 - 65% Relative Humidity) on two cowpea varieties (Borno white and Gwalam) and bambara groundnut. Ten gram grains of the two cowpea varieties and bambara groundnut were treated with three different dosages, 0.04 g, 0.06 g and 0.08 g of Bio-nimbecidine botanical powder. Each treatment had three replicates and a control (check) which were then infested with three pairs of 1 - 3 days old *C. maculatus*. Data on the number of eggs laid, number of adult first filial generation and severity of damage were collected. All data collected were subjected to two way analysis of variance (ANOVA). The mean number of eggs laid, adult bruchid emerged and severity of grain damage was significantly ($P < 0.05$) lower on all pulses treated with Bio-nimbecidine botanical powder than untreated grains. Amongst the treated grain legumes, mean values of the above three parameters assessed were all lower at higher doses of Bio-nimbecidine botanical powder (0.06 g and 0.08 g). The results indicated that higher dosages of Bio-nimbecidine botanical powder were highly effective against *C. maculatus* infestation and damage. It had significantly reduced the number of eggs laid, adult emergence and severity of damage by the cowpea bruchid, as lower infestation and damage were recorded on the pulse grains.
Key words: Bio-nimbecidine botanical powder, grain legumes, *Callosobruchus maculatus*, evaluation, control, infestation

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) (Walp.) and bambara groundnut (*Vigna subterranean* (L.) Verd.), are important sources of plant protein in sub-Saharan Africa, especially where the daily intake of animal protein derived from eggs, meat, fish and milk is low. The grain of both pulses contain fairly high amounts of protein (16 to 32% of grain weight), and in addition, supply carbohydrate, fats, minerals or vitamins (Brough and Azam-Ali, 1992; Philips *et al.,* 2003). The safe storage of these pulses against insect pest attack over long periods, especially with poor processing and storage infrastructure in tropical Africa remains a great challenge. The cosmopolitan pest of pulses and cowpea bruchid, *Callosobruchus maculatus* (F.), is particularly of economic importance, as bruchid infestation often results in dry weight loss, reduction in nutritional value (denaturing of protein) or physical quality (disfigured with egg covers or riddled with adult exit holes) and poor seed germinability (Ofuya, 2001). Bruchid attack of pulses initially begins in the field, and rapidly builds up during storage. Up to 100% infestation of pulse grains can occur after three to six months storage (Caswell, 1981; Seck *et al*., 1991; Ofuya and Credland, 1995; Maina *et al*., 2011), resulting in about 60% weight loss (Tanzubil, 1999; Umeozor, 2005). Although synthetic insecticides such as Pirimiphos methyl and Permethrin are effective against *C. maculatus* infestation in storage, human health and environmental hazards associated with their use makes them less desirable (Ogunwolu and Odunlami, 1996; Swella and Mushobozy, 2007). Botanical insecticides, therefore, continue to receive increased attention for use as safe and effective protectants of stored grains against insect pests infestation and damage (Ofuya and Salami, 2002; Alberto *et al*., 2005; Ngamo *et al*., 2007). Various studies have therefore found the leaf, bark and seed powder or oil extracts of some plants including *Azadirachta indica* A. Juss, *Dennetia tripetala* Baker and *Zanthozylum zanthozyloides* (Lam.) Waterm.; and spice oils applied at different rates to stored cowpea or bambara groundnuts to reduce adult bruchid emergence, oviposition and seed damage (Lale, 1994; Ogunwolu and ldowu, 1994; Ogunwolu and Odunlami, 1996; Adedire and Lajide, 2001; Ofuya and Salami, 2002; Lale and Maina, 2002; Maina and Lale, 2005 and Maina, 2006). The efficacy of several available plant products against insect pest infestation however remains to be ascertained. This study therefore investigated the efficacy of Bio-nimbecidine botanical powder in the control of *C. maculatus* in stored grains legumes.

MATERIALS AND METHODS

Insect Culture, Pulse Grain Variety and Bio-nimbecidine Botanical Powder

A laboratory culture of *C. maculatus* was raised using bruchid stock obtained from house-hold infested cowpea on 500 g grain of Borno white cowpea cultivar in a 1 L kilner jar kept under the prevailing conditions of 30 – 35

°C and 55 – 65 % RH. The grains of two cowpea varieties, Borno white and Gwalam, and also bambara groundnut were all purchased from the Monday Market in Maiduguri, Nigeria. Bio-nimbecidine powder was obtained from the Department of Crop Protection, University of Maiduguri, Nigeria.

Experimental Procedure

Three replicates and a control containing 10 g grains each in a 200 ml glass jar were prepared for both cowpea varieties (Borno white and Gwalam) and bambara groundnut. The replicates of each cowpea variety and bambara groundnut were treated with three dosages, 0.04 g, 0.06 g and 0.08g of Bio-nimbecidine botanical powder. Each experimental jar (treated or untreated) was then infested with three pairs of 1 – 3 days old adult *C. maculatus*. All adult bruchids were removed five days after infestation, and the number of eggs laid counted. The experimental jars were then left untouched until adult emergence. Daily counts of adults that emerged during the first filial generation (F_1) were taken per experimental jar. Data on the number of eggs laid, number of F_1 adults that emerged and severity of grain damage were subjected to two way analysis of variance (ANOVA) and means were compared using Least Significant Difference (LSD) statistic at 5% level of probability.

RESULTS

Results in Table 1 showed a high significant ($P < 0.05$) difference in the mean number of eggs laid between treated and untreated pulse grains of variety Gwalam, Borno white and Bambara groundnut. Comparing the treated grains of all pulses, the number of bruchid eggs laid were significantly ($P < 0.05$) different amongst the three dosages tested, but not between grains treated with 0.06 g and 0.08 g of Bio-nimbecidine botanical powder in all the pulse varieties (Table 1).

Table 1: Mean number of eggs laid by *C. maculatus* five days after infestation on 10 g cowpea grains and bambara groundnuts treated with Bio-nimbecidine botanical powder

Bio-nimbecidine botanical powder Dose (g)	Pulse variety		
	Gwalam	Borno white	Bambara groundnut
0.0	65.33	65.00	71.33
0.04	36.67	28.00	31.33
0.06	22.00	10.00	14.67
0.08	11.33	4.33	8.67
SE(±)	5.66	10.04	7.43
LSD	13.05	23.14	17.14

Values are means of three replicates

Similarly, the mean number of F_1 adult bruchids emerged were significantly ($P < 0.05$) different between the pulse grains of Gwalam, Borno white and Bambara groundnut treated with Bio-nimbecidine botanical powder and untreated grains (Table 2).There was no significant ($P < 0.05$) difference between grains treated with 0.06 g and 0.08 g of Bio-nimbecidine botanical powder (Table 2).

Table 2: Mean number of F_1 adults of *C. maculatus* emerged from 10 g cowpea grains and bambara groundnuts treated with Bio-nimbecidine botanical powder

Bio-nimbecidine botanical powder Dose (g)	Pulse variety		
	Gwalam	Borno white	Bambara groundnut
0.00	52.67	49.67	55.00
0.04	27.67	13.67	20.33
0.06	3.33	1.67	5.33
0.08	1.67	0.33	0.33

SE(±)	3.30	5.65	5.40
LSD	7.61	13.05	12.45

Values are means of three replicates

The mean severity of damage caused by bruchids were significantly ($P < 0.05$) different between the grains of all pulses treated with Bio-nimbecidine botanical powder and those untreated (Table 3). Among the treated grains of each pulse, the mean severity of damage by bruchids was significantly ($P < 0.05$) different between the dosages of Bio-nimbecidine botanical powder applied, but not particularly between 0.06g and 0.08 g dosages of the powder (Table 3).

Table 3: Mean severity of damage caused by of *C. maculatus* on 10 g cowpea grains and bambara groundnuts treated with Bio-nimbecidine botanical powder

Bio-nimbecidine botanical powder Dose (g)	Pulse variety		
	Gwalam	Borno white	Bambara groundnut
0.00	202.17	101.00	472.73
0.04	104.37	26.70	199.70
0.06	2.43	6.20	47.21
0.08	6.30	0.67	2.77
SE(±)	10.28	10.4	48.11
LSD	23.73	23.98	112.46

Values are means of three replicates

DISCUSSION

Significantly higher mean number of bruchid eggs laid on untreated compared to treated cowpea grains and bambara groundnuts indicate that Bio-nimbecidine botanical powder effectively deters oviposition by *C. maculatus* on these pulses. This effect is however dosage dependent, in that, exceedingly lower number of bruchid eggs were laid on pulses treated with higher dosages (0.06 g and 0.08 g) of the botanical powder. The botanical powder of neem (*A. indica*) and the West African Black Pepper (*Piper guineense* Schumach. & Thonn.) have also been documented by Lale (1994); Oparaeke *et al*. (1998) to highly deter oviposition by *C. maculatus* females on cowpea grains. Yahaya and Magaji (1997); Yahaya (2002) and Maina (2006) similarly reported that the oil and powder of *P. guinnense* significantly reduced the egg laying capacity of adult *C. maculatus* weevils, as well as their survival on cowpea grains. Both factors were observed to greatly decrease with increasing concentration of the botanical oil and powder applied. The ovicidal effects of *P. guinnense* were attributed to the irritating smell of its 'guineensine 1' component which causes suffocation of adult bruchids, thereby, preventing physical contact or hindering oviposition success. Moreover, large quantities of powders can exert negative mechanical effects against oviposition by the bruchid. In comparing the effects of various vegetable oils and botanical powders on cowpea infestation by *C. maculatus*, *Callosobruchus chinensis* and *Callosobruchus rhodesianus*. Rajapakse and Van Emden (1997) found that some botanical powders, especially of *Cymbopogon citratus* (DC.) Stapf, *Cinnamomum camphora* (L.) J. Presl., *Monodora myristica* (Gaertn.) Dunal and *Zingiber spectabile* Griff significantly reduced the number of eggs laid by all three bruchid species.

Higher mean number of F_1 adult bruchids emerged from untreated than treated pulses recorded in this study suggests that application of Bio-nimbecidine botanical powder, especially at 0.06 g or 0.08 g / 10 g grains, greatly reduces the number of bruchid larvae that survive till the emergence of adults. In line with the results of the current study, A. *indica* (Echendu, 1991; Rajapakse *et al.*, 1998), *Anacardium occidentale* Linn. Balogo (Ilk.) or *Z. officinale* (Echendu, 1991; Maina, 2006), *Citrus paradisi* (Rutaceae) or *Citrus aurantifolia* (Christm. & Panzer) Swingle (Onu and Sulyman, 1997), *Khaya senegalensis* (Desr.) (Bamaiyi *et al.*, 2006) and *Alium sativum* (L.) (Dauda *et al*., 2012) have also been reported to significantly reduce egg laying and adult emergence of *C. maculatus* on cowpea grains. Lowered F_1 adult emergence due to Bio-nimbecidine botanical powder application was not clear, but thought to be due to either higher mortality of immature larvae or emerging adults contacting the botanical powder while gnawing their way out of the pulses. The toxicity effect of botanical powders, are however, only well documented for adult bruchids. The powder of leaves and kernels of *A. indica* (Seck *et al*., 1991) and leaves of *Piper nigrum*. L. (Rajapakse, 1989) has been reported to increase the mortality of adult *C. maculatus* on cowpea grains.

Altogether, reduced bruchid oviposition and the number of F_1 adults emerged from pulses treated, especially with higher dosages (i.e., 0.06 g or 0.08 g / 10 g) of Bio-nimbecidine botanical powder, than from untreated ones must have contributed to the lowering of mean severity of damage to these pulses. This is because, considerable reduction in the population size of *C. maculatus*, for instance through fewer eggs laid or hatched, adults emerged and lowered adult longevity or fitness should ultimately influence the extent of damage caused by bruchid infestation in stored pulses. The correlation or quantification of such relationships are however scarce, and will need to be done in subsequent studies.

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