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Article · March 2011

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South Asian Journal of Experimental Biology

ISSN: 2230-9799 Vol. 1, Issue 3, Page 158-162 http://www.sajeb.org

REGULAR ARTICLE

Evaluation of leaf and vine powders of *Secamone afzelii (Schult) K. Schum* for control of *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae) in stored cowpea *Vigna unguiculata* (L.) Walp.

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ARTICLE INFO

Article History:
Received: 20-02-2011
Revised: 18-03-2011
Accepted: 19-03-2011

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Keywords: Callosobruchus maculatus, efficacy, leaf and vine powders, reduction, *Secamone afzelii,* significantly

ABSTRACT

The experiment was carried out to evaluate the efficacy of *Secamone afzelii* leaf and vine powders applied at the rate of 0.5g, 1.0g, 1.5g and 2.0g under ambient laboratory conditions on *Callosobruchus maculatus* on stored cowpea. Mortality of adult insects at 48 h post treatment, number of eggs laid, adult emergence, adult exit holes and percentage weight loss in each treatment were compared with those of control. The results indicated that vine powder caused significantly greater kill ($P < 0.05$) of *C. maculatus* adults when applied at 2.0g than other dosages. The application rate of 2.0g of leaf powder was able to cause reduction in number of eggs laid by the weevil (5.67/20g seed) and significantly ($P < 0.05$) suppressed adult emergence (21.12). Adult exit holes and percentage weight loss were significantly reduced at all levels of application. It is concluded that *Secamone afzelii* has great potential for use as a plant-based biopesticide for controlling *C. maculatus* on stored cowpea.

1. Introduction

Cowpea seeds *Vigna unguiculata* (L.) Walp are very important in meeting the dietary requirements of increasing human population in the tropics, being the affordable source of protein (Shaaya et al, 1997) and the major constraint in the storage of cowpea seeds in the tropics are infestation and damage by *Callosobruchus maculatus* (Ofuya and Arogundade, 2007). During storage, the weevils cause deterioration in the quality and quantity of the grains; about 30 – 50% annual loss was reported for tropical Africa (Lale, 1995; 2001). The huge post harvest losses and quality deterioration caused by these weevils is a major obstacle to achieving food security in the developing countries (IITA, 1995).

The use of synthetic insecticides is the most effective method of controlling storage pests in developing countries (Porca et al., 2003; Ngamo, 2004). The use of these insecticides has been characterised by several shortcomings such as hazard to man, livestock and the environment as result of residual effect and persistence (Ofuya, 2003; Lee et al., 2004), product adulteration (Oparaeke and Bunmi, 2006), erratic supplies and unavailability at critical period (Arannilewa, 2007). Moreover, insecticides often put a burden on the budget of small scale farmers (Mba and Okoronkwo, 2008). This situation necessitate the need for alternative storage pest management approach. Recent research efforts focused more on ecologically tolerable control measure including the use of inert materials, plant powders, extract and oils. This may proffer solution to problems emanating from the use of conventional insecticides.

There appear to be dearth of literature on the empirical information on the efficacy of *Secamone afzelii.* Therefore, the objective of this study was to evaluate the efficacy of *S. afzelii* powders in the control of *C. maculatus* in stored cowpea seeds.

2. Materials and Methods

2.1. C. maculatus and S. zeamais Culture and Experimental Condition

The *C. maculatus* used for the experiment were derived from a colony originating from infested cowpea seeds collected from Ulede (Oja Oba) market in Owo, Ondo State, Nigeria (latitude 5^o 12' N and longitude 5^o 36' E). The emerge adults were sub-cultured in the Crop Protection Laboratory of Agricultural Technology Department of Rufus Giwa Polytechnic, Owo, Ondo State, and the sub-cultures were maintained in kilner jars in the laboratory under ambient conditions (28 ± 3^{o}C and 70 ± 5 % relative humidity) and emerging adult insects were recycled from generation to generation. *C. maculatus* was maintained on Ife brown as substrate.

The clean cowpea seeds used for the experiment were obtained from the seed store of Ondo State Agricultural Development Project, Akure. The clean seeds showed no visible signs of beetle eggs, presence of adults or their exit hole, but were nevertheless disinfested by storing them in a deep freezer for two weeks and then acclimatized in the open laboratory for 24 h to avoid mouldiness before use (Olotuah, et al., 2007).

2.2. Preparation of Secamone afzelii powder

Fresh *S. afzelii* plants were collected from Laosuo Camp in Ondo West Local Government, Area of Ondo state, Nigeria (07^o 05$'$ N, 04^o 55$'$ N). The identity was confirmed at The Herbarium, Department of Forestry and Wood Technology, The Federal University of Technology, Akure, Nigeria. The plants were shade-dried and the leaves and vines were detached separately. Thereafter, the dried leaves and vines were grounded into powder using electric laboratory hammer mill (Ogendo et al., 2004). The powders from leaves and vine were stored separately in air tight plastic containers and placed in a wooden cupboard in the laboratory for future use.

2.3. Contact Toxicity of S. afzelii powder to C. maculatus

The powders of *S. afzelii* leaves and vines were tested at 0.5g, 1.0g, 1.5g, and 2.0g per 20g of uninfested cowpea seeds in separate Petri-dish glass (9.0cm) plates. Each of the Petri plate was tumbled several times to ensure homogenous mixing of powder with grains. Five males and females (ten insect) of *C. maculatus* were introduced into each Petri-dish glass. The sexes of *C. maculatus* were determined by examining the pattern as suggested in relevant literatures (Southgate et al., 1957; Bandara and Saxena, 1995; Iloba et al., 2007). Adult mortality was monitored and counted 48 h after infestation; percentage mortality was calculated using the method adopted by Omotoso and Oso (2004).

$$\text{\% Mortality} = \frac{\text{No of dead insects}}{\text{Total no of insects}} \times 100$$

The eggs laid by the female beetles on the seeds were counted 14 days after infestation and the number of adult emergence and exit hole were counted 35 days after infestation.

There was also a control treatment involving no addition of plant powder on to the seeds. At the end of the experiment the final weight of each of the treatment was taken and this was used to calculate the percentage weight loss (Omotoso and Oso, 2004).

$$\text{\% Weight loss} = \frac{\text{Initial weight - Final weight}}{\text{Initial weight}} \times 100$$

2.4. Experimental Design and Data Analysis

The experimental design adopted for the experiment was Complete Randomised Design (CRD) and each treatment was replicated three times. Data collected were subjected to analysis of variance (ANOVA). Whilst egg counts and exit hole were subjected to square root transformation, percent weight loss in seeds were arcsine transformed, before analysis. Treatment means were separated using Least Significant Difference (LSD) statistics at $P < 0.05$.

3. Results

Mortality of adults of *C. maculatus* 48 h post treat-

g powder/20g	*C. maculatus* mortality in:	
of grain	Leaf powder	Vine powder
0.0g	39.14	28.44
0.5g	38.01	23.36
1.0g	41.07	23.85
1.5g	45.29	23.85
2.0g	48.84	41.07
LSD (0.05%)	NS	9.40

Table 1: Percentage mean mortality of *C. maculatus* 48 hours after treatment of infested product with *Secmone afzelii* at different dosages.
NB: Value were arcsine transformed.

g powder/20g	Adult emergence in:	
of grain	Leaf powder	Vine powder
0.0g	47.97	60.96
0.5g	28.07	48.08
1.0g	21.82	46.30
1.5g	21.31	43.38
2.0g	21.12	40.19
LSD (0.05%)	12.14	NS

Table 3: Mean adult emergence of *C. maculatus* when treated with different dosages of *Secamone afzelii*

g powder/20g	% weight loss in:	
of grain	Leaf powder	Vine powder
0.0g	27.09	16.73
0.5g	18.01	17.74
1.0g	13.26	15.59
1.5g	12.38	14.75
2.0g	9.51	13.38
LSD (0.05%)	7.84	NS

Table 5: Percentage weight loss of cowpea seeds treated with different dosages of *Secamone afzelii.*
NB: Value were arcsine transformed.

ment with different concentration of *S. afzelii* powder is summarized in Table 1. The leaf powder did not exercise significant kill of *C. maculatus* at all levels of application in comparison with the control. The vine powder caused significantly greater kill (P < 0.05) of *C. maculatus* adults when applied at 2.0g than other dosages.

g powder/20g	Egg counts in:	
of grain	Leaf powder	Vine powder
0.0g	10.02	10.13
0.5g	8.11	9.99
1.0g	6.00	9.81
1.5g	5.86	8.66
2.0g	5.67	7.51
LSD (0.05%)	2.11	NS

Table 2: Mean number of eggs laid by *C. maculatus* when treated with *Secamone afzelii* at different dosages.
NB: Value were square root transformed.

g powder/20g	Adult exit hole in:	
of grain	Leaf powder	Vine powder
0.0g	6.73	9.71
0.5g	4.85	7.97
1.0g	3.71	7.72
1.5g	3.69	6.85
2.0g	2.94	5.92
LSD (0.05%)	1.37	3.57

Table 4: Mean number of adult exit hole on grains treated with different dosages of *Secamone afzelii.*
NB: Value were square root transformed.

Number of egg laid by *C. maculatus* with different dosages of *S. afzelii* powder is presented in table 2. The vine powder did not deter oviposition at all levels of application in comparison with the control. The leaf powder applied at 2.0g was able to cause reduction in the number of eggs laid by the weevil, and this was significantly different (P < 0.05) when compared with 0.5g dose and control than 1.0g and 1.5g dosages.

Adult emergence of *C. maculatus* 35 day post treatment with different concentration of *S. afzelii* powder is presented in table 3.

The vine powder did not exercise significant suppression of adult emergence of *C. maculatus* at all levels of application in comparison with control. The leaf powder recorded lowest *C. maculatus* adult emergence in 2.0g than other dosages and was significantly different (P < 0.05) compared to control and 0.5g.

Table 4 shows transformed mean number of adult exit hole on the grains treated with different dosages of *S. afzelii* powder. *C. maculatus* adult exit hole in leaf and vine powder treatment exhibit significantly difference (P < 0.05) when *S. afzelii* was applied at 2.0g compared to 0.5g and control.

Table 5 revealed the transformed percentage mean weight loss of grains treated with different dosages of *S. afzelii* powder. The leaf powder treated on the grains is significantly different at 2.0g compared with 0.5g and control. The vine powder on cowpea treated at all levels of concentration is not significantly different (P >0.05) in comparison with the control.

4. Discussion

The significant mortality of *C. maculatus* when leaf and vine powders of *S. afzelii* were applied indicates the presence of insecticidal properties in this plant, which negatively impacted on survival of the adult beetles. This is consistent with the findings of other workers who have reported the effectiveness of various plant powders used as grain protectants against various insect pests of stored products (Lawrence, et al., *1993;* Boeke et al., 2004; Udo, 2005; Sule and Ahmed, 2009).

Leaf powder was observed to significantly inhibit oviposition by *C.maculatus*. This is consistent with Ofuya (1986) and Chinwada and Giga (1997) that mixing cowpea seeds with inert materials like wood -ash and sand can cause physical impediment to beetle movement, thereby preventing mating and oviposition.

The comparative effectiveness of each of the treatment types against *C.maculatus* in suppressing adult emergence revealed that the plants were generally effective against the weevils. This is probably due to the behavioural tendency of the insects. *C. maculatus* eggs are laid on the seed coat. Thus, it is possible that the eggs of *C. maculatus* were brought in closer contact with toxic secondary metabolites in *S. afzelii* thus causing higher egg mortalities and in return suppress adult emergence. This confirmed earlier findings of Tapondjou et al. (2002), Abdelgaleil and Nakatani (2003) and Akob and Ewete (2007) that ash of some bioactive plant species cause oviposition deterrence and/or ovicidal action resulting in reduced progeny production of stored product insects.

The reduction in seed damage as reflected by the mean number of adult exit hole and percentage weight loss in grains is in tandem with the mean number of adult emergence from the treated grains. The lower the percentage adult emergence from the treated grains, the lower the adult exit hole and damage weight loss or vice versa.

5. Conclusion and Recommendation

This study has clearly demonstrated attractive potentials of vine and leaf powders of *S. afzelii* as plant derived insecticides against cowpea weevils.

The effectiveness of S. *afzelii* in reducing damage and controlling *C. Maculatus* infestation during storage could be encouraging and a possible important supplement or alternative to synthetic insecticides, and possible means of ensuring a steady supply of good quality cowpea grains.

Therefore, *S. afzelii* at the rate of 2.0kg is recommended for use by farmers in grains storage. The bioactive compounds in this plant needs to be identified.

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