EVALUATION OF *CLEOME CILIATA* (CAPPARACEAE) ETHANOLIC EXTRACT AS PROTECTANT AGAINST MAIZE WEEVIL (*SITOPHILUS ZEAMAIS* MOTSCHULSKY (COLEOPTERA: CURCULIONIDAE)

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Abstract

The biological activity of ethanolic extract of Cleome ciliata leaves was evaluated in the laboratory (70 ± 5% relative humidity and 28 ± 2ºC temperature). C. ciliata caused significant mortality at 6–10% (v/w) when compared with the control. Mortality was dose-and exposure period-dependent except for a treatment of 6% when mortality at 1 and 3 days after treatment (DAT) was 45%. At 3–5% (v/w) number of F1 adult was significantly lower than the two control treatments. At 5% (v/w) C. ciliata prevented weight loss. The control without ethanol had 6.51 g weight loss (out of 20 g initial weight) which was significantly higher than weight loss (1.76 g) observed in grain treated with 3% C. ciliata extract. Although, S. zeamais adults were not significantly repelled by C. ciliata, percentage repellency was dose-dependent with 40% repellency recorded in 0.3 ml/30 cm^2 while the control had 13.33% repellency. The result indicates that C. ciliata can be effectively used to control resident S. zeamais in stored maize but not prevent immigrant population.

Key words: *Cleome ciliata,* repellency, ethanolic extract, weight loss, F1 adult, *Sitophilus zeamais*

INTRODUCTION

Maize (*Zea mays*) is a major cereal being cultivated in the rain forest and the derived Savannah zones of Nigeria (Iken and Amusa, 2004). One of the setbacks in the production and storage of maize is insect pest infestation. The most important storage pest of maize is *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae) which is a serious cosmopolitan field-to-store pest of maize in tropical and subtropical regions (Obeng-Ofori and Ameteye, 2005). Weevil damage results directly in loss of food and may also reduce future maize production for farmers who use saved grain as seed.

Much post-harvest damage can be avoided by reducing transit and storage times before marketing or processing. In order to reduce the level of infestation by this pest to the barest minimum, a number of measures have been employed by farmers and researchers. In the developed countries, conventional fumigation technology is currently being scrutinized for many reasons such as ozone depletion potential of methyl bromide and carcinogenic concerns with phosphine (Zetler and Cuperus, 1990). Hazards associated with food can result in injury and harm to human health. Millions of people worldwide suffer from some sort of food poisoning each year due to uncontrolled application and abuse of agrochemicals. Also, some insect species do develop resistance against synthetic pesticides with time. With these demerits of synthetic chemicals, the search for alternative pesticides in stored products like maize becomes inevitable.

Cleome ciliata (=ruttidesperma) (Family Capparaceae) is a pantropical weed of coastal regions. It is widely distributed in coastal regions of Africa, especially in Nigeria, Uganda, Tanzania and Ghana. The leaves are collected from the wild and eaten as a cooked vegetable or added to soup. Its leaf sap is applied in Ghana, Gabon and DR Congo to cure earache and deafness (Grubben and Denton, 2004). With medicinal and nutritional uses of *C. ciliata,* incorporating it into maize seed meant for food might not posses any health risk.

The present research has its justification in the view that *C. ciliata* can be cheaply obtained by scientists and farmers and several of the risks imposed by synthetic pesticides could be eliminated by the botanicals. Therefore, the objective of this study was to evaluate the bioactivity of *Cleome ciliata* on mortality, repellency and reproductive biology of *S. zeamais.*

MATERIALS AND METHODS

Mass rearing of Sitophilus zeamais

Adults of *S. zeamais* were obtained from Storage Entomology Unit, Agronomy Laboratory of Ladoke Akintola

University of Technology (LAUTECH). Ogbomoso, Nigeria. They were introduced into transparent containers which contained clean uninfested Pajo white variety of maize obtained from Sabo Market, Ogbomoso, Nigeria and reared according to Babarinde et al. (2008).

Extraction of the plant material

Cleome ciliata was obtained within the campus of LAUTECH, Ogbomoso. The leaves were detached from the stem and were dried under shade. The sample was then milled into powder using a milling machine. One hundred and twenty grammes of powdered *C. ciliata* were mixed with 240 ml of 95% ethanol (1 : 2 w/v) for 48 hours. The obtained dark green ethanolic extract was then sieved with Whatman No. 1 filter paper and stocked in glass jar under ambient conditions until use.

Mortality bioassay

Different concentrations that corresponded to 2, 6 and 10% (v/w) of *C. ciliata* extract were introduced into 150 ml jars containing 20 g of Pajo white maize. Ten mixed-sex *S. zeamais* were counted into each jar. There were six replicates. Mortality data were taken at 1 and 3 days after treatment.

Effect of extract on emergence of F1 adult and weight loss of grains

Seven days after the mortality bioassay was set up, the insects (both live and dead) were discarded. The set up was kept to test for the emergence of F1 adult at 42 days after the treatment (DAT). Weight loss due to *S. zeamais* infestation was determined according to FAO (1985)

$$\% \text{ Weight loss} = \frac{\text{UaN U} + \text{D}}{\text{UaN}} \times 100$$

Where: U = weight of undamaged fraction in the sample; N = total number of grains in the sample; Ua = average weight of one undamaged grain; D = weight of damaged fraction in the sample

Effect of extract on repellency of *S. zeamais*

Repellency bioassay was done using area preference method (McDonald et al., 1970). Whatman No. 1 white filter paper having 9 cm diameter was cut into 2 equal halves and was cello-taped together at the under surface. Each half has an approximate area of 30 cm^2. The adjoined filter paper disc was then placed in 9 cm Petri dish, having 100 ml volume. Known concentrations (0.1 and 0.3 ml) of *C. ciliata* extract were introduced into one half of the filter paper. The other half of the filter paper had 0.2 ml ethanol. In the control treatment, one half of the filter paper was untreated while the other half had 0.2 ml ethanol. The set up was left for one hour for evaporation of ethanol before test insects were introduced into the repellency chambers. Ten *S. zeamais* were introduced at the centre of the repellency chamber and covered. The experiment was set up under light condition and replicated six times. The number of insects present in the untreated (Nc) and treated disc (Nt) was recorded at 30 minutes after experimental set up. Percentage repellency (PR) values were computed as follows:

$$PR= [(Nc - Nt)/(Nc + Nt)] \times 100$$

Repellency classes were assigned according to Dales (1996).

Statistical analysis

The data were subjected to analysis of variance (ANOVA) at 5% probability level. Significant difference between treatments means was determined using fisher's least significant difference (LSD) with SAS software (SAS Institute, 1985).

RESULTS

When maize seeds were treated with *C. ciliata* leaf ethanolic extract, 6–10% (v/w) caused significant mortality when compared with control at 1–3 days after treatment (DAT). Mortality progressively increased with exposure period and concentration of extract. Highest percentage mortality was observed in 10% (v/w) being 85% and 86.67% at 1 and 3 DAT respectively (Table 1).

C. ciliata leaf ethanolic extract had suppressive impact on F1 emergence of *S. zeamais.* The number of F1 adults that were observed at 3–5% was significantly lower than number of F1 adults when maize was treated with 1% *C. ciliata* extract. The highest number of F1 adults (17.17) was observed in ethanol treated control (Table 2). A treatment of 5% *C. ciliata* leaf ethanolic extract significantly prevented weight loss of maize seed due to *S. zeamais* infestation having absolute no loss. Significantly higher weight loss was observed in non-ethanol control when compared with 3% (v/w) which had 1.76 g weight loss (Table 2).

Although, repellency of *C. ciliata* against *S. zeamais* was not significant, percentage repellency increased with extract concentrations. When 0.1 ml and 0.3 ml of extract was applied per 30 cm^2, percentage repellency was 30% and 40%, respectively, whereas control (0.2 ml ethanol) gave lesser (13.33%) repellency (Table 3).

Tab. 1: Percentage mortality of adult *Sitophilus zeamais* in maize seeds treated with *Cleome ciliata* leaf ethanolic extract

Treatment	% mortality at 1 DAT	% mortality at 3 DAT
Control*	0.00c	0.00c
Control+	0.00c	0.00c
2%	16.67bc	18.3bc
6%	45.0bc	45.0bc
10%	85.00a	86.67a
LSD	35.7	323.7
SED	17.9	16.8

DAT = Days after treatment, * = 20 g maize with 0.2 ml ethanol, + = 20 g maize without ethanol
Values with similar alphabet along the column are not significantly different at 5% probability LSD

Tab. 2: Effect of *Cleome ciliata* leaf ethanolic extract on weight loss of maize due to *Sitophilus zeamais* infestation and F1 adult emergence

Treatment	Weight loss (g)	F1 adults
Control*	3.66ab	17.12a
Control+	6.51a	10.33b
1%	2.58ab	10.17b
3%	1.76b	0.00c
5%	0.00b	0.17c
LSD	4.36	5.0
SED	2.18	2.5

* = 20 g maize with 0.2 ml ethanol, + = 20 g maize without ethanol
Values with similar alphabet along the column are not significantly different at 5% probability LSD. Data are actual weight loss (g) out of initial 20 g weight of maize seed

Tab. 3: Effect of *Cleome ciliata* leaf ethanolic extract on repellency of adult *Sitophilus zeamais*

Treatment (ml/30 cm^2)	% repellency	Repellency class
Control	3.33	I
0.1	30.00	II
0.3	40.00	II
LSD	41.40	
SED	20.7	

Repellency class I = 0.1–20%, Repellency class II = 20.1–40%, Repellency class III = 40.1–60%

DISCUSSION

Recently, attempts have been made by scientists to screen plant materials for insecticidal properties in the developing countries. Losses due to storage pests are a major agricultural problem in the third world countries which has led to the continued search for humanly safe, host specific, cost effective and ecologically tolerable means of managing the pests as a part of the quest for an alternative to the use of chemical insecticides against insect pests. Research efforts are currently being focused on the use of plants products, such as powder, extracts and oils which are cheaper, safer and eco-friendly (Adedire and Ajayi, 1996). Several researchers have screened many plant products for the control of insect pests of stored cereal grains.

In this study, *Cleome ciliata* was toxic to *S. zeamais* adults. At 6–10% (v/w) ethanolic extract, significant mortality was recorded when compared with control. Mortality of *S. zeamais* due to *C. ciliata* indicates that the active principles of *C. ciliata* were toxic to *S. zeamais* as either contact or oral poison. Since toxicity progressively increased with exposure period and was dose-dependent, it could be said that toxic activity of *C. ciliata* improved due to inability of *S. zeamais* to get an escape route out of the experimental set up. Don-Pedro (1985) had reported bioactivity of citrus plant to *Dermestes maculatus* and *Callosobruchus maculatus* at high concentration of 18% (w/w). When maize seeds were treated with ethanolic extract of *C. ciliata,* F1 adult emergence was significantly reduced. Reduction in F1 adults could be due to the fact that parental generation was killed before oviposition, or that the plant extract had deleterious effect on mating, egg laying or development of immature. Maina and Lale (2005) attributed reduction in F1 adult emergence to reduced egg laying and increased mortality of egg.

This result agrees with Babarinde et al. (2008) who reported that *Xylopia aethopica* seed extract reduced fecundity of *S. zeamais.* The result of seed weight loss bioassay followed the same pattern as the F1 adult emergence. *C. ciliata* protected maize seed from weight loss due to *S. zeamais* feeding because the extract was toxic to the adults. Two major ways of weight loss due to *S. zeamais* infestation are adult feeding and nutritional or developmental requirement of the larvae which live entirely in the grains. Since mortality and F1 adult emergence were significantly affected by *C. ciliata,* weight loss was reduced because adults died and could not feed on the grain. As well, reduced numbers of F1 was responsible for lower losses of maize grain. Similar observation were made by Okonkwo and Okoye (1996) who reported that *Denitia tripelata* was more effective than *Piper guineense, Monodora myristica* and *Xylopia aethiopica* against *S. zeamais.*

Although repellency was dose dependent, it was not significant. At 0.3 ml/30 cm^2, percentage repellency of 40% being class II was not significantly different form control (13.33%) being class I. Higher dosage was not investigated because recommendation for practical usage of the plant materials should be at quantity that would not be too bulky for farmers to handle. This finding agrees with Babarinde and Adeyemo (2009) who reported weak repellency of *X. aethiopica* against *Tribolium castaneum.* The fact that *C. ciliata* caused significant mortality and reduced F1 adult emergence and seed weight loss, but did not repel *S. zeamais* implies that it can only be used to control resident pests and not effectively prevent immigrating pests.

It is therefore recommended that when *C. ciliata* is used to protect maize seed against *S. zeamais,* the storage structures should be well packaged to prevent immigrant pests. Use of *C. ciliata* would reduce cost and prevent ecological damage that is peculiar to synthetic pesticides.

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