

Original Research Article

EFFICACY OF ANACARDIUM OCCIDENTALE AND CYMBOPOGON CITRATUS AS BIOPESTICIDES AGAINST MAIZE WEEVILS (*SITOPHILUS ZEAMAI* MOTSCH.) ON STORED MAIZE

ABSTRACT

An experiment on the insecticidal potency of *Anacardium occidentale* and *Cymbopogon citratus* on maize weevils (*Sitophilus zeamais* Motsch.) on stored maize was evaluated at 1.0g, 1.5g and 2.0g doses per 20g maize grain in 300ml rearing jars. Toxicity in terms of mortality, oviposition, F1 generation emergence, grain damage, and grain weight loss were all noted. Data collected was subjected to Analysis of Variance (ANOVA) using SPSS version 16.0 at 5% level of significance ($P>0.05$). The results revealed the effect of the treatments in the control of *S. zeamais* when compared with the control (untreated) experiment. Significant difference ($P>0.05$) in the potency of the biopesticides was observed in the parameters measured. *A. occidentale* performed significantly lower than *C. citratus* as it recorded higher (18.75 ± 9.68) grain damage at 1.0g dose, as well as the grain weight loss (0.58) at 1.0g and 1.5g treatment doses respectively. This suggests that although the plant products were tested to possess insecticidal potency against the maize weevils, *C. citratus* performed significantly ($P>0.05$) better than *A. occidentale* in the control of *S. zeamais* on stored maize. Hence, could be used sustainably in the control of insect pests on stored products

KEYWORDS: *Anacardium occidentale*, Biopesticide, *Cymbopogon citrates*, Maize *Sitophilus zeamais*

INTRODUCTION

Maize (*Zea mays*) is a cereal crop majorly cultivated and grown in different parts of the world. Worldwide, about 785 million tons of maize is cultivated each year, with United States being the largest producer, with about 42% of the overall production [1]. Maize is an important food crop in the tropics, subtropics and temperate regions where they are grown [2]. In Nigeria, and in Adamawa State, maize is one of the most important economic crops grown [3]. But

unfortunately, maize production in most parts of Nigeria is restricted to only the rainy months of the year. This however necessitates the need to store the maize grains throughout the dry months of the year.

However, the storage of maize grains and its maximum utilization is seriously affected by the activities of pests in the store [4]. The major insect pest is *Sitophilus zeamais* Motch (Coleoptera: Curculionidae). To enhance productivity of maize both in the field and in the store, the control of insect pests activities is needed, one of which include the use of chemical insecticides. The use of insecticides is very effective and reliable, and can prevent loss of maize yield. The act quickly, which makes them suitable for use in emergency situations [2]. But unfortunately, the extensive use of insecticides has caused problems such as the residual effect and the effect on non-target organisms. Hence, safe alternatives which are also effective, non costly and biodegradable, are needed for the control of these pests against stored product pests, especially *S. zeamais* [5]. Farmers and researchers have been trying to control stored product pests like *S. zeamais* using plant products (biopesticide) which are readily available, cheap and environmentally friendly [6, 7].

In this study, the insecticidal potentials of *Anacardium occidentale* leaf powder and the leaf powder of *Cymbopogon citratus* were evaluated against the *S. zeamais* with a view of developing biopesticides against stored product pests.

MATERIALS AND METHODS

Study area

This study was carried out in Mubi town of Adamawa state, Nigeria. Mubi is located between latitude 10°12'N and longitude 13°10'E. The climate is tropical with average temperature of about 15-42°C in dry season and relative humidity ranging from 10-45% [8].

Collection of materials

Samples of lemon grass (*Cymbopogon citratus*) and cashew leaves (*Anacardium occidentale*) were obtained around the Botanical Garden, Adamawa State University, Mubi. They were cupboard-dried at room temperature in the laboratory of Biological Science, Adamawa University for four days and were subsequently pulverized into fine powder using

electric blender. Synthetic chemical (Rambo-permethrin 0.60%) was obtained in an agro-chemical store in Mubi market and was used as the positive control. Clean maize cobs was also obtained from a farmer in Mubi and shelled to obtain the grains.

Insect culture

Parent stock of *S. zeamais* was obtained from infested maize grain obtained from a store in Mubi. The adult weevils obtained from the parent stock were transferred onto a clean maize grain in 500cm³ rearing jar. This was allowed to stand for 48 hours. Thereafter, the insects were discarded and the exposed maize was maintained under laboratory conditions for adult emergence of *S. zeamais* [9]. This helped in raising *S. zeamais* adults of the same size and age that were used to carry out the experiment.

Experimental setup

Before the experiment was set up, the maize grains were oven-dried to a constant weight in an oven between 40-45°C for two hours (2hrs) and were later air-dried in the laboratory to prevent moldiness for about an hour [9, 10]. 20g of the maize grains were measured and put in all the treatment cups. Three treatment doses of 1.0g, 2.0g and 3.0g were constituted and replicated 4 times. These were added to the already measured 20g of maize grains in the treatment jars and were mixed thoroughly to ensure a uniform coating of the grain by the treatment samples. Thereafter, 10 newly emerged adult *S. zeamais* obtained from the cultured jar were introduced into the experimental jars at the same time. The content of the jars were covered with muslin clothes with the aid of a rubber band. This was to prevent the insects from escaping and also to allow ventilation.

Data collection

Mortality:

Mortality count was noted and recorded 24 hours post exposure. This continued for 96 hour (4) days. The dead insects were subsequently sorted as follows: The content of each experimental jar was emptied gently on a silver tray in the laboratory. Using a broom stick, the insects were touched one after the other. The inability of any of the insects to respond to a touch indicates a death individual. The dead insects were subsequently removed and the remaining contents of the jar including the live insects were put back.

87 **Oviposition:**

88 Oviposition was determined using the acid fuchsin staining method. 10 grains of maize
89 from each jar was randomly picked on the 10th day, immersed in warm water for two to three
90 minutes, drained and subsequently put in 0.5% acid fuchsin stained for two to five minutes. The
91 grains were rinsed in water and were determined for cherry red gelatinous egg plugs. The
92 number of egg plug noticed on the 10 grains was extrapolated for the entire jar using an average
93 number of 82 grains per jar [11].

94

$$Oviposition = \frac{\text{Average number of maize grain} \times \text{Number of eggs laid}}{\text{Number of maize grain picked randomly}}$$

95 **F1 generation emergence:**

96 The F1 progeny emergence was observed within 4-5weeks after the exposure to
97 treatments in the course of the experiment. The newly emerged adult *S. zeamais* was counted and
98 recorded.

99 **Grain damage:**

100 Ten maize grains were selected randomly from each plastic jar and were noted for grain
101 damage. Maize grains observed with holes, cracks and any form of abrasion noticed were
102 considered as damaged grains. The number of damages was noted on 10 randomly selected
103 maize grains, and was extrapolated for the entire jar using an average number of 82 grains per
104 jar.

105 **Weight loss:**

106 The weight of the maize grain in each experimental jar was initially noted using weighing
107 balance prior to the experimental setup. Thereafter, the final weight of the grain was also noted
108 after the experiment. Therefore, weight loss was determined by subtracting the final weight from
109 the initial weight, as shown in the formula below:

110 Weight loss= initial weight – final weight

111

Data analysis:

Data collected were subjected to Analysis of Variance (ANOVA), and the means were separated at $P>0.05$ level of probability using Least Significant Difference (LSD).

RESULTS

Table 1 shows the toxicity effect of treatments (*C. citratus* and *A. occidentale*) in terms of mortality of *S. zeamais* reared on maize grain. Overall, the mortality counts on various treatments and the control (untreated) experiment were significantly different ($P>0.05$). Although the mortality was spread across the four days of exposure in all the treated jars, there was no mortality recorded in the control experiment throughout the exposure period. At the end of the four days of exposures, there was a significant difference ($P>0.05$) in the mortality recorded across the treatments and the control. Among the plant treatments, *A. occidentale* appeared to have recorded a significant higher mortality than the *C. citratus* (Table 1).

Table 2 shows the effect of the plant treatments in suppressing egg laying and adult F1 progeny emergence of *S. zeamais*. The results revealed that there was a significant difference ($P>0.05$) in both the egg laying and the number of F1 generation emergence between the treatments and control (untreated) experiment. The treatments significantly ($P>0.05$) reduced the number of eggs laid by the adult *S. zeamais* and the number of adult emergence. The number eggs laid was significantly ($P>0.05$) lower in grains treated with *A. occidentale* (12.30) at 1.0g dose, while the highest (18.45) was recorded in *C. citratus* at 1.0g dose and *A. occidentale* at 1.5g dose respectively. As expected, the synthetic insecticide (Rambo-permethrin 0.60%) significantly ($P>0.05$) reduced the number of eggs laid to as low as 2.05 in 1.0g and 2.0g treatment dose, and no adult emerged (0.00) for F1 generation.

The effect of treatments in the protection of maize grain from damage and weight loss as a result of *S. zeamais* activities is shown in Table 3. There was a significant difference ($P>0.05$) in grain damage and subsequent weight loss by the maize grains as a result of the insect activities, when compared with the control (untreated) experiment. Here, the grains treated with *A. occidentale* significantly ($P>0.05$) recorded higher damages (18.75 ± 9.68) at 1.0g dose. The subsequent weight loss recorded was a clear reflection of the result on grain damage, as maize treated with *A. occidentale* significantly ($P>0.05$) recorded higher (0.58) at 1.0g and 1.5g

141 treatment doses respectively. As expected, the synthetic insecticide (Rambo) at all treatment
142 doses significantly reduced grain damage as well as the subsequent weight loss by the grains.

143 **TABLE 1:** Mortality of *Sitophilus zeamais* reared on maize grain

Treatment	Dose (g)	Days of Exposure (Mean±SD)				Total
		1	2	3	4	
Control	0.00	0.00±0.00 ^a	0.00±0.00 ^a	0.00±0.00 ^a	0.00±0.00 ^a	0.00±0.00 ^a
<i>C. citrates</i>	1.0	0.00±0.82 ^a	1.00±0.82 ^b	0.25±0.50 ^a	0.00±0.00 ^a	1.25±1.26 ^{ab}
	1.5	0.00±0.00 ^a	0.25±0.50 ^{ab}	0.00±0.00 ^a	0.00±0.00 ^a	0.25±0.50 ^a
	2.0	1.00±1.15 ^a	0.25±0.50 ^{ab}	0.50±1.00 ^a	0.00±0.00 ^a	1.75±1.71 ^{ab}
<i>A. occidentale</i>	1.0	1.00±1.15 ^a	0.00±0.00 ^a	0.50±0.58 ^b	0.00±0.00 ^a	1.50±1.29 ^{ab}
	1.5	1.00±2.00 ^a	0.25±0.50 ^a	0.00±0.00 ^a	0.50±1.00 ^a	1.75±2.06 ^{ab}
	2.0	0.25±0.50 ^a	0.75±0.96 ^a	0.00±0.00 ^a	0.25±0.50 ^a	1.25±0.50 ^{ab}
Rambo	1.0	3.50±0.58 ^b	4.25±1.26 ^b	2.00±0.82 ^b	0.25±0.50 ^a	10.00±0.00 ^c
	1.5	2.50±1.00 ^{ab}	6.00±1.83 ^b	1.25±0.96 ^b	0.25±0.50 ^a	10.00±0.00 ^c
	2.0	4.00±3.39 ^b	4.75±2.63 ^b	1.00±0.82 ^{ab}	0.25±0.50 ^a	10.00±0.00 ^c

144 Values are means of four replicates. Means carrying the same superscript alphabet along the
145 columns are not significantly different ($P>0.05$).

146

147 **TABLE 2:** Oviposition and F1 progeny emergence of *S. zeamais* reared on maize grain.

Treatment	Dose (g)	Parameters (Mean±SD)	
		Number of eggs laid	F1 generation Emerged
Control	0.0	36.9±10.59 ^c	4.50±1.29 ^c
<i>C. citrates</i>	1.0	18.45±14.00 ^b	1.50±0.58 ^b
	1.5	16.40±20.00 ^b	2.00±2.16 ^b
	2.0	18.45±12.30 ^b	2.50±1.29 ^b
<i>A. occidentale</i>	1.0	12.30±19.52 ^{ab}	2.25±1.26 ^b
	1.5	18.45±21.57 ^b	1.75±2.87 ^b
	2.0	20.50±4.74 ^b	2.50±2.52 ^b
Rambo	1.0	2.05±4.10 ^a	0.00±0.00 ^a
	1.5	6.15±7.85 ^a	0.00±0.00 ^a
	2.0	2.05±4.10 ^a	0.00±0.00 ^a

148 Values are means of four replicates. Means carrying similar alphabets along the columns are
149 not significantly different ($P>0.05$).

150

151

152 **TABLE 3:** Damages and weight loss of maize grain.

Treatment	Dose (g)	Parameters (Mean±SD)	
		Grain Damage	Weight Loss (g)
Control	0.0	22.50±13.69 ^b	1.00±0.18 ^b
<i>C. citrates</i>	1.0	15.00±6.12 ^{ab}	0.28±0.22 ^a
	1.5	11.25±4.33 ^{ab}	0.45±0.25 ^a
	2.0	11.25±4.33 ^{ab}	0.23±0.13 ^a
<i>A. occidentale</i>	1.0	18.75±9.68 ^b	0.58±0.26 ^a
	1.5	13.12±3.75 ^{ab}	0.58±0.33 ^a
	2.0	13.12±7.18 ^{ab}	0.55±0.13 ^a
Rambo	1.0	7.50±6.12 ^a	0.33±0.10 ^a
	1.5	5.62±7.18 ^a	0.30±0.16 ^a
	2.0	7.50±6.12 ^a	0.25±0.17 ^a

153 *Values are means of four replicates. Means carrying the same superscript alphabets along the*
154 *columns are not significantly different (P>0.05).*

155 DISCUSSION

156 In this study, two different samples of biopesticides (*Cymbopogon citratus* and
157 *Anacardium occidentale*) were tested for the insecticidal activities on maize weevils (*Sitophilus*
158 *zeamais*). All the treatments caused a significant mortality of adult *S. zeamais* than the control
159 (untreated), where no mortality was recorded throughout the four days of exposure, confirming
160 the effectiveness of the plant products (biopesticides) on *S. zeamais*. The order of their efficacy
161 is: Rambo>*A. occidentale*>*C. citratus*. The results of this study corroborate with the findings of
162 Dike and Mbah [12] where lemon grass products significantly protected cowpea grains in storage
163 from insect infestation. The powder of *A. occidentale* has been reported as protectant against
164 different storage insect pests [13]. In a similar study on the efficacy of plant products on stored
165 maize, Wahedi [7] reported the insecticidal effect of neem seed powder on adult *S. zeamais*
166 reared on maize grain in Mubi.

167 The biopesticides were able to reduce F1 emergence of *S. zeamais* on maize grain
168 significantly (P>0.05). *C. citratus* and *A. occidentale* showed some insecticidal activities by
169 reducing the number of eggs laid as well as F1 adult emergence, when compared with the control
170 (untreated) experiment. This further confirms the insecticidal properties in the plant products.
171 This agrees with the study conducted by Mba and Okoronkwo [2] and Wahedi [7] who reported

172 the efficacy of plant products in reducing egg laying as well as F1 progeny emergence of *S.*
173 *zeamais*.

174 Similar result was reported in the grain damage and weight loss by the grain. The
175 treatments showed some insecticidal activities by significantly protecting the maize grains from
176 damages and subsequent weight loss possibly as a result of the activities of *S. zeamais*. This also
177 agrees with the study performed by Wakole [14] and Wahedi [7], who reported plant products
178 effectively protected maize grain from damage as well as weight loss.

179 CONCLUSION

180 In conclusion, the overall results have confirmed the effectiveness of *A. occidentale* and
181 *C. citratus* as biopesticides for the control of adult *S. zeamais*. *A. occidentale* perfumed
182 significantly better than *C. citratus* in the various parameters tested.

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