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PROTECTANT EFFECT OF PLANT OILS AGAINST *SITOPHILUS ZEAMAIS* MOTSCH (COLEOPTERA: CURCULIONIDAE) ON STORED MAIZE

***L.Y. Bawa, A.M. Oparaeke, and L.J. Bamaiyi**
Department of Crop Protection, Ahmadu Bello University, Zaria, Nigeria.
***Corresponding author's email: bawalivinus@yahoo.com**

ABSTRACT

The efficacies of plant oils of groundnut, soya bean and Actellic E.C. were evaluated for the control of *Sitophilus zeamais* infesting maize seeds. The plant oils were used at 0.5 %, 1.0 % and 1.5 %/100 g maize seeds while Actellic E.C. 25 % was applied at the rate of 2.5 ml, while the control has no treatment. All the treatments were repeated three times and also the control. The following were assessed mortality, progeny emergence, and seed damage. The results showed that Actellic E.C. at 48 hrs and 72 hrs caused significantly higher ($P < 0.05$) mortality (100 %) of adult *S. zeamais* than plant oils (groundnut and soya oil) while groundnut oil at 1.5 % had higher mortality compared to the control. The groundnut oil at all levels and soya bean oil at 0.5 % and 1.0 % were not significantly different compared to control. At 8 weeks, the progeny emergence was significantly higher ($P < 0.05$) in the control than different concentrations of groundnut oil, soya oil, and Actellic E.C. There was no significant difference in term of grain damage in all the treatment except the control. These volatile oils can be used to protect stored products against insect pests in developing countries.

Keywords: Plant oils, maize, Actellic E.C, *Sitophilus zeamais*

INTRODUCTION

Maize (*Zea mays*) also known as corn belongs to the family Poaceae. It is the third most important cereal crop in the world after wheat and rice (FAO, 2002). Maize was introduced to West Africa by the Portuguese in the 10th century (Oladejo and Adetunji, 2012) and in Nigeria probably in the 16th century (Abdulrahaman and Kolawole, 2006). In Nigeria, maize production in 2011 was 9.18 million tones, and in 2009, maize was the third most consumed commodity (after sorghum and millet), (FAO, 2013).

Maize in storage is damaged or completely destroyed by *Sitophilus zeamais* as a result of their feeding activities. *S. zeamais* inflict their damage on stored products mainly by feeding on the endosperm causing loss of weight and quality, while other species feed on the germ resulting in poor seed germination. Thus, due to damage done by this insect, grain loss may be up 50 % in a season.

Every part of maize has economic value: the grain, leaves, stalk, and cob can all be used to produce a large variety of food and non-food products. In Nigeria maize is largely used as livestock feed and as a raw material for industrial products and mainly used for human consumption. Maize contains 80 % carbohydrate, 10 % protein, 3.5 % fiber and 2 % mineral (Oladejo and Adetunji, 2012).

Adult weevils and larvae feed on undamaged grains and reduce them to powdery from. Infestations by maize weevil commence from the field just before harvest and the weevil continues

to reproduce and destroy the grains in the store. The larvae develop and pupate within grain. The adults emerge through characteristic circular holes made on the grains. The developmental activities of the weevil often lead to severe powdering and tainting of the grains with their excrements. The infested grains are often rendered susceptible to caking and mould infection thereby reducing their market value. The larva is the most destructive stage of the weevil.

It is in the light of the above problems that the need to develop control strategy that will be affordable and eco-friendly becomes expedient. The use of plant oils in stored product protection has been reported (Obeng-Ofori, 1995; Mohiuddin *et al.,* 1987; Lale 1991; Kumar and Okoronkwo, 1991). The present work therefore was designed to investigate the protectant properties of two plant oils; groundnut oil and soyabean oil against the maize weevil, *S. zeamais*.

MATERIALS AND METHODS

Insect culture

Two hundred grams of already fumigated and ventilated maize seeds were placed in each of two kilner jars and infested with adult S. zeamais from the insect culture raised in the storage Laboratory of Crop Protection Department /Institute for Agricultural Research, Ahmadu Bello University Zaria, Nigeria for 30 days at temperature of 25 to 32^{o}C and relative humidity- 75±5 %. From this culture, newly emerged (24 hrs) adult S. zeamais were used for infestation.

Grains and plant oils

A total of seven kilograms of maize grains were used for the study. The grains were screened to remove contaminants and infested seeds. Screened seeds were fumigated with phostoxin tablet in an air – tight container for 48 hrs to kill any egg and larvae present. The seeds were later spread on a laboratory bench for three days to allow for dissipation of fumigant effect. One hundred grams of these seeds were weighed into kilner jars covered with fine wire mesh for aeration. Four litres each of groundnut oil and soya bean oil respectively, were purchased from Samaru market within Zaria metropolis, Nigeria. The oils were stored under laboratory conditions and then used for the experiment.

Bioassay

Each of the groundnut oil and soybean oil were applied at three levels of (0.5 %, 1.0 %, and 1.5 %) in kilner jars containing 100 g maize seeds. There was an untreated control and Actellic E.C. treatment was used as the standard check at the rate of 2.5 ml and all repeated three times. Each treatment was shaken vigorously for proper mixing and allowed to stand for an hour before introducing 10 pairs of newly emerged adult S. zeamais into each jar. The kilner jars were arranged in a completely randomized design (CRD) and kept on laboratory bench for eight weeks.

Adult S. zeamais mortality data were taken from each jar at 48 hrs and 72 hrs respectively. Progeny emergence was assessed at the end of eight weeks from each treatment jar and counting the number of insects that emerged. Maize seed damage was assessed also at the end of eight weeks by randomly selecting 100 seeds from each treatment jar and counting the number of emergent holes on each.

The data were analyzed using analysis of variance (ANOVA) to verify the existence of significant difference between treatments. Student's Neuman keul test (SNK) was used to separate treatment means.

RESULTS

Effects of plant oils on mortality of adult *S. zeamais*.

The results (Table 1) showed that Actellic E. C at 48 hrs and 72 hrs caused significantly higher ($P < 0.05$) mortality (100 %) of adult *S. zeamais* compared to plant oils treated grains and the control. The plant oils also caused significant mortality of *S. zeamais* while groundnut oil at 1.5 % had higher mortality and also soya oil at 1.5 % compared to the control. The groundnut oil at all levels showed significant difference and soya oil at 0.5 ml and 1.0 ml also showed a significant difference compared to control. At 8 weeks the progeny emergence was significantly higher ($P < 0.05$) on the control than on different concentrations of groundnut oil, soya oil, and Actellic E.C, but there no significant difference among the treated grains. The grain damage did not show any significant difference in all the treatments although; the control had more grain damage than the treated grains.

Table 1: Effect of plant oils on mortality of adult *S. zeamais* at 48 and 72 hrs post-treatment.

Treatment	Conc. (%)*	Mean mortality	
		48h	72h
G. oil	0.50	2.00b	3.67[b]
	1.00	1.67b	4.33[b]
	1.50	5.00a	8.33[a]
Soya oil	0.50	1.67b	4.00[b]
	1.00	3.33b	5.67[b]
	1.50	4.33a	8.00[a]
Actellic E.C.	2.50	10.00a	10.00[a]
Control	0.00	2.33b	5.66[b]
SE±		0.27	0.19

Means with the same letter(s) in a column are not significantly different at 5 % using SNK. "*" connotes that the treatments' concentrations were applied per 100g of Maize seeds.

Effect of plant oils on progeny emergence of adult *S. zeamais* at 8 weeks Post-treatment.

The results (Table 2) showed that at 8 weeks post-treatment the progeny emergence was more on the control than the treated grains. There was no significant difference among the plant oils and Actellic E.C but the control shows a significant difference. Also the plant oils at all levels did not show any significant difference.

Table 2: Effects of plant oils on progeny emergence of *S. zeamais* at 8 weeks post-treatment appplication.

Treatments	Conc. (%)	Emergence
	0.50	173.33[b]
G.oil	1.00	143.33[b]
	1.50	89.00[b]
	0.50	110.33[b]
Soya oil	1.00	76.67[b]
	1.50	46.67[b]
Actellic E.C	2.50	60.00[b]
Control	0.00	250.00[a]
SE±		16.50

Means with the same letter(s) in a column are not significantly different at 5 % using SNK. "*" connotes that the treatments' concentrations were applied per 100g of Maize seeds. Each value in the "Emergence" column is a mean of progeny emergence obtained in the study.

Effects of plant oils on percentage damage of maize seeds at 8 weeks.

The percentage grain damage showed no significant difference ($p \geq 0.05$) in the treated grains but the control had more grain damage than the treated grains. The plant oils at all levels and Actellic E.C did not show any significant difference but the control shows a significant difference ($p \leq 0.05$).

Table 3: Effects of plant oils on percentage damage to maize seeds at 8 weeks.

Means with the same letter(s) in a column are not significantly different at 5 % using SNK. "*" connotes that the treatments' concentrations were applied per

Treatment	Conc. (%)	Damage (%)
	0.50	39.33[b]
G. oil	1.00	34.00[bc]
	1.50	10.67[c]
	0.50	40.67[b]
Soya oil	1.00	27.33[b]
	1.50	25.33[b]
Actellic E.C	2.50	18.22[b]
Control	0.00	80.67[a]
SE±		6.75

100g of Maize seeds. Each value in the "Damage" column is a mean of percentage damage obtained in the study.

DISCUSSION

In the present study, plant oils were evaluated, along with Actellic E.C used as a control. Actellic E.C (2.5 %) caused significantly higher ($P < 0.05$) mortality of adult *S. zeamais* during the periods on maize seeds compared with plant oils. The plant oils also caused significant adult mortality of *S. zeamais* during the storage periods due to suffocation caused by oils. Stoll, (1998) had earlier reported that neem seed oil 2-3 ml per kilogram of maize seed was effective in controlling *S. zeamais* on maize.

In terms of adult emergence the plant oils significantly ($P < 0.05$) suppressed emergence of adult *S. zeamais* when compared with the control (Table 2). The efficacy of the plant oils in significantly suppressing emergence has largely been attributed to ovicidal properties, which prevent eggs from hatching into adults (Jadhav and Jadhav, 1984). Doharey *et al*., (1990) also showed that coconut oil has been found effective against *Callosobruchus maculatus* and *Callosobruchus chinensis* for a storage periods up to six months when applied to green gram at 1 %.

The damage inflicted on maize grains by *S. zeamais* after two months of storage as presented in Table 3, shows that damage was more in the control treatment but there was no significant difference ($p \geq 0.05$) in all the treatments.

CONCLUSION

Plant oils are readily available and poor resource farmers could use them to protect maize grains meant for short duration storage and for consumption. This will reduce the use of synthetic insecticides thus curtailing the risks involved in their usage.

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