EVALUATION OF THE EFFICACY OF OLIVE AND EUCALYPTUS OILS AGAINST THE DAMAGE CAUSED BY MAIZE WEEVILS (*Sitophilus zeamais* Motsh).

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ABSTRACT

The experiment was conducted in soil science laboratory in Jigawa State College of Agriculture, Hadejia (Yamidi).The objectives of the research were to determine the most effective concentration of oils that are effective in controlling damage caused by maize weevils (S. zeamais) on stored maize grain. Two selected plant oil concentrations (Olive and Eucalyptus) and the synergistic effects of the two were tested at the rate of 2ml, 5ml, and 7ml/100g of maize grain with control treatment. The experiment was laid out in a Completely Randomized Design (CRD) and each treatment was repeated three times. The result of the experiment revealed that, all treatments were significantly better than the control treatment (P<0.05) in reducing stored maize infestation. However, 7ml Olive, 2ml, 5ml, and 7ml Eucalyptus oil and 2ml, 5ml and 7ml of the synergist were found to be the most effective in reducing the infestation of stored maize grain caused by S.zeamais. The damage was assessed based on eggs laid, number of emerged larvae, Grain damage, weight loss and increase in adult mortality. The highest germination was observed at these treatments. Based on the result of the experiment, it could therefore, be suggested that farmers could use, 2ml Eucalyptus and 2ml of the synergist concentrations to control maize weevil during storage.

Keywords*: Sitophilus zeamais*, Olive oil, Eucalyptus oil, Maize grain

INTRODUCTION

Post-harvest losses especially on insect pests of maize are the major constraints of food security and income generation in Sub-Sahara Africa because of significant yield losses and grain quality degradation (Abebe *et al*., 2009). Abdullahi (2005) reported that agricultural produce are liable to a wide range of pests and disease attack in the fields, consequently, these limit both yield obtained in the fields and quality of the grain during storage. The most economically important post-harvest pests of maize in Africa are the maize weevil, (*Sitophilus zeamais* Mot.), and Larger Grain Borer (LGB), *Prostephanus truncatus* (Horn.) (Boxall, 2000), the Angoumois grain moth, (*Sitotroga cerealla* Olivier) (Olakojo and Kogbejo 2005).

Maize weevil *(S. zeamais)* (Coleoptera: Curculionidae) is a major pest of stored maize grain in the tropics and temperate region of the World (Adedire, 2003). Its infestation causes severe post-harvest losses of staple food crops in Nigeria leading to major economic losses (Oni and Ileke, 2008). Heavy infestation of the grain may cause weight loss of as much as 30% – 40% (Boxall, 2000). Production of maize in Nigeria has been very difficult because of activities of insect pests especially at storage level. Maize weevil, *S. zeamais* is one of the most serious cosmopolitan pests of the stored cereal grains in the tropical and Sub-tropical region (Throne, 1994).

Initially, control of *S. zeamais.* is heavily depended upon the use of synthetic chemical pesticides, however synthetic chemical pesticide penetrate in to the stored grain, thereby causing serious health hazard to both human beings and animals (Lale ,1995). In addition, Jood *et al.,* (1993), reported that the chemical pesticide adversity affect the taste /aroma and overall acceptability of the grain product, rendering the grain unsuitable for human consumption. Besides, the chemical pesticide pollutes the environment and is very expensive. Particular interest has focused on the use of oil and powder of several species of plant products to serve as an alternative; the products have shown to have no adverse effect on the germination of maize and other crops (Pandy *et al.*, 1980). This has encouraged Scientists to search for natural pesticides that are environment friendly, safe to man and non-target organism. It is in light of the aforementioned fact that the present research was initiated to evaluate the efficacy of two plant products against damage caused by maize weevil on stored maize grain and determines the most effective concentrations of the oils that are effective in controlling damage caused by maize weevil on the grain.

MATERIALS AND METHODS

Experimental design

The experiment was carried out using a Completely Randomized Design (CRD) and each variable (treatment) was replicated three (3) times, the control which was replicated three (3) times was also separated from other treatments to avoid contamination

Experimental site

The experiment was conducted in Soil Science Laboratory of Jigawa State College of Agriculture, Hedejia (Yamidi Village). Jigawa State is located in north-western part of Nigeria between latitudes 11ºN to 13ºN and longitudes 8ºE to 10.15ºE, in Sudan Savanna of Nigeria.

Source and rearing of experimental insects

Highly infested maize grain were obtained from Yan kura market, Kano and brought in to laboratory for rearing the F_1 generation of the insect species. Thereafter, three (3) hundred adult *S. zeamais* insects were introduced into the earth-pot containing 3 kg of un-infested whole maize grain. These together with the insects were covered with white cloth, and tightened firmly with rubber band. These were incubated at ambient temperature of 28ºC to 32ºC and relative humidity of 55%-75% respectively. After 2 weeks, the adults were removed from the earth-pot by sieving. 10

Adult insects of first generation (F1) were used for experimental insects.

Collection of plant materials and distillation of plant oils

Eucalyptus was obtained by distillation of the leaves of Eucalyptus, at National Research Institute of Chemical Technology (NARICT) Zaria, Kaduna State and olive oil was purchased from Hadejia central market Jigawa State for the experiment. Table 1 shows the mixing ratio of the plant oils used individually or in mixture.

Table 1: List of plant materials used.

Number of treatment	Plants material (oil)	Treatment composition (ml)
1	Olive	2
2	Olive	5
3	Olive	7
4	*E. citriodora*	2
5	*E. citriodora*	5
6	*E. citriodora*	7
7	Olive + *E. citriodora*. (1:1)	2
8	Olive + *E. citriodora*. (2.5:2.5)	5
9	Olive + *E. citriodora*. (3.5:3.5)	7
10	Control	-

Ovipostion count

The selection of grain-hosts by the maize weevil female was investigated under conditions containing one uninfested maize grain, one conditioned maize grain without egg and one conditioned maize grain of varying egg density (1, 2-3, 4 and 5 or more eggs/grain). The three different grains were exposed to an adult female weevil, which had been randomly selected from the laboratory cultures in a well. Eighteen to 24 replicates were performed for each egg density. The grain-host selection preference of *S. zeamais* was reflected in the number of times that the female was found on each type of grain.

Conditioned maize grains of varying egg density (0, 1, 2, 3 and 4 eggs/grain) were selected. At each density, five conditioned grains were mixed with five uninfested grains and placed on a Petri dish (55 mm). The uninfested grains were stained with acid fuchsin to avoid bias, because the conditioned grains had been stained. Both grain types were marked using two different coloured dots made with an "Artline 725" permanent marker. Adult weevils were selected randomly from the laboratory culture, and the sexes were separated based on the dimorphic rostrum characteristics (Halstead, 1963) and were presumed fertile.

Ten S. zeamais adults (five females and five males) were added to the grains and the Petri dishes were placed in the dark room under controlled laboratory conditions. Nine replicates were performed at each egg density. After 3 days, the adults were removed and the grains were stained again with acid fuchsin. Then, the number of egg plugs was counted for the two grain types. The average number of eggs laid on the conditioned grains was obtained after subtracting the number of eggs found from the number of eggs initially present.

Maize grain damage assessment

Grain damage by *S. zeamais* was assessed in terms of counting perforated holes on single seed; percent weight loss and viability loss of seeds caused by adult weevils and larvae feeding inside the seeds. The damage was therefore determined with respect to the number of perforated seeds, percent weight loss and grain viability.

Seed viability test

Top of Paper Method was used to test the seed viability.

Germination is defined as the clear and unobstructed emergence of the radicle, or seedling root, from the seed coat. In the top of paper method, the seeds were placed on top of substrate paper in containers with snug-fitting lids (to prevent moisture loss). Petri dishes were used for this method. A permanent marker was used to label the containers with the type of seed being tested and the replication number. Sterilize containers and cut substrate paper (we use a double-folded paper towel) to fit in the container. Appropriate amount of distilled water was added to completely moisten the paper without soaking it. Typical containers with a double-folded paper towel required from 2 to 6 ml of water, depending upon the size. The seeds were spread uniformly on the moistened substrate, ensuring that none of the seeds touch each other. The lid was closed and the container was placed inside a loosely fitting sandwich bag to help ensure additional moisture retention. To prevent loss of moisture, oxygen was diffused, which the seeds needed for germinating and respiring. The containers were placed in seed germination cabinet. Every day, or every other day, germinated seeds were counted and recorded.

Substrates were re-moistened during the course of the test to give containers with the same seed types an equal amount of water, making note of the amounts. During the test, any seeds that show signs of contamination were carefully remove and discarded (Rao *et al.* 2006)

RESULTS AND DISCUSSION

Table 2 shows the number of eggs laid on treated and untreated maize grains by maize weevils (*S. zeamais*).The results showed that there were significant differences among the treatment over the control in reducing number of eggs laid by *S. zeamais* and eggs were only found on maize treated with olive oil at 2ml and 5ml and the control treatments throughout the period of the observations. However, no egg was recorded on the remaining treatments. The difference in the number of eggs laid was highly significant between 2ml and 5ml treatments and the two treatments differed significantly with the control treatments.

Table 2: Effect of Olive and Eucalyptus Oils On Number of Eggs Laid by Maize Weevils (*S. zeamais)*

Treatment (oil)	Weeks after Treatment (WAT)											
	1	2	3	4	5	6	7	8	9	10	11	12
Olive 2 ml	46.33^{c}	91.67^{c}	145.66^{c}	192.33^{c}	243.00^{c}	291.33^{c}	332.00^{c}	380.00^{c}	403.66^{c}	430.66^{c}	478.00^{c}	36.33^{c}
Olive 5ml	30.67^{b}	60.33^{b}	90.00^{b}	119.00^{b}	147.66^{b}	181.00^{b}	201.00^{b}	237.00^{b}	262.00^{b}	288.00^{b}	319.33^{b}	349.00^{b}
Olive 7 ml	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Eucalyptus 2ml	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Eucalyptus 5ml	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Eucalyptus 7ml	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Olive + Eucalyptus 2ml	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Olive + Eucalyptus 5ml	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Olive + Eucalyptus 7ml	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Control	142.00^{d}	375.00^{d}	564.33^{d}	817.00^{d}	1103.60^{d}	1301.60^{d}	1495.60^{d}	1702.60^{d}	1900.00^{d}	2093.00^{d}	2284.00^{d}	4049.00^{d}
LS	***	***	***	***	***	***	***	***	***	***	***	***
SE±	(8.055)	(20.80)	(31.37)	(45.77)	(61.42)	(72.37)	(83.07)	(94.50)	(105.32)	(115.87)	(126.51)	(262.93)

Means within a column followed by the same latter are not significantly different (P=0.05) using Student Newman Keul (SNK) test.

Results in Table 3 showed that, all treatments tested were significantly better than the control throughout the period of observation (1-11days after treatment). However, when efficacy of plant products were compared and evaluated at 2 Days After Treatment (DAT) the highest adult mortality of maize weevil with 10.000c were recorded in 2ml, 5ml and 7ml *Eucalyptus* and synergist of the two concentrations. While less effect were observed at other treatments with 0.000a of adult mortality of the weevils. At 3 DAT there was no significant difference in mortality of the maize among the treatments over the control. At 4 DAT the highest mortality was recorded at 5ml *olive* of 2.3333b followed by 2ml olive with 0.6666a, while there was no any statistical difference among the other treatments in mortality. At 5 DAT The increase of mortality were observed at 5ml and 2ml *olive* with 3.3333c and 1.0000b adult mortality respectively. However, there were no significant differences among the other treatments. At 6 DAT there were significant differences among the treatments over the control, the highest increase in mortality was observed at 5ml and 2ml *olive* with 4.3333b and 2.0000c respectively. However, there was no statistical difference among the other treatment in reducing mortality of the maize weevils. At 7 DAT there was increase in mortality of the weevils in 5 ml and 2 ml olive with 5.0000 c and 3.0000c and there were no significant difference among the treatments. At 8, 9, 10, and 11 DAT there were no any statistical difference over the control over control.

Table 3: Effect of Olive and Eucalyptus Oils On Number of Eggs Laid by Adult Mortality Maize Weevils (*S. zeamais)*

Treatment (oil)	Days after Treatment (DAT)									
	2	3	4	5	6	7	8	9	10	11
Olive 2 ml	0.00^{a}	0.00^{a}	0.67^{a}	1.00^{b}	2.00^{b}	3.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Olive 5ml	0.00^{a}	0.00^{a}	2.33^{b}	3.33^{c}	4.33^{c}	5.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Olive 7 ml	10.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Eucalyptus 2ml	10.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Eucalyptus 5ml	10.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Eucalyptus 7ml	10.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Olive + Eucalyptus 2ml	10.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Olive + Eucalyptus 5ml	10.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Olive + Eucalyptus 7ml	10.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Control	0.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
LS	***	NS	***	***	***	***	NS	NS	NS	NS
SE±	(0.83)	(0.39)	(0.48)	(0.56)	(0.26)	(0.37)	(0.00)	(0.00)	(0.00)	(0.00)

Means within a column followed by the same letter are not significantly different (P=0.05) using Student Newman Keuls (NSK) TEST

Table 4: Showed the effect of the plant products on grain damage caused by maize weevil. The results showed that, there were significant differences between the plant products and the control in reducing damage caused by *S. zeamais* throughout the period of observation at (1 -12 WAT). There were no significant differences among the plant products at 1 and 2 WAT. The mixture of the two oils at different concentrations were the most effective in reducing damage caused by *S. zeamais* with no damaged grain (0.0000). The treatment which recorded the highest grain damage apart from the control treatment was 2ml *olive* followed by 5ml olive. The result of percentage loss in Table 4 also showed that there were significant differences between control and plant product treatments. However, when data were evaluated 2ml olive gave the highest percentage weight loss of 21.53 % followed by 5ml *olive* with 12.90 % of weight loss. The 7ml *olive*, 2ml, 5ml and 7ml *Eucalyptus* and 2ml, 5ml and 7ml synergist of two oil concentration gave no weight loss at all.

Result of germination test in Table 5 showed that there was significant difference between control and other treatments. However, when efficacy was evaluated and compared among the treatments, 5ml and 7ml of *Eucalyptus* gave the highest percentage germination of 100 % followed by 2ml, 5ml and 7ml of synergist of two oil concentration with 93.33 %, 96.67 % respectively. However the lowest germination percentages were observed at 2ml olive of 46.67 % followed by 5ml *olive* with 66.67 %, respectively.

Result of this work correlated positively with findings of Convey, (1990) who reported that, the *Eucalyptus* oil produce a strong substance which may have exerted a toxic effect by disrupting the normal respiratory activities of weevils, there by resulting in asphyxiation and subsequent death of the weevils. Another observation from the research is that all the plant products treatment acted either as contact, stomach poison or both because they were all found to be effective in suppressing growth of weevil. This result also confirms the finding of Moussa, (2001) who indicated that, the flora of the savanna consists of plant species that possess insecticidal properties. Mulungu *et al* (2007) also reported that use of plant products (powder and oil) has been provided in higher death of insect cause of physical barriers effect of the plant material, probably, coupled with tendency of blocking spiracles of the insect, thus impairing respiration leading to death of insects. The level of damage recorded was significantly higher in untreated maize grain than in those treated with plant products (oil concentration). This agrees with finding of Comes, (1997) who reported that the potential of exploiting insecticide from plant source is quite higher in Nigeria. The finding of this research also corroborated positively with finding of Convey, (1990) who reported that an insecticidal activity was observed in the concentration of olive, although, not as *Eucalyptus*.

Table 4: Effect of Olive and Eucalyptus Oils On Grain Damage Caused by Maize Weevils (*S. zeamais)*

Treatment (oil)	Weeks After Treatment (WAT)											
	1	2	3	4	5	6	7	8	9	10	11	12
Olive 2 ml	0.00^{a}	0.67^{a}	1.33^{b}	1.66^{b}	3.33^{b}	4.00^{c}	4.33^{c}	5.00^{c}	6.33^{a}	7.33^{a}	8.67^{c}	10.00^{c}
Olive 5ml	0.00^{a}	0.00^{a}	2.33^{b}	3.33^{c}	0.67^{a}	2.67^{b}	3.33^{b}	4.33^{b}	4.67^{b}	5.00^{b}	6.00^{c}	7.33^{c}
Olive 7 ml	0.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Eucalyptus 2ml	0.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Eucalyptus 5ml	0.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Eucalyptus 7ml	0.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Olive + Eucalyptus 2ml	0.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Olive + Eucalyptus 5ml	0.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Olive + Eucalyptus 7ml	0.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Control	3.00^{b}	4.33^{b}	5.33^{c}	6.33^{c}	8.66^{c}	10.67^{d}	13.33^{d}	16.33^{d}	18.00^{d}	20.33^{d}	25.67^{d}	28.33^{d}
LS	**	**	***	***	***	***	***	***	***	***	***	***
SE±	(0.17)	(0.25)	(0.30)	(0.36)	(0.50)	(0.68)	(0.75)	(0.92)	(1.02)	(1.16)	1.45	1.61

Means within a column followed by the same letter are not significantly different (P=0.05) using Student Newman Keuls (NSK) TEST

This result agrees also with finding of Lale (1995) who reported the tendency of possession of insecticidal properties by some plants. The quality and quantity of maize grain tested with plant products were not adversely affected by maize weevils during period of the experiment this agrees with result obtained by Oparaeke and Dike (2005) who reported cooking quality and taste of maize grain were negatively affected by damage caused on grains. The result of experiment revealed that maize treated with 7ml *olive*, 2ml, 5ml and 7ml of *Eucalyptus* and 2ml, 5ml and 7ml synergist of the two concentration gave significant decrease in number of adult emerged. The result is in

agreement with finding of Golob *et al*, (1982) who indicated that the use of local plant products (powder and oil) gave the higher level of protection to grain against stored insect pests. The result also indicated that, seed viability of treated and untreated grains were all significantly influenced by duration of storage and concentration of plant products (oil) treatment. The result agrees with the finding of Kasa and Tadese, (1995) who

reported that, the use of oil and crude powder of plants for control of *S .zeamais* on maize grains have been shown to have no adverse effects on seed germination.

Table 5: Effect of Olive And Eucalyptus Oils On Germination of Stored Maize Grains

Treatments (oil) (ml)	Percentage germination (%)
Olive 2	46.67
Olive 5	66.67
Olive 7	93.33
Eucalyptus 2	96.67
Eucalyptus 5	100
Eucalyptus 7	100
Olive + Eucalyptus 2	93.33
Olive + Eucalyptus 5	96.67
Olive + Eucalyptus 7	96.67
Control	0

CONCLUSION

The result clearly indicated the potential values of using plant products as complimentary to chemical pesticides in controlling *S. zeamais* on the grain. Based on the result obtained, 2ml *Eucalyptus* and 2ml synergist of the two oil concentrations/100g of maize grains may be recommended to the farmers for control of *S. zeamais* on maize grain during storage.

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