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LABORATORY EVALUATION OF TWO BOTANICALS ON THE MANAGEMENT OF COWPEA WEEVIL (*Callosobruchus maculatus* F.) IN SAMARU, NIGERIA

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ABSTRACT

Experiment was conducted at the soil science laboratory of Institute for Agricultural Research, Ahmadu Bello University, Zaria Nigeria to evaluate the efficacy of citrus of leaf powder, citrus rind powder, sunflower leaf powder and sunflower oil at 5.0g, 10.0g, and 15.0g/100g of cowpea grains on damage and weight loss of stored cowpea (*Vigna unguiculata* (L.) Walp grains on the development and mortality of (*Callosobruchus maculatus* F.) (Coleoptera: Bruchidae) attacking the grains. Cowpea grains were washed and kept for 24 hours in air tight condition to eliminate possible hidden infestation. The experiment consists of 16 treatments replicated three times in a complete randomized design. Treated cowpea was stored for eight weeks. Data was collected on weekly basis on mortality rate, grain weight loss and grain damage. Data was analyzed using new Duncan multiple range test. Least significant difference (LSD) test was used to determine the difference between the treatment means at various levels. *C. maculatus* was controlled from citrus leaf powder and sunflower oil at 10.0g, 15.0g and 10.0ml, 15.0ml/100g effectively respectively. And more results, especially grain damage and weight loss.

Keywords: C*allosobruchus maculatus*, Citrus leaf powder, Citrus rind powder, Sunflower leaf powder, Sunflower oil

1. INTRODUCTION

Cowpea (*Vigna unguiculata* L.) is an important grain legume in the diet of many people in the world. Global production of dried cowpea was 6.2million metric tons in 2013. Of which 94% was in Africa (FAOSTAT, 2014). Nigeria is the world largest producer with 2.9million metric tons followed by Niger and Mali with 1.3 and 0.2 million metric tons respectively.

The percentage nutritional value of cowpea indicated its protein content to be 23%, fats 1.3%, fibre 1.8%, carbohydrate, 67% and water 8 – 9% (Owulabi *et al.*, 2005).The haulm containing about 20 % protein is highly valued feed and is sold for almost the same price as cowpea grain on dry weight basis. Thus cowpea promotes crop-livestock integration, thereby leading to a better nutrient cycling and enhanced income generation. Insects attack cowpea and cause economic damage at all stages of plant growth from seedlings to harvest and in storage (Amatobi *et al.,* 2005). Several control measures in Nigeria have been advocated such as the use of synthetic insecticides, biological controls, physical control and host plant resistance by many researchers to control post-flowering insect pests in cowpea production (Sharah and Ali, 2008). Results show that insecticides are the most effective control measure against these pests and majority of the farmers rely heavily on the use of synthetic insecticides in the management of their cowpea pests. Synthetic insecticides are costly, toxic to humans and when used inappropriately may be harmful to the environment (Sharah and Ali 2008). The use of some plant extracts are promising alternative control measures to synthetic chemicals (Oparaeke, 2007).

Storage is an essential part of crop production and it is an age-long practice which the ancient farmers have adopted to preserve grains for food and seeds for replanting. The major constraint in the storage of cowpea is the attack by *C. maculatus* (Ebrisibe *et al,* 2011). However, better ways and sophisticated devices are being used to preserve seeds and increase their longevity in storage as compared to the crude methods of the olden days. However, some of

these methods are still relevant especially when upgraded using improved technology.

Observation in most of our markets today especially in the northern parts of the country where cowpea is mostly grown and sold has shown an appreciable level of cowpea infested with *C. maculatus* among other pests. The use of synthetic pesticides particularly in storage can lead to undesirable consequences. Also the cost of these chemicals has always been exorbitant, beyond the reach of common man. Hence to ensure food security and boost ecomnomy, it is necessary to source for cheaper and safer alternative that is environmentally friendly and sustainable from the readily available materials. The present study was focused on the use of four botanicals as alternative pesticides against *C. maculatus* attacking cowpea grains.

2. MATERIALS AND METHODS

2.1 Study site

The experiment was conducted at the soil science laboratory of Institute for Agricultural Research, Ahmadu Bello University, Zaria (latitude 11^0 11^0 N and longitude 7^0 38', 686m above sea level) for eight weeks.

2.2 Collection and preparation of experimental materials

The cowpea variety used for the experiment was the kanannado obtained from the seed unit of the Institute for Agricultural Research (IAR) ABU, Samaru Zaria. The *C. maculatus* species was obtained, identified and reared at room temperature (30-33^o C) and relative humidity (75%) in the storage Entomology Laboratory of the Department of Crop Protection Faculty of Agriculture. The plant extracts used were citrus leaf powder 5g, 10g 15g citrus rind powder 5g 10g 15g, sunflower leaf powder 5g 10g 15g and sunflower oil 5g 10g 15g. 50 male and 50 female weevils were introduced into the kilner jar and left undisturbed for two weeks and the adult weevils were sieved out in order to eliminate mixing with f1 generation, the main objective of this procedure was to obtain and use freshly emerged adults for the experiment. The adult *C. maculatus* are 2.0-3.5 mm long.

The sunflower leaves were obtained from Institute for Agricultural Research field while the leaves and the rind of citrus (sweet orange) were obtained from horticultural unit of IAR Samaru. Freshly plant leaves were washed thoroughly and later shade dried for 2 weeks and ground to fine powder using a mortar and a pestle. The powder was then sieved using a wire mesh of size 0.2 mm to obtain a fine powder. The cowpea seeds were washed with water before the experiment to make them free of insect pest. Sunflower seed was obtained from seed processing unit (IAR), ABU, Zaria and was taken to National Research Institute for Chemical Technology (NARICT). For oil extraction, the seed was cleaned and dried to remove foreign materials. It was crushed after threshing with milestone; it was then heated as a pre-heating step in heated conditioners. The crushed and heated seeds were pressed in the expellers. The oil-bearing material was fed into one end of the cylinder where a powder driven warm conveyer forces the material to the other end of the cylinder and out against resistance which squeezes out the oil. The oil was collected and ready for use. The quantity of sunflower oil needed was weighed in the laboratory using mettler weighing balance 15mls, 10mls and 5mls. Each was applied to 100 grams of cowpea in a plastic container using stirrer to mix the grain and the oil thoroughly. Treatments and grains were all weighed before commencing the experiment to establish the concentration. Also, the initial and final weights of the grains were ascertained after the experiment. The citrus leaf powder, citrus rind powder, sunflower leaf powder and sunflower oil were thoroughly mixed with the cowpea seed for about 30 seconds. The containers were then left to settle for about 2 hours. Ten (10) healthy weevils were introduced into each container and were shaken to get the powder and oil onto the weevils. The containers were then covered with a muslin cloth to facilitate proper aeration and prevent entry of other insects. The experiment was set up in the store for 8 weeks and observations were on the number of dead weevil adult on weekly basis. Data were analyzed using one-way analysis of variance (ANOVA). Differences between the mean were compared using the 5% level of probability ($p \leq 0.05$).

Mortality rate for each treatment was recorded for eight weeks at the interval of one week after the introduction of the insects by removing the muslin cloth gently. Dead insects were removed

and live ones returned into the set-up with the treated grains.

Grain damage assessment was carried out by picking 50 grains at random from each container and then counting the number of grains with holes. Percentage grain damaged was calculated using the formular

$$\% \text{ grain damage} = \frac{\text{Damaged grain}}{\text{Total nuber of grain}} \times \underline{100}$$

3. RESULTS

Table 1 shows the effect of the extracts on the insects after one week of treatment. Below 15g/100g concentration, all the plant powders and oil were similar in their effect but were however, more effective than the control experiment. At 15g/100g concentration level, citrus leaf powder was most effective recording the highest insect mortality rate which was only comparable to citrus rind powder and sunflower oil. Sunflower leaf powder was the least effective. All the treated samples exhibited significant level of insect mortality when compared with the control at all levels.

In the second week following treatment, sunflower oil took the lead at all concentrations with the highest (2.00) level of insect mortality recorded at 15g/100g when compared with others.

On the third week, all the treatments, irrespective of plant materials or level of concentration, were similar in their insect mortality capability. Between week 5 and 8, there was general decline in the performance of the plant treatments and were comparable in their efficacy.

The effect of extracts on grain damage was obtained. Sunflower leaf powder treatment recorded the highest cowpea weight loss. Samples treated to citrus leaf powder gave the highest level of cowpea seed protection at all levels of treatment (table 9).

4. DISCUSSION

This study showed that the citrus leaf powder and sunflower oil have insecticidal activity against *C. maculatus* and they can be used for the control of cowpea weevil. The ability of these two materials to control insects of stored cowpea is exhibited through promoting insect mortality reduction in grain damage and weight. Shaaya *et al.* (1997) reported that the edible oils are potential control agents against *C. maculatus* and can play an important role in stored grain protection.

The deterrence of *C. maculatus* by citrus leaf powder and sunflower oil was also concentration dependent. It was found that citrus leaf powder and sunflower oil caused significant increases in the mortality rate of *C. maculatus* as their concentration increases. A report has it that the larvae which hatch from eggs of *C. maculatus* spp penetrate the seeds to survive (FAO, 2000). Penetration of plant seeds by the insect is aided by the firm attachment of the larvae to the seed surface. It appears that the mortality of the insects due from feeding deterrent action of the extracts applied or may have resulted from direct ovicidal action from the extracts leading to lower number of eggs that hatched to produce viable larvae. Such actions have been reported in similar plant materials earlier investigated. (Tapondjou *et al.,* 2002). There is the likelihood that while feeding, the insect must have ingested the plant materials on the seed surface. It is on record that ingestion of such pesticidal materials by insects has resulted to inhibition on egg-laying. Su *et al. (*1972) reported that oil from peels of citrus fruits applied to the surface of cowpea seed resulted in failure by adult *C. maculatus* to produce progeny. There is great potential in using botanical formulations as fumigant (s) against stored cowpea on cowpea bruchid, *C. maculatus*. Citrus leaf powder at 15.0g/100g and sunflower oil at 15.0mls/100g proved effective in controlling *C. maculatus*. These products are healthy and environmentally friendly while giving the required control effect on the insect pests unlike their synthetic counter parts that are non target specific and pose great threat to the environment. The materials are also available within local communities and can easily be prepared for use.

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Table 1: Efficacy of citrus powder, citrus rind powder, sunflower leaf powder and sunflower oil on *C. maculatus* mortality rate after one week of treatment

Treatment	**Extracts (g or mls /100g grain)**		
	15	**10**	**5**
Citrus leaf powder	2.00[a]	1.33[a]	1.00[a]
Citrus rind powder	1.67[ab]	1.33[a]	1.00[a]
Sunflower leaf powder	1.00[b]	1.67[a]	0.67[a]
Sunflower oil (mls)	1.67[ab]	1.67[a]	1.00[a]
Control	0.00[c]	0.00[c]	0.00[c]
LSD	0.04	0.06	0.03

Means with the same letter (s) within a column are not significantly different at (P≤0.05)

Table 2: Efficacy of citrus powder, citrus rind powder, sunflower leaf powder and sunflower oil on *C. maculatus* mortality rate after two weeks of treatment

Treatment	**Extracts (g or mls /100g grain)**		
	15	**10**	**5**
Citrus leaf powder	1.67[ab]	1.33[ab]	1.00[ab]
Citrus rind powder	1.00[b]	1.33[ab]	1.00[ab]
Sunflower leaf powder	1.33[ab]	1.00[b]	0.67[b]
Sunflower oil (mls)	2.99[a]	2.00[a]	1.67[a]
Control	0.00[c]	0.00[c]	0.00[c]
LSD	0.04	0.04	0.04

Means with the same letter (s) within a column are not significantly different at (P≤0.05)

Table 3: Efficacy of citrus powder, citrus rind powder, sunflower leaf powder and sunflower oil on *C. maculatus* mortality rate after three weeks of treatment

Treatment	Extracts (g or mls /100g grain)		
	15	10	5
Citrus leaf powder	1.67[a]	1.33[a]	1.00[a]
Citrus rind powder	1.00[a]	1.00[a]	1.00[a]
Sunflower leaf powder	1.33[a]	1.33[a]	1.00[a]
Sunflower oil (mls)	1.67[b]	1.67[a]	1.33[a]
Control	0.00[c]	0.00[c]	0.00[c]
LSD	0.05	0.05	0.03

Means with the same letter (s) within a column are not significantly different at (P≤0.05)

Table 3: Efficacy of citrus powder, citrus rind powder, sunflower leaf powder and sunflower oil on *C. maculatus* mortality rate after four weeks of treatment

Treatment	Extracts (g or mls /100g grain)		
	15	10	5
Citrus leaf powder	1.33 [a]	1.33 [a]	0.67[ab]
Citrus rind powder	1.00[a]	1.00[a]	0.67[ab]
Sunflower leaf powder	1.00[a]	1.33 [a]	1.00[a]
Sunflower oil (mls)	1.33 [a]	1.33 [a]	1.00[a]
Control	0.00[b]	0.00[b]	0.00[b]
LSD	0.04	0.05	0.04

Means with the same letter (s) within a column are not significantly different at (P≤0.05)

Table 5: Efficacy of citrus powder, citrus rind powder, sunflower leaf powder and sunflower oil on *C. maculatus* mortality rate after five weeks of treatment

Treatment	Extracts (g or mls /100g grain)		
	15	10	5
Citrus leaf powder	1.33[a]	1.33[a]	1.00[a]
Citrus rind powder	0.67[ab]	1.00[a]	0.67[a]
Sunflower leaf powder	0.67[ab]	1.00[a]	1.00[a]
Sunflower oil (mls)	1.00[a]	1.00[a]	1.00[a]
Control	0.00[b]	0.00[b]	0.00[b]
LSD	0.05	0.04	0.03

Means with the same letter (s) within a column are not significantly different at (P≤0.05)

Table 6: Efficacy of citrus powder, citrus rind powder, sunflower leaf powder and sunflower oil on *C. maculatus* mortality rate after six weeks treatment

Treatment	Extracts (g or mls /100g grain)		
	15	10	5
Citrus leaf powder	1.33[a]	1.33[a]	1.00[a]
Citrus rind powder	1.00[a]	1.00[a]	1.00[a]
Sunflower leaf powder	1.33[a]	1.00[a]	1.67[a]
Sunflower oil (mls)	1.00[a]	1.33[a]	1.00[a]
Control	0.00[b]	0.00[b]	0.00[b]
LSD	0.04	0.04	0.03

Means with the same letter (s) within a column are not significantly different at (P≤0.05)

Table 7: Efficacy of citrus powder, citrus rind powder, sunflower leaf powder and sunflower oil on *C. maculatus* mortality rate after week seven of treatment

Treatment	**Extracts (g or mls /100g grain)**		
	15	**10**	**5**
Citrus leaf powder	1.00[a]	1.00[a]	0.00[b]
Citrus rind powder	1.00[a]	0.67[a]	1.00[a]
Sunflower leaf powder	1.00[a]	1.00[a]	0.33[b]
Sunflower oil (mls)	1.00[a]	1.00[a]	1.00[a]
Control	0.00[b]	0.00[b]	0.00[b]
LSD	0.02	0.03	0.03

Means with the same letter (s) within a column are not significantly different at (P≤0.05)

Table 8: Efficacy of citrus powder, citrus rind powder, sunflower leaf powder and sunflower oil on *C. maculatus* mortality rate after eight weeks of treatment

Treatment	**Extracts (g or mls /100g grain)**		
	15	**10**	**5**
Citrus leaf powder	1.00[a]	1.00[a]	0.00[b]
Citrus rind powder	1.00[a]	0.67[a]	1.00[a]
Sunflower leaf powder	1.00[a]	1.00[a]	0.33[b]
Sunflower oil (mls)	1.00[a]	1.00[a]	1.00[a]
Control	0.00[b]	0.00[b]	0.00[b]
LSD	0.02	0.03	0.03

Means with the same letter (s) within a column are not significantly different at (P≤0.05)

Table 9: Effect of four plant extracts on weight loss of cowpea grains caused by *C. maculatus* at the end of the experiment (initial weight 100g)

Treatment	**Extracts (g or mls /100g grain)**		
	15	**10**	**5**
Citrus leaf powder	93.33[ab]	88.67[a]	84.00[a]
Citrus rind powder	81.67[b]	73.67[b]	64.33[b]
Sunflower leaf powder	79.00[c]	63.00[c]	55.00[a]
Sunflower oil (mls)	91.67[a]	88.00[d]	81.00[a]
Control	60.00[d]	55.00[d]	48.67[d]
LSD	0.17	0.87	0.25

Means with the same letter (s) within a column are not significantly different at (P≤0.05)

Table10: Effect of four plant extracts on the grain damage of cowpea grains caused by *C. maculatus* in the laboratory (50 seeds)

	Extracts (g or mls /100g grain)		
Treatment	**15**	**10**	**5**
Citrus leaf powder	13.00[d]	13.33[c]	16.33[c]
Citrus rind powder	22.33[b]	22.33[b]	27.00[b]
Sunflower leaf powder	20.33[b]	21.67[b]	24.67[b]
Sunflower oil (mls)	16.33	13.67[c]	13.33[c]
Control	37.33[d]	37.33[a]	38.00[a]
LSD	0.40	1.05	0.85

Means with the same letter (s) within a column are not significantly different at (P≤0.05).

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