academicJournals

Vol. 13(3), pp. 121-128, 18 January, 2018
DOI: 10.5897/AJAR2017.12564
Article Number: F6C591855687
ISSN 1991-637X

http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Assessment of entomotoxic effects of powder and oil from leaves and seeds of *Hura crepitans* (L.) in the control of *Callosobruchus maculatus* (F.)

Adebayo R. A.[1]*, Onibon-oje O. O.[1] and Dauda Z.[2]

[1]Department of Crop, Soil and Pest Management, School of Agriculture and Agricultural Technology, Federal University of Technology, P. M. B. 704, Akure, Ondo State, Nigeria.
[2]Department of Crop Protection, Faculty of Agriculture, University of Maiduguri, Maiduguri, Borno State, Nigeria.

Received 29 June, 2017; Accepted 4 July, 2017

Entomotoxic effects of powder and oil from the leaves and seed of *Hura crepitans* (L.) on *Callosobruchus maculatus* (F.) was investigated at the Pest Management Laboratory in the Department of Crop, Soil and Pest Management, the Federal University of Technology Akure, Ondo State, Nigeria under prevailing laboratory conditions of 28±3°C temperature and 65 ± 5% relative humidity. The powders from the leaves and seeds of *H. crepitans* were applied singly at the rates of 1, 2 and 3 g per 20 seeds weighed into sterile Petri dishes and infested with 5 pairs of one day old *C. maculatus* adults in three replicates. The oils were applied at the rates of 1, 2.5 and 5 ml per 1 kg of seeds respectively in 3 L plastic containers by injecting the oils into 1 kg of seeds with a syringe and 20 seeds selected randomly from each container into Petri dishes in three replications including the controls. The oil-treated seeds were infested with 5 pairs of a day old adults of *C. maculatus*. Data were collected on number of dead *C. maculatus* adults, number of eggs laid, number of seeds with eggs, seeds without eggs, number of emerged aduls, number of seeds with holes, seeds without holes and weight loss after 12, 24 and 48 h of application of powders and oils. The results from the study showed that *H. crepitans* powders and oils caused mortality in adult *C. maculatus*. The mortality (80%) of adults *C. maculatus* at 48 h after application was significantly higher (P<0.05) in cowpea seeds treated with 2 g of seed powder. Application of *H. crepitans* significantly reduced (P<0.05) oviposition (4.58) at 2 g of the seed powder applied on cowpea seeds. The number of emerged adults (0.71) was significantly lower (P<0.05) on cowpea seeds treated with seed powder and seed oil at higher rates. Weight loss (0.08) was significantly lower in cowpea seeds treated with 2.5 and 5 ml of seed oil. Therefore, based on these results, *H. crepitans* could be explored as an alternative biopesticide to synthetic insecticide in the protection of stored cowpea against *C. maculatus* (F.).

Key words: *Hura crepitans, Callosobruchus maculatus,* entomotoxic, assessment.

INTRODUCTION

Food insecurity is a fundamental problem confronting developing countries of the world. Although, there are concerted efforts to boost food production in many countries, over 800 million people still suffer from malnutrition (FAO, 2005). Apart from inadequate food production, the problem of hunger and malnutrition is further aggravated by inability of developing countries to store harvested crops for a long period without losing a sizeable proportion of them to pests mainly micro-organisms and insects (Adedire and Lajide, 2001).

Cowpea (*Vigna unguiculata*) is a major staple food crop and essential source of protein in sub-Saharan Africa, especially in the dry savanna regions of West Africa where animal protein is rarely available. The seeds are a major source of plant proteins and vitamins for man, feed for animals, and also a source of cash income and the young leaves and immature pods are eaten as vegetables (Dugje, 2009). It is estimated that cowpea supplies about 40% of the daily protein requirements to most of the people in Nigeria (Odeyemi and Daramola, 2000). It has been suggested as a viable substitute for the costly fish, eggs and other animal proteins in the diet of children (Ileke et al., 2013). In Nigeria, cowpea is commonly consumed amongst others; in the form of bean pudding, bean cake, baked beans, fried beans and bean soup and in addition to dietary fiber, cowpeas contain many health-promoting components such as vitamins, minerals and phytochemicals, which include phenolic compounds (Cai, 2003). The consumption of leguminous plant such as cowpeas has been linked to reduced risk of free radical mediated diseases such as diabetes, obesity and coronary heart diseases (Bazzano, 2001).

In storage, the bruchid, *Callosobruchus maculatus* causes the major losses and they are field-to-store agricultural insect pests of Africa and Asia that presently range throughout the tropical and subtropical world (Beck and Blumer, 2011). *C. maculatus* causes substantial quantitative and qualitative loses by perforation, thus reducing the degree of usefulness and making the seeds unfit either for planting or for human consumption (Ali, 2004; Ofuya, 2003). In Nigeria, over 90% of the damage to cowpea seed storage attributed to bruchids is caused by C. *maculatus* alone (Caswell, 1981) while it has been estimated that 3% of the annual production in Nigeria in 1961/1962 was lost due to attack by *C. maculatus* (Tanzubil, 1991). Survey of cowpea in markets and village stores in West Africa indicate that 20 to 90% of seeds may be holed by storage beetles (Alebeek, 1996; Ogunkoya and Ofuya, 2001). There is therefore no doubt that serious depredation of cowpea seeds by *C. maculatus* can be a threat to food security as well as poverty alleviation in West Africa (Ofuya, 2003). Sub-Saharan Africa is therefore known to provide a favorable environment for this insect pest (Lephale, 2012). Protection of cowpea in the storage against *C. maculatus* had been through the use of synthetic chemicals. However, attempts to preserve the seeds through the use of these synthetic chemical insecticides sometimes result in poisoning of the cowpea plant and environment and with negative effects on non-target organisms including humans (FAO, 1992; Shetty, 1995). Most especially, the non-educated farmers in the sub-sharan Africa are poisoned when these chemicals are misused (Ofuya, 2003).

Currently, research efforts are being focused on the use of plant-derived biopesticides such as plant powders and oils, which are relatively cheaper and ecologically more tolerable than conventional chemical insecticides (Tamo, 2012). Most plant materials have repellant, anti-feedant and insecticidal properties which also interfere with normal activities of the pests preventing their multiplication and the plant materials are cheap, easily available and easy to use (Onu and Aliyu, 1995). Edible oils, which are produced in commercial quantities, are often used for this purpose. However, competitions for commercial edible plant oils which are obtainable from just about a dozen species of plants (Ihekoronye and Ngoddy, 1985) have necessitated the search for oils from underutilized tropical plants such as *Hura crepitans* L. (Sandbox) (Euphorbiaceae). *H. crepitans* is a widely occurring self-regenerating ornamental plant in the tropics (Keay et al., 1989). Results of determination of chemical composition of seeds of *H. crepitans* showed that the seed has high crude fat content and is very rich in magnesium (Muhammed et al., 2013).

Oleic acid is the most abundant fatty acid and contains more unsaturated fatty acids. Oil extracted from the dry seeds is used as a purgative. The juice of *H. crepitans* contains a volatile colorless liquid called "Hurin'' which some researchers claimed could be used for the treatment of elephantiasis and leprosy. Fagbemi and Adebowale (2000) had reported that sandbox seed contains 36.03% protein and 49.7% fat and that most of the fatty acids are essential fatty acids, which may possess some insecticidal properties. This study, therefore, examines the effects of *H. crepitans* leaves and seeds powder and oil in protecting stored cowpea seeds from infestation and damage by *C. maculatus.*

MATERIALS AND METHODS

Study area

The experiments were conducted in the pest management laboratory of the Department of Crop, Soil and Pest Management, the Federal University of Technology, Akure (FUTA) located in the southwestern part of Nigeria. Experiments were conducted under ambient laboratory conditions of 28 ± 3°C temperature and 65 ± 5% relative humidity.

Collection of materials

Adult insects used were obtained from infested cowpea seeds

*Corresponding author. E-mail: raphael.adebayo@yahoo.com or raadebayo@futa.edu.ng. Tel: 07038661128.

collected from Oja-oba in Akure, Nigeria, while the cowpea cultivar, Oloyin used for the experiment was obtained from a food store at the south gate of FUTA and kept in the freezer at a low temperature of 10°C in order to disinfest the seeds of any infesting insects.

Culturing of *C. maculatus*

After three days of freezing, the seeds were air dried and then infested with *C. maculatus* obtained from the infested cowpea seeds. The culturing was done in a container with perforated lid by weighing 200 g of clean uninfested cowpea seeds replicated three times and infesting each container with 50 pairs of adult *C. maculatus* in order to allow for oviposition to occur and to obtain fresh *C. maculatus.* The setup was left on the shelf for the emergence of fresh *C. maculatus* which were used for the experiments. The sexes of *C. maculatus* were determined by examining elytra pattern, female *C. maculatus* are usually maculated, dark colored and possessed four elytra spots, and in contrast males are plain, pale brown in color and less distinctly spotted.

Preparation of powders and extraction of oils from leaves and seeds of *H. crepitans* L.

The leaves and dried pods of *H. crepitans* were obtained from the front of the School of Agriculture and Agricultural Technology of the Federal University of Technology, Akure, Nigeria. The leaves were air dried for 2 weeks before being processed into fine powder with Philips blender, while the seeds were carefully removed from the pods and de-shelled. The creamy white cotyledons of sandbox seeds were sun-dried and pulverized in the blender into a fine powder.

The seeds and leaves oils were extracted in a Soxhlet apparatus using n-hexane as solvent. The resulting *H. crepitans* seeds and leaves oils were air-dried to allow for the escape of the solvent and then kept in a plastic container with tightly fitted lid and kept in a deep freezer. It was used within one month of preparation.

Setting up of the experiments

The powders from the leaves and seeds of *H. crepitans* were applied at the rate of 1, 2 and 3 g per 20 seeds. The seeds were weighed into Petridishes and infested with 5 pairs of a day old adult of *C. maculatus* in three replications. The oils from the leaves and seeds of *H. crepitans* were applied at the rate of 1, 2.5 and 5 ml per 1 kg of seeds respectively in 3 L plastic containers by injecting the oils into 1 kg of seeds with a syringe, mixed evenly and 20 seeds selected randomly from each container into Petri dishes and infested with 5 pairs of a day old *C. maculatus* in three replications. Control experiment was also setup (Oni, 2009).

Data collection

The number of dead adults of *C. maculatus* was taken after 12, 24 and 48 h of application of powders and oils. Data on the number of eggs laid was taken after 7 days of oviposition, number of seeds with eggs and seeds without eggs were also taken. The number of emerged adults, number of seeds with holes and seeds without holes was also recorded.

In calculating weight loss, the contents of each petri dish were sieved to remove dust, frass and any insect present within the seeds. The seeds were re-weighed and the weight loss was determined as the difference between the initial and final weights of seeds in each replicate.

Table 1. Mean percentage mortality of adults exposed to different treatments and rates after 12, 24 and 48 h of application.

Treatments	Rates	12 h	24 h	48 h
Control	0	6.67^{b}	10.00^{b}	26.67^{b}
	1 g	6.67^{b}	10.00^{b}	26.67^{b}
LP	2 g	6.67^{b}	13.33^{b}	30.67^{a}
	3 g	23.33^{a}	23.33^{a}	36.00^{a}
	1 g	13.33^{b}	13.33^{b}	36.67^{b}
SP	2 g	30.00^{a}	36.67^{ab}	53.33^{ab}
	3 g	33.33^{a}	53.33^{a}	80.00^{a}
	1 ml	0.00^{b}	6.67^{b}	16.67^{b}
LO	2.5 ml	10.00^{a}	23.33^{a}	30.00^{a}
	5 ml	10.00^{a}	20.00^{a}	43.33^{a}
	1 ml	0.00^{b}	3.33^{b}	20.00^{a}
SO	2.5 ml	3.33^{b}	20.00^{a}	30.00^{a}
	5 ml	16.67^{a}	20.00^{a}	30.00^{a}

Means followed by the same letter along the column were not significantly different at 5% using Tukey's Test. SO: Seeds oil; LO: leaves oil; SP: seeds powder; LP: leaves powder.

Data analysis

The experiment was laid out in a completely randomized design (CRD) with three replications. Analysis of variance (ANOVA) of the data was done using SPSS Statistical Package Version 15 (SPSS, 2015). Prior to analysis, all data in count were appropriately transformed employing square root transformation, while those in percentages transformed using Arcsine transformation. Where differences existed, means were separated using Tukey's test at 5% level of significance.

RESULTS

Effects of the treatments application on measured parameter

The results in Table 1 show the entomocidal effects of powders and oils at different rates of application on the adults of *C. maculatus*. The percentage mortality caused by the application of leaves powder was highest at the rate of 3 g after 12, 14 and 48 h of treatment application and showed significant differences at $P<0.05$ from the other rates. Cowpea seeds treated with 3 g of seed powder, however, caused the highest mortality of adults (80%) at 12, 24 and 48 h after application followed by 2 g of seed powder and was significantly different at $P<0.05$ from seeds treated at 1 g of seed powder. Adults mortality was highest with seeds treated with 2.5 and 5 ml of leaves oil and seeds oil which also showed significant difference at $P<0.05$ from that obtained when seeds were treated with 1 ml of leaves oil and seeds oil. The mortality was highest for the adult *C. maculatus* 48 h

Table 2. Mean number of eggs laid, seeds with eggs and seeds without eggs on cowpea seeds treated with powder and oil at different rates of application.

Treatments	Rate	Eggs laid	Seeds with eggs	Seeds without eggs
Control	0	12.33[a]	4.49[a]	0.88[a]
	1 g	12.37[a]	4.53[a]	0.71[a]
LP	2 g	10.46[a]	4.49[a]	0.88[a]
	3 g	11.69[a]	4.53[a]	0.71[a]
	1 g	10.18[a]	4.53[a]	0.71[a]
SP	2 g	4.58[b]	3.75[a]	2.56[a]
	3 g	5.66[b]	3.72[a]	2.32[a]
	1 ml	12.29[a]	4.49[a]	0.88[a]
LO	2.5 ml	14.28[a]	4.53[a]	0.71[a]
	5 ml	11.24[a]	4.29[a]	1.32[a]
	1 ml	8.97[a]	4.20[a]	1.44[a]
SO	2.5 ml	11.50[a]	4.53[a]	0.71[a]
	5 ml	11.43[a]	4.53[a]	0.71[a]

Means followed by the same letter along the column were not significantly different at 5% using Tukey's Test. SO: Seeds oil; LO: leaves oil; SP: seeds powder; LP: leaves powder.

Table 3. Mean number of emerged adult, seeds with holes, seeds without holes and weight loss on cowpea seeds treated with powder and oil at different rates of application.

Treatments	Rates	Emerged adults	Seed with holes	Seed without holes	Weight loss
Control	0	5.96[a]	4.01[a]	2.15[a]	0.85[a]
	1 g	6.78[a]	3.44[a]	2.59[a]	1.04[a]
LP	2 g	5.96[a]	3.94[a]	2.34[a]	0.66[a]
	3 g	6.54[a]	3.79[a]	2.49[a]	0.91[a]
	1 g	0.71[c]	0.71[b]	4.53[a]	0.22[a]
SP	2 g	0.71[c]	0.71[b]	4.53[a]	0.24[a]
	3 g	0.71[c]	0.71[b]	4.53[a]	0.11[a]
	1 ml	4.95[b]	4.00[a]	2.00[ab]	0.98[a]
LO	2.5 ml	7.21[a]	4.53[a]	0.71[b]	1.39[a]
	5 ml	2.58[b]	3.15[a]	3.11[a]	0.38[a]
	1 ml	0.71[c]	0.71[b]	4.53[a]	0.10[b]
SO	2.5	0.71[c]	0.71[b]	4.53[a]	0.08[b]
	5 ml	0.71[c]	0.71[b]	4.53[a]	0.11[b]

Means followed by the same letter along the column were not significantly different at 5% using Tukey's Test. SO: Seeds oil; LO: leaves oil; SP: seeds powder; LP: leaves powder.

after treatments application.

Table 2 shows the effects of powder and oil at different rates of application on measured parameters. The mean number of eggs laid (4.58) was least in the seeds treated at 2 g of seed powder followed by 3 g application of the same treatment. They are both significantly different ($P<0.05$) from the other treatments at various application rates. Although, highest number of eggs was laid (14.28) on seeds treated with 2.5 ml leaf oil, it was not different significantly ($P>0.05$) from that treated with 2.5 ml seeds oil. The values for the seeds with eggs and without eggs showed no significant difference for all the treatments and at various rates of application.

Table 3 shows the effects of powder and oil at different rates of application on adult emergence, seeds with holes, seeds without holes and weight loss parameters. Numbers of emerged adults (0.71) was significantly lower on cowpea seeds treated with seed powder and seed oil

Table 4. Mean number of eggs laid, seeds with eggs, seeds without eggs, emerged adults, seeds with holes, seeds without holes and weight loss on cowpea seeds treated with powder and oil.

Treatments	NEL	SWE	SWTE	EA	SWH	SWTH	WL
LP	11.71^{a}	4.51^{a}	0.79^{b}	6.31^{a}	3.80^{a}	2.39^{b}	0.86^{a}
SP	8.18^{b}	4.12^{b}	1.62^{a}	2.02^{c}	1.53^{b}	3.93^{a}	0.36^{b}
LO	12.54^{a}	4.45a^{b}	0.95^{b}	5.17^{b}	3.92^{a}	1.99^{b}	0.90^{a}
SO	11.05a^{b}	4.44a^{b}	0.93^{b}	2.02^{c}	1.53^{b}	3.93^{a}	0.29^{b}

Means followed by the same letter along the column were not significantly different at 5% using Tukey's Test. NEL: Number of eggs laid; SWE: seeds with eggs; SWTE: seeds without eggs; EA: emerged adults; SWH: seeds with holes; SWTH: seeds without holes; WL: weight loss.

at all rates. The cowpea seeds treated with 2.5 ml of leaf oil showed the highest mean value of emerged adults (7.21) and were significantly higher than the mean value from the seeds treated with 5 ml of leaf oil. Significantly, fewer adults emerged from the seeds treated with the seed powder and seed oil and were statistically different from the other treatments. The numbers of seeds with holes was significantly lower (P<0.05) in cowpea seeds treated with seed powder and seed oil at all rates. Cowpea seeds treated with 2.5 ml of leaf oil had the highest mean value of seeds with holes which was higher than those of seed powder and oil. The number of seeds without holes was significantly different at P<0.05 in cowpea seeds treated with leaf oil while other treatments showed no significant difference at P>0.05.

The weight loss (0.08) was significantly lower in cowpea seeds treated with 2.5 ml of seed oil and was significantly different at P<0.05 from that of control. The cowpea seeds treated with 2.5 ml leaf oil showed the highest mean value of weight loss (1.39). There was no significant difference at P>0.05 in cowpea seeds treated with leaf powder, seed powder and leaf oil for the weight loss.

The results in Table 4 show that the number of eggs laid (8.18) was significantly lower on cowpea seeds treated with seed powder and was significantly different at P<0.05 from other treatments. The highest numbers of eggs (12.54) were laid on seeds treated with leaf oil. Though was not significantly different (P>0.05) from those on seeds treated with leaf powder and seed oil. The least number of seeds with eggs (4.12) was observed on seeds treated with seed powder and was not significantly different (P>0.05) from other treatments except those treated with leaf powder. Highest value was obtained in seeds without eggs (1.62) for seed powder treated seeds which showed significant difference (P<0.05) among other treatments. Significant differences (P<0.05) existed in the number of emerged adults for all the treatments, with significantly higher value observed in seeds treated with leaf powder followed by those treated with leaf oil. Similar pattern of results were also observed in seeds with holes and seeds without holes. Significantly higher (P<0.05) weight losses were recorded on seeds treated with leaf powder and leaf oil and were different statistically from values obtained for seed powder and seed oil treated seeds.

Table 5 shows the effects of powder and oil at different rates of application on the measured parameters. The number of eggs laid (7.52) was significantly lower on cowpea seeds treated with 2 g of powder and was significantly different (P<0.05) from seed treated with 2.5 ml of oil. Although, highest number of eggs were laid (12.89) on seeds treated with 2.5 ml of oil there were no significant differences (P>0.05) in other rates of application. There were no significant differences (P>0.05) in the values observed in seeds with eggs and seed without eggs in all the treatments applied. The number of emerged adults (1.65) was lowest in cowpea seeds treated with 5 ml of oil, while the highest mean value for the emerged adults (5.96) was obtained on the control and were significantly different from each other. However, there were significant differences (P<0.05) in the values obtained for seeds with holes and seeds without holes. Highest number of seeds with holes (4.01) was recorded in the control while the least (1.93) was on the seeds treated with 5 ml of oil and were significantly different at P<0.05. The converse was observed for the seeds with holes. Although, there were no significant differences (P>0.05) observed in the weight loss at all rates of treatments application, highest weight loss (0.85) was recorded on the control while the least (0.24) was obtained from the seeds treated with oil at 5 ml application rate.

DISCUSSION

The findings from this study showed clearly that powder and oil from seed and leaf of *H. crepitans* possessed entomotoxic properties. Fagbemi and Adebowale (2000) had reported that sandbox seed contains 36.03% protein and 49.7% fat and that most of the fatty acids are essential fatty acids, which may possess some insecticidal properties. The effects of the oil on oviposition in this study could be due to blocking of spiracles thus causing respiratory impairment, which probably affected metabolism and consequently other systems of the body of the bruchids (Osisiogu and

Table 5. Mean number of eggs laid, seeds with eggs and seeds without eggs, emerged adults, seeds with holes, seeds without holes and weight loss on cowpea seeds treated at different rates of powder and oil application.

Rates	NEL	SWE	SWTE	EA	SWH	SWTH	WL
0 g	12.32[ab]	4.49[a]	0.88[a]	5.96[a]	4.01[a]	2.15[c]	0.85[a]
1 g	11.27[ab]	4.53[a]	0.71[a]	3.75[b]	2.07[b]	3.56[ab]	0.63[a]
2 g	7.52[b]	4.12[a]	1.72[a]	3.33[bc]	2.32[b]	3.43[ab]	0.45[a]
3 g	8.68[ab]	4.12[a]	1.52[a]	3.62[b]	2.25[b]	3.51[ab]	0.51[a]
1 ml	10.63[ab]	4.34[a]	1.01[a]	2.83[bc]	2.35[b]	3.26[abc]	0.54[a]
2.5 ml	12.89[a]	4.53[a]	0.71[a]	3.96[b]	2.61[b]	2.62[bc]	0.74[a]
5 ml	11.34[ab]	4.41[a]	1.01[a]	1.65[c]	1.93[b]	3.82[a]	0.24[a]

Means followed by the same letter along the column were not significantly different at 5% using Tukey's Test. NEL: Number of eggs laid; SWE: seeds with eggs; SWTE: seeds without eggs; EA: emerged adults; SWH: seeds with holes; SWTH: seeds without holes; WL: weight loss.

Agbakwuru, 1987; Onolemhemhem and Oigiangbe, 1991; Cockfield, 1992; Lale and Abdulrahaman, 1999; Ileke et al., 2013).

This present study also showed that *H. crepitans* significantly reduced oviposition as the rate of the seed powder applied on cowpea seeds increased. In a previous study, Idoko (2011) had reported a dose-dependent action of powder and oil of *Eugenia aromatica*. Apart from these findings, the few eggs laid were unable to stick to the cowpea seeds due to the obstruction effects of the seed powder which appeared like dust particles in the plates and on the seeds and the oil also rendered the cowpea seeds unacceptable to the bruchids as they showed oviposition preference for untreated cowpeas. Similar observation was reported by Adebayo and Ibikunle (2014). Oil-induced reduction or complete inhibition of oviposition of female bruchids and mortality of the developmental stages has been reported by a number of workers (Boughdad et al., 1987; Don Pedro, 1989; Lale and Abdulrahman, 1999). Numbers of emerged adults was significantly lower on cowpea seeds treated with seed powder and seed oil at all rates, because of adult mortality and reduced oviposition which consequently reduced adult's emergence at all rates applied. The reproductive potential of *C. maculatus,* which were exposed to *H. crepitans* seed powder and seed oil reduced significantly. Weight loss was significantly reduced in cowpea seeds treated with 2.5 and 5 ml of seed oil. This could be as a result of inability of the beetle to infest the seeds through egg laying or hatched larvae were unable to develop into adult in the seeds thereby prevented the holing of the protected seeds (Janzen, 1977).

Mortality at 48 h after application was significantly higher in cowpea seeds treated with 3 g of seed powder, the mortality effect of the oil on the beetles could be a result of the toxic components of the seed powder such as oleic acid and probably cyanolipids, which may be in the seeds, because *H. crepitans* is a member of the family Euphorbiaceae. The results obtained from this study also suggested that the entomotoxic effects of the parts studied increased with the rates of application and time of exposure. In a similar study, Adebayo (2015) reported an increase in the mortality of adult *C. maculatus* with increased rates of groundnut oil and as the time of exposure increased. The effectiveness of powders from the leaf and seed of *H. crepitans* could be due to hindrances to the movement of the adult insects which might cause reduced oviposition. This agreed with the observations of Adebayo and Ibikunle (2014) when worked on ash of rice husk and powdered clay as seed protectants against *C. maculatus*. The results on *H. crepitans* revealed that seed powder and seed oil have entomotoxic properties as an insecticide in stored products protection. This agreed with the analysis of *H. crepitans* seed oil carried out by Njoku et al. (1996), it was reported that *H. crepitans* seed contains about 50% fat and that it is very rich in fatty acids mainly as palmitic, stearic, oleic and linoleic acid. The observations from the study revealed the seed powder and oil to be more effective when compared with the leaves powder and oil. This could be as a result of the high concentrations of the active ingredients in the seeds. Idoko (2011) and Ileke et al. (2013) had reported similar results while working with oils of *Capsicum* spp. and *Alstonia boonei*

Conclusion

From the results of this study, it was discovered that the *H. crepitans* seed oil and seed powder were highly effective in causing adult mortality, reducing oviposition, adult emergence and reduced weight loss caused by *C. maculatus* while leaves oil and leaves powder were least effective. *Huran crepitans* possess toxic effects which could be used against stored product insects including storage bruchids. The extracts of *H. crepitans* could serve as alternatives to conventional synthetic insecticides for the control of stored pests due to their adverse effects such as ozone depletion, high mammalian toxicity, insect resistance and resurgence and other health hazards. The effectiveness of the parts used increased with the rates of application. The 3 g of powders and 5 ml of the oils were most effective in exerting entomocidal properties on the beetles.

RECOMMENDATIONS

Based on the results from the study, it is recommended that:

1. *H. crepitans* seed oil and seed powder should further be explored as an insecticide in the protection of cowpea against *C. maculatus*.
2. Research should be conducted to determine methods of increasing the effectiveness of the plant based insecticide through appropriate formulations.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Adebayo RA (2015). Food evaluation and response of C. *maculatus* to oils from seeds of groundnut and bitter kola. PhD Thesis, University of Ilorin, Kwara State P 145.

Adebayo RA, Ibikunle O (2014). Potentials of rice husk ash, cowdung ash and powdered clay as grain protectants against *Callosobruchus maculatus* (F) and *Sitophilus zeamais* (Mots). J. Appl. Trop. Agric. 19(2):48-53

Adedire CO, Lajide L (2001). Efficacy of powders of some tropical plants in the control of the pulse bettle, *Callosobruchus maculatus* (F). J. Appl. Trop. Agric. 6:11-15.

Alebeek FAN (1996). Natural suppression of Bruchid pest in stored cowpea *Vigna unguiculata* (L) Walp in West Africa. Intl. J. Pest Manage. 42:55-60.

Ali SM (2004). Infestation potential of *Callosobrunchus chinensis* and *C. maculatus* on certain broad bean seed varieties. Egypt. J. Agric. Res. 82:1127-1135.

Bazzano LA (2001). Legume consumption and risk of coronary heart disease in US men and women. Arch. Int. Med. 161(21):2573-2578.

Beck CW, Blumer LS (2011). A Handbook on Bean Beetle, *Callosobruchus maculatus*. Natl. Sci. Found. pp.1-10.

Boughdad A, Gillon Y, Gagnepain C (1987). Effect of *Arachis hypogea* seeds fats on larval development of *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae). J. Stored Prod. Res. 23:99-103.

Cai YZ (2003). High-performance liquid chromatography determination of phenolic constituents in 17 varieties of cowpeas. J. Agric. Food Chem. 51(6):1623-1627.

Caswell GH (1981). Damage to the stored cowpea in Northern part of Nigeria. Samaru J. Agric. Res. 1:1119.

Cockfield SD (1992). Groundnut oil application and varietal resistance for control of *Callosobruchus maculatus* (F.) in cowpea grain in The Gambia. Trop. Pest. Manage. 38:268-270.

Don-Pedro KN (1989). Effect of fixed vegetable oils on oviposition and adult mortality of *Callosobruchus maculatus* (F.) on cowpea. Intl. Pest Contr. 31(2):34-37.

Dugje IY (2009). Farmers' Guide to Cowpea Production in West Africa. IITA, Ibadan, Nigeria P 20.

Fagbemi TN, Adebowale KA (2000). Food potential of *Hura crepitans.* In: Nkama, I., V. A. Jideani, J. A. Ayo (eds.): Proceedings of the 24th Annual Conference of Nigerian Institute of Food Science and Technology (NIFST), Bauchi, Nigeria P 147.

Food and Agricultural organization (FAO) (1992). Pesticide Residues in Food. Report number 116: Rome.

Food and Agricultural organization (FAO) 2005. Pesticide Residues in Food and Agriculture Organization of the United Nations, World Health Organization. FAO Plant Production and Protection. Paper182/1.

Idoko JE (2011). Tolerance of *Callosobruchus maculatus* (Fabricius) to powders and essential oils of Piper guineense (Schum and Thonn) and *Eugenia aromatica* (Baill.) PhD Thesis. Federal University of Technology Akure, Ondo State, Nigeria P153.

Ihekoronye AJ, Ngoddy PO (1985). Integrated food science and technology for the tropics. Macmillan Publishers Ed., London and Basingstoke.

Ileke KD, Odeyemi OO, Ashamo MO (2013). Response of Cowpea Bruchid, *Callosobruchus maculatus* (Fabr.) [Coleoptera: Chrysomelidae] to Cheese Wood, Alstonia boonei De Wild Stem Bark oil extracted with different solvents. Arch. Phyto. Plant Prot. 46(11):1357-1370.

Janzen DH (1977). How southern cowpea weevil larvae (Bruchidae *Callosobruchus maculatus*) die on non-host seeds. Ecology 8:921-927.

Keay RWJ, Onochie CFA, Stanfield DP (1989). Nigeria trees, Revised Version pp. 174-175.

Lale NES, Abdulrahman HT (1999). Evaluation of neem (*Azadirachta indica* A. Juss) seed oil obtained by different methods and neem powder for the management of *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) in the cowpea. J. Stored Prod. Res. 35:135-143.

Lephale S (2012). Susceptibility of seven cowpea cultivars (*Vigna unguiculata*) to cowpea beetle (*Callosobruchus maculatus*). Agric. Sci. Res. J. 2:65-69.

Muhammed NA, Isiaka AA, Adeniyi OA (2013). Chemical Composition of *Hura Crepitans* Seeds and Antimicrobial Activities of its Oil. Int. J. Sci. Res. 2(3):2319-7064.

Njoku OU, Ononogbu IC, Nwaneri VO, Ugwuanyi JO (1996). Lipase activity in *Hura crepitans* seed endosperm during germination. Niger. J. Bot. 92:1-26.

Odeyemi OO, Daramola AM (2000). Storage practices in the tropics: Food storage and pest problems. First Edition, Dave Collins Publication, Nigeria 1:235.

Ofuya TI (2001). Biology, Ecology and Control of Insect Pests of stored Legumes in Nigeria. In: Pests of Stored cereals and Pulses in Nigeria: Biology, Ecology and Control (Eds) T. I. Ofuya and N. E. S. Lale, Dave Collins Publication, Nigeria pp. 24-58.

Ofuya TI (2003). Beans, insects and man. Inaugural lecture series 35, the Federal University of Technology, Akure, Nigeria P. 45.

Ogunkoya AMO, Ofuya TI (2001). Damage to cowpea by *C. maculatus* (F.) in a humid tropical environment in Nigeria. J. Appl. Trop. Agric. 6(1):45-50.

Oni MO (2009). Insecticidal activity of extracts from fruits of three local cultivars of pepper *(Capsicum species)* on cowpea seed beetle, *Callosobruchus maculatus* (Fabricius) and maize weevil *(Sitophilus zeamais* Motschulsky. P.hD Thesis. The Federal University of Technology Akure P. 105.

Onolemhemhem OP, Oigiangbe ON (1991). The biololgy of *Callosobruchus maculatus* (F.) on cowpea *(Vigna unguiculata)* and Pigeon pea (*Cajanus cajan* L. druce) treated with vegetable oil and Thioral. Samaru J. Agric. Res. 8:57-63.

Onu I, Aliyu M (1995). Evaluation of powdered fruits of four peppers (*Capsicum* spp.) for the control of *Callosobruchus maculatus* (F) on stored cowpea seed. Intl. J. Pest Manage. 41(3):143-145.

Osisiogu IUW, Agbakwuru EOP (1987). *Dennettia* oil-a new seed preservative. Niger. J. Sci. 2:477-485.

Shetty NJ (1995). Insecticide susceptibility studies in thirty strains of *Anopheles stephensi* Liston a malaria vector to alphamethrin, bifenthrin (synthetic pyrethroids) and neem (a botanical insecticide). Pest 30(10):21-28.

Statistical Package for Social Sciences (SPSS) (2015). Inc. Statistical Package for Social Sciences. SPSS, Inc., Chicago, IL.

Tanzubil PB (1991). Control of some insect pests of cowpea (*Vigna*

unguiculata) with neem (*Azadirachta indica* A. Juss) in Northern Ghana. Intl. J. Pest Manage. 37(3):216-217.
Tamo M (2012). Farmers in Africa should switch to biopesticides. Sci. Innov. Policy pp. 1-3.
Wasserman SS, Futuyma DJ (1981). Evolution of host plant utilization in laboratory populations of the southern cowpea weevil, *Callosobruchus maculatus* Fabricius (Coleoptera: Bruchidae). Evolution 35:605-617.