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EVALUATION OF LATEX, WOOD ASH AND LEAF POWDER OF Jatropha Curcas AND Jatropha Gossypyfolia AS PROTECTANTS OF STORED COWPEA AGAINST Callosobruchus Maculatus

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ABSTRACT

Jatropha carcus and *Jatropha gossypyfolia* powder, wood ash and latex were assayed for their insecticidal potential against cowpea bruchid, *Callosobruchus maculatus* in the laboratory at ambient temperature and humidity. The plants wood ash, powder and latex were tested at rate 2 g/20 g of cowpea seeds. Adult mortality and fecundity of the insect were further investigated. Result showed that wood ash of *J. carcus* caused 100 % mortality of adult cowpea bruchid after 4 days of application, followed by powder of *J. carcus* which caused 92.5 % mortality while powder of *J. gossypifolia* was the least effective that caused 90 % mortality of adult bruchids. Progeny development was hindered in seeds treated with wood ash and latex of both *J. carcus* and *J. gossypifolia* compared with untreated that had 81.1 % adult emergence. The result obtained from this study revealed that *J. carcus* and *J. gossypifolia* wood ash and latex were effective in controlling *C. maculatus* and could serve as an alternative to synthetic insecticides for the protection of stored cowpea bruchid.

Keywords: *Jatropha carcus*, *Jatropha gossypifolia*, *Callosobruchus maculatus*, Toxicity

INTRODUCTION

Cowpea, *Vigna unguiculata* is an important food crop in tropical countries especially in West Africa where it is a cheap source of dietary protein (Adedire, 2002). The dry seed consists of about 25% protein and 67% carbohydrate. It is also a good source of calcium, iron, vitamins and carotene. Initial infestation of cowpea seeds occurs in the field just before harvest and the insects are carried into the store where population builds up rapidly (Adedire, 2002). Some people relish vegetable dishes of young cowpea leaves, immature pods, or immature seeds (Alabi *et al*., 2006). *Callosobruchus maculatus* has become a major storage insect pest of the seeds. The cowpea bruchid is a cosmopolitan insect, with its initial infestation starting in the field just before harvest and the insects are carried into the store where the population increases rapidly (Ofuya, 2001; Ileke *et al*., 2012). The magnitude of infestation between *C. maculatus* and human beings for this important crop necessitates its control to avoid food shortage and promote self-sufficiency. The general use of insecticides to protect stored grains has been enhanced by the public suspicion of any chemical of a persistent nature, whether or not evidence is available of any adverse effects (Adedire, 2002). Effective control of stored products insects' pest has long been the aim of entomologists throughout the world (Ileke *et al*, 2013). Synthetic insecticides have been used for many years to control stored product insect pests (Ileke *et al*, 2013). Developing of resistance of insect pest to these conventional storage insecticides increased concern by customers over insecticide residues, ecological consequences and increasing cost of application calls for new approaches to control stored products insect pest that are readily available, affordable and less detrimental to the environment (Adedire and Lajide, 2013: Ileke and Oni, 2011: Ileke and Bulus,
2012). The objectives of this research are to investigate the insecticidal potential of *Jatropha curcas* and *Jatropha gossypyfolia* wood ash and leaf against cowpea bruchid, *C. maculatus*, and also the comparative effectiveness of *Jatropha curcas* and *Jatropha gossypyfolia* wood ash and leaf as contact and fumigant entomocide in the management of *C. maculatus*.

MATERIALS AND METHODS Collection

of Cowpea Seeds

Cowpea seeds used for this study were obtained from a newly stocked seeds free of insecticides at Agricultural Development Program (ADP), Akure, Ondo State, Nigeria. Firstly, the seeds were cleaned and disinfested by keeping at -5 ºC for 7 days to kill all hidden infestations. This is because all the life stages, particularly the eggs are very sensitive to cold (Koehler, 2003). The disinfested cowpea seeds were then placed inside a Gallenkamp oven (model 250) at 40 ºC for 4 h (Jambere *et al*., 1995) and later air dried in the laboratory to prevent mouldiness (Adedire *et al*.,
2011) before they were stored in plastic containers with tight lids.

Insect culture

The insects used to establish a laboratory colony of *C. maculatus* came from a batch of infested cowpea seeds, *Vigna unguiculata* Walp variety Ife brown purchased from iwaro-oka market, Akungba Akoko, Ondo State, Nigeria.

Beetles were reared subsequently by replacement of devoured and infested cowpea seeds with fresh un-infested cowpea seeds in 2-L kilner jars covered with muslin cloth to allow air circulation. Insect rearing and the experiments were carried out at ambient temperature of 28+2 °C and 75+5 % relative humidity.

Identification and sexing of adult *Callosobruchus maculatus*

The identification and sexing of *C. maculatus* were carried out in the Research Laboratory, Department of Environmental Biology and Fisheries, Adekunle Ajasin University, Akungba Akoko, Ondo State using Binocular Microscope based on observations of Halstead (1998), Appert (1997), Odeyemi and Daramola (2000). Male have comparative shorter abdomen and the dorsal side of the terminal segment is sharply curved downward and inward. In contrast the females

have comparatively longer abdomen and the dorsal side of the terminal segment is only slightly bent downward. The female also has two dark visible spots on their elytra (Odeyemi and Daramola, 2000).

Plant collection

The plants evaluated in this work were *Jatropha curcas* and *Jatropha gossypyfolia* wood ash and leaf. They leaf were harvested fresh while the wood were harvested fresh from Supare and Akungba town, Ondo State, Nigeria and authenticated by the taxonomist in Plant Science and Technology Department of Adekunle Ajasin University, Akungba Akoko, Ondo State. These plant parts were rinsed in clean water to remove sand and other impurities, cut into smaller pieces before air dried in a well ventilated laboratory and ground into very fine powder using an electric blender. The powders were further sieved to pass through 1 mm^2 perforations. The powders were packed in plastic containers with tight lids and stored in a refrigerator at 4 °C prior to use. The plant were also burnt into ashes by placing them in a stainless steel plate and placed on a camp gas. The fine powders and ashes were packed in plastic containers with tight lids and stored in a refrigerator at 4 °C prior to use.

Collection of Plants latex

The stem of *Jatropha curcas* and *Jatropha gossypyfolia* each was cut with knife to allow the plant latex to come out into a container. Ten (10 ml) of each of the plant latex were collected in separate beaker and corked tightly to prevent evaporation and solidification. They were then labeled and kept in refrigerator to keep then fresh.

Effect of contact toxicity of *Jatropha* leaf powders and wood ash on adult mortality, oviposition and progeny development of *Callosobruchus maculatus*

Fine powders of *Jatropha curcas* and *Jatropha gossypyfolia* wood ash and leaf were admixed with cowpea seeds at the rate 2 g / 20 g of cowpea seeds in 250 ml plastic containers. The seeds in the controls contained no plant powders. The containers with their contents were mixed with the aid of glass rod to ensure uniform loading of the plant material with the cowpea seeds. Ten pairs of 2 – 3 days old adult *C. maculatus* were introduced to each of the containers and covered. Four replicates of the treated and untreated controls were laid out in Complete Randomized Design. The adult mortality was assessed after every 24 h for 96 h. Adults were considered dead when probed with sharp objects and there were no responses. At the end of day 4, all insects, both dead and alive, were removed from each container and oviposition were counted and recorded before returning the seeds to their respective containers.

Percentage adult mortality were corrected using Abbott (1925) formular thus:

$$P_T = \frac{P_o - P_c}{100 - P_c} \times \frac{100}{1}$$

Where P_T = corrected mortality (%) P_o

= observed mortality (%)

P_C = control mortality (%)

The experimental set up was kept inside the insect rearing cage for further 30 days for the emergence of the first filial (F_1) generation. The containers were sieved out and newly emerged adult cowpea bruchid were counted and recorded. The percentage adult emergence was calculated using the method of Odeyemi and Daramola (2000).

$$\%\ \text{Adult emergence} = \frac{\text{Total number of adult emergence}}{\text{Total number of eggs laid}} \times \frac{100}{1}$$

Percentage weight loss of the cowpea seeds was determined by re-weighing after 35 days and the % loss in weight was determined as follows:

$$\%\ \text{Weight loss} = \frac{\text{Change in weight}}{\text{Initial weight}} \times \frac{100}{1}$$

After re-weighing, the numbers of damaged cowpea seeds were evaluated by counting wholesome seeds and seeds with bruchid emergent holes. Percentage seed damaged was calculated as follows:

$$\%\ \text{Seed damage} = \frac{\text{Number of seeds damaged}}{\text{Total number of seeds}} \times \frac{100}{1}$$

Beetle Perforation Index (BPI) used by Fatope *et al.* (1995) was adopted for the analysis of damage. Beetle perforation index (BPI) was define as follows:

perforated 100

% control cowpea seeds perforated ^ 1

BPI value exceeding 50 was regarded as enhancement of infestation by the weevil or negative protectability of the extract tested.

Bioassay for *Jatropha* latex

2 ml of *Jatropha curcas* and *Jatropha gossypyfolia* latex was mixed separately with 20 g of un- infested cowpea seeds in 250 ml plastic containers. The latex and seeds were thoroughly mixed using a glass rod and then agitated for 5-10 min to ensure uniform coating (Ileke *et al.,* 2014a). Control experiment was also set up without latex. Ten pairs of 2 – 3 days old adults *C. maculatus* were introduced to each of the containers and covered. Four replicates of the treated and untreated controls were laid out in Complete Randomized Design. The adult mortality was assessed after every 24 hours for 96 hours. Adults were considered dead when probed with sharp objects and there were no responses. At the end of day 4, all insects, both dead and alive, were removed from each container and ovipositions were counted and recorded before returning the seeds to their respective containers. Percentage adult mortality were corrected using Abbott (1925) formular as described above.

Statistical Analysis

Data were subjected to analysis of variance (ANOVA) and treatment means were separated using the new Duncan's multiple Range Test. The ANOVA was performed with SPSS 16.0 software (SPSS, inc. 2007).

RESULTS

Toxicity of plant wood ash and powder to *C. maculatus*

The effectiveness of the various plants powders and ached on the survival of cowpea bruchid, *C. maculatus* at rate 2 g/20 g of cowpea seeds is presented in Table 1. The results revealed that in each treatment, the mortality of *C. maculatus* increased gradually with time of exposure. *J. carcus* wood ash evoked 100% mortality of *C. maculatus* at rate 2 g/20 g of cowpea seeds within 4 days of exposure (Table 1). The corresponding value for *J. carcus* powder, *J. gossypyfolia* wood ash and powder were 92.5 %, 97.5 % and 90 % mortality of adult cowpea bruchid respectively at rate
2 g/20 g of cowpea seeds.

Table1: Percentage mortality of adult *C. maculatus* treated with plants ashes powder at rate 2 g/20 g of cowpea seed.

Plant ached and powders	(Mortality ± SEM) % on Days			
	1	2	3	4
J. carcus (WA)	40.00 ±4.08	52.50 ±7.50	92.50 ±7.50	100.00 ±0.00
J. carcus (P)	35.00 ±2.89	45.00 ±2.89	85.00 ±2.89	92.50±7.50
J. gossypyfolia (WA)	37.50 ±2.50	45.00 ±2.89	87.50±2.50	97.50±2.50
J. gossypyfolia (P)	30.00 ±4.08	42.50 ±7.50	80.00 ±4.08	90.00 ±4.08

Control	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00

Each value is a mean ±standard error of four replicates. Means within the same column followed by the same letter (s) are not significantly different at (P > 0.05) using New Duncan's multiple range tests.

Key: WA – Wood Ached, P – Powder.

Effectiveness of Plant Latex as Insecticide

The effectiveness of *J. carcus* and *J. gossypyfolia* latex on the survival of cowpea bruchid, *C .maculatus* after 4 days of post treatment is presented in Table 2. The results revealed that in each treatment, the mortality of cowpea bruchid increased gradually with increase in exposure period. *Jatropha curcas* latex caused 100 % mortality of *C. maculatus* at rate 2 ml/20 g of cowpea seeds after 4 days of post treatment. The corresponding values for *J. gossypyfolia were* 92 % mortality of adult cowpea bruchid respectively.

Table 2: Percentage mortality of adult *C.* maculatus treated with plant latex at rate 2 ml/20 g of cowpea seeds.

Plant latex	(Mortality ± SEM) on Days			
	1	2	3	4
J. curcas	40.00 ±4.08	60.00 ±4.08	87.50 ±2.50	100.00 ±0.00
J. gossypyfolia	35.00 ±2.50	50.00 ±5.79	80.000±4.08	92.50±7.50
Control	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00

Each value is a mean ±standard error of four replicates. Means within the same column followed by the same letter (s) are not significantly different at (P > 0.05) using New Duncan's multiple range tests.

Effect of various plant powders, ached and latex applied as contact insecticides on oviposition and adult emergence of *C. maculatus*

Table 3, presented the oviposition and percentage adult emergence of *C. maculatus* after being exposed to various plant powders, ached and latex as contact insecticide at rate 2 g/20 g of cowpea seeds after 4 days infestation. Progeny development was significantly suppressed by various plant powders, ached and latex with *J. carcus* and *J. gossypyfolia* wood ached and latex completely inhibited the emergence of *C. maculatus* (100 % efficiency).

Table 3: Oviposition and adult emergences of *C. maculatus* treated with plant latex, ashes and powder.

Plants	Oviposition	% adult emergence
J. curcas (WA)	9.50 ± 1.23	0.00 ± 0.00
J.curcas (L)	10.75 ± 0.85	0.00 ± 0.00
J. curcas (P)	12.25± 1.70	16.33 ± 2.14
J. gossypyfolia (WA)	10.25 ± 1.70	0.00 ± 0.00
J. gossypyfolia (L)	12.00± 0.91	0.00 ± 0.00
J. gossypyfolia (P)	15.00±0.91	20.00± 4.08
Control	83.75± 2.81	81.93± 4.13

Each value is a mean ±standard error of four replicates. Means within the same column followed by the same letter (s) are not significantly different at (P > 0.05) using New Duncan's multiple range tests.

Key: WA – Wood Ached, P – Powder, L - Latex

DISCUSSION

Results reported in this study show that *Jatropha carcus* and *J. gossypyfolia* wood ached, powders and latex have insecticidal effects on cowpea bruchid, *C. maculatus*. The two *Jatropha* species wood ached and latex applied as contact insecticides were very effective against *C. maculatus* causing high mortality of adult *C. maculatus* at rate 2 g/20 g of cowpea seeds within 4 days of application. They also reduced oviposition and completely inhibited adult emergence. This shows that *Jatropha* species probably have oviposition deterrent, ovicidal and lavicidal properties. *Jatropha* has shown insecticidal and anti-feedant efficiency against a wide range of insect pests. These effects may be comparable with synthetic insecticides. *Jatropha* have been reported to control maize weevil, *Sitophilus zeamais* (Ohazurike *et al.*, 2003), *Podagrica* spp. On okra (Emosairue and Uguru, 1999), *Spodoptera litura* (Phowichit, *et al.,* 2008), anti-oviposition and ovicidal effects on *C. maculatus* in cowpea (Adebowale and Adedire, 2006). The *Jatropha* oil also caused oviposition deterrence and inhibits hatching of eggs in potato tuber moth, *Phthorimaea operculella* (Shelke *et al.*, 1987). *Jatropha* oil when mixed with artificial diet inhibited growth of tobacco hornworm, *Manduca sexta* larvae (Sauerwein *et al.*, 1993). These results are in agreement with the report of Ogunleye *et.al* (2010). According to their findings, the effects of *Jatropha* oil on *Sitophilus zeamais* when applied at rate of 0.1ml and 0.2 ml doses, after 12 h of application produced mortality ranged from 50 % - 100 % and 60 %-100 %

respectively and cause 70 % mortality for the application doses of 0.3ml and 0.4ml after 12 h and reached 100% after 24 h. The plants also prevented oviposition and adult emergence of bruchid. The effect of the plant ached, powder and latex on oviposition could be due to respiratory impairment which probably affects the process of metabolism and consequently other systems of the body of the bruchid (Osisiogu and Agbakwuru, 1978; Onolemhemhem and Oigiangbe, 1991; Adedire *et al*., 2011). The inability of the eggs to stick to the cowpea seed due to the presence of the ached, powder and latex also reduced adult emergence arising from egg mortality (Adedire *et al*., 2011). It has been reported that one of the main mechanisms of action of plant extracts is their ability to penetrate the chorion of bruchid eggs via the micropyle and cause the death of developing embryos through asphyxiation (Don-Pedro 1996a, 1996b). The protectant ability of the extracts was highly remarkable. It is evident from this study that all the extracts tested have the potential of being used as biopesticides.

CONCLUSION AND RECOMMENDATION

This study has revealed the insecticidal potential of *Jatropha curcas* and *Jatropha gossypyfolia* as protectants of stored cowpea against *Callosobruchus maculatus* and could serve as alternative to synthetic insecticides for the protection of stored cowpea seeds against cowpea bruchid, *C. maculatus*. These plants are medicinal, readily available, safe, eco-friendly, biodegradable and have not been reported to be toxic to man.

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