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COMPARATIVE STUDY OF THE TOXIC EFFECTS OF *JATROPHA CURCAS* L. EXTRACTS AND ACTELLIC 25 E.C® ON *CALLOSOBRUCHUS MACULATUS* (FABRICIUS) (COLEOPTERA: CHRYSOMELIDAE: BRUCHINAE) IN STORED COWPEA

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ABSTRACT

Laboratory experiments were conducted at the Federal University of Technology, Owerri, southeastern Nigeria to evaluate the efficacy of the seed and root extracts of *Jatropha curcas* L. with a known synthetic insecticide and its residual toxicity in controlling *Callosobruchus. maculatus* (F.) on stored cowpea seeds. The experiments were laid out in a Completely Randomized Design. The treatment materials consisted of root and seed extracts of *J. curcas* tested at 0.00, 1.00, 2.00 and 3.00 ml/ 100 g seed and solution of Actellic 25 .E.C® (Pirimiphos-methyl) which were applied at 0.00, 0.20, 0.30 and 0.40 ml/ 100 g seed. *Jatropha curcas* seed oil and Actellic caused mortality of adult *C. maculatus*, suppressed oviposition and inhibited adult emergence. Actellic at the lowest concentration (0.20 ml/ 100 g seed) caused 66.67 % mortality of adult *C. maculatus* in the first 48 h of exposure and reduced ovipostion by 70.00 %. *Jatropha curcas* seed oil at the highest concentration (3.00 ml/ 100 g seed) caused 60.00 % mortality of the bruchid in 48 h of exposure period, reduced oviposition by 56.67 % and decreased seed damage by 76.67 %, when compared with the untreated control which recorded 96.67 % oviposition and seed damage by the bruchid, respectively. Actellic treated seeds had the best protection with weevil protection index (WPI) of between 0.00 – 6.67 %, followed by the seed oil, (16.67 to 33.33 %). These results differed significantly ($P<0.05$) from the root extract which gave the lowest (46.67 – 53.33 %) protection index. The root extract performed poorly and could not compare effectively with either the seed extract or synthetic chemical. The residual test results were not statistically different from the first trial ($P=0.05$). *J. curcas* at high concentration (2.00 and 3.00 ml/ 100 g seed) compared most favourably with the lowest concentration of Actellic 25 .E.C®. The treatment materials had no significant effect on the germination of stored cowpea seeds. *J. curcas* seed extract gave significant protection to stored cowpea seeds against *C. maculatus* and could serve as alternative to synthetics in the management of cowpea bruchids.

Keywords: Mortality, Oviposition, Emergence, Weevil Perforation Index, Germination

INTRODUCTION

Cowpea, *Vigna unguiculata* (L.) Walp, has been reported to be a protein staple food crop in many developing countries, including sub-Saharan Africa (Bressani, 1985), where it is used not only as human food but also as livestock feed. It serves as source of income to poor farmers in most parts of the continent (Oparaeke and Dike, 1996). Cowpea also plays an important role in providing soil nitrogen to cereal crops (maize, millet, and sorghum) when grown in rotation (Dugje *et al*., 2009).

The Bean beetle, *Callosobruchus maculatus* (Fabricius, 1775) (Coleoptera: Chrysomelidae: Bruchinae) is an agricultural insect pest of Africa and Asia that presently range throughout the tropical and subtropical world (Beck and Blumer, 2014). The bruchid is the economic insect pest of stored cowpea seeds in Nigeria (Ojiako and Adesiyun, 2008a) and is termed 'field -to-store' because the pest's infestation often begins in the field as the mature pods dry (Huignard *et al*., 1985). When the infested seeds are harvested and stored, the pest population increases rapidly resulting in total destruction within a short duration of 3-4 months (Rahman and Talukder, 2006).
In West Africa, market surveys in northern Ghana has recorded 15 to 94 % cowpea seed damage and 65 % weight loss, each year, due to infestation by *C. maculatus* (Golob *et al*., 1988).

Several methods and measures have been adopted to curb the problems of this insect pest infestation. These include the use of chemical insecticides such as DDT and lindane (Srivastava 1998) and more recently, dichlorvos, pirimiphos-methyl, permethrin, deltamethrin and fumigants like phosphine tablets (Ojiako and Adesiyun, 2008a). These measures, however, are becoming more and more expensive and less available at the peasant farmers' level. Though, synthetic insecticides have proven very effective in controlling these beetles, the problems associated with its usage such as insect resistance, pest resurgence, health hazards, residual toxicity, increasing costs of application and widespread environmental hazards have directed the need for effective, biodegradable pesticides (Talukder and Howse, 2000; Elhag, 2000).
Plant extracts have been reported to possess insecticidal properties against a wide range of insect pests (Lale, 1992). For instance, petroleum ether extract of *Azadirachta indica* A. Juss. (Saxena and Saxena, 2000), *Jatropha curcas* Linnaeus seed oil and seed powder (Adebowale and Adedire, 2006; Ahuchaogu *et al*., 2014, Ojiako *et al*., 2014), powdered leaves and extracts of *Vitex negundo* Linnaeus (Rahman and Talukder, 2006), plant lectins derived from *Cicer arietinum* Linnaeus (Sadeghi *et al*., 2006), powder of *Terminalia chebula* Retzius and *Cassia auriculata* Linnaeus (Govindan and Jeyarajan- Nelson, 2008), plants extracts of *Aloe vera* Burm.f., *Cannabis sativa* Linnaeus and *Trema orientalis* (L.) Blume (Jibrin *et al*., 2013) essential oils isolated from *Zingiber officinale* Linnaeus and *Mentha pulegium* Linnaeus (Loni and Panahi, 2015), essential oils of *Lippia multiflora* Moldenke, *Hyptis spicigera* Lam. and *Ocimum americanum* Linnaeus (Ilboudo *et al*., 2015), plant powders of *Cymbopogon citratus* (DC.) Stapf, *Alstonia boonei* De Wild. , *Hyptis suaveolens* (L.) Poit. , *Loranthus braunii* Engl. and *Lycopersicon esculentum* Mill. (Azeez and Pitan, 2015), etc. have been reported to have significant oviposition deterrence and diverse biological activity against *C. maculatus* and other field pests.

Among the many Jatropha species, *Jatropha curcas* Linnaeus. is the most studied as the seed is rich in oil and protein (Makkar and Becker, 1997). The plant, dubbed the 'diesel plant' has been used in traditional human and veterinary medicine for a long time (Duke, 1985). Oliver-Bever (1986) has reported the use of the plant's root powder as an aphrodisiac and in curing asthma and rheumatism when mixed with milk. The bark, roots and leaves are acidic and pungent and are taken to promote digestion. They are also used as a molluscicide and rodenticide (Devappa *et al*., 2011).
The seed and root parts of *J. Curcas* have been variously reported (Chomnong, 1990; Ohazurike *et al*., 2003; Agu *et al*., 2013; Ahuchaogu *et al*., 2014; Ojiako *et al*, 2014) to have cytotoxic, insecticidal and nematicidal activities on stored seeds and field crops. Various parts of the plant have also been reported to be used in soap making, as bio-diesel, as activated charcoal, as chewing-stick, in making ceiling boards, floor tiles as well as in dye and pigments production (Belewu, 2008).
This study aimed at evaluating the comparative efficacy of the seed and root extracts of *J. curcas* with a known synthetic insecticide and its residual toxicity in controlling *C. maculatus* on stored cowpea seeds.

MATERIALS AND METHODS

Insect Culture

Adult *C. maculatus* were collected from infested cowpea seeds from Ihiagwa

community market in Owerri West Local Government Area of Imo State, Nigeria. The insects were introduced into two 500 ml breeding jars containing disinfected wholesome cowpea seeds (Ife brown variety) and kept under ambient temperature of 28^0C ± 3^0C and relative humidity of 75± 5%. These were used to establish a laboratory culture.

Collection and Preparation of Cowpea Seeds

Ten (10) kg of cowpea seeds (Ife brown variety) sourced from the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, were sorted to remove holed/wrinkled seeds from the wholesome ones. The selected seeds were disinfested by putting them in a transparent polythene bag with 2 tablets of Phostoxin® (Aluminum phosphide) in an envelope. The polythene bag was then inserted into a plastic bucket, tightly covered, and kept for one week. The seeds were air- dried under shade for 24 hours before use.

Preparation of Test Plant Powders and Actellic 25 .E.C®

Seeds and roots of *J. curcas* were obtained from Ilorin, Kwara State. The roots were chopped into bits and air dried under shade for one week. The kernel and the dried root parts were pulverized into fine powder using a Philips electric blender (Cucina HR 1731/37, 2L/400w.220v-50/60Hz.) and passed through a ten-micron sieve. One hundred grams of the plant materials was separately dissolved in 500 ml of acetone (BDH Chemicals, 99.5 %) and the solution filtered through a calico cloth. The filtrate was subjected to low pressure distillation (using a Soxhlet extractor) and the solvent recovered for further use. Actellic 25 .E.C® was bought from an agro-chemical store in Owerri, Imo State and dissolved in water at the rates stated below.

Bioassay

One hundred grammes of cowpea seeds were weighed out into 250 ml translucent plastic containers, which were covered with clean calico cloth. The extracts of *J. curcas* root and seeds were measured out at 1.00, 2.00 and 3.00 ml and separately mixed with the 100.00 g of the seeds in the 250.00 ml plastic containers. Actellic 25 .E.C® was measured at 0.20, 0.30 and 0.40 ml and dissolved in 10.00 ml of water each. 1.00 ml of each of the solutions was measured out and mixed with the 100.00 g of cowpea seeds and air-dried. The treated seeds were returned into the 250.00 ml plastic containers. These served as the treated seed stock.

Twenty four hours later, 50 seeds from each of the treated and untreated (control) cowpea seeds from the reserved seed stock were put into 100.00 ml plastic containers. The treatments were replicated three times including the control.

Five pairs of male and female adult *C. maculatus* were introduced into each of the 100 ml container. The containers were covered with calico cloth and held firmly with rubber bands to preclude exit or entry of insects.

Data Collection

Adults Mortality*:* Data were collected on the effect of the plant extracts and Actellic on the mortality of the adults, which were assessed 24, 48 and 168 hrs (7 days) after treatment. The percent mortality was calculated as described by Niber, (1994):

$$\text{Percent mortality} = \frac{\text{No. of dead insect} \times 100}{\text{Total No. of insects}}$$

Oviposition: The Number of eggs laid on the cowpea seeds was recorded on the 7th day on a sub sample of 10 randomly selected seeds. The seeds were put back into their respective containers, covered and left until the emergence of the first filial generation.

Emergence: The total number of adults that emerged (dead and living) was counted. This was by summing up the number of adults that emerged 24, 48 and 96 hours during the first filial generation emergence.

Damage Assessment: Damage was assessed by the number of exit holes. This was done using a sub-sample of 10 seeds at 96 hours after the first emergence. The weevil perforation index (WPI) (Fatope *et al*., 1995), was then calculated thus:

$$\text{WPI} = \frac{\text{\% Treated cowpea grains perforated} \times 100}{\text{\% control cowpea perforated}} \quad 1$$

Weevil perforation index exceeding 50 was regarded as enhancement of infestation by the weevil or negative protectant ability of the plant material or insecticide tested.

Residual Test: To assess the residual effect of the plant materials and the synthetic insecticide on the stored seeds, the above procedures were repeated 3 months after the initial bioassay. The seeds for the residual experiment were collected from the seed stock

in the 250 ml plastic container. Fifty seeds from each of the treated and untreated (control) cowpea seeds were used for this experiment.

Germination Test: For the control germination test, 30 untreated cowpea seeds were planted before the commencement of the experiment. Ten (10) seeds were put in a petri-dish lined with Whatman's filter paper moistened with water. This was replicated thrice. Seven days later, the number of germinated seeds was counted and expressed as percentage germination.

The germination test was repeated three months after storage with the plant material and Actellic. This was to determine the effect of the treatment materials on seed germination.

Data Analysis

All data collected were analyzed using Analyses of Variance (ANOVA) in a Completely Randomized Design and treatment means separated using Fisher's Least Significant Difference (F-LSD) at 5.00 % probability levels

RESULTS

In both the initial and residual experiments, mortality of adult *C. maculatus* after 24 and 48 h exposure was higher in seeds treated with *J. curcas* seed extract (Table 1). The *J. curcas* root extracts recorded a lower percentage mortality (3.33 - 20.00 %) of the target insect pest, which did not differ significantly (P=0.05) with the untreated control (0.00 – 13.33%). The synthetic insecticide at 24 and 48 h gave a mortality of between 36.67- 83.33 %., while the *J.* seed oil reached 60.00 % in 48 h after three months of storage

Actellic 25 .E.C® and *J. curcas* seed oil significantly reduced the number and distribution of eggs laid all through the duration of the experiment when compared with the root extract and the untreated control (Table 2). In the Actellic and *J. curcas* seed oil treated seeds, the highest number of eggs laid per seed was 0.43 and 0.93, respectively, with a maximum of 26.7 and 46.7 % seeds oviposited on. Seeds treated with the root extracts recorded a maximum of 1.73 eggs per seed with 80 % of the seeds oviposited on. This differed statistically with the untreated control which recorded 3.00 eggs per seed with all the seeds (100 %) oviposited on.

Emergence of adult *C. maculatus* in the treated samples during the experiments is shown in Table 3. Actellic treated seeds recorded the lowest (9.34) adult emergence of the bruchid in the residual test trial, followed by *J. curcas* seed oil (42.00 emerged adults). The results however differed significantly (P<0.05) from the root extract treated seeds with 118.33 total adult emergence which compared closely with the untreated control (120.67 insects).

Actellic treated seeds were the least damaged (Table 4). The mean number of holes per seed and the number of seeds with holes ranged from 0.10 - 0.22 and 0.00 - 0.67, respectively, , this was followed by *J. curcas* seed oil, with 0.40 to 0.60 holes per seed and 1.67 to 3.33 seeds with holes, respectively. The untreated control, ranged from 2.20 to 2.43 holes per seed and 9.67 to 10.00 seeds with holes, respectively. Similarly, Actellic treated seeds had the best protection with weevil protection index (WPI) of between 0.00 – 6.67 %, followed by the seed oil, (16.67 to 33.33 %). These results differed significantly (P<0.05) from the root extract which gave the lowest (46.67 – 53.33 %) protection index.

Though there were no significant differences (P=0.05) among the various application concentrations, however, the medium and highest concentrations for each treatment material were better than the lowest rates.

Actellic 25 .E.C® and the *J. curcas* seed and root extracts used in storing the cowpea seeds had no significant (P=0.05) effect on seed germination (Table 5). The treated seeds did not differ statistically from the untreated control with 86.44 % germination.

Table 1: Effect of Extracts of *Jatropha curcas* and Actellic 25 .E. C on Adult Mortality of *Callosobruchus maculatus.*

		ADULT MORTALITY					
Treatment Material	**Rate (ml/ 100 g)**	**24 hr 1st Exp.**	**24 hr Res.Exp.**	**48 hr 1st Exp.**	**48 hr Res.Exp.**	**168hr 1st Exp**	**168hr Res.Exp.**
JSE	1.00	16.67	16.67	40.00	40.00	73.33	80.00
	2.00	23.33	20.00	53.33	43.33	80.00	83.33
	3.00	26.67	23.33	60.00	56.67	66.67	93.33
JRE	1.00	3.33	3.33	13.33	16.67	30.00	23.33
	2.00	6.67	6.67	16.67	13.33	30.00	33.33
	3.00	10.00	9.67	20.00	20.00	40.00	36.67
ACT	0.20	36.67	43.33	66.67	66.67	96.67	96.67
	0.30	46.67	43.33	76.67	80.00	96.67	96.67
	0.40	50.00	43.33	83.33	83.33	100.00	100.00
C	0.00	6.7	0.00	23.33	13.33	33.33	30.00
LSD0.05		**10.90**	**9.960**	**11.00**	**11.86**	**9.101**	**11.72**

Key: 1st Exp.: First Experiment
Res.Exp.: Residual Experiment
JSE: *Jatropha curcas* seed extract
JRE: *J. curcas* root extract
ACT: Actellic 25 .E. C
C: Control

Table 2: Effect of Extracts and Actellic 25 .E. C on Oviposition of *Callosobruchus maculatus.*

		OVIPOSITION			
Treatment Material	**Rate ml/100 g**	**No. of egg/10 seeds**	**No. of eggs/10 seeds**	**No. of seeds with eggs**	**No. of seeds with eggs**
		1st Exp.	**Res.Exp.**	**1st Exp.**	**Res.Exp.**
JSE	1.00	0.93	0.90	4.67	4.67
	2.00	0.90	0.90	4.67	4.00
	3.00	0.70	0.73	4.00	3.67
JRE	1.00	1.70	1.73	8.00	8.00
	2.00	1.67	1.60	7.67	7.00
	3.00	1.63	1.50	8.00	7.00
ACT	0.20	0.43	0.33	2.67	2.00
	0.30	0.37	0.33	2.00	1.33
	0.40	0.30	0.27	1.00	0.67
C	0.00	2.76	3.00	9.67	10.00
LSD 0.05		**0.412**	**0.504**	**1.176**	**1.085**

Key: 1st Exp.: First Experiment
Res.Exp.: Residual Experiment
JSE: *Jatropha curcas* seed extract
JRE: *J. curcas* root extract
ACT: Actellic 25 .E. C
C: Control

Table 3: Effect of Extracts and Actellic 25 .E. C on Adult Emergence of *Callosobruchus maculatus*.

		ADULT EMERGENCE							
Treatment Material	**Rate ml/ 100 g**	**24 hr 1st Exp.**	**24 hr Res. Exp.**	**48 hr 1st Exp.**	**48 hr Res. Exp.**	**96 hr 1st Exp.**	**96 hr Res. Exp.**	**Total emergence 1st Exp.**	**Total emergence Res. Exp.**
JSE	1.00	9.33	10.67	3.33	3.67	2.00	2.00	14.70	15.67
	2.00	8.00	8.33	3.00	3.33	2.00	1.33	13.00	13.33
	3.00	7.67	8.33	2.67	3.00	2.33	1.33	12.70	13.00
JRE	1.00	25.00	23.67	3.33	9.67	6.00	5.33	39.30	38.00
	2.00	28.33	27.00	3.74	9.00	5.33	4.67	42.00	40.00
	3.00	26.00	26.00	3.47	8.33	5.33	4.67	40.30	40.33
ACT	0.20	2.00	3.00	1.00	1.67	0.00	0.00	3.00	4.67
	0.30	1.67	2.33	0.67	0.67	0.00	0.00	2.33	3.00
	0.40	1.00	1.33	0.00	0.33	0.00	0.00	1.00	1.67
C	0.00	92.33	90.67	18.67	19.33	11.00	10.67	122.00	120.67
LSD0.05		**7.623**	**9.77**	**2.258**	**2.327**	**1.587**	**1.502**	**10.37**	**12.11**

Key: 1st Exp.: First Experiment
Res.Exp.: Residual Experiment
JSE: *Jatropha curcas* seed extract
JRE: *J. curcas* root extract
ACT: Actellic 25 .E. C
C: Control

Table 4: Effect of Extracts and Actellic 25 .E. C on Damage by *Callosobruchus maculatus*.

		DAMAGE ASSESSMENT					
Treatment Material	**Rate ml/ 100 g**	**No.of holes/ seed**	**No.of holes/seed**	**No.of seeds with holes**	**No.of seeds with holes**	**W.P.I (%)**	**W.P.I (%)**
		1st Exp.	**Res.Exp.**	**1st Exp.**	**Res.Exp.**	**1st Exp.**	**Res.Exp.**
JSE	1.00	0.57	0.60	3.00	3.33	30.00	33.33
	2.00	0.53	0.53	2.67	2.67	26.67	26.67
	3.00	0.45	0.40	2.00	1.67	20.00	16.67
JRE	1.00	1.03	1.07	5.00	5.33	50.00	53.33
	2.00	0.94	0.93	4.67	5.00	46.67	50.00
	3.00	0.71	0.67	4.67	5.00	46.67	50.00
ACT	0.20	0.10	0.21	0.67	0.67	6.67	6.67
	0.30	0.22	0.10	0.33	0.33	3.33	3.33
	0.40	0.11	0.10	0.00	0.00	0.00	0.00
C	0.00	2.43	2.20	9.67	10.00	------	------
LSD 0.05		**0.3927**	**0.619**	**0.760**	**1.291**	**7.900**	**13.68**

Key: 1st Exp.: First Experiment
Res.Exp.: Residual Experiment
JSE: *Jatropha curcas* seed extract
JRE: *J. curcas* root extract
ACT: Actellic 25 .E. C
C: Control

Table 5: Effect of Extracts and Actellic 25 .E. C on Germination of Cowpea Seeds

Treatment Material	Rate ml/ 100 g	Germination (%)
JSE	1.00	85.00
	2.00	86.56
	3.00	84.45
JRE	1.00	83.44
	2.00	84.22
	3.00	86.56
ACT	0.20	86.56
	0.30	85.67
	0.40	84.11
C	0.00	86.44
LSD 0.05		**NS**
Germination test before treatment application.		**86.67**

Key: JSE: *Jatropha curcas* seed extract
JRE: *J. curcas* root extract
ACT: Actellic 25 .E. C
C: Control

DISCUSSION

The seed oil of *J. curcas* was found to be very effective in controlling *C. maculatus* infestation with a low weevil perforation index (WPI) (16.67%) which compared most favourably with the WPI of Actellic 25 EC®. All parts of the *J curcas* plant have been shown to possess biopesticidal activity against many pests. Previous works have reported the insecticidal activities of *J. curcas* plant parts against *Busseola fusca* and *Sesamia calamistis* (Makhar *et al.*, 2007), *Helicoverpa zea* (Olapeju *et al*., 2008), termites (Acda, 2009, Verma *et al*., 2011), mosquitoes (Zewdneh *et al*., 2011), mites (Juliet *et al.*, 2012), Desert locusts (Bashir and Shafie, 2013), cockroaches (Lateef *et al.*, 2014) and *Sitophilus zeamais* (Ojiako *et al*., 2014),

This high bioactivity may be related to the presence of phorbol esters in the kernels, stem, flowers, buds, roots, bark (outer brown and inner green) skins and wood, but not in latex of *J. curcas* (Makkar *et al.*, 1998). *Jatropha species* have also been confirmed as a rich source of terpenoid compounds, among which are diterpenoid compounds with about 68 diterpenes (Devappa *et al*., 2011). Further phytochemical analysis of the root, stem and petiole of the plant showed the presence of alkaloids, saponins, tannins, terpenoids, steroids, glycosides, phenols and flavonoids (Sharma *et al.*, 2012) which are known to have bactericidal, fungicidal and antimicrobial properties (Rachana *et al.*, 2012; Narayani *et al*., 2012).

In this experiment, however, only the seed extract of *J. curcas* was found to be effective in the control of *C. maculatus* which activity was comparable to the action of the synthetic insecticide, Actellic.

Aiyelaagbe *et. al*. (2007) had observed that *J. curcas* seed oil, used as an emulsifiable concentrate on mung bean, was more toxic than other parts to *Callosobruchus chinensis* and inhibited the insect's oviposition. The seed oil have also been shown to effect oviposition deterrence and inhibited egg hatching in potato tuber moth, *Phthorimaea operculella* (Shelke *et al.*, 1987), inhibited growth of tobacco hornworm, *Manduca sexta* larvae (Sauerwein *et al.*, 1993), had anti-ovipositional activity against the seed beetle *C. maculatus* (Adebowale and Adedire, 2006) and meaningfully reduced the number of tested insect pests (*Aphids crassivora, Maruca testulalis* and *Megalurothrips sjostedti*) in a field trial to control field pests of cowpea (Ahuchaogu *et al*., 2014).

Makkar *et al*. (1998) had reported that *J. curcas* seed extracts contained more phorbol

esters which exerted potential insecticidal effects against *Busseola fusca* and *Sesamia calamistis* when compared with the root extract. This finding was later corroborated by Fang *et al*. (2005) who observed that *J. curcas* root contains a smaller amount of phorbol ester (0.55 mg / g dry matter) when compared with the seed (2.00- 6.00 mg/ g dry matter).

Jatropha seed has also been found to contain a generous amount of curcin toxalbumin than other parts (Stirpe *et. al*., 1976). Curcin toxalbumins are toxic plant proteins that disable ribosomes, thereby inhibiting protein synthesis, producing severe cytotoxic effects in multiple organ systems, modifying amino acids (arginine, lysine, and tryptophan) in the active site resulting in loss of the inhibitor activity (Weike *et. al.,* 2006) which may be fatal to insects. These protein phytotoxins have a powerful inhibitory action upon protein synthesis in reticulocyte lysate with an IC50 (95 % confidence limits (Lin *et al*., 2003) and are similar in structure to the toxins found in cholera, tetanus, diphtheria and botulinum which physiological and toxic properties resemble those of viperine snake venom (Anon., 2015). Curcin toxalbumins were later found to be absent in the root of *J. curca* (Makkar and Becker, 2009).

The efficacy of Actellic 25 .E.C® (Pirimiphos-methyl) could be as a result of its contact and fumigant activity (Čerňáková *et al*., 1992, WHO, 2004). It is reportedly fast acting, effective at low concentrations and has, at 375 mls/100 liters of water, been used to control Aphids (*Myzus persicae*) and Whiteflies (*Bemsisa tabasi*) in Okra (Shoura Chemicals, 2012). Ojiako and Adesiyun (2008b) have reported the efficacy of Actellic 2 % Dust® (Pirimiphos- methyl) in the control of *C. maculatus* in stored cowpea.

Germination tests showed no significant differences (P=0.05) among the treatment materials used when compared with the control. All cowpea seeds treated recorded at least 83.44% germination which was not statistically different from the 86.67 % observed before the commencement of the experiment. Earlier work (Ojiako *et al*., 2014) had shown that the seed and root powders of *J. curcas* had no significant effect on germination of stored maize. It has been reported that plant extracts generally do not affect the germination of seeds treated with them (Akinkurolere *et al*., 2006).

CONCLUSIONS AND RECOMMENDATION

The result of this study shows that *J. curcas* seed oil was able to control *C. maculatus* in stored cowpea. However, the root extracts did not compare effectively with either the synthetic chemical or seed extract used. The treatment materials had no negative effect on the germination of the treated seeds. *Jatropha curcas* is readily available, cheap, easily bio-degradable and environmentally friendly. It could serve as a valuable alternative to the use of synthetic insecticide in the management of insect pests of stored cowpea.

The study recommends the need for follow-up studies on the potentials of this plant product as protectants of stored produce. Probable agronomic practices aimed at the domestication and or cultivation of *J. curcas* plants could be the focus of agricultural institutes and departments of agriculture in tertiary institutions in Nigeria. This may invariably increase the availability of plant materials that could serve as models for the synthesis of new insecticidal compounds. Since Jatropha have been found to contain poisonous alkaloids, it is further recommended these extracts be used for seeds meant for planting only.

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