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Insecticidal Evaluation of Some Botanical Leaf Powders On Cowpea Beetle *Callosobruchus maculatus* (F.) On Stored Bambara Groundnut (*Vigna subterranea* (L.) Verdcourt.

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Abstract

Two Laboratory trials were conducted at the Department of Crop Protection, Faculty of Agriculture, Ahmadu Bello University, Samaru-Zaria to evaluate the efficacy of five plants species. Anogeissus leiocarpus Guill. and Per., Antidesma venosum Tull., Maranthes polyandra (Benth.) Prance. Mitragyna inermis (Willd.) Kuntze. and Vitex madiensis Olive., for their leaf powders at two levels of concentrations (5.0 and 10.0 g/100 g seed) as protectant against Callosobruchus maculatus F. infesting stored bambara groundnut. Actellic dust 2% at 2.0 g/100 g seed (treated check) and untreated control were placed alongside with these plant powders to serve as checks. Treated and untreated experiments were infested with adult C. maculatus under prevailing storage conditions. Anogeissus leiocarpus, Antidesma venosum and Mitragyma inermis leaf powders at 10 g/100 g seed recorded over 45% adult C. maculatus mortality at 24 hours of treatment. All the plant leaf powders considerably reduced oviposition of C. maculatus as compared to untreated control. Vitex madiensis leaf powder at 10 g/100 g seeds of Bambara groundnut maintained low F1 –F3 progeny emergence for the 12 weeks of observation while Antidesma venosum and Maranthes polyandra all at higher concentration levels maintained low F1 and F2 progeny emergence for 8 weeks of observation. The leaf powders of Vitex madiensis, Antidesma venosum and Maranthes polyandra seem promising in inhibiting progeny emergence of C. maculatus for 2 months of treatment. The Bambara groundnut seed qualities were not adversely affected by the leaf powdered treatments of the botanicals. These plants have potential insecticidal properties which can further be researched upon to serve as alternatives of synthetic insecticide.

Keywords: *Botanicals insecticides, leguminous crop, stored product, insect antifeedant*

Introduction

Bambara groundnut (*Vigna subterranea* (L.) Verdcourt) is a Leguminous crop of the tribe Phaseolae, Family Leguminosae with creeping stems and branching just above ground level with tap root system that are rounded or lobed with nodules. The leaves are alternate and tri-foliate, glabrous; the flowers are bisexual and the fruits are indehiscent pod of about 2.5 cm in diameter and usually one-seeded. The seeds are variously coloured from white to cream, red, black or brown, sometimes mottled, blotched or striped (Linnemann and Azam-Ali, 1993 PROTA, 2006).

Bambara groundnut is an indigenous African crop and reported to have originated from north-eastern Nigeria and Northern Cameroon where the wild forms are still found (PROTA, 2006).

The crop is grown primarily for its seeds which are eaten fresh when semi-ripe and as a pulse when dry and mature, or ground into flour (Williams, 1993). Bambara groundnut is a major source of vegetable protein in sub-Saharan Africa where it constitutes an important part of the local diet, culture and economy (Goli, 1997; Heller *et al*., 1997. The seed is regarded as a completely balanced food (Anchirina et al., 2001; Rowland, 1993; Lacroix et al., 2003; Amarteifio et al., 2002). Bambara groundnut seeds, haulm and dry leaves have been used to feed livestock and poultry (Ancchirina et al., 2001).

Callosobruchus maculatus F. and *Callosobruchus subinnotatus* Pic. are the major storage insect pest of Bambara groundnut seeds in West Africa (Haines, 1991; Mbata, 1992). Of these bruchids, *C. maculatus* is the more destructive on account of its shorter life cycle (Lale and Vidal, 2001; Maina and Lale, 2004). Whilst *C. maculatus* attacks a wide range of grain legumes, *C. subinnotatus* is restricted to Bambara groundnut (Haines, 1991; Silim *et al*, 1998; Maina and Lale, 2004). These bruchids start infestation from the field and continued in storage when Bambara groundnut seeds are stored, thereby reducing the quality and quantity of the seeds in storage (Dike, 1994).

In Nigeria there are limited reports in the literature on effective methods of controlling *Callosobruchus maculatus* on Bambara groundnut in storage. Frequent use of synthetic insecticides may lead to a destabilization of the ecosystem and to enhance resistance to insecticides in pests. Botanical insecticides have long been reported to be safer to use than synthetic chemical in view of their little or no threat to the environment or to human health (Murray, 2005).

A number of plant substances have been considered for use as insect antifeedant or repellents, but apart from some natural mosquito repellents, little commercial successes have ensued for plant substances that modify arthropod behaviour (Murray, 2005). The integration of insecticidal products from locally available plants for use in storage, and the growing of varieties of grain legumes with some resistance to *C. maculatus* may lead to the sustainable management of the bruchid especially in subsistence agriculture (Lale and Mustapaha, 2001; Maina and Lale, 2004). Since there are increasing drawbacks of the continued use of today's conventional insecticides, efforts are needed in the development of new compounds to replace those currently been used (Bell and Willson 1995; Chaudhry 1995; Lee *et al*,. 2001; Bamaiyi *et al.*, 2006).

In Nigeria, many botanicals are still unexploited whose potentials appear to be quite high (Olaifa and Akingbohungbe, 1986). Therefore, the aims and objectives of this research were to investigate and evaluate the insecticidal efficacy of leaf powdered treatments of five plant species *Anogeissus leiocarpos* (Common name-African birch), *Antidesma venosum*, *Maranthes polyandra*, *Metragyna inermis* (Common name False abura) and *Vitex madiensis i*n the control of Bambara groundnut bruchid, *Callosobruchus maculatus* F. in storage.

Materials and Methods

Adult *C. maculatus* were obtained from an already infested Bambara groundnut seeds from a warehouse at Samaru, Zaria, Nigeria. These were subsequently raised on pristine Bambara groundnut seeds [disinfected for two days with phostoxin tablet in an airtight kilner jars] in the insect museum of the Institute for Agricultural Research (IAR), Ahmadu Bello University, Samaru, Zaria. The insects were sieved out from this initial infested batch of Bambara groundnut and 100 pairs of gravid *C. maculatus were* re-infested on 2kg seeds of Bambara groundnut divided into four kilner jars. This was done in order to maintain the stability and acclimatization of *C. maculatus* in the laboratory.

Fresh bambara groundnut seeds (25 Kg) were obtained from Samaru market, Zaria for experiment. The seeds were treated with phostoxin® tablets obtained from an Agro-allied Dealer for five days and later the seeds were air dried under screen in the laboratory for 24 hr prior to the start of the experiment. Actellic dust 2% used in the experiment was also obtained from the same source.

Five different plant species were collected from their natural habitat (bush) in Lafia and its environments in Nasarawa State. The plant samples were identified at the Herbarium of the Department of Biological Sciences, Ahmadu Bello University, Zaria, Nigeria. The plant samples identified were as shown in Table 1.

Table 1. List of Plants Screened for the Efficacy of their Stem Bark Powders

Plant	Family	Acronym used
Anogeissus leiocarpus Guill and per	Combretaceae	Ano LP
Antidesma venosum Tul	Euphobiaceae	Ant LP
Maranthes polyandra (Benth)	Prance Chrysobalanceae	Mar LP
Mitragyna inermis (Wild) Kuntze	Rubiaceae	Mit LP
Vitex madiensis Oliv	Verbenaceae	Vit LP

Each leaf sample of the five plant species were collected separately and air dried under shade on the laboratory top bench in the open for three weeks. Thereafter, each plant part species was independently ground using mortar and pestle and sieved with 0.1 mm wire mesh size. The pulverized contents obtained in each case were each kept in separate polyethylene bags and kept in the laboratory fridge until ready for use.

100 g of pristine bambara groundnut seeds were placed in each 500 ml Kilner jars. Treatment consisted of two concentrations of the leaf powder of the different plants applied at 5.0 and 10.0 g/100 g bambara groundnut seeds while Actellic dust 2% was applied at 2.0 g/100 g seeds to serve as treated check. The control (untreated check) was also set up along. All the treatments were replicated three times.

All the jars excluding the control were vigorously shaken to ensure proper mixing of the plant products and Actellic dust with the bambara groundnuts. The powdered treatments in each jar were allowed to settle for two hours. Thereafter, five pairs of freshly emerged *C. maculatus* adults were introduced into each jar and the jars were properly covered with an aerated cap. The treatments were arranged in a completely randomized design (CRD) on the laboratory bench and experiments were carried out under laboratory temperature and relative humidity.

Data Collection and Analysis

***Determination of toxicity efficacy*:** In each treatment, observations were made and recorded for toxicity effect on mortality rates in all the jars at 24, 48, 72 and 96 hours. Data collected were analyzed as percentage mortality of the number of insects used for the experiments.

After 14 days of infestation and of exposing the beetles to the treatments, 100 seeds of bambara groundnut were randomly removed from each jar containing the treatments and the number of eggs oviposited on them were counted. These were placed in another equal volume of Kilner jars separately until progeny emergence. Progeny emergence in each treatments and replicates were taken for F_1, F_2 and F_3 respectively. At each time of observation the newly emerged progenies were sieved out, counted and recorded.

After 12 weeks of treatment, the percentage weight loss of the seeds were evaluated by weighing the entire bambara groundnut seeds in each jar and the difference from the initial weight of 100 g was transformed into percentage weight loss. The percentage seed damage was evaluated by randomly selecting 100 seeds from each jar and counting the number of holes on each seed of the treatments.

At the end of the 12 weeks of trials, 10 seeds were randomly selected from each jar of all the treatments and placed on sterilized plastic Petri dishes lined with moistened blotting paper and kept on the benches in the laboratory. Occasionally, distilled water was added to the Petri dishes to maintain humid environment around the germinating seeds. This test was monitored for 9 days after which the germination percentage counts were taken.

Organoleptic studies were conducted at the end of 12 weeks of treatment. A popular food *okpa* (a local delicacy made from ground and cooked bambara groundnut) was made from each of the powdered treatments at their respective concentration levels. This was separately tested for palatability and flavour retention of the powdered treatments. Visual observations were also made on the seed coat texture and colour changes in each of the treatments to ascertain the quality of the products that will appeal to market demand.

Results

The leaf powders of *Anogeissus leiocarpus*, *Antidesma venosum*, *Maranthes polyandra*, *Mitragyna inermis* at both concentration levels and *Vitex maidiensis* at higher concentration level recorded over 40% mortality rate of adult *C.maculatus* within 48 hours post treatment (table 2). However, *Antidesma venosum* and *Vitex maidiensis* recorded over 50% mortality at the 96 hours post treatment.

The leaf powders of *Antidesma venosum*, *Maranthes polyandra*, and *Vitex maidiensis* recorded oviposition rate when compared to other treatment (table 3) with the exception of actellic dust treatment which is significantly lower than all the treatments. Lower concentrations of the treatment recorded moderate oviposition while untreated control recorded the highest oviposition of all the treatments.

All the powder treatments at both concentration levels recorded low F_1 progeny emergence while higher concentration of the treatments maintained low F_2 progeny emergence. These treatments (table 4) were significantly better than untreated control. Only *Vitex maidiensis* and *Anogeissus leiocarpus* at higher concentrations recorded low F_3 progeny emergence. These treatments, with the exception of the two above were not effective beyond 8 weeks of treatment.

Table 2: The Effect of five bioinsecticide leaf powders on mortality rate in percentage of *Callosobruchus maculatus* on Bambara groundnut in storage.

Treatment	Cocn. in g/100g seed	24 hours		48 hours		72 hours		96hours	
		Trials		Trials		Trials		Trials	
Anogeissus leiocarpus	5.0	1.0 b	(30.9)	1.147 ab	(45.4)	1.63 ab	(42.0)	1.15 c	(35.5)
	10.0	1.29 b	(39.8)	1.58 a	(48.8)	1.41 ab	(43.5)	1.47 ab	(45.4)
Antidesma venosum	5.0	1.08 b	(33.3)	1.41 ab	(43.5)	1.22 ab	(37.7)	1.58 ab	(48.8)
	10.0	1.47 b	(45.4)	1.47 ab	(45.4)	1.22 ab	(37.7)	1.73 a	(53.4)
Maranthes polyandra	5.0	1.29 b	(39.8)	1.47 ab	(45.4)	1.53 ab	(47.2)	1.41 ab	(43.5)
	10.0	1.29 b	(39.8)	1.47 ab	(45.4)	1.69 a	(52.2)	1.22 c	(37.7)
Mitragyna inermis	5.0	1.16 b	(35.8)	1.41 ab	(43.5)	1.36 ab	(42.0)	1.41 abc	(43.5)
	10.0	1.15 b	(35.5)	1.78 a	(54.9)	1.47 ab	(45.4)	1.35 ab	(41.7)
Vitex maidiensis	5.0	0.92 b	(28.4)	1.22 ab	(37.7)	1.47 a	(45.4)	1.63 a	(50.3)
	10.0	1.22 b	(37.7)	1.35 ab	(41.7)	1.41 ab	(43.5)	1.63 a	(50.3)
Check (actellic dust 2%)	2.0	3.24 a	(100.0)	3.24 a	(100.0)	3.24 a	(100.0)	3.24 a	(100.0)
Control (no treatment)	0.00	0.71 b	(21.9)	0.71 b	(21.9)	0.92 b	(28.4)	0.82 d	(25.3)
CV %		41.3		62.39		78.49		59.41	
SE ±		0.21		0.25		0.27		0.23	

Means within the same column followed by the same letter(s) were not significantly different at $P \leq 0.05$ using Student Newman Keuls (SNK) grouping.
Means of the powders were compared among themselves along the column.
Figures in the table are transformed (square root) from original data, and those in parathensis are in percentages (%).
Initial number of insects used = 5 pairs

Table 3: The Effect of five bioinsecticide leaf powders on oviposition in percentages of *Callosobruchus maculatus* on stored Bambara groundnut after two weeks of treatments

Treatment	**Cocn. in g/100g seed**	**Leaf powder**	
		Trials	
Anogeisssus leiocarpus	5.0	7.66 [b]	(56.0)
	10.0	7.42 [b]	(54.7)
Antidesma venosum	5.0	6.0 [bc]	(44.3)
	10.0	5.05 [bc]	(37.2)
Maranthes polyandra	5.0	6.14 [bc]	(45.3)
	10.0	5.0 [bc]	(36.9)
Mitragyna inermis	5.0	7.95 [b]	(58.6)
	10.0	7.89 [b]	(58.2)
Vitex maidiensis	5.0	6.35 [bc]	(46.8)
	10.0	5.54 [bc]	(40.9)
Check (actellic dust 2%)	2.0	2.97 [c]	(21.9)
Control (no treatment)	0.0	13.56 [a]	(100.0)
CV %		19.88	
SE ±		3.02	

Means within the same column followed by the same letter(s) were not significantly different at $P \leq 0.05$ using Student Newman Keul (SNK) grouping

Means of the powders were compwered among themselves along the column

Figures in the table are transformed (square root) from original data, and those in parathensis are in percentages (%).

Initial number of insects used = 5 pairs

Table 4: The effects of leaf powders and actellic dust on Progeny emergence *Callosobruchus maculatus* at 4, 8 and 12 weeks of treatment on Bambara groundnut

Treatment	**Cocn. in g/100g seed**	**F_1 (4 weeks)**		**F_2 (8 weeks)**		**F_3 (12 weeks)**	
		Trials		**Trials**		**Trials**	
Anogeissus leiocarpus	5.0	2.52 b	(33.3)	4.71 b	(32.7)	16.67 b	(53.1)
	10.0	2.31 b	(30.5)	3.46 b	(24.0)	11.78 bcd	(37.6)
Antidesma venosum	5.0	2.16 b	(28.5)	3.42 b	(23.7)	12.23 bcd	(39.0)
	10.0	2.04 b	(27.0)	2.71 b	(18.8)	7.50 cd	(23.9)
Maranthes polyandra	5.0	2.48 b	(32.8)	3.39 b	(23.5)	11.69 bcd	(37.3)
	10.0	1.87 b	(25.0)	2.35 b	(16.3)	8.05 cd	(25.7)
Mitragyna inermis	5.0	2.24 b	(29.6)	4.36 b	(30.2)	16.75 b	(53.4)
	10.0	2.00 b	(26.4)	2.94 b	(20.4)	10.80 cd	(34.4)
Vitex maidiensis	5.0	2.38 b	(31.4)	3.27 b	(22.4)	10.02 cd	(32.0)
	10.0	1.63 b	(21.5)	2.48 b	(17.2)	4.98 cd	(15.9)
Check (actellic dust 2%)	2.0	0.71 c	(9.4)	0.71 b	(4.9)	0.71 d	(2.3)
Control (no treatment)	0.0	7.57 a	(100.0)	14.42 a	(100.0)	31.36 a	(100.0)
CV %		51.06		53.23		39.53	
SE ±		0.64		3.90		22.38	

Means within the same column followed by the same letter(s) were not significantly different at P $\leq$ 0.05 using Student Newman Keul (SNK) grouping
Means of the powders were compwered among themselves along the column
Figures in the table are transformed (square root) from original data, and those in parathensis are in percentages (%).
Initial number of insects used = 5 pairs

All the leave powdered treatments with the exception of *Antidesma venosum*, and *vitex maidiensis* at 10 g/ 100 g seeds of Bambara groundnut recorded high seed damage beyond 8 weeks post treatment. *Antidesma venosum*, *Maranthes polyandra*, *Mitragyna inermis* and *vitex maidiensis* at higher concentration recorded moderate seed damage at 12 weeks post treatment (table 5).

Low weight losses were observed in *Antidesma venosum*, *Maranthes polyandra*, *Mitragyna inermis* and *vitex maidiensis* at higher concentration but significantly higher than actellic dust treatment. Untreated control recorded the highest percentage of weight loss when compared to other treatments (table 5).

Antidesma venosum, *Maranthes polyandra*, and *vitex maidiensis* recorded high percentage of over 89% germination count and were significantly better than all the treatments with the exception of actellic dust treatment (table 5).

Table 5: The effect of five bioinsecticide leaf powders on Percentage Seed Damage, weight loss and germination count of Bambara groundnut due to *Callosobruchus maculatus* after 12 weeks of treatment

Treatment	**Cocn. in g/100g seed**	**% seed damage**		**% wt loss**		**% germination count**	
		Trials		**Trials**		**Trials**	
Anogeissus leiocarpus	5.0	9.25 ^{a}	(92.3)	3.34 ^{c}	(60.3)	1.29 ^{e}	(43.0)
	10.0	7.98 ^{b}	(79.6)	2.83 ^{d}	(51.1)	1.82 ^{d}	(60.7)
Antidesma venosum	5.0	7.74 ^{b}	(77.3)	2.21 ^{ef}	(39.9)	1.96 ^{d}	(65.3)
	10.0	4.38 ^{c}	(49.7)	1.92 ^{ef}	(34.7)	2.68 ^{ab}	(89.3)
Maranthes polyandra	5.0	7.61 ^{b}	(76.0)	2.62 ^{de}	(47.3)	2.20 ^{c}	(73.3)
	10.0	5.90 ^{c}	(58.9)	2.26 ^{de}	(40.8)	2.74 ^{ab}	(91.3)
Mitragyna inermis	5.0	9.18 ^{a}	(91.6)	4.60 ^{b}	(83.1)	1.58 ^{de}	(52.7)
	10.0	8.27 ^{a}	(82.5)	4.47 ^{b}	(80.6)	1.82 ^{d}	(60.7)
Vitex maidiensis	5.0	7.31 ^{b}	(73.0)	2.41 ^{be}	(43.5)	2.16 ^{c}	(72.0)
	10.0	4.40 ^{c}	(43.9)	2.18 ^{ef}	(39.4)	2.78 ^{ab}	(91.3)
Check (actellic dust 2%)	2.0	0.71 ^{d}	(7.1)	0.71 ^{f}	(12.8)	3.0 ^{a}	(100.0)
Control (no treatment)	0.0	10.02 ^{a}	(100.0)	5.51 ^{a}	(100.0)	0.71 ^{e}	(23.7)
CV %		28.51		15.09		39.33	
SE ±		4.39		0.42		0.47	

Means within the same column followed by the same letter(s) were not significantly different at P ≤ 0.05 using Student Newman Keul (SNK) grouping
Means of the powders were compwered among themselves along the column
Figures in the table are transformed (square root) from original data, and those in parathensis are in percentages (%).

From the organoleptic test carried out, it was observed that *Antidesma venosum*, *Maranthes polyandra*, and *vitex maidiensis* at their higher concentration levels were rated well in terms of seed quality. V*itex maidiensis* at higher concentration in terms of taste/flavor rating was rated good while *Antidesma venosum* and *Maranthes polyandra* at higher concentration were accorded fair ratings respectively.

Table 6: The Effect of five bioinsecticide Plant Powders in percentages on Quality (colour, texture and palatability) of Bambara groundnut seeds at 12 weeks post storage treatment.

	Seed quality ratings (colour and texture)						Seed taste/flavour ratings			
Treatments	**Conc. (g)**	**Very poor**	**Poor**	**Good**	**Very Good**	**Overall Assessment**	**Poor**	**Fair**	**Good**	**Overall assessment**
Anogeissus leiocarpus	5.0	(9.2)	(51.1)	(30.5)	(9.2)	Poor	(56.3)	(31.9)	(10.1)	Poor
leasf powder	10.0	(9.2)	(9.2)	(49.4)	(30.5)	Good	(10.1)	(54.4)	(36.4)	Fair
Antidesma vernosum leaf	5.0	(9.2)	(51.1)	(30.5)	(9.2)	Poor	(56.3)	(33.8)	(10.1)	Poor
powder	10.0	(9.2)	(37.9)	(43.3)	(9.2)	Good	(41.7)	(50.8)	(10.1)	Fair
Maranthes polyandra leaf	5.0	(9.2)	(51.1)	(30.5)	(9.2)	Poor	(56.3)	(33.8)	(10.1)	Poor
powder	10.0	(9.2)	(9.2)	(55.8)	(20.5)	Good	(10.1)	(58.0)	(30.3)	Fair
Mitragyna inermis leaf	5.0	(58.8)	(9.2)	(9.2)	(9.2)	Very poor	(64.7)	(10.1)	(10.1)	Poor
powder	10.0	(30.5)	(51.1)	(9.2)	(9.2)	Poor	(58.0)	(30.3)	(10.1)	Poor
Vitex madiensis leaf	5.0	(9.2)	(9.2)	(42.0)	(42.0)	Good	(10.1)	(41.7)	(50.6)	Fair
powder	10.0	(9.2)	(9.2)	(30.5)	(51.1)	Very good	(10.1)	(26.7)	(59.7)	Good
Actellic dust (check)	2.0	(9.2)	(9.2)	(9.2)	(58.8)	Very good	(10.1)	(10.1)	(64.7)	Good
Control	0.0	(58.8)	(9.2)	(9.2)	(9.2)	Very poor	(64.7)	(10.1)	(10.1)	Poor

Figures in the table are transformed (square root) from original data, and those in parathensis are in percentages (%).

Discussions

The effects of the five bioinsecticide leaf powders on adult mortality of *C. maculatus* were found to increase with increase in concentration levels, although in certain cases the mortality with 5 g treatments was at par with 10 g concentration, and time of exposure to treatments. This trend of results was reported by Gupta and Srivastava (2008) with the use of *Withania somnifera* (leaf, stem, fruit and root extracts) applied at 5% and 10% against *Callosobruchus chinensis* L. infesting green gram (*Vigna radiata*). High mortality of storage beetles have been recorded in treatments of lemon grass products and eucalyptus products (Dike and Mbah, 1992; Dike and Mshelia, 1997; Agina and Sani 1995; Oparaeke 1997). Higher concentration levels of the treatments favoured high mortality of *C. maculatus* as well as duration of exposure of the pest to treatments. Higher concentrations of the treatments recorded lower oviposition in all the plants under trials. Ofuya and Bamigbola,(1991) reported that 2.0 g plant powder added to 500 cowpea seeds reduced oviposition and egg hatch in *C. maculatus.* Oviposition rates between and within treatment were significantly lower than the control. Ivbijaro (1983) reported that neem seed powder drastically reduced egg laying in female *S. oryzae* from 154 in the untreated control to only 9 and 3 at neem powder doses of 0.5 and 1.0/20 g maize grains, respectively. Dike and Mba (1992); Dike and Mshelia (1997) reported similar conclusions on cowpea treated with lemon grass, eucalyptus and pepper products, respectively. It has been reported that the mode of action of plant powders in reducing oviposition of female *C. maculatus* was not fully understood but it may be due to higher mortality rates as well as repellent activity of the products which disorientated the bruchids and forced them to migrate to the wall of the jars where they laid most of their eggs (Dike and Mbah, 1992; Oparaeke 1997; Babu *et al.,* 1989).

Generally, there were significant increases in progeny development of *C. maculatus* from $F_1 – F_3$ in all the treatments except *Vitex madiensis, Antidesma venosum* and *Maranthes polyandra* leaf powders at their higher concentrations that maintained low progeny emergence from $F_1 – F_3$ respectively. It was also observed that higher concentration levels of the treatments were more effective in suppressing $F_1 – F_3$ progeny emergences. Similar findings were observed by Oparaeke, (1997); Lale, (1994); Dike and Mbah, (1992).

The plant powders showed no adverse effects on seed quality, taste and viability. Oparaeke and Dike (1996) reported that *Allium sativum* (garlic bulb) powder at 10 g/100 g grains of cowpea did not affect seed germination and quality. They also reported that Lemon grass (*Cymbopogon citratus* (DC) Stapf) did not affect seed germination and quality of cowpea. Meanwhile, the poor germination count recorded by some treatments may be as a result of the high degree of damage on endosperm of the seeds by *C. maculatus* during storage. Weight loss at the end of the experiment was a function of the degree of infestation on Bambara groundnut seeds. Oparaeke (1997); Dike and Mshelia, (1997), reported that the percentage reduction in weight of grains could be attributed to similar reduction in degree of infestation of the grains. On seed colour, texture and palatability, all these plant formulations that proved to be effective against *C. maculatus* after 12 weeks of treatment were not affected negatively.

Although actellic dust completely controlled *C. maculatus* on the stored Bambara groundnut seed for the 3 months period of storage, the toxic effects of synthetic pesticides to beneficial arthropods, pollution of agro-eco system and risk to human health have created serious threat to the world (Matsumura, 1975). Nevertheless, suitable alternatives to chemical pesticides, the plant products which are biodegradable, breaking down quickly and unlikely to loss efficacy due to buildup of genetic resistance in pest, resurgence of secondary/minor pest is not possible; hazardous residue of chemicals is not left in the crop; non-toxic and non-persistent and eco-friendly, cheaply available even in the villages and easily prepared by the farmers, are being tested through research and development projects in Africa, Asia and other parts of the world (Shaaya *et al.* 1997; Belmain, *et al.* 2001; Bamayi, *et al.* 2006 and Gahukar, 2010).

References

Agina, S.E. and Sani, T. (1995). Studies on the Use of Peels of Orange (*Citruss sinesis (L)*. Osbeck), Queen of the Night *Cestrum nocturnum* L. and African Curry (*Ocimum gratissium* L.) Plants as Insecticides and Repellants. *A Paper Presented at the 7th Annual Conference of the Botanical Society of Nigeria at the National Agricultural Extension and Research Liason Services, Ahmadu Bello University Zaria.* 3-7 September, 1995. 24 pp.

Amarteifio, J.O., Karikari, S. K., Modise, J.O. (2002). The Proximate and Mineral Composition of Six Landrace of Bambara Groundut. *Tropical Sci*ence, 42:188 – 191.

Anchirina, V.M., Yiridoe, E. K., Bennett-Lartey, S.O. (2001). Enhancing Sustainable production and Genetic Resource Conservation of Bambara Groundnut. A Survey of Indigenous Agricultural Knowledge Systems. *Outlook in Agriculture* 30(4): 281 – 288.

Babu, T.R., Reddy, V.S. and Hussain, S. H. (1989). Effect of Edible and Non-edible Oils on the Development of the Pulse Bettle *Callosobruchus chisensis.* L. and on Viability and yield of Mungobean *Tropical Science* 29(3): 215-220.

Bamaiyi, L.J., Ndams I.S., Toro, W.A., Odekina, S. (2006). Effect of Mahogamy *Khaya senegalensis* Seed Oil in the Control of *Callosbruchus maculatus* on Stored Cowpea. *Plant Protection Science*, 42:130-134.

Bell, C.H. and Wilson, S.M. (1995). Phosphine Tolerance and Resistance in *Trogoderma garanarium* Everts (Coleoptera: Dermestidae) *Journal of Stored Product Research* 31: 199 – 205.

Belmain, S. R., Neal, G. E., Ray, D. E., Golop, P. (2001). Insecticidal and Vertebrate Toxicity Associated with Ethnobotanicals used as Post-harvest Protectants in Ghana. Food and Chemical *Toxicology*, V. 39:287-291

Chaudhry, M.Q. (1995). Molecular Biological Approaches in Studying the Genes that Confer Phosphine-resistance in Insects. *Journal of Cellular Biochemistry,* 21 (Suppl.): 215.

Dike, M. C. and Mshelia, G. B. (1997). Laboratory Assessment of the efficacy of Eucalyptus leaf and stem powders in the control of *Callosobruchus maculatus* (Fab.) on stored cowpea. *Samaru Journal of Agricultural Research*. Vol. 13, 1996.

Dike, M.C, (1994). An Annoted Check List and Identity of Major Storage Insect Pests in Nigeria. *Samaru Miscellaneous Paper No. 130:*17 pp.

Dike, M.C. and Mbah, O.I. (1992). Evaluation of Lemon Grass *Cymbopogon citralus* Stpf) Products in the Control of *Callosobruchus maculatus* Fab. (Coleopteran: Bruchidae) on Stored Cowpea. *Nigeria Journal of Plant Protection* 14:88-91.

Gahukar, R. T. (2010). Role and Perspective of Phytochemicals in Pest Management in India. *Current Science*, Vol. 98, no. 7.

Goli, A.E. (1997). Bibliographical Review. In: Bambara Groundnut. *Vigna subterranean* (L.) Verdc. In: Proceedings of the Workshop on Conservation and Improvement of Bambara Groundnut (*Vigna subterranean* (L.) Verdc.). Heller, J., Begemann, F. and Mushonga, J., eds. 14 – 16 November 1995, Harara, Zimbabwe, pp. 4 – 10.

Gupta, L. and Srivastava, M. (2008). Effect of Wthania somnifera extracts on the mortality of Callosobruchus chinensis L. *Jounal of Biopesticides*, 1(2):190-192.

Haines, C.P. (1991). *Insects and Arachnids of Tropical Stored Products. Their Biology and Identification.* Second Edition Crown, Chatham, Kent, UK, 246 pp.

Heller, F., Begemann, F., and Mushonga, J. (1997). Bambara Groundnut: *Vigna subterranean* (L.) Verdc. Promoting the Conservation and use of Underutilized and Neglected Crops, 9, IPGRI, Rome/Gatersleben, 165 pp.

Ivbijaro, M.F. (1983). Preservation of Cowpea *Vigna unguiculata* L. Walp. With Neem Seed; *Azadirachta indica* A. Juss. *Protection Ecology*. 5: 177 – 182.

Lacroix, B., Assoumou Ndong, Y., Sangwan, R.S. (2003). Efficient in vitro Direct School Regeneration Systems in Bambara Groundnut (*Vigna subterranea* L. Verdc.). *Plant Cell Replication*, 21:1153 – 1158.

Lale, N.E.S and Mustapha, A. (2001). Potential of Combining Neem *Azadirachta indica* A. Juss Seed Oil with varietal Resistance for the Management of the Cowpea bruchid, *Callosobruchus maculatus* (F). *Journal of Stored Products Research* 36:215-222.

Lale, N.E.S. (1994). Effectiveness and Persistent Effects of Spices on Cowpea Bruchchid and Maize Weevil *Samaru Journal of Agricultural Research*, 11: 79-84.

Lale, N.E.S. and Vidal, S. (2001). Intraspecific and Interspecific Competition in *Callosobrushus maculatus* (F) and *Callosobruchus subinnotatus* (Pic) on Stored Bambara Groundnut, *Vigna subterranean* (L) Verdcourt. *Journal of Stored Products Research* 37:329-338.

Lee, Choi, W., Lee, S., Park, B. (2001). Fumigant Toxicity of Essential Oils and their Constituent Compounds towards the Rice Weevil, *S. oryzae* (L.) *Crop Protection*, 20: 317 – 320.

Linneman, A.R., Azam-Ali, S.N. (1993). Underutilized Crops. Pulses and Vegetables. In: Bambara Groundnut (*Vigna subterranea*), pp. 13 – 57. (Ed. Williams, J.T.) Chapman and Hall, London.

Maina, Y.T. and Lale N.E.S. (2004). Efficacy of Integrating Varietal Resistance and Neem (*Azadirachta indica* A. Juss.) and Seed Oil for the Management of *Callosobruchus maculatus* Infesting Bambara Groundnut in Storage. *Nigerian Journal of Entomology*, 21: 94-103.

Matsumura, F. (1975). Toxicity of insecticides Plenum Press New York. pp 503.

Mbata, G.N. (1992). Studies on the Comparative Susceptibility by *Callosobruchus maculatus. Tropical Science,* 32:47-51

Murray, B. Isman (2005). Botanical Insecticide Deterrents, Repellents in Modern Agriculture and an Increasingly Regulated World. *Abstract Annual Review of Entomology* Vol. 51: 45-66 (doi: 10.1146/annurev. ento. 51.110104.151146). British Columbia, V6T IZ4, Canada

.Ofuya, Th. I. and Bamigbola, K.A. (1991). Damage Potential, Growth and Development of the Seed Beetle. *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae) on some Tropical Legumes. Tropical Agriculture, 68: 33 – 6.

Olaifa J.I. and Akingbohungbe A.E. (1986). Antifeedant and Insecticidal Effects of the Passive Extracts of *A. indica, P. alliacea and P. guinease* on the Variegated Grasshoppers, *Zonocerus variegatus*. Proc. 3rd International Neem Conference for Protection of Cowpea against *C. maculatus. Insect Science and its Application,* 9(1) : 55-59.

Oparaeke, A.M. (1997). Evaluation of Comparative Efficacy of some Plant Powders for the Control of *Callosbruchus maculatus* (F) (Coleoptera: Bruchidae) on Stored Cowpea. M.Sc. Thesis, Ahmadu Bello University, Zaria, 105 pp.

Oparaeke, A.M. and Dike, M.C. (1996). Comparison of Garlic and Lemon Grass Products in the Control of *Callosobruchus maculatus* F. (Coleoptera: Bruchidae) on Stored Cowpea Grains. *Nigerian Journal of Entomology*. 13: 73-80.

PROTA (2006). Plant Resources of Tropical Africa 1: Cereals and Pulses. Editors: M. Brinks and G. Belay, 2006. pp. 213 – 218.

Rowland, J.R.J. (1993). Bambara Groundnut. In: Rowland J.R.J. (ed). Dryland Farming in Africa, Macmillan Ltd.

Shaaya, E., Kostiukoviski, M., Eilberge, J. Sukprakarn, C. (1997). Plants Oils as Fumigants and Contact Insecticides for the Control of Stored Product Insects. *Journal of Stored Products Research,* 33: 7 – 15.

Silim Nahdy, M., Ellis, R.H., SILIM, S.N. and Smith, J. (1998). Field infestation of pigeon pea (*Cajanus cajan* (L) Millsp) by *Callosobruchus chinensis* (L) in Uganda. *Journal of Stored Products Research* 34:207-216.

Wlliams, J.T. (1993). Pulses and vegetables. International Centre for Underutilized Crops. International Fund for Agricultural Research. Washington DC Metro USA, 13-49 pp.