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POTENTIALS OF TWO BIO-PESTICIDES IN THE CONTROL OF SOME FIELD INSECT PESTS OF BAMBARA GROUNDNUT IN ILORIN

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Abstract
A field experiment was carried out to determine the predominate order of insects associated with Bambara groundnut and to compare the efficacy of aqueous leaf extracts of Jatropha (Jatropha curcas) and lemon grass (Cymbopogon citratus), used as bio-pesticides in controlling some field insect pests of Bambara groundnut. The experiment was laid out in a Randomized Complete Block Design (RCBD) using four treatments with four replications. The following parameters were recorded and used to evaluate the efficacy of the treatments; flower population, weight of pods (damaged and undamaged pods), number of pods (damaged and undamaged pods), number of holes on damaged pods and number of insects. The results of the experiment showed that insects of seven distinct Orders- Hymenoptera, Coleoptera, Diptera, Hemiptera, Homoptera, Lepidoptera and Orthoptera attack Bambara groundnut with each affecting the plant at different stages of the plant's development. The bio-pesticides significantly (P <0.05) reduced the effects of attack by insects when compared to the control. Lemon grass was the most effective of the bio-pesticides evaluated and can be used by resource poor farmers in the management of Bambara groundnut on the field.

Key Words: *Bambara groundnut, bio-pesticide, Cymbopogon citratus, Jatropha curcas*

Introduction

Bambara groundnut (*Vigna subterranean* L. Verdc.) is an indigenous African legume crop which is cultivated throughout sub-Saharan Africa, especially in the drier parts of the continent (Mkandawire, 2007). It is produced mainly as a subsistence crop, usually by small-scale female farmers (Sellschop, 1962; Doku and Karikari, 1970; Rachie and Silvestre, 1977; Linnemann, 1992). They are a rich source of minerals, energy and protein, with as much as 25.2% protein, 65% carbohydrates and 6% lipid, on a dry weight basis (Rowland, 1993; Amarteifio *et al*., 1997). Its tolerance to drought and poor soils which makes it ideally suited to production in marginal areas where low- input arable agriculture is the norm (Doku, 1999; Maina *et al*., 2006; Amarteifio *et al*., 2006). In most African countries, its importance comes after

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cowpeas and groundnuts (Doku, 1999; Sesay *et al*., 2001).

Bambara groundnut is a promising commodity which needs more publicity, both as a crop and as food (Ojimelukwe, 1992). According to Coudert (1984), the annual production is about 330 000 tons of which Africa produces half, with Nigeria being the major producing country. The yields are low because production and improvement of Bambara groundnut has been neglected for many years by researchers, even though the crop is important for the small scale farmers due to its considerable commercial potential (Oguntunde, 1985; Enwere, 1998). There are a number of pest problems and diseases found on Bambara groundnut, but very little is known about the kind of pest attacks and the extent of the damage to the plant, pods or seeds (Baudoin and Mergeai, 2001). Insect pests that have been reported to attack Bambara groundnut on the field include groundnut leafhoppers (*Hilda patruelis* Stal.), the larvae of *Diacrisia maculosa* L. and *Lamprosema indicate* Fabricius (Mabika and Mafongoya, 1997).

Approaches aimed at controlling attack by insect pests have relied heavily on the use of synthetic insecticides (Udo, 2011). Cost of purchase, residual effect, health hazard to grain handlers and the widespread development of resistance in insect pests are still issues of great concern (Udo, 2011; Abulude *et al*., 2007). It is in the light of the above problems that the need to develop alternative control strategies that will be affordable and eco- friendly becomes expedient. The use of aqueous extract of botanicals in field pests' protection has been researched upon but more studies need to be done in this direction.

This work aims to investigate the main insect orders associated with Bambara groundnut and to evaluate the efficacy of two botanicals in the control of field insect pests of Bambara groundnut in Ilorin.

Materials and Methods

The study was conducted under field condition at the University of Ilorin Teaching and Research Farm, located at latitude 08° 29′N and longitude 04° 35′E in the Southern Guinea Savanna of Ilorin, Nigeria. The annual precipitation is 800-1200 mm (World Climate, 2013) and the annual temperature range is 22-34°C with a marginal soil type suitable for Bambara groundnut cultivation.

The bambara groundnut seeds used for this experiment were obtained from a local market in Ilorin, Kwara state. The grain colour is cream with brown eye, moderate size and very smooth in texture. The synthetic chemical used was cypermethrin, which was obtained from an agro–chemical store in Ilorin, Kwara state, while the natural plant materials used were fresh leaves of Jatropha (*Jatropha curcas)* and Lemon grass (*Cymbopogon citratus)* which were obtained from different localities in Ilorin, Kwara State.

The experiment was carried out using a Randomised complete block design. There were four treatments namely; aqueous Jatropha leaf extract, aqueous lemon leaf extract, cypermethrin and the control. Each treatment was replicated 4 times. The experimental site measured 99.64m^2 (10.6m ×9.4m) and this was cleared, ploughed and harrowed. The land was then prepared into flat beds, on

which seeds were planted. The land was divided into 4 blocks and the blocks further divided into 16 plots. Each plot measured 1.54m^2 (1.4m × 1.1m) and 1m alley between plots were maintained. Plants were spaced at 15cm and 60cm intra row and inter row respectively. There were three rows per plot giving a total of 21 stands per plot. Two seeds of Bambara nut were sown on flat bed at a planting depth of 3cm. The plots were weeded manually using a hand held hoe at the 3rd and 6th week after planting as recommended by BNARDA (2003).

400 grams each of matured fresh leaves of Jatropha and lemon grass were weighed, thoroughly washed and pulverized in a mortar and pestle for 30 minutes. These plant materials were each placed in separate 15 litre plastic container. 8 litres of water was added to it and left for 24 hours. Thereafter the mixture was stirred rigorously and filtered using a muslin cloth. The resultant homogeneous solution was poured into a plastic container and kept in the cool area (room temperature) until ready for use. These mixtures were used in the field for spraying Bambara groundnut. Fresh extracts were prepared each time when needed. Cypermethrin 10 EC was applied at the recommended dosage. A 16 litre Knapsack sprayer was used for the application of the treatments. All the botanicals were sprayed once every week for 10 weeks except for the synthetic chemical which was sprayed twice (that is, in the 4th and the 6th week) during the course of the experiment. The experiment lasted for 12 weeks.

Four sticky traps were placed in the middle of each experimental plot to catch the insects. Seven plants per plot were randomly sampled twice every week using sweep net for the flying insects and hand picking for the crawling insects. Counting of insects was done early in the morning between 7 a.m. - 9a.m. and the number of each order collected was recorded on weekly basis. The data collected and used to assess the efficacy of the botanicals were; number of insects per plot, pod yield per plot, number of damaged and undamaged pods, weight of damaged and undamaged pods, flower count per plot and number of holes on damaged pods.

The data collected were transformed using the square root transformation. Analysis of Variance was carried out with GEN-STAT (2003). Treatment means showing significant difference ($P<0.05$) were separated using New Duncan's Multiple Range Test.

Results and Discussion

The results of the present study show that there are 7 Orders of insects associated with Bambara groundnut in Ilorin. The Order Hemiptera and Homoptera are the two predominant Orders of insects attacking Bambara groundnut throughout its growing season, with Order Homoptera being the most abundant followed by Hemiptera. Other orders such as Diptera, Coleoptera, Orthoptera, Lepidoptera and Hymenoptera also attack the plant but to a lesser degree. The Orders Hemiptera and Homoptera were present from the seedling (week 3) to podding stage (week 12) of the crop (Fig. 1), while the Orders Hymenoptera, Diptera, Coleoptera, Lepidoptera and Orthoptera respectively were only present from the seedling (week 3) to the flowering stage (week 9) (Fig. 1).

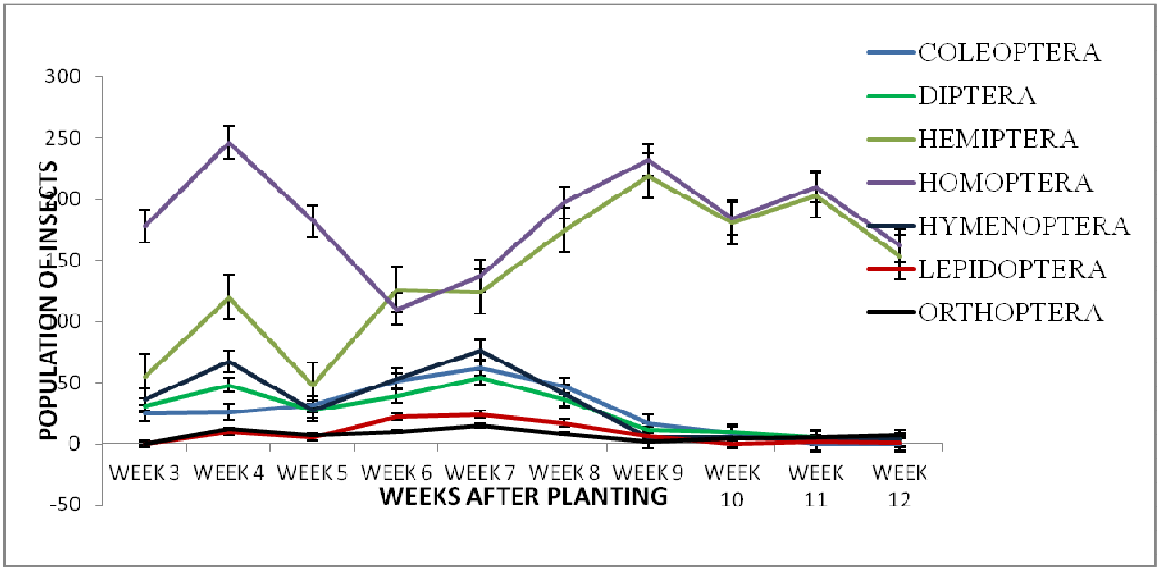

Fig. 1: Populations of insect Orders associated with Bambara groundnut

The botanicals tested proved to be effective in reducing the insect population which resulted in an increase in the number of flowers produced per plot. There was a significant difference (P< 0.05) between the treatments and the control at week 8, 9 and 11 (Table 1). Aqueous extract of lemon grass treated crop had a higher flower count when compared to Jatropha treated plant but there was no significant difference (P> 0.05) between the botanicals (Table 1).

Table 1: Effects of treatments on the mean number of flowers/plot

	Weeks after Planting								
	4	5	6	7	8	9	10	11	12
Treatments									
Jatropha	0.0±0.0a	8.5±3.3a	30.0±1.1b	27.3±0.5b	32.3±1.6b	13.8±3.4c	2.5±1.0b	1.3±1.0c	4.0±0.4b
Lemon grass	0.0±0.0a	8.8±6.6a	19.3±2.7c	30.3±1.1b	35.3±0.5b	14.3±1.6c	1.50±0.7b	13.5±2.3b	5.0±0.4b
Cypermethrin	0.0±0.0a	25.8±3.0a	39.3±1.0a	50.3±1.3a	55.0±1.1a	45.0±3.1a	33.8±1.0a	30.0±2.2a	15.5±2.4a
Control	0.0±0.0a	16.3±7.0a	23.8±3.0bc	26.5±1.0b	25.5±1.0c	26.0±0.4b	1.0±0.5b	6.50±1.0c	2.50±1.4b

Values in a column followed by the same letter (s) are not significantly different at P< 0.05
Values are means ± standard error of means

The botanicals were able to reduce the population of insects which resulted in an increase in the number of undamaged pods (Table 2). Aqueous leaf extracts of lemon grass had the highest mean number of undamaged pods (38) and this was higher than the value for aqueous Jatropha leaf extract (19.3) and the control (21.75) though it was not significantly different (P>0.05). Meanwhile aqueous Jatropha leaf extract had the lowest mean number of damaged pods (4.75) and it was not significantly different (P>0.05) to the value of cypermethrin (1.25) (Table 2). Aqueous leaf extract of lemon grass had a high mean number of damaged pods (12) and it was not significantly different from the control (15) (Table 2).

In this study, lemon grass appeared to be more effective than Jatropha in protecting Bambara nut on the field. This is evident as lemon grass treated crops gave a two- fold increase in yield when compared to the untreated crops. The effectiveness of lemon grass could be as a result of the presence of phyto-constituents in the essential oils that contain Citral α, Citral β, Nerol Geraniol, Citronellal, Terpinolene, Geranyl acetate, Myrecene and Terpinol Methylheptenone (Negrelle and Gomes, 2007; Akhila, 2010 and Faruq, 1994).

Table 2: Effects of treatments on mean number of pods

	Number of Pods	
Treatments	Damaged Pods	Undamaged Pods
Jatropha	4.75±1.44bc	19.3±8.03b
Lemon grass	12.0±3.34ab	38.0±10.98b
Cypermethrin	1.25±1.25	203.5±34.95a
Control	15.0±1.29a	21.75±7.73b

Values in a column followed by the same letter (s) are not significantly different at P< 0.05

Values are means ± standard error of means

Though there was no significant difference (P> 0.05) between the treatments and the control, aqueous leaf extract of lemon grass had a higher mean weight of undamaged pods (35.4g) and this was higher than the control (14.0g) which had the least value (Table 3). This study shows that Bambara groundnut is able to tolerate field insect pests since there was no difference in the yield obtained from the control and those obtained from the botanicals. Nonetheless, application of the botanicals showed that Bambara groundnut can produce a considerably higher yield if properly protected from insect pests. In this study, lemon grass appeared to be more effective than Jatropha in protecting Bambara nut on the field. This is evident as lemon grass treated crops gave a two-fold increase in yield (35.4g) when compared to the untreated crops (14g) (Table 3).

Table 3: Effects of treatments on mean weight of pods

	Weight (g)	
Treatments	Damaged Pods	Undamaged Pods
Jatropha	3.94± 2.54a	12.5±6.64b
Lemon grass	2.99±1.54a	35.4±19.86b
Cypermethrin	0.46±0.46a	216.9±68.45a
Control	5.00±1.22a	14.0±5.77b

Values in a column followed by the same letter (s) are not significantly different at P< 0.05

Values are means ± standard error of means

The trend was similar for the number of holes on damaged pods. There was no significant difference (P> 0.05) between the treatments and the control for the number of holes on damaged pods, though aqueous leaf extract of lemon grass had lower number of holes (12.5) compared to the control (15.75) (Table 4). The effectiveness of lemon grass could be as a result of the presence of phyto-constituents in the essential oils that contain Citral α, Citral β, Nerol Geraniol, Citronellal, Terpinolene, Geranyl acetate, Myrecene and Terpinol Methylheptenone (Negrelle and Gomes, 2007; Akhila, 2010 and Faruq, 1994).

These constituents were reported to have insecticidal repellent properties (Cavalcanti *et al*., 2004; Kumar *et al*., 2013). Garcia and Azambuja (2004) reported that the volatile, odorous and lipophilic characteristics of the essential oils can be toxic to insects, induce their

behavioural modifications, provoke direct disruption of specific physiological routes related to neuroendocrine systems and in their reproduction. Some studies also reveal that *C. citratus* essential oil and their main components (Citral α and 1,8 cineole) are important repellent and insecticides against flies, but these studies are mainly focused on instant effectiveness after application and not in long time effects (Kumar *et al*., 2013; Sinthusiri and Soonwera, 2013).

Table 4: Effects of treatments on mean number of holes on damaged pods

Treatments	Mean number of holes
Jatropha	14.25±4.05a
Lemon grass	12.50±2.78a
Cypermethrin	0.00±0.00b
Control	15.75±2.56a

Values in a column followed by the same letter (s) are not significantly different at P< 0.05

Values are means ± standard error of means

Solsoloy and Solsoloy (2000) and Adebowale and Adedire (2006) showed that jatropha products reduced significantly nesting insects at high concentrations and caused total mortality of eggs and larvae regardless of concentration. According to these authors, the insecticides effects could be caused by sterols and terpene alcohols contained in jatropha product. In this study, the active ingredients of *J. curcas* did not appear to be as effective as that of *C. citratus* since lemon grass treated crops had a two-fold increase in the yield when compared to *J. curcas* treated crops.

Conclusion

The result from this study shows that Bambara groundnut has two predominant insect Orders, Homoptera and Hemiptera associated with it from the seedling to podding stage while insects in the Orders Diptera, Coleoptera, Orthoptera, hymenoptera and Lepidoptera also attacked the plant but to a lesser degree. The botanicals evaluated possessed insecticidal potentials against some field insect pests of Bambara groundnut. Aqueous leaf extract of lemon grass was more effective in increasing the yield of Bambara groundnut giving a two-fold increase in yield.

References

Abulude, F.O., Ogunkoya, M.O. and Ogunleye, R.F. (2007). Storage properties of oils of two Nigeria oil seeds *Jatropha curcas* (Physic nut) and *Helianthus annus* (Sunflower). *Am. J. Food Tech.* 2(3): 207-211.

Adebowale K.O. and Adedire C.O. (2006). Chemical composition and insecticidal properties of the underutilized Jatropha curcas seed oil. *Afri. J. Biotechnol*., 5(10): 901-906.

Akhila, A. (2010). Essential oil-bearing grasses: The genus Cymbopogon. Medical and aromatic plants-industrial profile. Edited by Akhila, A.Boca Raton, FL: CRC Press Taylor & Francis Group

Amarteifio, J.O., Sawula, G. and Gibbons, M.R.D. (1997). Comparison of four landraces of Bambara groundnut. *Trop. Sci.,* 37: 143-145.

Amarteifo, J.O., Tibe, O. and Njogu, R.M. (2006). The mineral composition of bambara groundnut

(*Vigna subterrenea*) (L.) (Verdc.) grown in southern Africa. *African Journal of Biotechnology* 5(23): 2408-2411.

Baudoin, J.P. and Mergeai, G. (2001). Grain Legumes in Crop production in Tropical Africa. P. 313 – 317. BNARDA (2003). Annual Report. P25

Cavalcanti, E.S.B., Morais, S.M., Lima, M.A.A. and Santana, E.W.P. (2004). Larvicidal activity of essential oils from Brazilian plants against *Aedes aegypti* L. *Mem Inst Oswaldo Cruz*; 99(5): 541-544. http://dx.doi.org/10.1590/S0074-02762004000500015. PMid:15543421

Coudert, M.J. (1984). Cowpea and Bambara groundnut; prospects for regional trade development in West Africa. FAO microfiche XF 83322635. International Trade Centre UNCTAD/GATT, Geneva, Switzerland.

Doku, E.V. (1999). Problems and Prospects for the Improvement of Bambara Groundnut. In: Proceedings of the International Bambara Groundnut Symposium. University of Nottingham UK.

Doku, E.V. and Karikari, S.K. (1970). Flowering and pod production of bambara groundnut. *Ghana Journal of Agricultural Science* 3:17-26.

Enwere, N.J. (1998). Foods of plants origin: Processing and utilization with recipes and Technology profiles. Afro-orbis Publishers, Nsukka, Nigeria. p59-61.

Faruq, M.O. (1994). TLC technique in the component characterization and quality determination of Bangladeshi lemongrass oil (*Cymbopogon citratus* (DC) Stapf.) *Bangladesh J. Sci. Ind. Res.*, 29: 27–38.

Garcia, E.S. and Azambuja, P. (2004). Lignoids in insects: chemical probes for the study of ecdysis, excretion and Trypanosoma cruzi-triatomine interactions. *Toxicon*, 44(4): 431-440. http://dx.doi.org/10.1016/j.toxicon.2004.05.007. PMid:15302525

GenStat (2003). GenStat for Windows. Release 4.23DE Discovery Edition. VSN International Ltd., Hemel Hempstead, UK

Kumar, P., Mishra, S., Malik, A. and Satya, S. (2013). Housefly (*Musca domestica* L.) control potential of *Cymbopogon citratus* Stapf. (Poales: Poaceae) essential oil and monoterpenes (citral and 1,8-cineole). *Parasitol Res*; 112(1): 69-76.

Linnemann, A.R. (1992). Bambara groundnut (*Vigna subterranea*) literature: a revised and updated bibliography. Tropical Crops Communication 7. Department of Tropical Crop Science, Wageningen Agricultural University, Netherlands, pp. 124.

Mabika, V. and Mafongoya, P. (1997). Zimbabwe country report. In: Bambara groundnut (*Vigna subterranea* [L.] Verdc.). In: Proceedings of the Workshop on Conservation and Improvement of Bambara Groundnut (*Vigna subterranea* [L.] Verdc.). Publisher, International Plant Genetic Resources Institute, Rome, Italy.P 162.

Mkandawire, C. (2007). Review of Bambara groundnut (*Vigna*

subterranean (L.) Verdc. Production in sub-sahara Africa. *Agricultural Journal,* 2(4): 465-470.

Negrelle, R.R. and Gomes, E.C. (2007). *Cymbopogon citrates* (DC) Stapf: Chemical Composition and Biological Activities. *Revista Brasileira De Plantas Medicinais, Botucatu*, 9(1):80-92.

Oguntunde, A.O. (1985). Development of new food products from readily available raw materials. Paper presented at the Nigerian Institute of Food science and Technology Training workshop Ibadan, Nigeria.

Ojimelukwe, P.C. (1992). Oligosaccharide composite and functional properties of flour and starch isolates from four cultivars of Bambara groundnut seeds, *Journal of Food Science and Technology*, 29: 319-321.

Rachie, K.O. and Silvestre, P. (1977). Grain legumes. In: C.L. Leakey and J.B. Wills (Eds.). Food crops of the lowland tropics. Oxford University Press, London, pp. 41-47.

Rowland, J.R.J. (1993). Bambara Groundnut. In: Rowland J.R.J. (ed). Dryland Farming in Africa, Macmillan Ltd., London, pp. 278-282.

Sellschop, J.P.F. (1962). Cowpeas (*Vigna unguiculata* (L) Walp). *Field Crop Abstracts* 15(4): 259-266.

Sesay, A., Kunene, I.S. and Earnshaw, D.M.(2001). Farmers' knowledge and cultivation of bambara groundnut (*Vigna subterranea* (L.) Verdc.) in Swaziland. *UNISWA Research Journal of Agriculture, Science andTechnology* 3: (1) 27-37.

Sinthusiri, J. and Soonwera, M. (2013). Efficacy of herbal essential oils as insecticides against the housefly, *Musca domestica*L. *Southeast Asian J. Trop. Med. Public Health*; 44(2): 188-196.

Solsoloy, A.D. and Solsoloy, T.S. (2000). Insecticide resistance management in cotton in the Philippines. Philippine *J. Crop Sci.*, 25: p. 26.

Udo, I.O. (2011). Potential of *Zanthoxylum xanthoxyloids* (LAM) for the control of stored product insect pests. *Journal Stored Product and Postharvest.* Res. Available online at: http://www.academicjournals.org/JSPPR.2:40-44.

World Climate (2013). NOAA National Centre for Environmental Information, State of the Climate: Global Analysis for Annual 2013. Available: http://www.ncdc.noaa.gov/sotc/global/2013.