YIELD AND COST-BENEFIT ANALYSIS OF COWPEA PRODUCTION USING THREE BOTANICAL PESTICIDES AND ONE SYNTHETIC INSECTICIDE AT DIFFERENT PERIODS OF APPLICATION

F. A. AJAYI[1]* AND S. A. RAHMAN[2]

[1]*Nasarawa State University, Keffi, Faculty of Agriculture, Department of Agronomy, P.M.B. 135, Shabu-Lafia, Nasarawa State, Nigeria.

[2]Nasarawa State University, Keffi, Faculty Of Agriculture, Department of Agric. Economics and Extension, P.M.B. 135, Shabu-Lafia, Nasarawa State, Nigeria.

*Author for correspondence. E-mail: faajayi_dr@yahoo.com

(Received 25 June 2007, Accepted 30 August 2007)

ABSTRACT

Cowpea growers have long recognised the usefulness of synthetic insecticides, but factors such as availability and cost have constrained its use. In order to boost cowpea production there is need to develop effective, low-cost and readily available technologies for insect pest control. This study evaluated the yield and economic returns of cowpea during the raining seasons of 2003 and 2004 at the Teaching and Research Farm of the College of Agriculture, Lafia (Lat. 08: 32'E) in Nasarawa State of Nigeria using aqueous leaf extracts (ALE) from three botanicals (Neem, wild basil and Eucalyptus) and one synthetic insecticide (Cypermethrin^R 10% EC). The data obtained were subjected to two-way analysis of variance and gross marginal analysis. Spraying twice in a day (morning and evening) significantly ($P<0.05$) improved the effectiveness of both the botanicals and the synthetic insecticides in the two seasons with mean yield values of 385.30 and 342.15 Kgha^{-1} when compared with spraying alone in the morning (164.63 and 169.05 Kgha^{-1}) and evening alone with values of 236.78 and 189.24 Kgha^{-1}. Among the botanicals, only neem positively influenced the yield and economic returns in cowpea production, but not as effective as the synthetic insecticides. The economic benefit for using neem extracts in controlling the insect pests was 168.09% gain in gross margin over the control. Cypermethrin^R was the most effective with 214.57% gain in gross margin.

Keywords: *Botanical insecticides, cowpea production, cost-benefit analysis, time of spray, Cypermethrin^R*

INTRODUCTION

Cowpea, (*Vigna unguiculata* L. Walp.) is an important leguminous crop grown primarily for its cheap source of dietary protein in the third world where meat is expensive

(Stanton, 1966). Their high protein lysine content make them a natural supplement to staple diets of cereals, roots and tubers (Bresami, 1985) and they are also an important source of fodder for domestic animals (Alzouma, 1989). Unfortunately, cowpea is attacked by a wide range of insect pest throughout the geographical ecology where it is grown (Apeji, 1988). Insect attack starts on cowpea right from the time of germination to harvest and these often lead to huge yield loss (Jackal *et al.*, 1992; Kabeh and Lale, 2004).

Cowpea needs to be protected from these insect pests so that farmers can obtain marginal profit. Most often, more than one spray regime is required to protect cowpea against insect pest attack (Metcalf, 1975). Presently the use of synthetic insecticide is the most popular effective method of controlling the menace of insect pests that decimate the crop (Apeji, 1988). However, despite the effectiveness of these pesticides, they are currently very expensive and so many cowpea growers cannot afford them (Afun *et al.*, 1991). Also, there is an increasing world-wide outcry against the heavy usage of agro-chemicals like insecticides because of their undesirable side effects on non-target organisms including man. They are also environmentally disruptive (Metcalf, 1975; 1992; Jilani, 1992; Larew, 1992; Emosairue and Ubana, 1998).

Due to these problems, an alternative to the use of synthetic pesticides are sought for in keeping with the philosophy and principles of integrated pest management (IPM) which advocates for a reduction in the use of synthetic pesticides, a stabilization of crop yield, increase of farmers profits while ensuring an ecological balance (Jilani, 1992; Emosairue and Ukeh, 1996). To this end, plant derivative pesticides are being used in order to ward-off pests. Some of these plant products have had long history of usage among traditional farmers mostly as protectants of produce against stored product pests (Golob and Webley, 1980). Others that are used in the control of field pests, do not completely knock down the pests as in the case with synthetic insecticides, but they are gaining more popularity in their usage because their use reduces the high cost of pest control, they are safer to use without much hazard to the user and they give good marginal profit (Jackai *et al.*, 1992; Emosairue and Ubana, 1998).

This study reports the bioefficacy of aqueous extracts of leaves of neem (*Azadirachta indica* A. Juss), wild basil (*Ocimum suave* Willd) and Eucalyptus (*Eucalyptus* spp.) on the yield of cowpea, IAR 48. Secondly to assess the cost effectiveness of the use of these plant products against standard synthetic insecticide, Cypermethrin^{R} 10% EC.

MATERIALS AND METHODS

The study was conducted during the rainy season of 2003 and 2004 at the Teaching and Research Farm of College of Agriculture, Lafia, Nasarawa State of Nigeria. The area falls within the Guinea savannah zone of North Central Nigeria and is located between

Latitude 08°. 33°N and Longitude 08°. 32°E. The cowpea seeds IAR 48, used for the study is reported to be characterised by its susceptibility to field pests and was developed by the Institute for Agricultural Research (IAR) of the Ahmadu Bello University, Zaria.

The three botanical pesticides used for the study were obtained from the environment surrounding the Teaching and Research Farm; while the synthetic insecticide (Cypermethrin^R) was purchased from a pesticides dealer in Lafia. Leaves of neem, wild basil and Eucalyptus were plucked fresh from trees or shrub 12 hrs before spraying. At each time of plucking, the leaves were rinsed with distilled water to rid them off any dirt. Thereafter, 2 Kg each of the leaves of neem, wild basil and Eucalyptus were weighed, respectively. The leaves were separately pounded with a mortar and pestle to pulverize them so that the active principle in the leaves can be freely released in water. This was carried out at the prevailing ambient temperature. Afterwards, the pounded leaves were put in a 12 litre plastic buckets separately and 8 litres of distilled water was added. The leaves were then dispersed in the water, stirred and allowed to stand for 12 hr according to the method of Ajayi and Lale (1999), after which it was filtered using a cheese cloth. Two litres of water was added to the filtrate obtained from each macerated bio-pesticide to make up to 10 litres, and this was used for the experiment.

After land preparation, single super phosphate (SSP) was broadcast over the area at the rate of 90 Kg P/ha in order to enhance nodulation, faster root and shoot development (Mughogho *et al.*, 1985). The field was marked out into four blocks with each block containing 15 plots of 2x2 m. Each plot and the blocks were separated by a space of 1 m. Cowpea seeds were sown 2 seeds per stand at the rate of 15 Kg/per hectare and at a depth of 2.5 cm at a spacing of 45 x 45 cm towards the end of July in 2003 and 2004. Two hand weeding were carried out during the duration of the trials by hand hoeing at two and five weeks after sowing.

The trial was laid out in a randomised complete block design and replicated four times in a factorial arrangement thus giving 60 experimental plots. Treatments consisted of one dosage rate (20%) (Emosairue and Ukeh, 1996) of aqueous leaf extracts (ALE) of neem, wild basil and Eucalyptus and recommended rate of Cypermethrin^R 10% EC (3.5 litres/ha) and untreated check (control). The plots were sprayed once in the morning (7.00 am - 9.00 am); once in the evening (5.00 pm - 7.00 pm) or both morning and evening. Effluents from macerated bio-pesticides and Cypermethrin^R was applied in 10 litres of water to the four plots constituting the replications in each treatment at bi-weekly intervals using a CP-15 Knapsack sprayer from 2 weeks after sowing (WAS) to a maximum of four sprays. Untreated check was sprayed with distilled water only at each time of spraying period.

Ripped pods were harvested 90 days after sowing and threshed. The grains were thereafter sun dried to a moisture content of 12% for safe storage. The mean yield of

cowpea seeds obtained from each plot for each season was expressed in Kg per ha. Data obtained were subjected to two-way analysis of variance and differences between means were determined using the least significant difference (LSD) statistic. Gross margin analysis was employed to examine the cost-benefit status of every treatment for ascertaining the economic feasibility of synthetic and botanical pesticides.

The Gross Margin as expressed by Rahman and Lawal (2003) is:

$$=Qv\ Pv - \Sigma X_1\ P_{xi}$$

Where,
GM = Gross margin (₦/ha)
Q_y = Yield of cowpea (kg/ha)
P_y = Farm gate price of cowpea (₦/kg)
X_i = Quantity of ith input used per hectare
Px_i = Price per unit of the ith input.
Σ = Summation sign.

RESULTS AND DISCUSSION

The effects of aqueous leaf extracts of neem, wild basil and *Eucalyptus* and Cypermethrin^R on yield of cowpea seeds for the two seasons are shown in Table 1. The yield of cowpea seeds obtained in treated plots with biopesticide and synthetic insecticides in 2003 and 2004 are significantly higher than in untreated plots ($P<0.05$). Treatments with Cypermethrin^R performed significantly better than all three botanical pesticides. Cowpea seed yield obtained from plots sprayed with aqueous leaf extract of neem was significantly higher than in plots treated with *Eucalyptus* and wild basil aqueous leaf extracts. Significantly higher yield was obtained from treated plots sprayed both in the morning and evening times than in plots sprayed in the evening or morning times alone. There was no significant differences ($P>0.05$) between spraying periods in untreated check during the two season of trials.

The results of this study have shown that the yield obtained from treated plots especially with Cypermethrin^R was significantly higher than the yields obtained from plots treated with the botanicals. Aqueous neem leaf extract on the other hand was more effective than extracts from wild basil and Eucalyptus leaves. The result of this study has shown that aqueous neem leaf extract can be as effective in comparison with the use of synthetic insecticides for the control of pests of field crops (Jackai, 1993, Emosairue and Ubana, 1998). The reason for the better performance of the synthetic insecticide could be due to its higher biological efficacy (Metcalf, 1975). Although, neem plant products on the other hand have been reported to contain a cocktail of active principles among which the most active principle is azadirachtin (Butterworth and Morgan, 1971); but the mode of extraction of the active ingredients contained in plant products have been reported to be a major factor

influencing their effectiveness (Vietmeyer, 1992). Also, both Eucalyptus and wild basil are reported to contain volatile oils, much of which contain monoterpenes and some isolated alkly isothiocyanate compound (Chogo and Crank, 1981; Rehm and Espig, 1991). It is possible that some of the active compounds contained in these natural plant products were not released into the water solvent. On the other hand, the use of Eucalyptus and wild basil has found much application in the protection of pests of stored products (Poore and Fries, 1985; Warren *et al.*, 1991).

Table 1: Mean yield of cowpea seeds in Kgha^{-1} obtained in protected and unprotected plots sprayed with three botanicals and one synthetic insecticide at three different periods.

	Pesticides					
Time of spray	Control	Neem	Wild basil	Eucalyptus	Cypermethrin	Mean
			2003			
Morning	82.98	196. 36	112. 17	144.45	287.17	164.63
Evening	92.77	324. 28	152. 03	205.88	408.95	236.78
Morning and evening	92.74	676. 65	203. 03	224.83	729.26	385.30
Mean	89.50	399. 10	155. 74	191.72	475.12	

SED = 21.17, LSD (0. 05) = 42.79 (Pesticides); SED = 16.40, LSD (0. 05) = 33.14 (time of Spray); SED = 36. 67, LSD (0.05) = 74. 11 (Interaction)

			2004			
Morning	65. 40	211. 73	88. 25	95.97	383.88	169.05
Evening	65. 53	268. 56	102. 67	128.01	381.44	189.24
Morning and evening	63. 24	581.76	188. 27	221.88	655.60	342.15
Mean	64. 72	354. 02	126. 39	148.62	473.65	

SED = 24.34, LSD (0.05) = 49. 19 (Pesticides); SED = 18.85, LSD (0.05) = 38. 10 (Time of Spray); SED = 42.16, LSD (0. 05) = 85. 21 (Interaction)

In order to obtain a significant yield of cowpea seeds, it has been suggested that more than one spray of pesticide is necessary (Jackai and Daoust, 1986). In this study, though more than one spray of pesticide was carried out in all the treated plots; some plots received at least two sprays of pesticide a day. This is because cowpea pests generally hibernate during the day especially when it is sunny (Matteson, 1982). Therefore, for a

Table 2: Cost-benefit of synthetic and botanical pesticides for the protection of cowpea against insect pests using cowpea yield for tow season, 2003 and 2004.

Production Variable	Cost/ha (₦)*				
	Control	Cypermethrin	Neem	Wild basil	Eucalyptus
Seed	900.00	900.00	900.00	900.00	900.00
Fertilizer	1880.00	1880.00	1880.00	1880.00	1880.00
Pesticide	-	1650.00	500.00	500.00	500.00
Land preparation	2500.00	2500.00	2500.00	2500.00	2500.00
Planting	1000.00	1000.00	1000.00	1000.00	1000.00
Fertilizer application	500.00	500.00	500.00	500.00	500.00
Pesticides application	-	400.00	400.00	400.00	400.00
Weeding	6000.00	6000.00	6000.00	6000.00	6000.00
Harvesting	2000.00	2000.00	2000.00	2000.00	2000.00
Total variable cost	14780.00	16830.00	15680.00	15680.00	15680.00
Mean yield for two seasons (Kg/ha^{-1})	77.11	474.38	376.65	141.07	170.17
Farm-gate price (₦/kg^{-1})	60.00	60.00	60.00	60.00	60.00
Revenue (₦/ha^{-1})	4626.60	28462.80	22593.60	8464.20	10210.20
Gross Margin (₦/ha^{-1})	-10153.40	11632.80	6913.60	-7215.80	-5469.80
Percentage gain in gross margin over the control (%)	-	214.57	168.09	28.93	46.13

*Conversion rate, US dollar = ₦130.00

Note: Cost of labour used for obtaining the extracts represents Cost of pesticide for botanicals.

pesticide spray to be effective in curtailing the activities of field pests there is need to capture the pests at the time when they are vulnerable at the peak of their activities. Hence, spraying in the morning and in the evening times or at the two times in a day was to capture any insects that might have escaped the effects of the pesticides at any of the spraying time in the morning or in the evening times.

Data on cost-benefit analysis (Table 2) show that, it is profitable to use either Cypermethrin^R or neem extracts to control insects in cowpea production. The gross margin of ₦11,632.80 and ₦6,913.80 per hectare was obtained by spraying Cypermethrin^R and neem extract, respectively. This agrees with Rahman and Macaver (2000) that neem extracts as insecticides could increase economic returns and resource productivity in cowpea production. Negative gross margin was recorded for cowpea production under the use of wild basil (-₦7,215.80) and *Eucalyptus* (-₦5,469.80). Among the three botanicals only neem was economically beneficial in controlling the insect pests with 168.09% gain in gross margin over the control. Cypermethrin^R was the most effective with 214.57% gain in gross margin.

REFERENCE

Afun, J. V. K, Jackai, L. E. N. & Hodgson, C. J. 1991. Calendar and monitored insecticide application for the control of cowpea pest. *Crop Protection.* 10:363-700.

Ajayi, F. A. & Lale, N. E. S. 1999. Evaluation of aqueous neem (*Azadirachta indica* A. Juss) seed extract and pirimiphos-methyl for the control of tomato fruit worm, Helicoverpa (Heliothis) armigera (Hubner) in Maiduri, Nigeria. *Bioscience Research Communications,* 11:165-172.

Alzouma, I. 1989. Economic incidence of sahelian cowpea bruchids in Africa. Propositions for controlling this grain legume pests. In: Yoshidas T. (ed). Loss from control of Bruchid in developing countries (1-14) Okayama: ISBL.

Apeji, S.A. 1988. Pests of cowpea and soyabean in Nigeria. Kaduna Federal Department of Pest Control Services 31p.

Bresami, R. 1985. Nutritive value of cowpea. In: Sigh, S. R. and Rachie, K. O. (eds). Cowpea Research Production and Utilization. (353-359) New-York: John Willey and Sons.

Butterworth, J. H. & Morgan E. D. 1971. Investigation of the locust feeding inhibition of the seeds of the neem tree, *Azadirachta indica. Journal of Insect Physiology.* 17: 969-77

Chogo, J. B. & Crank, G. 1981. Chemical composition and biological activity of the Tanzanian plan, *Ocimum suave. Journal of Natural Products.* 44: 308-11.

Emosairue, S. O. & Ubana, U. B. 1998. Field evaluation of neem for the control of some cowpea pests in south eastern Nigeria. *Global Journal of Pure and Applied Sciences,* 4: 237-41

Emosairue, S. O.& Ukeh, D. A. 1996. Field trial of neem product for the control of okra flea beetles (*Podagrica* spp.) in south eastern Nigeria. *Global Journal of Pure and Applied Sciences,* 3: 13-19.

Golob, P. & Webley, D. T. 1980. The use of plants and mineral in traditional protectants of stored products. Chatham, Tropical Products Institute, G138.

Jackai, L. E. N. & Daoust, R. A. 1993. The use of neem in controlling cowpea pests. *IITA Research Highlights.* 7: 5-11.

Jackai, L. E. N. & Daoust, R. A. 1986. Insect pests of cowpeas. *Annual Review of Entomology,* 31: 95-119.

Jackai, L. E. N. Inang, E. E. & Nwobi, P. 1992, The potential for controlling post-flowering pests of pests of cowpea, *Vigina unguiculata* Walp, using neem, *Azadirachta indica* A. Juss. *Tropical Pests Management* 38: 58-60

Jilani, G. 1992. A decade of research on botanical pest control in Pakistan. In: Proceedings of the Final Workshop on Botanical Pest Control Project, Phase 2. (28-31). July 1992.

Kabeh, J. D. & Lale, N. E. S. 2004. Effects of pre-harvest sprays on neem (*Azadirachta indica* A. Juss) seed products and pirimiphos-methyl and harvest time modification on infestation of cowpeas by storage Bruchids in the field and store in Maiduguri, Nigeria. *Nigerian Journal of Entomology,* 21: 104-16.

Larew, H. 1992. Recent scientific advances in botanical pest control. In: Proceedings of the Final Workshop on Botanical Pest Control Project Phase 2. (5-13), July, 1992.

Metcalf, R. L. 1975. Insecticide in pest management. In: Metcalf. R. L. and Lukman. W. H. (eds.) *Introduction to Insect Pest management.* New-York, John Wiley and Sons

Matteson, P. C. 1982. The effects of intercropping with cereals and minimal permethrin applications on insect pests of cowpea and their natural enemies in Nigeria. *Tropical Pest Management* 28: 372-80.

Mughogho, S. K., Bationo, A., Christianson, B. & Vlek, P. L. G. 1985. Management of N and P fertilizers for tropical African soils. Proceedings of a symposium on Management of N and P fertilizers in sub-Saharan Africa.

Poore, M. E. D. & Fries, C. 1985. The ecological effect of Eucalyptus. FAO Forestry Paper No. 59. FAO/SIDA, Rome.

Rahman, S. A. & Lawal, A. B. 2003. Economic analysis of maize-based cropping systems in Giwa Local Government Area of Kaduna State, Nigeria. *ASSET, Series* A, 3: 139-148.

Rahman, S. A. and Macaver, O. J. (2000). The effects of neem leaf extracts as insecticides on cowpea production in Daudawa village. Katsina State, Nigeria. *Nigerian Journal of Technical Education,* 17: (1 & 2), 1-9.

Rehm, S. & Espig, G. 1991. *The cultivated plant of the Tropics and subtropics.* Germany: Verlag Josef Margraf, 552pp

Schmutterer, H. 1990. Properties and potentials of natural pesticides from the neem tree. *Annual Review of Entomology,* 35, 271-98.

Singh, S. R. & Allen, D. J. 1980. Pest disease resistance and production of *Vigna unguiculata* (L) Walp. In: Summerfield, R. J. and Bunting, A. H. (eds.). *Advances in Legumes Sciences* 419-43. London: Royal Botanical Garden and Ministry of Agriculture, Fish and Food.

Stanton, W. R. 1996. *Grain Legumes in Africa.* Rome FAO.

Vietmeyer, N. D. (1992). Neem: a tree for solving global problems. Report of an adhoc panel of the Board of Science and Technology for International Development, National Research Council, Washington, D.C.: National Academy Press, 141pp.

Warren, D. K., Dunkel, F. V., Ntezurubanza, L., Jackson, L. L. & Stock, D. T. 1991. The efficacy of Linalool a major component of freshly milled *Ocimum canum* Sims. (Lamiaceae), for protection against post-harvest damage by certain stored product Coleoptera. *Journal of Stored Products Research,* 27, 213-20.