Field Evaluation of Extracts of Five Nigerian Spices for Control of Post-Flowering Insect Pests of Cowpea, *Vigna unguiculata* (L.) Walp.

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Abstract

Oparaeke A. M., Dike M. C., Amatobi C. I.: **Field evaluation of extracts of five Nigerian spices for control of post-flowering insect pests of cowpea**, *Vigna unguiculata* (L.) Walp. Plant Protect. Sci., **41**: 14–20.

The insecticidal efficacy of aqueous extracts of five Nigerian spices (*Piper guineense* Schum and Thonn., *Aframomum melegueta* (Roscoe), *Xylopia aethiopica* (Dunal) A. Rich., *Zingiber officinale* L. and *Capsicum annuum* L.) was tested in a field study for the control of two important post-flowering insect pests, *Maruca vitrata* Fab. (*Lepidoptera*: *Pyralidae*) and *Clavigralla tomentosicollis* Stal. (*Hemiptera*: *Coreidae*) of cowpea. The extracts were applied at 10% (w/v) and sprayed every week for 4 weeks. *P. guineense,* followed by *A. melegueta,* significantly reduced ($P < 0.01$) abundance of the pests and decreased the damage to cowpea pods. Grain yields were significantly higher in plots treated with *P. guineense* and *A. melegueta* extracts compared to plots treated with other extracts. This technology is cheap, safe, environmentally friendly and easy to adopt by limited resource farmers in third world countries.

Keywords: spices; extracts; *Maruca vitrata*; *Clavigralla tomentosicollis*; control; cowpea

Cowpea, *Vigna unguiculata* (L.) Walp is an important food crop and accounts for about 60% of human protein intake in Nigeria. Yields are low (< 200 kg/ha) on farms owned by limited resource farmers in the northern Guinea Savanna who produce the bulk of cowpea grains consumed in the country. Several biotic factors are responsible for the losses on fields, most importantly infestation by insect pests at all stages of plant growth. This may include severe damage at the reproductive stage of the crop. The responsible pest complex consists of the flower bud thrips *Megalurothrips sjostedti* Trybom, legume pod borer *Maruca vitrata* Fab., and several species of pod sucking bugs of which *Clavigralla tomentosicollis* Stal. is dominant, and aphids, mostly *Aphis craccivora* Koch (Singh *et al.* 1997). Of these, *M. vitrata* alone causes losses in field cowpea varying from 20–80% in different parts of Africa (Singh & Allen 1980). Similarly, losses from infestation by pod sucking bugs are estimated at about 60–90% (Jackai *et al.* 1989).

While chemical control of these pests is popular and effective (Jackai & Daoust 1986), the improper application of pesticides has resulted in environmental, human health problems and insect resistance (Perkins 1982). The high cost of importing pesticides, aggravated further by local currency devaluation, not only creates a serious drain on the economy of countries with low Gross Domestic Products such as Nigeria, but also makes such pesticides unaffordable to limited resource farmers. In response, locally

available and economically sustainable products and crop protection strategies are now being developed to control crop pests in these countries. The strategies include the use of plant extracts (botanical pesticides) and mineral products. At the Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria, studies on alternatives to synthetic insecticides are aimed at developing a pest management strategy that will use locally available resources (plant extracts and mineral products) which are less harmful, effective and affordable for the control of noxious pests ravaging crops in the mandate ecological zone. Available information on investigations worldwide on insecticidal plants (Saxena 1989; Schmutterer 1990) indicates that most of the trials dealt with storage pests (Ivbijaro 1983; Lale & Ajayi 1996; Oparaeke & Dike 1996). However, extracts of neem, *Azadirachta indica* A. Juss (Olaifa & Adenuga, 1988; Jackai *et al.* 1992); *Dennetia tripetala* Baker (Iwuala *et al.* 1981); *Allium sativum* L. (Oparaeke *et al.* 2000); *Syzygium aromaticum* (L.) Merr & Perr. (Oparaeke *et al.* 2002) and of *P. guineense* Schum & Thonn. and *Lippia adoensis* Hoschst (Olaifa *et al.* 1987) have all been found effective against a number of insect pests of cultivated crops. The present study was aimed at investigating the insecticidal efficacy of extracts from five spices grown in Nigeria (*Piper guineense* Schum & Thonn., *Xylopia aethiopica* (Dunal) A. Rich., *Aframomum melegueta* (Roscoe), *Zingiber officinale* L., and *Capsicum annuum* L.) to protect cowpea against post-flowering insect pests.

MATERIALS AND METHODS

Dried fruits of West African black pepper (*P. guineense*), Aethiopian/African pepper, (*X. aethiopica*), Alligator pepper (*A. melegueta*), Ginger (*Z. officinale*) and Chilli pepper (*C. annuum*) purchased from local markets in Zaria (11°11´N and 07°38´E) were further dried in an oven at 80°C for 24 h and milled separately in an electric hammer mill to obtain fine powders. Of each sample, 500 g were soaked in 3 l hot (70°C) tapwater in plastic buckets for 24 h. The extracts were filtered with 1.5 l of water using a muslin cloth, 250 ml of each of 20% (w/v) starch and soap solutions were added to the extracts to bring their concentration to 10% (w/v). The contents of the buckets were vigorously stirred to obtain a thorough mixture. A spray volume of 200 l/ha was used in all cases. There were four spray applications at weekly intervals, beginning with the flower bud formation phase.

The tests were performed in 1997, 1998 and 1999. Seed of the cowpea variety Sampea 7 used in the trials was purchased from the National Seed Service in Samaru, Zaria. The seeds were dressed with Fernasan-D at the rate of one satchet per 2 kg seeds, and planted at 25 cm on ridges 0.75 m apart. The field layout was a Randomized Block Design (RBD) consisting of seven treatments (five plant extracts, a synthetic insecticide check and an untreated check) and each treatment was replicated three times. Each plot was 6.0 × 5.0 m in size and surrounded by unplanted areas of 1.5 m on all sides. The plots were sprayed with a mixture of pre-emergent (Galex, Metalachlor 250 g a.i. and Metabromuron 250 g a.i. applied at 2.5 kg a.i./ha) and post emergent (paraquat) herbicides immediately after sowing to get rid of weeds. Fertiliser NPK (15:15:15) applied at 250 kg/ha was used for top-dressing the seedlings at 14 d after sowing. At 21 d post planting, the plants were thinned to two seedlings per stand. A tank mixture of 0.33 kg a.i/ha each of benomyl + mancozeb was sprayed on the seedlings every week for 4 weeks to control fungal diseases. Manual weeding was also carried out 5–6 weeks after planting to ensure clean plots. Uppercott (Cypermethrin 250 g a.i /l + Dimethoate 350 g a.i /l) was applied four times at weekly interval at the rate of 1.5 kg a.i/ha.

Maruca vitrata and *Clavigralla tomentosicollis* were sampled before each spraying for 4 weeks beginning at flower bud initiation. *Maruca* pod borer larvae were sampled by removing 20 flowers per plot and placing them in vials containing 30% alcohol. These were taken to the laboratory and dissected the next day and the insects found were counted and recorded. Both *Maruca* larvae and pod sucking bugs were also randomly sampled on plants located in three quadrants in each plot (Amatobi 1994; Dike 1997) and each pest identified was counted and recorded. Plants were examined for phytotoxicity effects (discoloration, burning, wilting and terminal bud stunting) by a random sampling of 20 plants in each plot. Pod damage (shriveling, twisting, stunting, constriction) was assessed by examining 20 pods randomly selected per plant on nine plants per plot. Yields were recorded from each plot after harvesting and threshing.

Data obtained were compared after square root transformation (for insects sampling) and analysed using analysis of variance, while Student Newman's

Keuls ($P < 0.05$) test was applied to separate treatment means (SAS Institute 1990).

RESULTS

The results indicated that all the extracts significantly ($P < 0.05$) reduced the number of legume pod borer (*M. vitrata*) larvae by 3.3–29.3% and pod sucking bugs *C. tomentosicollis* by 5.6–21.8% compared with the untreated control during the three cropping seasons (Tables 1 and 2). However, the extracts of *P. guineense* and *A. melegueta* (in that order) gave better control of the two pests than the other three extracts. Similarly, cowpea pods were significantly ($P < 0.05$) protected in the years 1997, 1998 and 1999 by 18.6–51.9%, 19.1–54.5% and 19.0–54.5% respectively, from damage caused by these pests using plant extracts compared with the untreated control. The best protection was observed on plots treated with extracts of *P. guineense* and *A. melegueta* (Table 3). Plots treated by these two extracts also gave higher grain yields than those of the *X. aethiopica, Z. officinale* and *C. annuum* treatments. The untreated check gave the lowest yield throughout the three seasons. However, the plots treated with synthetic insecticide had the least pod damage and highest grain yield and was thus superior to plant extract treatments.

DISCUSSION

The results demonstrated the potential of *P. guineense* and *A. melegueta* extracts to control *M. vitrata* and *C. tomentosicollis* on cowpea plants. The mode of action of these two extracts in controlling the target pests is not clear. However, it could be contact activity for the extract of *P. guineense,* and possibly antifeedant action for that of *A. melegueta*. Visual observations after direct spraying against *C. tomentosicollis* and *Maruca* larvae on cowpea plants indicate that *P. guineense* extract first had a 'hallucination' effect on these pests and then caused their death within 10–15 min of contact with the extracts. Generally, the pest populations were reduced after the second week of treatment, suggesting that the extracts may be slow to act, hence the effect could not be noticed after the first week of spraying. Some resurgence of the pests that occurred a few days after each spraying, especially during weeks of incessant rainfall, indicates that repeated application of plant

Table 1. Effects of weekly application of extracts of five spices on the population of *Maruca vitrata* larvae on cowpea during 1997–1999 cropping seasons

Treatment (extract)	Mean number of *M. vitrata* larvae/flower and/or pod											
	1997				1998				1999			
	Week											
	1	2	3	4	1	2	3	4	1	2	3	4
P. guineense	0.8 ± 0.6^{c}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}	0.3 ± 0.2^{c}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}	0.7 ± 0.2^{c}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}
A. melegueta	1.5 ± 0.8^{bc}	0.8 ± 0.6^{bc}	0.8 ± 0.6^{bc}	0.0 ± 0.0c	1.0 ± 0.0^{bc}	0.3 ± 0.2^{bc}	0.3 ± 0.2^{bc}	0.0 ± 0.0^{c}	1.3 ± 0.2^{bc}	0.7 ± 0.2^{bc}	0.7 ± 0.2^{bc}	0.0 ± 0.0^{c}
X. aethiopica	1.9 ± 0.0^{bc}	1.2 ± 0.0^{bc}	0.8 ± 0.2^{bc}	0.7 ± 0.2^{bc}	1.3 ± 0.8^{bc}	0.7 ± 0.8^{bc}	0.3 ± 0.2^{bc}	0.3 ± 0.0^{bc}	1.7 ± 0.2^{bc}	1.0 ± 0.8^{bc}	0.7 ± 0.2^{bc}	0.7 ± 0.2^{bc}
Z. officinale	2.3 ± 1.7^{b}	1.5 ± 1.4^{b}	1.2 ± 0.6^{bc}	1.0 ± 0.6^{bc}	1.7 ± 0.2^{b}	1.3 ± 0.7^{b}	0.7 ± 0.2^{bc}	0.7 ± 0.8^{b}	2.0 ± 1.7^{b}	1.7 ± 0.8^{b}	1.0 ± 0.2^{bc}	1.0 ± 0.6^{b}
C. annuum	1.9 ± 0.8^{bc}	1.5 ± 0.2^{b}	1.4 ± 0.6^{b}	1.3 ± 0.2^{b}	1.3 ± 0.8^{bc}	1.3 ± 0.8^{b}	1.0 ± 0.6^{b}	0.7 ± 0.8^{b}	1.7 ± 1.4^{bc}	1.7 ± 0.8^{b}	1.7 ± 0.6^{b}	1.0 ± 0.6^{b}
Uppercott	0.7 ± 0.2^{c}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}	0.3 ± 0.2^{c}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}	0.3 ± 0.6^{c}	0.3 ± 0.2^{c}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}
Control (0.0)	4.1 ± 0.6^{a}	5.8 ± 0.2^{a}	6.4 ± 0.2^{a}	2.7 ± 0.6^{a}	4.3± 0.2^{a}	4.7 ± 0.8^{a}	5.7 ± 0.8^{a}	2.0 ± 0.0^{a}	4.7 ± 0.8^{a}	5.0 ± 0.0^{a}	7.3 ± 1.3^{a}	2.3 ± 0.2^{a}

Means followed by the same letter(s) do not significantly differ according to Student Newman Keuls ($P < 0.05$) test

Table 2. Effects of weekly application of extracts of five spices on the population of *C. tomentosicollis* on cowpea during 1997–1999 cropping seasons

Treatment	Mean number of C. *tomentosicollis*/plant											
	1997				1998				1999			
	Week											
	1	2	3	4	1	2	3	4	1	2	3	4
P. guineense	1.1 ± 0.3^{c}	0.4 ± 0.1^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{c}	1.0 ± 0.6^{c}	0.3 ± 0.2^{b}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}	1.3 ± 1.2^{c}	0.7 ± 0.8^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{c}
A. melegueta	1.9 ± 0.2^{bc}	1.1 ± 0.2^{b}	0.8 ± 0.3^{b}	0.0 ± 0.0^{c}	1.7 ± 0.2^{bc}	1.0 ± 0.0^{b}	0.7 ± 0.6^{b}	0.0 ± 0.0^{c}	2.0 ± 0.0^{bc}	1.3 ± 1.2^{b}	1.0 ±0.7^{b}	0.0 ± 0.0^{c}
X. aethiopica	2.2 ± 0.0^{bc}	0.8 ± 0.1^{b}	0.7 ± 0.0^{b}	0.7 ± 0.0^{bc}	2.0 ± 0.6^{bc}	0.7 ± 0.2^{b}	0.7 ± 0.5^{b}	0.7 ± 0.5^{bc}	2.3 ± 0.2^{bc}	1.0 ± 0.0^{b}	1.0 ± 0.0^{b}	1.0 ± 1.0^{bc}
Z. officinale	3.0 ± 0.2^{b}	1.5 ± 0.2^{b}	1.1 ± 0.2^{b}	0.7 ± 0.1^{bc}	2.7 ± 0.2^{b}	1.3 ± 0.7^{b}	1.0 ± 0.6^{b}	0.7 ± 0.2^{bc}	3.0 ± 1.7^{b}	1.3 ± 0.8^{b}	1.3 ± 0.2^{b}	1.0 ± 0.6^{bc}
C. annuum	2.2 ± 0.0^{bc}	1.5 ± 0.2^{b}	1.1 ± 0.1^{b}	1.0 ± 0.1b	2.0 ± 1.7^{bc}	1.3 ± 0.8^{b}	1.0 ± 0.9^{b}	1.0 ± 0.0^{b}	2.3 ± 0.2^{bc}	1.7 ± 0.2^{b}	1.3 ± 0.7^{b}	1.3 ± 0.6^{b}
Uppercott	0.3 ± 0.1^{d}	0.3 ± 0.2^{c}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}	0.3 ± 0.2^{d}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}	0.3 ± 0.2^{d}	0.3 ± 0.2^{c}	0.0 ± 0.0^{c}	0.0 ± 0.0^{c}
Control (0.0)	5.0 ± 0.6^{a}	7.1 ± 2.1^{a}	8.6 ± 2.0^{a}	6.3 ± 0.8^{a}	5.3 ± 0.2^{a}	8.3 ± 1.4^{a}	9.0 ± 2.3^{a}	6.0 ± 0.6^{a}	5.7 ± 1.3^{a}	8.7 ± 0.8^{a}	9.7 ± 1.4^{a}	6.7 ± 0.2^{a}

Means followed by the same letter(s) do not significantly differ according to Student Newman Keuls ($P < 0.05$) test

Table 3. Effects of weekly application of extracts of five spices on pod damage and grain yield of cowpea during 1997–1999 cropping seasons

Treatment	Means of values					
	1997		1998		1999	
	pod damage (%)	grain yield (kg/ha)	pod damage (%)	grain yield (kg/ha)	pod damage (%)	grain yield (kg/ha)
P. guineense	17.6 ± 0.2^{f}	847.0 ± 53.2^{a}	17.4 ± 0.1^{f}	837.1 ± 52.2^{a}	17.9 ± 0.2^{f}	863.0 ± 56.5^{a}
A. melegueta	28.9 ± 0.0^{e}	491.8 ± 31.4^{b}	29.7 ± 0.0^{e}	523.5 ± 32.7^{b}	30.6 ± 0.0^{e}	539.7 ± 34.4^{b}
X. aethiopica	31.2 ± 0.1^{d}	463.9 ± 41.1^{c}	32.6 ± 0.1^{d}	435.9 ± 37.2^{c}	33.6 ± 0.1^{d}	449.3 ± 41.0^{c}
Z. officinale	49.2 ± 0.6^{b}	202.4 ± 12.9^{e}	49.7 ± 0.6^{b}	189.7 ± 12.1^{e}	51.2 ± 0.6^{b}	195.5 ± 12.9^{e}
C. annum	43.9 ± 0.4^{c}	225.6 ± 4.3^{d}	43.8 ± 0.4^{c}	206.6 ± 4.0^{d}	45.1 ± 0.5^{c}	213.0 ± 4.2^{d}
Uppercott	11.8 ± 0.2^{g}	1027.4 ± 46.1^{g}	12.2 ± 0.2^{g}	988.6 ± 37.7^{g}	10.6 ± 0.2^{g}	1087.5 ± 47.5^{g}
Control (0.0)	94.8 ± 0.5^{a}	44.1 ± 5.4^{f}	91.2 ± 0.5^{a}	58.3 ± 12.1^{f}	94.0 ± 0.5^{a}	47.6 ± 5.4^{f}

Means followed by the same letter(s) do not significantly differ according to Student Newman Keuls ($P < 0.05$) test

extracts at shorter intervals may be required for more effective control.

In Nigeria, past studies on the insecticidal activity of plant extracts were mostly screen-house trials using neem, African nutmeg, *P. guineense* and garlic products (Ekesi 2000; Olaifa *et al.* 1987; Jackai *et al.* 1992). For example, both aqueous extracts and powders of neem seed and kernel interfered with the development of *Maruca vitrata* and *C. tomentosicollis* (Jackai *et al.* 1992). Reports have shown that different concentrations of neem oil emulsifiable concentrate (5, 10 and 20%) exhibited a high degree of insecticidal activity on larvae of *Maruca* (Jackai & Oyediran 1991). It was, therefore, concluded that all treated flowers were protected from larval damage 2 days after treatment as compared to 100% damage recorded on untreated flowers and on flowers treated with *Tetrapleura tetraptera* (emulsifier) solution alone. Other researchers have also reported the efficacy of neem oil against bruchid on stored cowpea and variegated grasshopper *Zonocerus variegatus* L. (Ivbijaro 1983; Sowunmi & Akinnusi, 1983; Olaifa *et al.* 1987). The effect of neem extract in reducing thrips incidence in treated plants has been reported (Tanzubil 1991). *Dennetia tripetala* oil has been found to be effective on cockroach, *Periplanata americana* L., and the variegated grasshopper, *Z. variegatus* (Iwuala *et al.* 1981). Volatiles of black pepper and garlic bulb have shown superiority over other plant extracts in reducing the hatch of freshly laid (12 h-old) eggs of both *M. vitrata* and *C. tomentosicollis* in laboratory studies (Ekesi 2000).

One desirable advantage *P. guineense* and *A. melegueta* may have over synthetic insecticides in spite of their relatively lower yield as recorded in this investigation, is that these plants are readily available locally, have simple, inexpensive extraction methods which can easily be adopted by limited resource farmers. In contrast, the extraction method (Cobbinah & Osei-Owusu 1998) used for neem-based extracts is reported to have very limited application to small-scale farmers (Jackai & Oyediran 1991). The admixture of 50% (w/v) solution of bar soap (as an emulsifier) and starch to the extracts enhances uniform distribution of the spray liquid and its persistency on the surface of leaves and other plant parts. This would reduce the problem of searching for botanical emulsifiers that may be difficult to obtain in some geographical ecologies. Fortunately, in the northern part of Nigeria where this study was conducted, some of the research findings are already in use by local farmers who grow improved, high yielding cowpea varieties such as the one used in this trial. Although the improved varieties require chemical treatments such as fertiliser application, which is low compared to cereals and fungicide spraying to achieve optimum yield, the output of farmers' fields would justify such investment.

Further studies are necessary to elucidate the effect of various concentrations and optimum spraying conditions for *P. guineense* and *A. melegueta* extracts to find the most effective combination of concentration and spraying that would offer adequate protection to cowpea pods. Field observations indicate that none of the extracts used in this study produced any phytotoxic effect (leaf yellowing and shedding) on cowpea leaves. This contrasts with the observation made by (Olaifa & Adenuga 1988) about some yellowing and subsequent shedding of leaves within 5 d of application of neem oil emulsifiable concentrate. In another study the phytotoxic effects of neem-treated eggplants at the pre-flowering stage caused the edges of some leaves to lose their green coloration (Cobbinah & Osei-Owusu 1998).

The effectiveness of plant-based insecticidal application may be enhanced if it is conducted early in the morning or late afternoon because the biologically active principles contained in such plant extracts may be denatured when exposed to strong direct sunlight during field operations. Alternatively, the search should be intensified for botanical stabilisers to be used in mixtures with insecticidal plant extracts to protect them from rays of the sun as well as improving their shelf life. The results presented in this study have shown that extracts of *P. guineense* and *A. melegueta* have great potentials as biopesticides and could provide suitable alternatives for pest control on field crops of small scale and low-input agriculture as commonly practiced in tropical countries without degrading the environment.

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Abstrakt

Oparaeke A. M., Dike M. C., Amatobi C. I. (2005): **Polní hodnocení extraktů z pěti nigerijských koření v ochraně proti hmyzím škůdcům vigny**, *Vigna unquiculata* (L.) Walp., **po odkvětu**. Plant Protect. Sci., **41**: 14–20.

V polních podmínkách byla testována insekticidní účinnost vodních extraktů z pěti druhů nigerijského koření (*Piper guineense* Schum and Thonn., *Aframonum melegueta* (Roscoe), *Xylopia aethiopica* (Dunal) A. Rich., *Zingiber officinale* L. a *Capsicum annuum* L.) proti dvěma důležitým hmyzím škůdcům, *Maruca vitrata* Fab. (*Lepidoptera*: *Pyralidae*) a *Clavigtralla tomentosicollis* Stal. (*Hemiptera*: *Coreidae*), které napadají vignu v období po odkvětu. Extrakty byly aplikovány postřikem v 10% koncentraci (w/v) čtyřikrát v týdenních intervalech. Ošetření extraktem z *P. guineense* a z *A. melegueta*, redukovalo průkazně ($P < 0.01$) abundanci škůdců a snížilo škodu na luscích vigny. Na parcelách ošetřených extrakty z *P. guineense* a z *A. melegueta* byl výnos zrna průkazně vyšší než na parcelách ošetřených ostatními extrakty. Tato technologie je levná, bezpečná, šetrná pro životní prostředí a snadno osvojitelná omezenými prostředky farmárů v zemích třetího světa.

Klíčová slova: koření; extrakty; *Maruca vitrata*; *Cravigralla tomentosicollis*; ochrana; vigna

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