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Bio-potential of Different Rates and Application Schedules of *Xylopia aethiopica* (Dunal) A. Rich Extracts for Control of *Maruca* Pod Borer and Spink Bug on Cowpea Plants

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Abstract: The efficacy of different rates (0, 5, 10 and 20% w/v) and spraying frequencies (0, 2, 4 and 6 weekly applications) of Aethiopian pepper, *Xylopia aethiopica* (Dunal) A. Rich extracts against *Maruca vitrata* Fab. and *Clavigralla tomentosicollis* Stal on cowpea plants was compared with a synthetic insecticide (cypermethrin+dimethoate) and untreated check in two years of field study under rain fed conditions in Zaria, northern Guinea savanna of Nigeria. The results showed that *Maruca* pod borer and spink bug were significantly reduced at higher extract rate (20% w/v) and more frequent sprayings (4 and 6 weekly applications) compared with the untreated check. Pod damage reduction, grain yield and quality were also significantly enhanced in extracts treated plots at similar level compared with the untreated check. The synthetic insecticide treatment check was however, superior to *X. aethiopica* extracts in all the parameters tested. The application of higher doses and more frequent sprayings of *X. aethiopica* extract could play an important role in pest management of cowpea farms managed by resource limited farmers in less developed countries.

Key words: *Xylopia aethiopica*, extract, IPM, *Maruca vitrata*, *Clavigralla tomentosicollis*, cowpea

Introduction

Pest pressure on cowpea particularly at the post-flowering stages of growth is the most limiting factor for its production worldwide. Cowpea yield may be as low as 150 kg ha^{-1} if modern pest protection measures are not put in place to checkmate the menace of pests. The most important post-flowering pests of cowpea include, Legume Flower Thrips (LFT) *Megalurothrips sjostedti* Trybom (Thysanoptera: Thripidae), *Maruca* Pod Borer (MPB), *Maruca vitrata* Fab. (Lepidoptera: Pyralidae) and coreid bugs complex predominated mainly by the spink bug, *Clavigralla tomentosicollis* Stal (Hemiptera: Coreidae). *M. sjostedti* and *M. vitrata* feed on flowers causing flower abortion. *M. vitrata* and *C. tomentosicollis* (adults and nymphs) feed on immature pods causing premature drying and abscission of pods and seed abortion (Jackai *et al*., 1992) which results in considerable losses in grain yield and quality. Currently, synthetic insecticides (cypermethrin, dimethoate, lambdacyhalothrin, imidacloprid, etc.) are the chief means of control (Jackai and Oyediran, 1991) and have shown efficacy against a wide number of pest species of agricultural crops.

The indiscriminate use of synthetic pesticides has caused some environmental concerns including genetic resistance of pest species, accumulation of chemical residues in treated food materials (Champ and Dyte, 1976; Snelson, 1987; Georghiou and Lagunes-Tejeda, 1991), health risk to the user and livestock. The increased importation and high costs of synthetic insecticides have caused a serious drain on the fragile economy of third world countries where the exchange rate is in favour of the developed economies where these pesticides are produced. The ugly situation necessitates the search for alternative, effective, biodegradable, safe, low cost, low technological base, selective and environmentally friendly pest control measures to replace the toxic synthetic insecticides.

Extracts of *Nicotiana tabacum* L., *Dennetia tripetala* L., *Chrysanthemum cinerariaefolium*, *Azadirachta indica* (A. Juss), *Piper guineense* (Schum and Thonn), *Anacardium occidentale* L., *Syzigium aromaticum* Dunal, *Monodora myristica* Gaertn and others have shown remarkable efficacy against many pests of arable and horticultural crops (Stoll, 1988; Olaifa and Adenuga, 1989; Jackai and Oyediran, 1991; Tanzubil 1991; Oparaeke *et al*., 2000, 2005). Most trials using the above plant extracts have been screen house studies. In few cases where field trials were carried out, limited information was available on the rates and application frequency required for good control of the noxious pests and ensure high grain yield. This study was conducted to establish the effectiveness of different rates and spraying frequencies of extracts of *Xylopia aethiopica* (Dunal) A. Rich against two most important post-flowering insect pests of cowpea under rain fed conditions in the northern Guinea savanna ecological zone of Nigeria.

Materials and Methods

Preparation of Different Concentrations of Aqueous X. aethiopica Extracts

Dried pods of *X. aethiopica* were purchased from local markets around Zaria (11° 11′ N; 08° 15′ E), located in the Northern Guinea savanna. The pods were selected to remove contaminants such as soil debris and woody particles of the plant. The pods were oven dried at 60°C for 12 h to stabilize the dried weight. Dried pods weighing 250, 500 and 1000 g were separately ground in an electric hammer mill into powder. The *X. aethiopica* powder of different weights were then soaked overnight in separate plastic buckets containing 3.5 l hot water (70°C). The solutions were separately filtered with one liter of tap water using a muslin cloth. Each of the solutions in plastic buckets received some 250 mL bar soap and starch (20% solution each) to improve its rain fastness and even-spread on plant surfaces. The plastic buckets were labeled and the extracts taken to the field for spraying the same day.

Experimental Site

The trials were established in 2000 and 2001 cropping seasons in the Research Farm of the Institute for Agricultural Research, Zaria. The rainy season began on average in early June and lasted till the first or second week of October. Cowpea is usually sown from mid July to third week of August in this ecological zone. The soil is described as a leached Ferruginous, tropical soil, which developed on very fine sandy Aeolian drift over gneiss with a well developed B-horizon (sandy clay loam) with iron concretions (McDonald and Fowler, 1975). The field was sprayed with glyphosate at 5l ha^{-1} and kept for three weeks to fallow before harrowing and ridging.

Field Layout

The treatments comprising different concentrations (0, 5, 10 and 20% w/v) of *X. aethiopica* extracts with various spraying frequencies (0, 2, 4 and 6 weekly applications), a synthetic insecticide check and untreated control were laid out in a split-split plot design with three replicates. The main plot (3.75×54.0 m) consisted of treatment sources (*X. aethiopica* extracts and synthetic insecticide) while the sub plots and sub-sub plots (3.75×6.0 m) comprised of different concentrations and spraying frequencies, respectively. Each plot had five ridges, three main and two discard ridges spaced at 0.75 m apart and was separated by a 1.5 m wide border along the ridge with two unplanted ridges.

The variety of cowpea used was SAMPEA 7. It is of medium duration (80-85 days), semi determinate, semi erect growth habit and highly susceptible to the major post-flowering insect pests whose peak populations synchronize with the growth period of the plant in the northern Guinea savanna where this study was conducted. The seeds were dressed with Apron plus 50 DS (one satchet/2 kg seeds) and sown three seeds per hole at intra-row spacing of 0.25 m apart in the first week of August in both seasons. The plots were sprayed with Galex (Metolachlor 250 g a.i. and Metobromuron 250 g a.i., l^{-1}) at 2.5 kg a.i. ha^{-1} immediately after sowing to suppress weeds regrowth. Compound fertilizer NPK (15:15:15) was applied at 37.5 kg a.i. ha^{-1} by side placement two Weeks After Sowing (WAS). Two to three WAS the seedlings were thinned to two plants per hole. At four WAS, the plants received a tank mixture of 0.33 kg a.i, ha^{-1} each of benomyl and mancozeb which were sprayed once every week for four weeks to control fungal diseases. Manual weeding was also carried out at five to six WAS to ensure a weed free condition. Field spraying of different rates of *X. aethiopica* extracts and synthetic insecticide against MPB and spink bug commenced at flower bud initiation phase (6 WAS). Four weekly sprayings of synthetic insecticide were made while the extracts were sprayed at 0, 2, 4 and 6 weekly intervals using CP 3 knapsack sprayers. All the sprayers were rinsed with water after each application to avoid contamination.

Insect Pests Population Counts

Before spraying, insect populations were sampled within the three sample rows between 7.00 and 9.0 am every week. *M. vitrata* was assessed by randomly picking 20 flowers from 10 plants in each plot. The flowers were placed in vials containing 30% alcohol and dissected the next day in the laboratory. The number of *Maruca* pod borer larvae found was recorded. *Maruca* pod borers (MPB) were also sampled by randomly picking 2 pods each per plant from 10 plants in a plot. These were also taking to the laboratory, dissected and the borer larvae observed were recorded. Adults and nymphs of *C. tomentosicollis* were assessed visually on plants located in three 1.0×1.0 m quadrants, which were randomly placed within the sample rows in each plot (Amatobi, 1994). Pod damage was rated at 70 Days After Planting (DAP) using the formula below:

$$\%\text{ Pod damage} = \frac{\text{Total No. of pods produced/plant-No. of undamaged pods/plant}\times 100}{\text{Total No. of pods produced/plant}} \qquad 1$$

Grain yields were recorded from harvested dried pods in the sample rows after threshing and winnowing.

All the data obtained were transformed (with angular or arcsine for percentages) before analysis using Analysis of variance while treatment means were separated with Student Neumann Keuls ($p<0.05$) test of SAS Institute (1990).

Results

The results show that there were significant differences ($p < 0.05$) in the numbers of *Maruca* Pod Borers (MPB) and Pod Sucking Bugs (PSB) among the treatments in two seasons (Table 1). All the treated plots caused significant reduction of MPB compared with the untreated check while there were no significant differences between the untreated check and 5% *X. aethiopica* extract with 2 or 4 weekly sprayings. The synthetic insecticide (Uppercott) had significant control of MPB compared to different rates of *X. aethiopica* extracts tested while it was only superior ($p<0.05$) to 5% extract at all the application schedules and 10% extract with two weekly applications. None of the extract treatments was significantly different from each other in the number of MPB recorded but 20% exteact rate with 4 or 6 weekly applications caused significant reduction of PSB compared with 5% extract only applied at 2 or 4 weekly application schedules.

Table 1: Effect of different rates and spraying schedules of *X. aethiopica* extracts on the populations of *Maruca* pod borer and *C. tomentosicollis*

	Mean No. of *M. vitrata*/flower and/or pod		Mean No. of *C. tomentosicollis*/plant	
Treatments	2001	2002	2001	2002
C1 R1	2.0b	1.7b	2.9ab	3.8ab
C1 R2	2.0b	1.7b	2.8ab	3.7ab
C1 R3	1.8b	1.5b	2.3bc	3.2bc
C2 R1	1.5b	1.2b	1.9bc	3.0bc
C2 R2	1.4b	1.2b	1.7bcd	2.5bcd
C2 R3	1.3b	1.1b	1.5bcd	2.4bcd
C3 R1	1.5b	1.2b	1.4bcd	2.4bcd
C3 R2	1.3b	1.1b	1.2cd	2.1cd
C3 R3	1.2b	1.0b	1.2cd	2.0cd
UPC	0.7c	0.5c	0.3d	0.6d
CON (0.0)	3.4a	2.8a	4.0a	7.2a
SE±	0.4	0.4	0.3	0.4

Means in a column followed by the same superscript(s) are not significantly different by SAS-SNK test ($p<0.05$)
Keys: C1=5% w/v, C2=10% w/v, C3=20% w/v, R1=2 weekly application, R2=4 weekly applications, R3=6 weekly applications

Table 2: Effect of different rates and spraying schedules of *X. aethiopica* extracts on pod damage and grain yields of cowpea

	Mean% pod demage/plant		Mean grain yield ha^{-1}	
Treatments	2001	2002	2001	2002
C1 R1	46.4b	47.1b	389.3g	395.2g
C1 R2	45.2b	45.9b	420.0fg	426.4fg
C1 R3	42.3bc	42.9bc	474.6efg	481.9efg
C2 R1	39.2c	39.8c	506.8ef	514.6ef
C2 R2	33.7d	34.2d	543.9de	630.9de
C2 R3	32.1d	32.6d	621.5cd	686.9cd
C3 R1	29.8de	30.2de	676.6bc	695.8bc
C3 R2	25.9ef	26.3ef	686.3bc	729.5bc
C3 R3	23.9f	24.2f	718.5b	764.1b
UPC	10.0g	10.2g	1128.3a	1241.*a*
CON (0.0)	90.4a	91.8a	148.5h	150.7h
S.E ±	1.2	1.3	19.1	20.8

Means in a column followed by the same superscript(s) are not significantly different by SAS-SNK test ($p<0.05$)
Keys: C1=5% w/v, C2=10% w/v, C3=20% w/v, R1=2 weekly application, R2=4 weekly applications, R3=6 weekly applications

Percentage pod damage and grain yields were significantly ($p<0.05$) reduced among the treatments. The untreated check recorded the highest pod damage and consequently the lowest yield while Uppercott had the least ($p<0.05$) pod damage and the highest grain yield among the treated plots (Table 2). Within the extract treatments 20 and 10% rates with 6 and 4 weekly sprayings (in that order) were superior to 5% rate (at all the application schedules) and 10% extract with 2 weekly applications in the reduction of pod damage and ensuring higher grain yields (Table 2) in both years.

Discussion

In the present study, pods of *X. aethiopica* were oven-dried at 60°C for 4 h and ground into powder in an electric hammer mill. Oven-drying method under low temperature regime as above for a short period and grinding in an electric hammer mill was chosen against sun-drying and pounding in a mortar with pestle in order to standardize the moisture content of the plant material and reduce drudgery during processing. The results showed that higher extract rate (20%) and more frequent applications (6 or 4 weekly applications) could significantly reduce the population of the target pests, protect pods from damage and results in higher grain yields compared with lower extract rate (5% w/v) at all the application schedules. This result is consistent with the work of Oparaeke *et al*., (2005) who reported lower efficacy of *X. aethiopica* extract at 10% rate compared to similar rate of *Piper guineense* Schum and Thonn and *Aframomum melegueta* Roscoe extracts in protecting cowpea pods from pest infestation. Similarly, Oparaeke *et al*. (2005) and Okonkwo and Okoye (1996) observed lower efficacy due to low rates of *X. aethiopica* powders used against *Callosobruchus maculatus* Fab, *C. subinnotatus* Pic and *Sitophilus zeamais* Motsch on stored cowpea, bambarra groundnut and maize respectively, which necessitated the present study. The superior efficacy achieved by Uppercott compared with *X. aethiopica* extract is due probably to the crude, aqueous nature of the solution used instead of the concentrated formulation using the active principles in the plant material. *X. aethiopica* contains Annonaceine-an alkaloid similar to morphine in action (Watt and Bryer-Brandwijk, 1962; Kerharo and Adams, 1974). Burkill (1985) reported a repellency action of *X. aethiopica* against kolanut weevils in storage.

Under field conditions, direct contact of 20% (w/v) *X. aethiopica* extract caused hyper-excitability reaction on MPB larvae while adults and nymphs of *C. tomentosicollis* became temporarily motionless for about 10-15 min before regaining consciousness and moved about sluggishly in a confused state. This sedative action may open up a new approach to pest management other than quick kill, antifeedant or repellency action which may cause the target pest to become disoriented and go off-feeding resulting in significantly lower pod damage on plots sprayed with 20% extract of *X. aethiopica* as observed in this study. The use of *X. aethiopica* in soup preparation as a spice for lactating mothers in some communities in Nigeria is not based only on its action of 'healing' the womb after birth but also causes relaxation of the woman after such meal (Augustine Amadi, personal communication). Although, Uppercott had better control of the target pests, its well-known health concern to human beings and livestock may negate its positive impact of increasing crop yields. However, since *X. aethiopica* is readily available, cheap, easily biodegradable, less toxic to mammals and environmentally friendly, the material should be subjected to further tests using its active principles (Annonaceine, etc.) and testing such against the target pests with a view to maximizing its biopesticidal potential for the benefit of limited resource farmers in developing countries. The residues can be incorporated into the soil as fertilizer material being organic matter, for soil amelioration and/or soil pest management.

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