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Pesticidal Activity of Three Rates and Spraying Frequencies of Extracts of *Xylopia aethiopica* (Dunal) A. Rich for Reducing Thrips Infestation on Cowpea Flowers*

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Abstract: Extracts of *Xylopia aethiopica* (Dunal) A. Richard were assayed at different dosages (0, 5, 10 and 20% w/v) and weekly application schedules (0, 2, 4 and 6) to control flower thrips, *Megalurothrips sjostedti* Trybom on cowpea flowers. The extracts were compared with a synthetic insecticide check in two years of field study under rain-fed conditions. The results indicated that thrips population on cowpea flowers was significantly reduced ($p<0.05$) while pod density was also enhanced ($p<0.05$) on plots treated at 20% extract rate with 6 or 4 weekly application intervals. The values in the two parameters tested were inferior to the synthetic insecticide check but superior to the untreated check in both periods. *X. aethiopica* contains Annonaceine, which acts in similar way as morphine and this sedative mode of activity could play an important role in the quest to control pests on crops using this plant extract either singly or in mixtures with other potential insecticidal plants. The pods are readily available, easily bio-degradable, low cost and environmentally friendly while the technology for processing and application of the extract is simple for use by limited resource farmers in third world countries.

Key words: *Xylopia aethiopica*, extract, dosages, spraying schedules, thrips, control, flowers, cowpea

Introduction

Cowpea, *Vigna unguiculata* (L.) Walp is an important legume crop which supplies the bulk of protein needs in the diet of many people in Africa. Nigeria produces one-third of the world's cowpea grains but yield is low (< 200 kg ha^{-1}) due to insect pests attack (Raheja, 1976). The legume flower thrips, *Megalurothrips sjostedti* Trybom (Thysanoptera: Thripidae), *Maruca vitrata* Fab. (Lepidoptera: Pyralidae) and pod suckers predominated by the spink bug, *Clavigralla tomentosicollis* Stal (Hemiptera: Coreidae) are the most important post flowering pests of cowpea in sub-saharan Africa (Jackai and Daoust, 1986).

M. sjostedti is the primary pest to appear at the reproductive stage and the most difficult to control without insecticide application (Singh *et al*., 1990; Tamo *et al*., 1993). Thrips infestation is characterized by distortion, malformation, dicolouration of floral parts and drying up of flowers (Taylor, 1969). Different crop protection measures have been tried to reduce thrips population on cowpea flowers and these include mixed cropping, use of resistant varieties, biological control (e.g., entomo-pathogens) (Ekesi, 2000) and chemical (Jackai and Adalla, 1997). However, none of these

**Originally Published in Journal of Plant Sciences, 2006* intervention measures at the moment (except chemical) has impacted much on thrips control on cowpea flowers across the African continent.

Insecticide application protects cowpea flowers and helps to maintain reasonable pod yield but has some constraints such as unavailability at critical period (Oparaeke and Dike, 1996), their residual and high mammalian toxicity (Perkins, 1982), pest resistance and resurgence (Amatobi, 1994), high procurement costs and environmental degradation (Gbolade and Adebayo, 1993). This situation coupled with the harsh economic conditions in many third world countries which has led to the withdrawal of various agricultural subsidies (especially on pesticides) given to farmers by their governments have prompted the search for alternative sources of insecticide that would become a component of socio-economically sustainable and environmentally friendly crop protection strategies (Jackai and Oyediran, 1991).

Many plants possess secondary metabolites which they sequestered over the years and forming part of their defence mechanism against herbivores (Harbourne, 1977). Scientists all over the world, two decades ago had experimented with plant constituents to protect crops from arthropod pests infestation both on the field and in storage. For instance, neem, *Azadirachta indica* (A. Juss), has been found to be effective in the reduction of pest infestation on many crops (Kambu *et al*., 1982; Cardet *et al*., 1998). *Dennetia tripetala*, *Piper guineense* Schum and Thonn, *Monodora myristica* and *Allium sativum* L. have shown remarkable efficacies against many crop pests (Iwualla and Osisiogwu, 1981; Olaifa and Akingbohungbe, 1986; Oparaeke and Dike, 2005; Oparaeke *et al*., 2000).

A limited database is assembled on the insecticidal properties of *Xylopia aethiopica* (Dunal) A. Rich (Annonaceae) for pest control on crops and those available were mainly for storage protection studies (Ofuya, 1990; Oji *et al*., 1992; Okonkwo and Okoye, 1996; Oparaeke and Bunmi, 2005). Field studies of 10 % (w/v) extracts of *X. aethiopica* have revealed lack of potency against some crop pests (Oparaeke *et al*., 2005; Ogunlana *et al*., 2002).

The present study forms part of a long-term screening of insecticidal plants for low-cost management of field pests of arable and horticultural crops in the Institute for Agricultural Research, Ahmadu Bello University, Zaria, 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), which is located in the Northern Guinea savanna. The pods were selected to remove contaminants such as soil debris and woody particles of the plant and 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 powder materials 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 1 L of tap water using a muslin cloth. Each of the solutions in plastic buckets received 250 mL of 20% solutions of bar soap and starches 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 5 l ha^{-1} and kept for three weeks to fallow before harrowing and ridging.

Field Layout

The treatments comprising of concentrations 0, 250, 500 and 1000 g representing 0, 5, 10 and 20% (w/v) of *X. aethiopica* extracts with spraying frequencies (0, 2, 4 and 6 weekly applications), a synthetic insecticide check and untreated control were laid out using split-split plot design with three replicates. The main plot (3.75×54.0 m) consisted of treatment source (*X. aethiopica* extract and synthetic insecticide) while sub-plots and sub sub-plots (3.75×6.0 m) contained the different concentrations and spraying schedules respectively. Each plot had five ridges, three main and two discard ridges spaced at 0.75 m apart which 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 pre-emergent herbicide Galex (Metolachlor 250 g a.i. and Metobromuron 250 g a.i./l) at 2.5 kg a.i./ha immediately after sowing to suppress weeds regrowth. Compound fertilizer NPK (15:15:15) was applied at 37.5 kg a.i./ha 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 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 concentrations of *X. aethiopica* extracts and synthetic insecticide against thrips 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 spraying to avoid contamination. A single row of cowpea plant was sprayed per trip.

Thrips Population Count

The bean flower thrips were sampled by randomly removing 20 flowers from plants located within the three inner rows per plot. These were placed in vials containing 30% alcohol and taken to the laboratory where flowers were dissected the next day and the number of thrips found was recorded.

Pod Density Assessment

Pod yield (a measure of efficacy of an insecticide to control thrips incidences on cowpea flowers) was assessed at 10 WAS by finding the average number of pods produced from a random sample of 10 plants in each plot.

All data collected were transformed by angular transformation and subjected to Analysis of Variance (ANOVA) while treatment means were separated by Student Neumann Keuls test ($p<0.05$) (SAS, 1989).

Results

Mean thrips infestation on cowpea flowers was significantly lower ($p<0.05$) on plots sprayed with *X. aethiopica* extract and the synthetic insecticide than on unsprayed plots in both seasons (Table 1). The synthetic insecticide treatment caused greater reduction ($p<0.05$) in thrips number than *X. aethiopica* extracts at all treatment levels. *X. aethiopica* extract at 20% (w/v) with 6 or 4 weekly applications and at 10% rate with 6 weekly applications (in that order) were superior in the reduction of thrips population compared with other extract treatments. The number of pods produced per plant was significantly higher ($p<0.05$) on plots sprayed with synthetic insecticide compared to plots sprayed with *X. aethiopica* extract. Pod density per plant on plots sprayed with *X. aethiopica* extracts was higher at doses of 20 and 10% with 6 or 4 weekly applications but the values at 10 % rate with 6 or 4 weekly applications were inferior to 20% rate at 2 weekly applications and 5% rate at 6 weekly applications. Pod density in the latter treatment was not statistically significant compared to 10% extract rate with 2 weekly sprayings and 5% extract with 4 weekly sprayings. However, all the extract sprayed plots had significantly higher ($p<0.05$) pod density per plant than the untreated check.

Discussion

The present trial has shown the potential of plants as bio-control agent for management of insect pest on crops. Application of aqueous extract of *X. aethiopica* can cause reasonable reduction of thrips population on cowpea flowers. The mechanism of activity of *X. aethiopica* on thrips is not clear but since the insect lives and feeds inside the flowers an antifeedant effect might be suspected. It is also possible that the spray liquid being absorbed by the flowers might have come into contact with the

Table 1: Mean *Megalurothrips sjostedti* population on flowers and pod yields on cowpea plants treated with three doses and spraying schedules of *Xylopia aethiopica* extracts

	No. of *M. sjostedti*/flower		No. of pods produced/plant	
Treatments	2000	2001	2000	2001
C1 R1	1.7b	2.0b	22.4e	22.7e
C1 R2	1.5bc	1.5bc	28.6d	28.9d
C1 R3	1.4bc	1.5bc	29.4cd	29.6cd
C2 R1	1.7bc	1.8bc	27.0d	27.4d
C2 R2	1.3bc	1.3bc	31.1bc	31.5bc
C2 R3	1.0d	1.1da	32.2bc	32.7bc
C3 R1	1.4bc	1.4bc	29.5cd	30.0cd
C3 R2	1.2cd	1.2cd	32.6b	32.7b
C3 R3	1.0d	1.0d	33.0b	33.5b
UPC	0.5e	0.5e	50.4a	51.1a
CON (0.0)	3.2a	3.6a	8.6f	8.7f
SE±	0.05	0.06	0.22	0.23

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 insect causing high mortality. This was evident when some flowers were opened after 30 min of extract application and some dead thrips were observed particularly on flowers sprayed with 20% extract while on 10% extract sprayed plants some thrips found in the flowers were weak and gliding sluggishly on the walls of the dissected flowers in a confused state-an evidence of extract toxicity.

The result obtained in the present trial was consistent with the report of Oparaeke *et al*. (2005) who screened five Nigerian spices (*X. aethiopica*, *Piper guineense* Schum and Thonn, *Capsicum annum* L., *Zingiber officinale* L. and *Aframomum melegueta* Roscoe) at 10% rate and found the extract of *X. aethiopica* less effective compared to *P. guineense* and *A. melegueta* extracts in the control of thrips, *Maruca* pod borer and the spink bug. However, in a storage work 2 g powder of *X. aethiopica* admixed with 500 g cowpea seeds had shown slight ovicidal activity against *Callosobruchus maculatus* Fab. and subsequent egg hatch (Ofuya, 1990). Similarly, Okonkwo and Okoye (1996) and Oji *et al.* (1992) used 1.5 g/25 g maize and ethanolic extract of *X. aethiopica* respectively to achieve significant mortality of adult *Sitophilus zeamais* Motsch within 24 and 96 h, respectively after three months storage period. Repellency activity has also been reported in the extract of *X. aethiopica* on kola nut pests (Burkill, 1985).

X. aethiopica contains Annonaceine-an alkaloid similar to morphine in biological activity (Watt and Bryer-Brandwjik, 1962; Kerharo and Adams, 1974). This sedative action of *X. aethiopica* extract might result in sluggish movement in thrips as observed in the present study and may open up a new approach to pest management on crops. In this trial, 20% rate of *X. aethiopica* aqueous extract with more frequent sprayings (six or four applications at weekly intervals) were more effective in the reduction of thrips population and prevented drying up and subsequent abortion of flowers resulting in higher pod load on sprayed plots compared to the untreated check. However, 20% extract rate with 6 or 4 weekly application schedules was inferior to the synthetic insecticide treatment in the two parameters tested probably due to its non-concentration form. More work is required to isolate the major active principles in the plant with the view to using them in more trials to ascertain their efficacy. Since *X. aethiopica* has shown its potential as biopesticides, there is the need to domesticate this important spice through breeding to produce varieties that have rapid growth with early maturity and high pod densities than is currently the case. This material is readily available in Nigerian markets, non-toxic to human users, easily biodegradable, environmentally friendly and technologically simple to use compared with the synthetic insecticides.

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