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Effect of Aqueous Extracts of Tropical Plants for Management of *Maruca vitrata* Fab. and *Clavigralla tomentosicollis* Stal. on Cowpea, *Vigna unguiculata* (L.) Walp. Plants

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Abstract: The present study aimed at increasing the data bank of botanical pesticides evaluates the effect of crude aqueous extracts of some tropical plants for their insecticidal properties under field conditions for the control of two major post-flowering insect pests of cowpea. The extracts were applied at 10 % (w/v) with four weekly spraying intervals and compared with a synthetic insecticide and an untreated check. The results showed that the extracts of neem, *Azadirachta indica* (A. Juss), bread fruit, *Artocarpus altilis* Park and fermented cassava tuber, *Manihot esculentus* Crantz. (in that order) caused significant ($p<0.05$) reduction of both *Maruca vitrata* Fab. and *Clavigralla tomentosicollis* Stal. on cowpea plants compared with other plant extract treatments and were equi-toxic with the synthetic insecticide treatment in the control of both pests in the two years of trials. Pod damage was considerably reduced (< 35%) with consequent increases in grain yields on seed extracts of neem and breadfruit treated plots compared with the other plant extract treatments but were inferior to the synthetic insecticide treatment on the yield parameters tested. Seed quality followed similar trend and was significantly higher in neem seed extract treated plots (79.97%), followed by breadfruit extract (72.3%) and fermented cassava tuber extract (61.97%) among other plant extract treatments.

Key words: Plant extracts, *Maruca vitrata*, *Clavigralla tomentosicollis*, control, cowpea

Introduction

Insect pests infestation on cowpea, *Vigna unguiculata* (L.) Walp plants especially at the post-flowering phase is a major hindrance to its production worldwide. The legume pod borer, *Maruca vitrata* Fab. (Lepidoptera: Pyralidae), the pod sucking bug complex predominated by the spink bug, *Clavigralla tomentosicollis* Stal (Hemiptera: Coreidae) and the legume flower bud thrips, *Megalurothrips sjostedti* Trybom (Thysanoptera: Thripidae) are the main pests of cowpea in tropical Africa (Jackai and Daoust, 1986). The larvae of *M. vitrata* feed on flowers and pods while adults and nymphs of *C. tomentosicollis* feed on succulent pods. Complete crop failure may occur where insecticide protection is not introduced (Jackai and Adalla, 1997) especially for the improved, high yielding varieties. Efforts to popularize these improved varieties of cowpea among limited resource farmers have been a difficult task due to their high demand for insecticidal sprays. These synthetic insecticides are not only expensive due to the high exchange rate of the local currency against the major foreign ones, but also are unavailable at critical period of need.

Insecticide application on a large scale causes a number of problems including environmental degradation, destruction of natural enemies of pests, pest resistance and resurgence and health risk to the farmers and livestock. *M. vitrata* larvae have shown some resistance to different classes of insecticides (Ekesi, 1999). These situations coupled with the current economic hardship in Africa which led to the withdrawal of various subsidies previously enjoyed by farmers and the demand for pesticide-free food have stimulated interest on alternative sources of insecticide that would become a component of socio-economically sustainable and environmentally friendly crop protection strategies (Jackai and Oyediran, 1991). Botanical pesticides could offer such a management option.

Aqueous or oil extracts from plants have been used for centuries as bio-agents (Crosby, 1971) by farmers worldwide. In the past two decades, researches were directed at developing new botanical pesticides that were effective against pests but present minimal hazards to the user and damage to the environment. These plants contain complex mixture of compounds which the plants sequestered and stored over the years and have formed part of their survival strategy (Yang and Tang, 1987). These compounds may act synergistically (Berenbaum, 1985) and become more lethal to pests than the individual components of the mixture (Berenbaum *et al*., 1991; Chen *et al*., 1995). However, due to geographical differences in the distribution of biologically active compounds (Ermel *et al*., 1987), field activities of extracts from some plant species on pests of crops are varied (Raymundo and Alcazar, 1983; Olaifa and Adenuga, 1988; Williams and Mansingh, 1993).

The present study is part of the ongoing research in the Institute for Agricultural Research, Ahmadu Bello University, Zaria to evaluate the insecticidal attributes of many herbal landraces and introduced species in Nigeria and their mixtures for pests control on field crops.

Materials and Methods

Plant materials including the rhizomes of *Cyperus rotundus* Linn. (Cyperaceae), *Artemisia judaica* L. (Compositae), the seeds of *Azadirachta indica* (A. Juss) (Meliaceae), *Artocarpus altilis* Park (Moraceae), *Garcinia cola* (Heckel-Holl.) (Guttiferae), *Parkia biglobosa* L. (Leguminosae) and tubers of *Manihot esculentus* Crantz (Tuberaceae) were purchased (fresh or dried) from the market in Zaria (except neem seeds that was picked around trees located near the institute). The cassava tubers were peeled, washed with tap water before drying in the oven. The plant materials were oven-dried at 60°C for 12 h to stabilize the moisture contents. The seeds of Breadfruit (*A. altilis*) and neem were decorticated before weighing. Five hundred gram each of the plant materials were weighed separately and pounded in a wooden mortar with pestle. Each of the powders was soaked in 3.5 L water overnight (except for cassava powder which was soaked for 2 weeks to ferment) before filtering with 1.0 L water using a muslin cloth. 250 mL flaked bar soap and starch solutions (20% w/v) were each added to the extracts to improve its rain fastness and even spread on the sprayed plants. All the extracts (10% w/v) were labeled and sprayed same day.

Experimental Site

The trials were conducted on the Research Farm of the Institute for Agricultural Research, Zaria (Latitude 11°11′ N, Longitude 7°38′ E; Altitude 686 m) during the rainy season of 1998 and 1999 which commenced on average in early June and lasted till the first week of October. Cowpea crop is usually sown from mid July to the third week of August in this ecological zone. The soil is described as a leached Ferruginous tropical soil, developed on very fine sandy Aeolian drift over gneiss with a well developed B-horizon (sandy clay loam) with iron concoctions (McDonald and Flower, 1975). The field was sprayed with glyphosate three weeks before harrowing and ridging. The experiment comprised of 9 treatments: seven plant extracts, Uppercott (Cypermethrin 30 g a.i.+ Dimethoate 250 g a.i. L^{-1}) and an untreated control. Plot sizes were 6.0x5.0 m and each plot consisted of five ridges (three main ridges and two discards, one on each side of the main ridges). Inter-row spacing was 0.75 m apart. Each plot was separated by 1.50 m wide border margin along the ridge. The experimental design was a Randomized Block Design with three replications.

SAMPEA 7-cowpea, a semi determinate, medium duration and semi erect variety was sown three seeds per hole at 0.25 m intra-row spacing in the first week of August 1998 and 1999 cropping seasons. Pre-emergent herbicide (Galex–Metolachlor 250 g a.i. + Metobromuron 250 g a.i. L^{-1}) and post emergent herbicide Gramoxone (Paraquat 150 g a.i. L^{-1}) were applied at 2.5 kg a.i. ha^{-1} each immediately after sowing. Seedlings were thinned to two per hole three Weeks After Sowing (WAS). Compound fertilizer (NPK 15:15:15) was applied at 37.5 kg a.i. ha^{-1} by side placement two WAS. A tank mixture of benlate + mancozeb at 0.30 kg a.i. ha^{-1} was applied at 4 weekly intervals from the fourth week after sowing. Manual weeding was carried out at five WAS to ensure a weed free condition. Spraying of extracts and the synthetic insecticide against insect pests commenced at flower bud initiation (7 WAS). Spraying was conducted once weekly for four weeks using CP Knapsack sprayers. The sprayers were rinsed with copious amount of water after each application to avoid extract contamination. A single row of cowpea per pass was taken during field spraying.

The larvae of *Maruca* pod borer 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 larvae found was recorded. *Maruca* pod borers were also sampled by randomly picking 20 pods from a random sample of 10 plants per plot. These were dissected and the number of borer larvae observed was recorded. Adults and nymphs of *C. tomentosicollis* were assessed visually on plants located in three 1.0x1.0 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). Grain yields were recorded from harvested dried pods in the sample rows after threshing and winnowing. Grain quality (clean seeds) was measured by weighing out 300 g seeds from each treatment replicates and removal of damaged seeds (deformed, small sized, cracked, wrinkled or holed seeds) from the bulk seeds and reweighing the good seeds. These were also expressed in percentages. All the data obtained were angular transformed before analysis of variance was performed while treatment means were separated by Student Newman Keuls test ($p<0.05$) (SAS, 1990).

Results and Discussion

The synthetic insecticide and plant extract treatments significantly ($p< 0.05$) reduced the numbers of *M. vitrata* and *C. tomentosicollis* on treated plots compared with the untreated check in the two seasons. Although, the synthetic insecticide treatment had lower number of *M. vitrata* and *C. tomentosicollis* among the treated plots, their values (Table 1) were not significantly different compared to neem seed, breadfruit and fermented cassava extract treatments for the former (*M. vitrata*) and neem seed, breadfruit extracts for the latter (*C. tomentosicollis*). Neem seed, breadfruit and fermented cassava extracts (in that order) were superior to other plant extracts in causing reasonable reduction of the tested pests as well as reducing damage (<35%) to cowpea pods in both seasons (Table 2). Similar trend was observed on grain yields assessment where the three plant extracts (neem seed, breadfruit and fermented cassava) gave higher grain yields and better quality grains (>60%) compared to the other plant extracts but their values were inferior to that in the synthetic insecticide

Table 1: Mean number of *Maruca vitrata* larvae and *C. tomentosicollis* (adults and nymphs) on cowpea plants sprayed with aqueous extracts of different plant species

	N. of *M. vitrata*/flower and/or pod		No. of *C. tomentosicollis*/plant	
Treatments	1999	2000	1999	2000
Untreated control	4.17a	4.83a	7.17a	7.68a
C. rotundus	1.84b	2.17b	2.50bc	2.83bc
A. judaica	1.00b-d	1.34b-d	1.42de	1.75de
G. cola	1.75b	2.00b	2.92b	3.25b
P. biglobosa	1.59b	1.92b	184.00cd	2.17cd
M. esculentus	0.67cd	0.92cd	1.25de	1.58de
A. indica	0.50cd	0.75cd	067.00ef	0.92ef
A. altilis	0.67cd	0.92cd	0.92d-f	1.25d-f
Uppercott	0.17d	0.42d	017.00f	0.33f
SE ±	0.39	0.47	0.47	0.50

Means in a column followed by the same letter (s) are not significantly different by SAS-SNK test ($p<0.05$)

Table 2: Mean pod damage, grain yields and seed quality of cowpea sprayed with aqueous extracts of different plant species

	% Pod damage/plant		Grain yields kg ha^{-1}		%Clean seed/300 g seeds	
Treatments	1999	2000	1999	2000	1999	2000
Control (0.0)	92.17a	94.66a	46.13a	47.56a	5.22a	5.38a
C. rotundus	72.36c	74.60c	81.05ab	83.56ab	37.50c	38.66c
A. judaica	48.89e	50.40e	194.69c	200.71c	53.05e	54.69e
G. cola	74.91b	76.88b	76.77ab	79.49ab	21.98b	22.66b
P. biglobosa	59.03d	60.85d	97.43b	100.45b	41.32d	42.59d
M. esculentus	37.78f	38.94f	353.52d	364.45d	61.97f	63.88f
A. indica	28.27h	29.14h	569.06f	586.66f	79.97h	81.42h
A. altilis	31.61g	32.62g	450.51e	464.44e	72.29g	74.53g
Uppercott	10.68i	11.10i	1115.94g	1150.46g	94.38i	97.29i
SE ±	0.38	0.41	8.28	8.75	0.41	0.38

Means in a column followed by the same letter(s) are not significantly different by SAS-SNK test ($p<0.05$)

treatment. Extracts of *G. cola*, *C. rotundus*, *P. biglobosa* and *A. judaica* were found to be less effective but were significantly superior to the untreated control in all the parameters considered.

The results obtained in this study have shown the potential of neem seed, breadfruit and fermented cassava extracts in that order as biopesticides for the control of two major post-flowering pests of cowpea. The results were consistent with the reports of several authors working with various plant materials on different crop pests (Ekesi, 200; Dike, 1997; Oparaeke *et al*., 2002; Oparaeke *et al*., 2005). The activity of neem seed extracts against *M. vitrata* and *C. tomentosicollis* and other crop pests is well documented (Jackai and Oyediran, 1991; Saxena, 1981; Schmutterer, 1990; Jackai *et al*., 1992). However, limited data are available on the mode of action of breadfruit and cassava extracts on pests of crops. Field observations made after few minutes of spraying these extracts did not reveal any abnormal behaviour on *M. vitrata* and *C. tomentosicollis*, which might rule out any contact activity contrary to the reports of Williams and Mansingh (1993) who showed in a laboratory study that the extract of *A. altilis* caused 47, 70 and 93% mortality of *Tribolium confusum* Duval in day 1, 2 and 3, respectively ahead of *Annona reticulata* L., *Eupatorium odoratum* L. and *A. indica*. However, subsequent observations made after two days of spraying showed sluggish movements on both pests found on the plants even after prodding with a stick which might suggest lack of feeding thereby implicating antifeedant mechanism. This is the first time breadfruit extract is reported to show insecticidal activity against *M. vitrata* and *C. tomentosicollis* on field cowpea.

Breadfruit contains alkaloids belonging to the triterpenes known for their antifeedant and repellent activity while cassava contains Prussic acid (from cynanide chemical group), which have shown lethal effect on some mammals (priviledged information). Neem on the other hand, contains Azadirachtin, nimbin, salannin and meliantriol, which have exhibited insecticidal, antifeedant, repellent and growth regulatory properties on different species of insect pests (Warthen *et al*., 1978; Reed *et al*., 1982). Compared with the synthetic insecticide, the poor performance of neem seed, breadfruit and fermented cassava extracts in protecting pods from damage caused by insect pests with relatively lower grain yields as observed in this study might be due to the slow action of plant extracts, low concentration of extract applied (10% w/v) and non persistence of the extracts on cowpea plants as a result of incessant rainfall which might have washed away or diluted the extracts soon after application. Therefore, for effectiveness these materials should be applied at >20%.

Neem and breadfruit are planted to provide shade along the major highways and for food respectively in Nigeria. The leaves of both trees have been used for centuries by communities in Nigeria for the treatment of various health disorders in patients. Cassava tubers on the other hand, are boiled and eaten with palm oil or fermented and processed as fufu and garri, both local staple foods consumed by millions of people across the West African sub region. These plants are readily available, cheap and biodegradable and have no known health hazards associated with the synthetic insecticides.

Further studies are required to identify, isolate and characterize the active principles in breadfruit and its mode of action, which is useful in the formulation of pesticides since that of neem are known. There is also the need to test the optimum concentration and spraying schedule of breadfruit extract for greater efficacy against crop pests. These extracts could be tried in mixtures with other less effective plant extracts to improve their overall efficacy in pest management of field crops.

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