Evaluation of aqueous extracts of five plants in the control of flea beetles on okra (*Abelmoschus esculentus* (L.) Moench)

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ABSTRACT

The emergence of biodegradable pesticides as safe option has reduced the problems that result from the use of synthetic insecticides, thus creating a renewed interest in their development and use in integrated pest management of crops. The objective of this study was to investigate the insecticidal properties of the water extracts of *Jatropha curcas, Vernonia amygdalina, Ageratum conyzoides, Chromolaena odorata* (L) and *Annona squamosa* on two species of flea beetles (*Podagrica uniforma* and *P. sjostedti* (Coleoptera : Chrysomelidae) infesting okra (*Abelmoschus esculentus* (L.) Moench), variety NHAE 47-4). The leaves and seeds of the plants used in the experiment were collected from the locality, washed and shade dried. A synthetic insecticide, lambda-cyhalothrin (karate) was included in the treatments as a standard check alongside the untreated (control). The experiment was laid out in a randomized complete block design (RCBD) with seven treatments and four replicates. The efficacy of the treatments was based on reduction in flea beetles and percentage reduction in population of the pests. The results showed that only three of the plant extracts (*Jatropha curcas, Vernonia amygdalina and Annona squamosa*) significantly ($P < 0.05$) reduced the population of the two flea beetles at 64%, 55% and 49%, respectively. Though the other two botanicals were not significant in reducing the population of the pests, they were better than the control. All the plant extracts tested were not as effective as the synthetic insecticide in reducing flea beetles population. Among the tested plants, *J. curcas*, was found to be more effective, hence its use by resource poor farmers is recommended in the protection of okra against the infestation of *P. uniforma* and *P. sjostedti*.

Key words: Biodegradable, botanicals, plant extracts, *Podagrica uniforma*, *P. sjostedti*

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench.] is the most important fruit vegetable crop and a source of calorie (4550 kcal/kg) for human consumption. It ranks first before other vegetable crops (Babatunde *et al.*, 2007). Okra is an important vegetable in West Africa, India, Brazil and the United states (Kemble *et al*., 1995). In Nigeria, okra is one of the most important vegetables in terms of consumption and production area (Iremiren and Okiy, 1986). Okra occupies about 1.5 million hectares of the arable land in Nigeria alone (IFA,1992). The World production of common okra as fresh fruit vegetable is estimated at 1.7 million t/year (Schippers, 2000).

Okra is rich in vitamins, calcium, potassium and other mineral matters. Its fruits can be cooked in a variety of ways. It can be fried in butter or oil and cooked with necessary ingredients (Yadav *et al*., 2001). Okra mucilage is suitable for medicinal and industrial applications. It has been medically found that its application serves as a plasma replacement or blood volume expander. Industrially, okra mucilage is usually used to glace certain papers and also useful in confectionery among other uses (Markose and Peter, 1990). However, the yield of okra has been reported to be very low in Nigeria, hardly up to 7t/ha (Schippers, 2000). Among the problems of okra production in Nigeria are insect pest infestations, disease incidence and poor soil nutrient level.

Egwuatu (1982) reported that *Podagrica uniforma*, Jacoby and *P. sjostedti* Jacoby (Coleoptera: Chrysomelidae) are the most destructive insect species of okra at Nsukka, Nigeria. Emosairue and Ukaegbu (1994) in a study of insects associated with okra showed that the flea beetles, *P. uniforma* and *P. sjostedti*, are the most prevalent and most serious insect pests of okra in the Calabar humid area of Nigeria. The two flea beetles are important vectors of okra mosaic virus (OMV), a tymovirus. In Nigeria, okra is heavily infected by this virus if grown without controlling for the flea beetles (Lana and Taylor, 1976).

The effectiveness of various synthetic organic insecticides has been reported in the control of flea beetles in particular as well as other pests of okra. Adenuga (1971), revealed that vetox 85WP (carbaryl) applied eight times at 1.0-1.68 kg a.i./ ha was very effective in the control of okra flea beetles. The population trend of these species of flea beetle monitored on late season dwarf okra under four spray regimes of lamdacyhalothrin, a synthetic pyrethroid, significantly reduced their population (Emosarue and Ukaegbu, 1994). The use of pesticides in most pest control programmers is inevitable as they boost agricultural production, but their haphazard use causes harmful effect on human health (Hassan *et al.*, 2007; Soomro *et al.*, 2008). The development of resistance of flea beetles to synthetic insecticides in crucifers has also been noted (Fan and Huang, 1991). Awareness regarding the food safety has increased the demand for organically produced food, which necessitates evaluating the performance of biopesticides as safer alternatives to conventional insecticides (Muhammad *et al.*, 2010). In response to the high costs of pesticides and their negative side effects is the need for a paradigm shift to the development of non-chemical technologies which may eliminate the use of insecticides and could have economic and health benefits to the applicators, consumers and the environment (Murdock *et al*., 1997).

In view of the importance of okra, the flea beetles that cause considerable crop losses and the health and environmental hazards that result from the use of pesticides to reduce the effect of insect pests, it was considered appropriate to evaluate the biological efficacy of five botanicals against the flea beetles of okra under field conditions.

MATERIALS AND METHODS

Field trials were conducted during the cropping seasons of 2007 and 2008 at the Teaching and Research Farm, Adeyemi College of Education, Ondo (Latitude 07º 05'N, Longitude 04º 50'E, 27.5 m) in the rain forest zone of Nigeria. The site for the experiment measuring 17 m ×25 m (425 m^2) which had been previously cultivated was cleared and marked out into plot sizes of 3 x 4 m and separated by a 1-m pathway. The experiment was laid out in a Randomized Complete Block Design (RCBD) with five treatments and four replicates.

The planting material, an early maturing cultivar of okra (NHAE 47-4), was procured from the Ondo State Agricultural Development Project, Ondo, Nigeria. The okra seeds were dibbled at a spacing of 60 cm between rows and 30 cm between plants. The five plant materials that were used in the trials included: goat weed (*Ageratum conyzoides* L.), physic nut (Jatropha *curcas* L.), siam weed (*Chromolaena odorata* L.), bitter leaf (*Vernonia amygdalina* L.) and Sweetsop (*Annona squamosa* Linn.). These botanicals, in addition with the synthetic insecticide, lambda-cyhalothrin and the control represented the seven treatments that were executed in the experiment. The experimental plot was kept weed free throughout the period of the trial. Fertilizer (N.P.K.) was incorporated into the soil at the rate of 200kg/ha.

Selection and collection of plant species

The selection of plants used in the study was based on previously reported insecticidal properties of the plants against many insect pests of vegetables. The plants, with the exception of *Annona* spp., which was collected within Ondo town, were all collected from the main campus, Adeyemi College of Education, Ondo. The plant parts were plucked by hand and put in a jute bag ready for extraction.

Preparation of aqueous extract

The plant parts were washed to remove sand, dust and chemical contaminants, shade-dried for 5-6 days on a clean concrete platform and then powdered using wooden pestle and mortar. The extracts of the botanicals were prepared following the method of Rezaul Karim *et al.* (1992). Each of the five plants extracts was prepared at a concentration of 10% w/v by weighing 450 g of the powder and then soaked in plastic bucket containing 3.5 litre of warm water (60^0 C). The resulting solution was stirred continuously for 10 minutes and left to stand for 12 hrs. Filtration of the plant extracts was done shortly before application in the field using muslin cloth. The final volume of each plant extract filtrate was made up by diluting with 1 litre of distilled water. The stickiness and adherence of each of the plant extract was enhanced by the addition of 100 ml of 5 % soap solution as surfactant. Spraying of the plant extracts was done early in the morning before sunrise because of the photodegradable nature of the extracts.

Data collection and statistical analysis

Sampling of the beetles was by visual count and this commenced three weeks after planting (WAP). Data collection on flea beetles took place in the morning between 7 - 9 am. There were three samples per plot consisting of five stands per sample with the mean numbers of the insects recorded in each case. Reduction in number of flea beetles was converted to percent reduction by the use of Henderson and Tilton formula (1995). Data were subjected to one- way analysis of variance (ANOVA) while differences in treatment means were separated by Student Newman Keuls (SNK) test at 5% level of significance. All statistical analyses were done by SPSS version 17.0 for windows.

RESULTS

The results of the effect of aqueous extracts of five plants and synthetic insecticide to control okra flea beetles, *Podagrica uniforma* and *P. sjostedti* during 2008 and 2009 cropping seasons are presented in Tables 1and 2. Effects of treatments on the two flea beetles species were evaluated from the reduction in numbers of flea beetles after application of treatments. The percent reduction in flea beetles population density is shown in Figures 1 and 2. The analysis of variance for the effects of treatments generally indicated the plant extracts treatments significantly reduced flea beetles populations than the untreated during the two seasons ($p < 0.05$). However, the plant extracts were not as effective as the insecticide, lambda-cyhalothrin, in lowering populations of the insects per plant.

The results of 2008 field trial showed that all the treatments significantly suppressed infestation of the two flea beetle species throughout the period of observation. In the first day after application of treatments, the numbers of flea beetles were significantly reduced by plant extract- treated plants and lambda-cyhalothrin- treated plants than the untreated plants ($p<0.05$). Among the plant extracts treatments, significant difference in reduction of flea beetles population was only observed in plots where seeds extract of *Jatropha curcas*, was applied ($p<0.05$). In the two years of study, the seeds extract of *Jatropha curcas* proved most effective in

Table 1. The effect of plant extracts on the population of *Podagrica sjostedti* in 2008 and 2009 seasons

Treatment	2008				2009			
	Pre-counting	Days after application			Pre-counting	Days after application		
		1	3	5		1	3	5
Jatropha curcas	9.00^{a}	3.69^{b}	3.55^{b}	3.50^{b}	8.75^{a}	3.50^{b}	3.00^{c}	3.50^{b}
Ageratum conyzoides	9.75^{a}	5.33^{b}	5.75^{b}	6.25^{a}	7.75^{a}	5.75^{a}	6.25^{b}	7.75^{a}
Chromolaena odoratum	9.00^{a}	5.84^{b}	4.90^{b}	3.50^{b}	8.50^{a}	4.00^{b}	4.50^{c}	4.95^{b}
Vernonia amygdalina	12.25^{a}	5.35^{b}	6.50^{b}	7.00^{a}	10.50^{a}	6.50^{a}	8.00^{ab}	8.25^{a}
Annona squamosa	9.50^{a}	4.75^{b}	5.85^{b}	4.20^{b}	9.25^{a}	3.75^{b}	3.00^{c}	5.50^{b}
Lamdacyhalothrin	11.00^{a}	0.25^{c}	0.50^{c}	1.50^{b}	9.25^{a}	0.50^{c}	1.50^{c}	1.75^{c}
Untreated	12.50^{a}	14.25^{a}	14.25^{a}	9.75^{a}	$11.75a^{a}$	12.25^{a}	$10..24^{a}$	10.50
SE±	1.76	1.86	1.56	0.98	0.60	0.63	0.69	0.66

Table 2. The effect of plant extracts on the population of *Podagrica uniforma* in 2008 and 2009 seasons

Treatment	2008				2009			
	Pre-counting	Days after application			Pre-counting	Days after application		
		1	3	5		1	3	5
Jatropha curcas	5.00^{a}	2.25^{bc}	1.75^{b}	2.00^{ab}	5.50^{a}	2.75^{ab}	2.00^{a}	1.50^{b}
Ageratum conyzoides	3.25^{a}	1.50^{b}	1.50^{ab}	2.57^{ab}	4.75^{a}	2.25^{ab}	1.75^{a}	2.50^{b}
Chromolaena odoratum	5.25^{a}	2.25^{bc}	2.50^{ab}	1.75^{bc}	5.25^{a}	1.50^{bc}	2.00^{a}	2.75^{b}
Vernonia amygdalina	4.75^{a}	2.25^{bc}	1.95^{ab}	2.30^{ab}	5.75^{a}	2.00^{ab}	3.00^{a}	3.25^{a}
Annona squamosa	5.25^{a}	2.50^{b}	1.75^{b}	1.50^{bc}	6.00^{a}	2.50^{abc}	2.00^{ab}	3.20^{b}
Lamdacyhalothrin	4.50^{a}	0.25^{c}	0.25^{c}	0.50^{c}	5.00^{a}	$.50^{c}$	$.50^{b}$	1.80^{b}
Untreated	4.64^{a}	4.50^{a}	3.50^{a}	3.75^{a}	5.00^{a}	4.50^{a}	3.50^{a}	4.75^{a}
SE ±	0.24	0.30	0.20	0.26	0.22	.293	.197	.306

Mean followed by the same alphabets in a column do not significantly according to Student Newman Keuls ($P < 0.05$) test.

Figure 1. Plant extracts on the percent reduction of *P. sjostedti* population

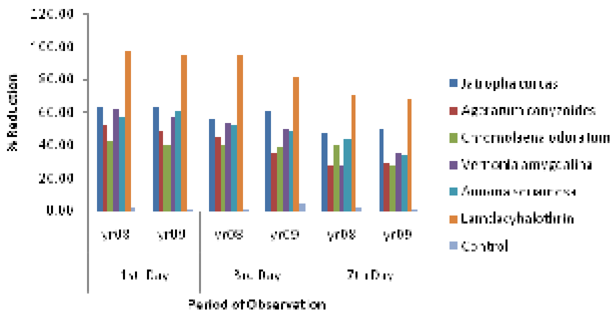
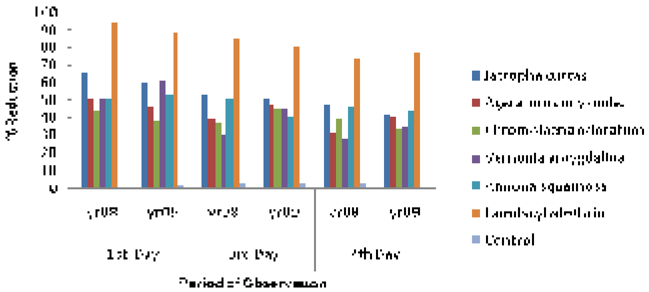


Figure 2. Plant extracts on the percent reduction of *P. uniforma* population



reducing the population of *P. sjostedti* 24 hrs after application. The effect of *J. curcas* led to a mean percent reduction of 63% compared to *Vernonia amygdalina*, *Annona squamosa*, *Ageratum conyzoides* and *Chromolaena odorata* at 58%, 55%, 49% and 41%, respectively (Figs. 1 and 2). Similar trends in efficacy of treatments in reduction of flea beetles were found for third and seventh day after application of treatments.

The effects of plant extracts on population of beetles followed similar trend in 2009 field investigation with lambda-cyhalothrin treatment and the plant extracts significantly reducing the infestation of flea beetles when compared with the untreated ($p<0.05$). The insecticide was observed to be most active and significantly effective against the flea beetles when compared with the plant extracts ($p<0.05$). Insect populations among the five plants extracts were significantly lower in plants sprayed with *Jatropha curcas*, *Chromolaena odorata* and *Annona squamosa* as compared to the untreated plots 24 hrs after application. The infestations of *P. sjostedti* in plant extracts treated plots were observed to be lowest in plots treated with the seeds extract of *J. curcas* throughout the period observation. This trend was also observed 3 days after treatment for *P. uniforma*. In both years of study, significant reduction in population of flea beetles was observed in plots sprayed with plant extracts treatments ($p< 0.05$). However, plots sprayed with the synthetic insecticide was found to be most effective than the plant extracts.

The fresh fruit weights obtained in the treated plots in 2008 field trial were significantly different from the untreated (Table 3). Though, the insecticide treated plots produced the highest yield, this was not significantly different from the fresh yield recorded in the plots sprayed with *Ageratum conyzoides* leaves extract. The yield obtained in the plots treated with *C. odoratum*, *V. amygdalina* and *A. squamosa*. In the treated

Table 3. Effects of plant extracts on the fresh pod weight and pod density of okra.

Treatment	2008		2009	
	Pod density/plant	Fresh fruit wt(tons/ha)	Pod density/plant	Fresh fruit wt(tons/ha)
Jatropha curcas	13.33[a]	16.67[b]	12.47[a]	17.52[b]
Ageratum conyzoides	13.45[a]	18.52[b]	13.83[a]	17.37[b]
Chromolaena odoratum	14.44[a]	13.00[ab]	11.17[a]	14.65[b]
Venonia amygdalina	10.51[a]	13.00[ab]	11.79[a]	17.00[b]
Annona squamosa	14.68[a]	15.13[ab]	15.33[a]	16.20[b]
Lamdacyhalothrin	14.44[a]	18.33[b]	14.67[a]	19.00[b]
Untreated	14.22[a]	7.32[a]	11.51[a]	8.67[a]
SE(±)	0.65	1.02	0.85	0.70

Mean followed by the same alphabets in a column do not significantly according to Student Newman Keuls ($P < 0.05$) test.

plots, pod density per plant in the two years of study was not significantly different from the untreated.

DISCUSSION

In the present investigation the insecticidal activity of plants extracts of *J. curcas*, *A. conyzoides*, *C. odorata*, *V. amygdalina* and *A. squamosa* have been evaluated for the control of flea beetles, *P. uniforma* and *P. sjostedti* on okra during the years of 2008 and 2009. The results indicated that the extracts of the five plant species exhibited moderate level (41-64%) of insecticidal activity in effectively reducing flea beetle population and proved significantly different from the untreated. Joshi and Paneru (1999) have shown that the plant extracts of *A. calamus*, *A. conyzoides*, *A. indica* and *U. dioca* demonstrated potent insecticidal properties against the flea beetle, *P. nemoru*.

Among the plant extracts there was no significant difference in reducing infestation of flea beetles up to the 3rd day after application, the seeds extracts of *J. curcas* and the leave extracts of *V. amygdalina*, proved to be most effective among the plant extracts in reduction of flea beetles numbers up to the seventh day after application. These results confirmed the previous work conducted by Emosairue and Uguru (1999), who reported that 5% aqueous and 5% petroleum ether extract of *J. curcas* seeds were effective in reducing the infestation of *Podagrica* spp. on okra variety (NHAE 47-4). The researchers demonstrated that the petroleum ether (5%) extract was more effective than the aqueous extract, resulting in elevated pod yield of okra. Ohazurike *et al*. (2003) had also reported the inhibition and control of maize weevil (*Sitophilus zeamais*) in the stored maize grains by *J. curcas* seed extracts.

The effects of lambda-cyhalothrin on flea beetle had been reported by Emosauire and Ukaegbu (1994), Dabiré-Binso *et al*. (2009), Oladimeji and Kannike (2010). The petroleum ether extracts of *Monodora myristica* and the 5% seeds extracts of *J. curcas* were reported by Emosauire *et al*. (1998**)** to be effective against the control of *Podagrica spp*. In a study on the insecticidal activity of extracts of four tropical plants, the crude extracts of *V. amygdalina* was found to result in higher toxicity of beans weevil, *Acanthoscelides obtectus* (Adeniyi *et al*., 2010). The bark, roots and leaves of *J. curcas* have been reported to contain hydrogen cyanide in addition to toxalbulmin and curcin as active ingredients believed to be insecticidal against many insect pests (Tobih, 2011; Lambert *et al*., 1985). The insecticidal potential of the different plant species including those used in this study have been reported by several authors against many species of crop pests (Dike and Mbah, 1992; Attieri, 1993; Oparaeke, 1997).

The findings in these trials showed the potentials of the seeds extracts of *J. curcas* and leaves extracts of *V. amygdalina* and *A. squamosa* in controlling a variety of insects in the field. The development and use of extracts of *J. curcas* is recommended. However further research work on the mode of action of and rates of application should be investigated.

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