Exploration of *Erythrina Excelsa* Baker and *Aneilema Beniniense* (P. Beauv.) Kunth Aqueous Extracts For The Management of Flea Beetles (*Podagrica* Spp) On Okra (Abelmoschus Esculentus)

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Abstract: Control of insect pests involves the management of pest populations to an equilibrium whereby their effect on yield is reduced. The efficacy of aqueous extracts of *Aneilema beniniense* and *Erythrina excelsa* plants were compared for effectiveness in the control of flea beetles (*Podagrica uniforma* and *Nisotra dilecta*) on okra during the 2013 cropping seasons at the Teaching, Research and Commercial Farm, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria. The extracts were sprayed every week for 5 weeks, starting from crop establishment till fruiting. The results show that the two plant extracts were able to exercise significant (P<0.05) insect controlling influence against *P. uniforma* and *N. dilecta* and caused impressive reductions of both insect pests population and protected the okra plant from serious damage and increased pod yield in comparison with the control. Fruit yields were significantly (P<0.005) higher in plots treated with *A. beniniense* extracts compared to other treatments. From the results, *A. beniniense* and *E. excelsa* was recommended for use on farms managed by limited resource farms in Nigeria, since the technology is cheap, safe, environmentally friendly and easy to adopt in tropical countries.
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Introduction

Okra *Abelmoschus esculentus* L. (Moench), is a commercial vegetable crop with considerable area under cultivation in Africa and Asia. In 2009-2010, the total world area under cultivation was 0.43 million hectares and the production stood at 4.54 million tons; with India being largest producer (67.1%), followed by Nigeria (15.4%) and Sudan (9.3 %) (Varmudy, 2011).

Okra plays an important role in the human diet (Kahlon et al. 2007, Saifullah and Rabbani 2009). by supplying fats, proteins, carbohydrates, phosphorus, calcium, iron, sulphur, fibre, minerals and vitamins (Lamont 1999, Owolarafe and Shotonde 2004, Gopalan et al. 2007, Arapitsas 2008, Dilruba et al. 2009). Okra fruit is usually boiled in water resulting in slimy soups and sauces, which are relished. The fruits also serve as soup thickeners. Okra seed can be dried, and the dried seeds are a nutritious material that can be used to prepare vegetable curds, or roasted and ground to be used as coffee additive or substitute (Moekchantuk and Kumar 2004).

Industrially, okra mucilage is usually used for glace paper production and also has a confectionery use. Okra has found medical application as a plasma replacement or blood volume expander (Savello et al. 1980, Markose and Peter 1990, Lengsfeld et al. 2004, Adetuyi et al. 2008, Kumar et al. 2010) and it is said to be very useful against genito-urinary disorders, spermatorrhoea and chronic dysentery (Nadkarni, 1927). Its medicinal value has also been reported in curing ulcers and relief from hemorrhoids (Adams, 1975). Tests conducted in China suggest that an alcohol extract of okra leaves can eliminate oxygen free radicals, alleviate renal tubular-interstitial diseases, reduce proteinuria, and improve renal function (Liu et al. 2005, Kumar et al. 2009).

Insect pest infestation is one of the most limiting factors for accelerating yield potential of okra. The crop is prone to damage by various insects; various growth stages of the crops are susceptible to the different insect pests and diseases (Ek-amnuay 2007, Fasunwon and Banjo 2010). Insect pests like crickets can be a problem during germination/seedling stage of the crop while the thrips, whitefly and other phloem feeders are common during vegetative stage (Fajinmi and Fajinmi 2010). The most destructive insect pests are two flea beetle species, *Podagrica uniforma* (Jac.) and *P. Sjostedti* (Coleoptera: Chrysomelidae) which are responsible of heavy defoliation (Odebiyi, 1980). Important yield losses are reported in Nigeria and Ghana (Obeng-Ofori and Sackey, 2003; Ahmed et al., 2007). These insects also transmit the okra mosaic virus which causes significant yield losses (Van Lommel et al., 1996).

The control of field insect pests of okra remains a major production constraint of farmers. In Nigeria, use of chemical insecticides is in vogue for the control of insect pest. Although synthetic insecticides application is popular and effective means of pest control their use in okra production is limited because the crop was regarded as low value cash crop. Exclusive reliance on insecticides as a control strategy against insect pest has resulted in several undesirable effects, like pesticide pollution, resurgence of secondary pests, insecticide resistance, elimination of beneficial fauna and different human health problems. There is a need to explore alternative approaches to reduce the sole dependence on insecticides. The use of plants derived insecticides are in recent time being investigated by researchers as possible replacement for synthetic insecticides because they are supposedly safer and may be more readily available and affordable (Dudu and Williams 1991). Therefore an attempt was made to study the efficacy of *Erythrina excelsa* Baker and *Aneilema beniniense* aqueous extracts for controlling *P. uniforma* (Jaq.) and *N. dilecta* (Jaq.) (Coleoptera: Chrysomelidae) infestation and boost yield of okra *Abelmoschus esculentus.*

Material and Methods

Experiment site and field layout

The experiment was conducted during rainy season 2013 in the horticultural farm of the Teaching and Research Farm Rufus Giwa Polytechnic Owo, Ondo state, Nigeria. The land was cleared of all vegetation cover and was then ploughed and harrowed with a disc plough and disc harrow respectively to render the soil loose. The trial was laid out in a Randomized Complete Block Design (RCBD) in a total land area of $456m^2$ measuring 24m x 19m; with three treatments and each treatment was replicated thrice. It was then partitioned into three blocks and each block was further divided into nine plots, with each plot measuring 7m x 5.9m ($41.3m^2$). A distance of 1 m was left as walkway between the blocks and the plots. Planting was done in 27^{th} May, 2013. The seeds of an early maturing okra variety "NH-47-H" obtained from Ondo State Agricultural Development Programme, Akure, Nigeria and were directly sown at two seeds per hole at a planting distance of 60cm x 60cm and a planting depth of not more than 0.5cm; this was later thinned to one seedling per stand. Supplying was carried out 2 weeks after sowing and weeding was done manually when necessary; but no fertilizer application was made.

Preparation and application of treatments

The treatments were 10% (w/v) crude extracts each of *Erythrina excelsa* and *Aneilema beniniense* leaves (Table 1) collected from Owo and Irun Akoko, Nigeria and control (synthetic insecticide) purchased from Agro-chemical store in Owo, Nigeria. Each of these treatments was prepared by weighing 1.0kg of plant material with an electronic balance (DH-V1000/d model), homogenized with pestle and mortar and then allowed to seep overnight in 4 litre of water. The extracts were then filtered through muslin cloth to obtain aqueous extracts. The treatments were applied to the plants on the field at 20 days after sowing (DAS) when the plants were about 30 cm tall, using Spray well 16 L Knapsack sprayer model. Subsequent application of the treatments was carried out at weekly intervals till the plants reached the fruiting stage.

Data collection and Analysis

Number of *P. uniforma* (Jaq.) and *N. dilecta* (Jaq.) was counted before each spray and also at 24, 72, 120 hrs and 7 days after treatment. Five plants were selected at random in each plot and number of brown and blue flea beetles was counted from 2 leaves on top, 2 leaves on bottom and 2 leaves at middle. The collected data were pooled and mean population was worked out separately for 20, 27, 34, 41 and 48 days after sowing. The efficacy of the plant extracts has been worked out by comparing it with the untreated control plot.

Data collected was transformed using the square root transformation method to ensure homogeneity of the variance and normal distribution of the data. The data was later subjected to analysis of variance (ANOVA) using Genstat Release version 12.1 (Payne et al 2009). Means were separated using least significant difference at a probability of 5%.

Results

Table 2 shows that population of *N. dilecta* and *P. uniforma* before spraying were not significantly different from each other in all the assigned treatment plots on the okra plants. However, flea beetle population ranges from 1.7 – 1.9 insects/plant.

At 27 days after planting (DAP), insect population was significantly ($P < 0.05$) reduced by the application of Cypermethrine (Table 3) compared to the spraying effect observed in plots treated with plant extracts at 24 and 72 hrs after spraying (HAS). However, *P. uniforma* population increased slightly at 120hrs and 7 days after spraying (DAS) in plots treated with *E. excelsa* extract and at 7 DAS in plots treated with *A. beniniense* for *N. dilecta* respectively (Table 3). The increase in the insect population mighty is due to light shower recorded on the eve prior to insect count.

The result presented in Table 4 shows that days after second spraying (DAS), plot sprayed with synthetic insecticides maintained significant ($P<0.05$) reduction in insect population for both *P. uniforma* and *N. dilecta* compared to plots treated with plant extracts. Non-significant ($P>0.05$) difference was observed for *P. uniforma* population at 24, 72 and 120 HAS in all the treatments application. The result also shows that there exist no significant ($P>0.05$) difference in the insect population at 24, 72, 120hrs and 7 DAS in plots treated with plant extracts, except for *P. uniforma* population observed at 7 DAS in which there exist significant difference (P<0.05) between *E. excelsa* and other treatments. In addition, there was no significant difference (P>0.05) on *P. uniforma* population on plots treated with Cypermethrin (0.7 insect/plant) and *A. beniniense* (0.9 insect/plant) respectively.

Table 5 shows the result for third spraying at 41 DAP with aqueous plant extract indicates that there is significant different (P<0.05) among the treatments evaluated with the synthetic insecticide significantly (P<0.05) maintained reduction in insect population for both species days after spraying (DAS). Though, the aqueous plants extracts does not exhibit any significant difference (P>0.05) to one another post treatments application. However, at 72 HAS *N. dilecta* population suppression was not significantly different (P<0.05) between the plant extracts and Cypermethrine treated plots.

Results presented in Table 6 shows the population of *N. dilecta P. uniforma* after the fourth spraying at 48 DAP. The result shows that there was no significant different (P>0.05) among the plots treated with synthetic insecticides and plant extracts post application hours and days, except for 24 HAS in which there exist significant difference between plant extracts and Cypermethrin. However, there was no significant difference between *A. beniniense* and Cypermethrin on *N. dilecta* population at 24 HAS. Above all, the result clearly indicates significant reduction in the beetle population compared to result obtained in Table 5.

N. dilecta = Blue flea beetle, *P. uniforma* = Brown flea beetle

The mean number of insect population after fifth spraying with aqueous plants extracts was presented in Table 7. The result shows that there are no significant difference (P>0.05) between the plots sprayed with synthetic and the aqueous plants extracts days after spraying (DAS). The insects population ranges between 0.7 – 0.8 insect/plant in all the treated plots.

The effect of botanical insecticides on okra yield attributes is shown Table 8. The result of the yield shows that there was no significant differences (p>0.05) between plots treated with *E. excelsa* and control (Cypermethrin) in terms of fruits number and fruit length, but there was significant difference (p<0.05) in fruit weight across the different treatment. *A. beniniense* has the highest value in fruit number (20.3 fruits), fruit length (27.9cm) and fruit weight (0.25kg/pod), while Cypermethrine had the lowest fruit weight (0.12kg/pod).

Discussion

Growing awareness of health and environmental issues associated with the intensive use of chemical inputs has led to interest in alternate forms of agriculture in the world.

Plant extracts often consist of complex mixtures of bioactive constituents plant metabolites may produce toxic effects if ingested leading to rejection of the host plant (Russel and Lane, 1993). The active compounds may act as antifeedants, disturb insect growth, development and inhibit oviposition (Gerard and Ruf, 1991; Emimal Victoria, 2010).

P. uniforma and *N. dilecta* is a major okra defoliator and fruit feeder (Parh et al., 1997) reported to cause heavy defoliation of up to 80% of the okra leaves surface (Dabire-Binso et al 2009). Therefore, substantial reduction or controlling of the population of flea beetles on the okra plants by the plant extracts also resulted in a significant reduction in the pest damage on leaves of the okra plants treated with the plant extracts. This experiment suggests that the two plants used as insecticide effectively reduced the level of insect infestations which consequently lead to high yield. This work confirms the findings of other workers (Krishnareddy, et al 1995; Ogunjobi and Ofuya, 2007; Adesina and Idoko, 2013; Adesina and Afolabi, 2014) which showed that okra plants treated with the plant extracts recorded higher yield as compared to the yield of the untreated control okra plants. Okra plants protected with the plant extracts recorded significantly lower leaf damage than the control. This may be due to the ability of the phytopesticides to control the population of the flea beetles on the okra plants as compared to the control.

The findings from this study shows that the plant extracts insecticidal potential manifest greatly at 41 and 48 DAP i.e. 4th and 5th spraying. This indicates that the plant extract is a slow acting insecticide and support the findings of Okuku *et al* (2007) and Adesina and Afolabi, (2014) who both reported the slow action of plant extract(s) in the control of cocoa mirids and flea beetles on cocoa and okra respectively. Also the result concurs with earlier observation raised by (Alao and Adebayo, 2011) that the delayed effect is one of the major problems of botanical insecticides.

Even though the effectiveness of botanicals is not superior to chemical insecticides, they are slow in their efficacy due to their repellent and antifeedent properties. The present study revealed that all the treatments showing insecticidal activity against okra flea beetle and considering their ecofriendly and non-toxic nature, these botanicals may be recommended it was found effective in reducing the population of flea beetle and achieving high yield of okra, thus could serve as an eco-friendly approach in future pest management strategies of okra in developing countries especially in poverty ridden societies.

Table 1. Plant used as botanical insecticides

Botanical Name	Common Name	Family Name	Plant part used
Erythrina excelsa	Coralbean	Leguminosae	Leaves
Aneilema beniniense	Aneilema	Commenlinaceae	Leaves

Table 2. Mean number of flea beetles counted on okra plants before application treatments

Treatments	*N. dilecta*	*P. uniforma*
E. excelsa	1.7^{a}	1.8^{a}
A. beniniense	1.8^{a}	1.7^{a}
Cypermethrine	1.7^{a}	1.9a

N. dilecta = Blue flea beetle, *P. uniforma* = Brown flea beetle

Table 3. Effect of plant extracts on the population of *N. dilecta P. uniforma* after the first spraying at 27 DAP.

24h	72h		120h		Day 7			
Treatments	Blue	Brown	Blue	Brown	Blue	Brown	Blue	Brown
E. excelsa	1.2^{a}	1.4^{a}	1.7^{a}	1.5^{a}	2.0^{a}	2.1^{a}	2.1^{a}	2.4^{a}
A. beniniense	1.3^{a}	1.2^{a}	1.6^{a}	1.4^{a}	1.8^{a}	1.3b	2.1^{a}	1.6^{b}
Cypermethrine	0.8^{b}	0.8^{b}	0.7^{b}	0.7^{b}	0.7^{c}	0.7^{c}	0.7^{b}	0.7^{c}

N. dilecta = Blue flea beetle, *P. uniforma* = Brown flea beetle

Table 4. Effect of plant extracts on the population of *N. dilecta P. uniforma* after the second spraying at 34 DAP

24h	72h		120h		Day 7			
Treatments	Blue	Brown	Blue	Brown	Blue	Brown	Blue	Brown
E. excelsa	1.3^{a}	0.9^{a}	1.4^{a}	0.8^{a}	2.0^{a}	1.3^{a}	1.2^{a}	1.0^{a}
A. beniniense	1.3^{a}	0.8^{a}	1.4^{a}	0.9^{a}	1.7^{a}	1.0^{a}	1.1^{a}	0.9^{b}
Cypermethrine	0. 7^{b}	0.7^{a}	0.7^{b}	0.7^{a}	0.7^{b}	0.7^{a}	0.7^{b}	0.7^{b}

N. dilecta = Blue flea beetle, *P. uniforma* = Brown flea beetle

Table 5. Effect of plant extracts on the population of *N. dilecta P. uniforma* after the third spraying at 41 DAP.

24h	72h		120h		Day 7			
Treatments	Blue	Brown	Blue	Brown	Blue	Brown	Blue	Brown
E. excelsa	1.0^{a}	1.0^{a}	1.2^{a}	1.2^{b}	1.1^{b}	1.1^{b}	1.2^{b}	1.1^{b}
A. beniniense	1.0^{a}	1.0^{a}	1.1^{a}	1.1^{b}	1.2^{b}	1.0^{b}	1.1^{b}	1.0^{b}
Cypermethrine	0.7^{b}	0.7^{b}	0.7^{a}	0.7^{a}	0.7^{a}	0.7^{a}	0.7^{a}	0.7^{a}

N. dilecta = Blue flea beetle, *P. uniforma* = Brown flea beetle

Table 6. Effect of plant extracts on the population of *N. dilecta P. uniforma* after the fourth spraying at 48 DAP.

24h	72h		120h		Day 7			
Treatments	Blue	Brown	Blue	Brown	Blue	Brown	Blue	Brown
E. excelsa	1.0^{a}	0.9^{a}	1.0^{a}	0.6^{a}	1.1^{a}	0.8^{a}	0.9^{a}	0.9^{a}
A. beniniense	0.9^{b}	0.9^{a}	0.9^{a}	0.9^{a}	0.9^{a}	0.9^{a}	0.8^{a}	0.9^{a}
Cypermethrine	0.7^{b}	0.7^{a}	0.7^{a}	0.7^{a}	0.7^{a}	0.7^{a}	0.7^{a}	0.7^{a}

N. dilecta = Blue flea beetle, *P. uniforma* = Brown flea beetle

Table .7 Effect of plant extracts on the population of *N. dilecta P. uniforma* after the fifth spraying at 41 DAP.

24h	72h		120h		Day 7			
Treatments	Blue	Brown	Blue	Brown	Blue	Brown	Blue	Brown
E. excelsa	0.8^{a}	0.8^{a}	0.8^{a}	0.8^{a}	0.8^{a}	0.8^{a}	0.8^{a}	0.8^{a}
A. beniniense	0.8^{a}	0.7^{a}	0.8^{a}	0.7^{a}	0.8^{a}	0.8^{a}	0.8^{a}	0.8^{a}
Cypermethrine	0.7^{a}	0.7^{a}	0.7^{a}	0.7^{a}	0.7^{a}	0.7^{a}	0.7^{a}	0.7^{a}

N. dilecta = Blue flea beetle, *P. uniforma* = Brown flea beetle

Table 8. Mean yield attributes of okra fruits on plots treated with aqueous plant extracts

Treatments	Fruit number	Fruit length	Fruit weight
E. excelsa	15.3[b]	20.8[b]	0.16[b]
A. beniniense	20.3[a]	27.9[a]	0.25[a]
Cypermethrine	13.3[b]	21.1[b]	0.12[c]

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