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Research Article

Comparative Assessment of a Pyrethroid Insecticide with Some Plant Materials for the Control of *Podagrica* Spp. on Okra, *Abelmoschus esculentus* (L.) Moench

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Abstract

The efficacy of different leaf extracts of *Chromolaena odorata, Carica papaya,* and *Ageratum conyzoides* were evaluated in the control of okra (*Abelmoschus esculentus* (L.) Moench.) Flea beetles (*Podagrica* spp.) and to compare the plant extracts with a synthetic insecticide (Deltamethrine). The experiment was laid in the Randomized Complete Block design (RCBD) with five treatments and three replicates. The treatment includes 150g leaf extracts of *Chromolaena odorata, Carica papaya,* and *Ageratum conyzoides*, distilled water (control), and a synthetic insecticide (Deltamethrine) as a standard check. The efficacy of the treatments was evaluated based on reduction of okra flea beetles population and percentage defoliation of leaf lamina. The results indicated that leaf extract of *Carica papaya* significantly ($p < 0.05$) reduced the population of flea beetles by 20.7% and leaf defoliation by 57.7%, other extracts were better than the control (distilled water). All the plant extracts used were not as effective as the synthetic insecticide (Deltamethrine) in reducing both flea beetles population and defoliation of leaf lamina. Among leaf extracts, leaf extract of *Carica papaya* was found to be most effective, hence its use by farmers is recommended in the protection of okra against infestation by *P. uniforma* and *P. sjostedii* as it is biodegradable and environmental friendly.

Keywords: Control *Podagrica* spp.; Okra; Plant Extracts; *Chromolaena odorata*; *Carica papaya*; *Ageratum conyzoides*; Deltamethrine; Randomized Complete Block design (RCBD)

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench.) is an annual, herbaceous, 0.91-1.83m tall plant with a hibiscus like flower. It belongs to the family "Malvaceae" and order "Malvales". Okra originated somewhere around Ethiopia and was cultivated by the ancient Egyptians by the 12th century B.C. Its cultivation spread throughout Middle East and North Africa and many parts of the world [1]. It is grown in many parts of the world, especially in tropical and sub-tropical countries [2]. Okra is a short day plant, and needs temperatures above 20^{o}c for normal growth and development [1]. Germination percentage and speed of emergence are optimal at 30-35oc (Akande., et al. 2003). Harvesting is usually done early in the morning, after which it enters the market (Moekchantuk and Kumar, 2004).

Okra ranks first before other vegetable crops because of its importance [3]. It is an important vegetable in West Africa, India, Brazil, and the United States [4]. In Nigeria, okra is one of the most important vegetables in terms of consumption and production area [5]. Okra occupies about 1.5 million hectares of the arable land in Nigeria alone [6]. The world production of common okra as fresh fruit vegetable is estimated at 1.7 million t/year (Schippers, 2000). In Nigeria, okra production was estimated at 15.4% in the year 2009-2010, after India at 67.1% (Varmudy, 2011).

Okra is reach in vitamins, calcium, potassium, and other mineral matters (Adeboye and Oputa, 1996). It can be fried in butter 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 plasma replacement or blood volume expander. Industrially, okra mucilage is usually used to glace certain papers and also useful in confectionery [7].

However, the yield of okra has been reported to be very low in Nigeria, hardly up to 7 t/ha (Schippers, 2000). Among the problems of okra production in Nigeria are insect pest infestation, disease incidence and poor nutrient level. Despite the varieties, okra is known to be attacked by a wide range of insect pests (Fasunwon and Banjo, 2010). Egwuatu [8], reported that *Podagrica uniforma,* Jacoby and *P. sjostedti*, Jacoby (Coleoptera: Chrysomelidae) are the most destructive insect species of okra in Nigeria. The two beetles are important vectors of okra mosaic virus (OMV), a tymovirus. Okra is highly infested by this virus in Nigeria if grown without controlling the flea beetles [9]. From times past, efforts have been made to control insect pests of okra such as the one made by Asawalam., et al. [10]. However, the only popular and effective method of controlling these pests in the tropics is largely obtained by the use of synthetic pesticides (Stoll, 2000). Despite the effectiveness of the pesticides,

the synthetic pesticides are also associated with the various ecological problems such as environmental hazards, lethal effects on non-target organisms, pest resurgence, pest resistance and mammalian toxicity due to residue persistence [11].

Due to the above mentioned challenges, an alternative to the use of synthetic pesticide are sought for in keeping with the philosophy and principle of organic agriculture which advocates the reduction in the usage of synthetic chemicals and stabilization of crop yields to increase farmer's profit, while ensuring ecological balance (Yanggen., et al. 2004). Therefore, plant based insecticides are currently evaluated to meet a new world order of producing crops without the use of agro-chemicals [12]. In view of the importance of okra, the flea beetles that cause considerable crop losses and environmental hazards that results from the use of pesticides, the present study was planned to investigate the potential of three botanicals (*Chromolaena odorata, Carica papaya,* and *Ageratum conyzoides*) against field insect pest of okra (*Podagrica* spp.).

Materials and Methods

- **Experimental Site:** This experiment was conducted in the teaching and research farm of the department of Plant Health Management, Michael Okpara University of Agriculture Umudike. (Latitude 05o 29|N, Longitude 07o 33|E and 122m above sea level.).

- **Source of Seed and Plant Materials:** The planting material, an early maturing cultivar of okra seed (Clemson spineless) was obtained from National Agricultural Seeds Council, NRCRI premises Umudike, Abia State. While the plant materials (*Chromolaena odorata, Carica papaya*, and *Ageratum conyzoides*) were collected from Umuariaga.

- **Field Layout:** The experimental design used was randomized complete block design (RCBD) with five treatments replicated three times. The treatments were extracts of *Chromolaena odorata, Carica papaya,* and *Ageratum conyzoides*, Deltamethrine (Decis) and distilled water been the control. The experimental plot size was comprised of 15 plots, each measuring 3m x 2.5m (7.5m2) with 0.5m furrow and separated by 1m pathway.

- **Land Preparation:** The field was manually cleared off its vegetation, ploughed, harrowed, and later spade was used to prepare the seed beds.

- **Planting:** Poultry manure weighing 7kg per plot was applied (pre-planting) to the soil to enhance the soil fertility. Before sowing, okra seeds were tested for viability by soaking them in water for 24 hours, where by the non-viable seeds floated and was discarded. The seeds were directly sown to the field at the spacing of 60cm between rows and 30cm between plants and 2 seeds per hole maintaining the depth of 2cm. Planting population per plot is 40 stands and overall population was 55,500 stands/hectare. The missing stands (that is those that did not germinate after four days) were replanted one week after germination has taken place.

- **Weeding and Other Cultural Practices:** Weeding was done manually by hoeing and was done fortnightly. NPK fertilizer in the ratio 20:10:10 was applied at 3WAP (weeks after planting) at the rate of 10g per stand using ring method.

- **Preparations of Aqueous Extracts:** Cold water was used in the extraction of the plant materials. The plant materials (*Chromolaena odorata, Carica papaya,* and *Ageratum conyzoides*) were washed with clean water to remove sand, dust and contaminants, air dried for 7-12 days on a clean concrete platform and then pulverized using wooden pestle and mortar so that the active ingredients can be freely released in water. 150g of the powder of each of the plant materials was soaked in 1litre of cold water. The resulting solution was stirred continuously for 10 minutes and left to stand for 24 hours. Filtration of the plant extracts was done shortly before application in the field using muslin cloth. The final volume of each extract filtrate was made up by diluting with 1liter of distilled water (Elwell and Mass, 1995).

- **Treatment Application:** Extracts from the plant materials at the rate of 1.5g a.i g/liter and distilled water (control) were applied at the seedling stage. Spraying of the plant extracts was done using hand sprayer early in the morning before sunrise because of the photodegradable nature of the extracts.

- **Assessment of Population:** Assessment of population of the beetles started three weeks after planting (WAP) and the population were estimated by visual observation and counting on 5 randomly selected plants in each plot. This was carried out by gently observing the selected plants and by carefully turning the leaves for correct assessment of the *Podagrica* species present on each of the okra plants.

- **Data Collection:** Data collection was done at 7 days intervals between 7-9am when the insects were relatively inactive and easy to spot. The following data were collected from the study; plant height, percentage defoliation, and insect pest population. Percentage defoliation was calculated using the formula below:

- Percentage defoliation= $\frac{Total\ number\ of\ leaves\ defoliated}{\text{Total number of leaves in sample}} X \frac{100}{1}$

- **Measurement of Yield and Yield Components:** Two plants out of the 5 randomly selected plants were used by assessing the height of the plants. The tallest and the shortest plants were measured from the soil level to the apex of the plant and the average height recorded. At 6 weeks after planting (WAP), fresh pod weight was taken harvest.

- **Statistical Analysis:** Data collected were subjected to analysis of variance (ANOVA) procedure for RCBD and mean were separated using least significant difference (LSD) at five percentage (5%) probability levels.

Results

Effects of plant extracts and synthetic insecticide on the population of flea beetles (*Podagrica* spp.)

The result of insect population before and after application of treatment is represented in table 1. In all the treatment used, (leaf extracts of *Chromolaena odorata, Carica papaya, Ageratum conyzoides* and *Deltamethrine*) insect populations were significantly ($P<0.05$) lower than in distilled water (control).

It was observed that insect populations decreased in plots treated with leaf extracts of *Chromolaena odorata, Carica papaya,* and *Ageratum conyzoides,* but the plot treated with leaf extracts of Carica papaya proved most effective in reduction (20.7%) of the population of flea beetles compared to other leaf extracts; *Chromolaena odorata* and *Ageratum conyzoides* at 24.6% and 23.3% correspondingly. This shows that leaf extracts of *Carica papaya* significantly ($P<0.05$) reduced the population of flea beetles than other leaf extracts. The synthetic insecticide (Deltamethrine) was observed to be most active and significantly ($P<0.05$) effective in reducing the population of flea beetles when compared to plant extracts.

Treatment	Insect Population (%) Before Treatment Application	Insect Population (%)After Treatment Application
Chromolaena odorata	18.9	24.6
Carica papaya	21.2	20.7
Ageratum conyzoides	21.9	23.3
Deltamethrine	20.4	6.5
Control	17.6	24.9
LSD(0.05)	0.26	0.32

Table 1: Effects of plant extracts and synthetic insecticide on the population of flea beetles (*Podagrica* SPP.).

Effects of plant extracts and synthetic insecticide on the percentage defoliation of okra leaves

The results of the defoliation percentage of okra leaves before and after application of treatments are represented in table 2. Okra plants treated with leaf extracts of *Carica papaya* recorded the lowest leaf defoliation while the highest the defoliation was recorded on the plants in the control plots. The effect of the leaf extracts of *Carica papaya* led to defoliation percentage of 57.7% compared to leaf extracts of *Chromolaena odorata* and *Ageratum conyzoides* at 61.8% and 70% respectively. However, the plant extracts were not as effective as the synthetic insecticide (Deltamethrine) in lowering leaf defoliation per plant.

Effects of plant extracts and synthetic insecticide on the okra fruit yield and okra plant height

The results of the plant height before and after application of treatments and yield of okra are presented in table 3. Okra plants treated with leaf extracts of Carica papaya recorded the highest plant height. The effect of leaf extract Carica papaya led to plant height of 29.60cm compared to leaf extracts of Chromolaena odorata and Ageratum conyzoides at 29.40cm and 23.83cm respectively.

Treatment	Defoliation (%) Before Treatment Application	Defoliation (%) After Treatment Application
Chromolaena odorata	96.3	61.8
Carica papaya	94.9	57.7
Ageratum conyzoides	95.2	70
Deltamethrine	97.7	20.7
Control	90.3	70.5
LSD(0.05)	0.1942	0.3365

Table 2: Effects of plant extracts and synthetic insecticide on the percentage defoliation of okra leaves.

Treatment	Plant Height Before Treatment Application(Cm)	Plant Height After Treatment Application(Cm)	Fresh Fruit Yield (Kg/Ha)
Chromolaena odorata	10.55	29.40	633
Carica papaya	13.67	29.60	1748
Ageratum conyzoides	15.17	23.83	1124
Deltamethrin	13.28	22.40	2366
Control	11.13	22.60	578
LSD (0.05)	1.545	4.273	1438.4

Table 3: Effects of plant extracts and synthetic insecticide on the okra fresh fruit yield and okra plant height.

It was observed that plants treated with leaf extracts of *Carica papaya* had higher yield of 1.40kg/ha than those sprayed with leaf extracts of *Chromolaena odorata*, and *Ageratum conyzoides* at 0.49kg/ha and 0.84kg/ha respectively. Okra plants treated with distilled water (control) had lowest yield (0.43kg/ha) when compared to other treatments. On the other hand, plots treated with synthetic insecticide (Deltamethrine) had the highest yield compared to the plant extracts.

Discussion

The lowest defoliation and reduction of insect population which was recorded on okra plants treated with leaf extracts of *Carica papaya* showed that it had a better control against field insect pest of okra (*Podagrica* spp.) and proved significantly different from distilled water (control). These agree with the findings of James., et al. [13] who conducted field trials to assess the efficacy of leaf extracts of neem (*Azadirachta indica*), pawpaw (*Carica papaya*), and bulb extract of onion (*Allium cepa*) and untreated (control) for the control of two species of flea beetles (*Podagrica uniforma* and *Podagrica sjostedti*). Plant extracts have been shown to have insecticidal properties [14]. This also agree with the work by Echero-

bia., *et al*. (2010), who reported that 10% aqueous extracts of *Piper guineense* and *Azadirachta indica* could be used as repellents in the control of okra flea beetles. Emeasor and Okorie [15], had also reported the control of maize weevil (*Sitophilus zeamais*) in the stored maize grain by *Citrus sinensis* rind oil.

Among the plant extracts, leaf extract of *Carica papaya* proved to be most effective in reduction of the population of flea beetles. These result confirmed the previous work carried out by Coelho., *et al*. (2009), Freitas., *et al*. (2010), and Ravikumar., *et al.* (2011) who reported that the plant extracts exhibit insecticidal properties through ovipositional deterrence, larvicidal effects, repellency, and as insect growth regulator. Plants in the control plots were found to have more defoliation and high insect population, while in the other cases where okra plants were treated with plant extracts, reduction both in defoliation and insect population was observed. It is thus obvious that extracts of plants were able to control insect population (*Podagrica* spp.) of okra especially the leaf extract of *Carica papaya*.

The yield difference between okra plants treated with leaf extracts of *Carica papaya, Chromolaena odorata, Ageratum conyzoides*, distilled water (control) and synthetic insecticide (Deltamethrine) indicated that *Podagrica* spp. infestation can reduce the yield of okra. Okra yield can be significantly reduced also by the yellow vein mosaic virus, powdery mildew (*Erysiphe cichoracearum*), fruit borer (*Earias vittela*) and jassids (*Amarasca biguttala*) [16]. Yield reduction can also be affected by other parameters such as poor soil nutrient, flooding and other environmental factors (Olasantan, 2004; Akinyele., *et al*. 2007). Mochiah., *et al.* 2011, also observed that vegetables in which botanicals were applied produced the highest mean fruit weight and fruit numbers (yield) of okra and eggplant, supporting what was discovered in this work as the fruit weight and numbers (yield) of okra treated with the botanicals were found to be significantly higher than the fruit weight and number (yield) of the untreated plot. This could be as a result of high level of population of flea beetles in the untreated plots that defoliated larger proportion of the leaf surface thereby inhibiting cell multiplication, amino acid synthesis and energy formation which invariably inhibit photosynthetic ability of the plant, its products thereby not easily translocated to the sinks (Eifedeyi and Remison, 2010) [17-44].

Conclusion and Recommendation

The plant extract of *Carica papaya* could successfully serve as the best option in the pest management considering its effectiveness in reducing the population of flea beetles which translated to better yield. This botanical is effective, eco-friendly, cheap, readily available and do not pose any threat to the user. It is due to these reasons that aqueous extract from leaf of *Carica papaya* which showed insecticidal activities in controlling field insect pest of okra is recommended. There is need to investigate further on effectiveness of combined application of these botanicals on pests that attack crops to reduce total reliance on synthetic pesticides. Based on the result of this work, however further research work on the use of other extractors or solvents should be investigated.

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