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Original Research Article

Management of Insect Pests of Okra (*Abelmoschus esculentus* L. Moench) Using Levo Botanical Insecticide

ABSTRACT

A field trial was undertaken in Ghana to evaluate the insecticidal potency of Levo (a. i. Oxymatrine) botanical insecticide for the management of insect pests of okra (*Abelmoschus esculentus* L Moench). *Podagrica uniformis* Jacoby, *P. sjostedti* Jacoby, *Bemisia tabaci* (Gennadius), and *Aphis gossypii* (Glover) were identified as insect pests that attack okra in the study area. There were significant differences in *Podagrica* spp., *B. tabaci* and *A. gosspyii* densities between insecticide-treated and the control plots. No significant differences were obtained between insecticide-treated and the control in terms of fruit yield. Defoliation by *Podagrica* spp. was significantly different among treatment plots. The study showed that Levo was as effective as Lambda super (a. i. lambda cyhalothrin) and can be recommended as a substitute for the management of insect pests of okra.

1. INTRODUCTION

Vegetables are important in human diets throughout the world [1] and are rapidly becoming an important source of income for rural population [2]. Okra (*Abelmoschus esculentus* L. Moench) is a vegetable widely grown in West Africa. In Ghana, it is grown for its immature edible pods. Okra is available almost throughout the year and cultivated even in poor soils and dry areas [3]. Insect pest infestation is one major factor affecting okra cultivation in Ghana. The crop is observed to share the same broad pest spectrum with cotton and hibiscus.

In West Africa, the plant is attacked by two flea beetle species, *Podagrica uniformis* (Jac.) and *Podagrica sjostedti* (Jac.) (Coleoptera: Chrysomelidae) which are responsible for heavy defoliation [4]. West-Africa produces more than 75% of okra produced in Africa, but the average yield in the region is very low (2.5 t/ha) [5]. Important yield losses are reported in Nigerian and Ghana [6, 7]. According to [8], *Podagrica*

species attack the lamina of the foliage and matured leaves of the Okra plant which results in the reduction of photosynthetic ability of the leaves. The insect is also responsible for transmission of mosaic virus. Whiteflies also feed on plant sap and this can cause okra leaf curl disease and yellow mosaic virus.
Generally, synthetic insecticides are the most effective means of controlling insect pests due to their quick action and lasting effect [9]. Traditionally, farmers in Northern Ghana usually dust wood ash on leaves to protect their okra from pest damage. Although synthetic pesticides application remains the primary agricultural pest control strategy, it is evident that society cannot continue to tolerate their effects on the environment and non-target organisms. The development of pest management systems that are based on judicious application of synthetic insecticides is the most prudent alternative. There is the urgent need for the development of alternative control strategies [10].

Many entomologists have explored naturally occurring insecticidal plants for pest management and have reported some of them to be effective against some insect pests. According to [11], botanicals are one of the groups of safe insecticides which have a broad spectrum of anti-pest activity, relatively to specific mode of action, low mammalian toxicity and more tendency to disintegrate, in nature or metabolic in a biological system. Moreover, their preparation and application at farm level are more convenient for the farmers and are quite incorporable into integrated pest management programs. It is based on this that Oxymatrine (Levo 2.4 SL, DWA Dizengoff Ghana ltd, Ghana) botanical insecticide, a stomach poison having anti-feeding and repelling activity against a wide range of insects, was evaluated for its insecticidal activity against insect pests of okra. The specific objectives were to determine the effect of Levo on (i) the incidence of insect pests of okra, (ii) damage caused by the insects on okra, and (iii) fruit yield of okra.

2. MATERIALS AND METHODS

2.1. Experimental Site

The study was conducted in both major and minor cropping seasons at the Faculty of Agriculture plantation site of the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana. The major cropping season lasted June to early September, 2013 while the minor season spanned September to December, 2013. Average annual rainfall collected in the major cropping season was 850.5 mm while the minor cropping season had 640.5 mm of rainfall. The soil texture is sandy loam; mean

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temperature and humidity recorded during the study were 21.9^{o}C and 84% for the major cropping season and 31.1^{o}C and 71 % during the minor cropping season [12].

2.2. Source of seeds

The variety of okra seeds used was "Asontem" which was obtained from the Crops Research Institute of the Council for Scientific and Industrial Research (CSIR-CRI), Kwadaso, Kumasi, Ghana. This variety is improved but is susceptible to insect pests and diseases.

2.3. Field layout and experimental design

The field was laid out in a randomized complete block design (RCBD) with three treatments. Each treatment plot measured 5 m x 5 m with inter and intra-row spacing of 1 m x 0.5 m. A 2 m alley was allowed between the plots so as to minimize spray drifts to adjacent plots.

2.4. Agronomic practices

Okra seeds were sown on 25th June 2013 and 10th October 2013 during the major and minor seasons, respectively. Prior to the sowing, the seeds were soaked in water overnight to facilitate field germination. Two seeds were sown per hole at a depth of 3 cm and later thinned after full emergence to one plant per hill. Each plot consisted of five rows with 10 plants per row. The normal agronomic practices (e. g. weeding, irrigation, fertilization) were carried out. Manual weeding was done at three weeks intervals. The plots were irrigated as and when necessary since rainfall was erratic. Fertilizer was applied in two splits. The first dose of N: P: K 15: 15: 15 was applied three weeks after sowing of okra at a rate of 10/g per plant while Urea (46 % N) at 2.2 g per plant was applied three weeks later.

2.5. Treatments

Three treatments, each with four replications were used.

(i) Levo (a.i. Oxymatrine) at 1.68 ml / 0.5 litre water (recommended dose)

(ii) Lambda super (a.i. Lambda-cyhalothrin) at 1.5 ml / 0.5 litre water (recommended dose)

(iii) Control (water only)

Lambda super and Levo in water solutions were applied weekly using separate CP 15 Knapsack starting on 18th July and 17th October, 2013 for the major and minor seasons, respectively. There were seven insecticide applications.

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2.6. Sampling for insect pests

Sampling for insect pests was done weekly between 09.00 – 11.00 GMT when insect numbers were high. Sampling was done on five plants randomly selected from the three middle rows per plot. For *B. tabaci* and *Podagrica* spp, sampling involved visual examination with the aid of a magnifying lens of each plant and the number of the two insects on two leaves were recorded. This was done for the first two weeks of sampling but thereafter three leaves were examined. For *A. gossypii*, three leaves from both the upper and lower canopies were collected into high density polyethylene bottles containing 70% ethanol. These were transported to the insectary for processing and identification under a stereo microscope at 40-100x magnification.

2.7. Estimation of fruit yield

Okra fruits were harvested every three or four days when they reached maturity and then weighed using a Switzerland-made Metler Toledo PB302 electronic weighing scale in the laboratory. The results obtained for each treatment were then extrapolated to kilograms per hectare (kg/ha) using the formula:

Fruit yield/ha $= \frac{1000}{\text{area harvested}} \times$ fruit yield/plot [13].

2.8. Other data collected

Per cent defoliation, number of fruits per plant, per cent damaged fruits and yield were also taken. Damaged fruits included all okra fruits that had injuries or blemishes apparently caused by insects. Defoliation caused by the flea beetles (*Podagrica* spp.) on okra leaves was estimated using the method described by [14]. A leaf each from the top, middle and lower canopy levels of five randomly selected plants on each treatment plot was compared to a chart of leaves graded 5%, 10%, 20%, 30%, 40% and 50% depending on the level of damage observed on the leaves (sections of the leaves that have lost virtually all the photosynthetic sites - scarified leaves or holes) by the feeding habits of the flea beetles and the mean level of defoliation recorded. The percentage defoliation was then estimated using the formula:

$$\%\text{Defoliation}= \frac{\text{Total number of leaves defoliated}}{\text{Total number of leaves in a sample}} \times 100$$

2.9. Data analysis

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Insect and other count data were subjected to analysis of variance using Statistix software, version 9.0 of pooled data over date after square-root transformation whiles data in percentages were arcsine transformed before analysis. Treatment means were separated using Tukey at 5% probability.

3. RESULTS

3.1. Insect Pests collected on okra in the major cropping season

Insect pest species collected were whiteflies, *B. tabaci*, aphids, *A. gossypii*, and flea beetles, *P. uniformis* and *P. sjostedti*. Because over 99% of the *Podagrica* species were *P. uniformis*, the two species were combined as one as *Podagrica* spp. There were significant differences in *Podagrica* spp, *B. tabaci* and *A. gossypii* densities among the treatments (Table 1).

Table 1: Mean number of insect pests collected on okra (*Abelmoschus esculentus* L. Moench) as affected by insecticides treatments in the major cropping season in Kumasi, Ghana in 2013.

	Mean number (± SEM) of insect per leaf		
Treatment	*Podagrica* spp.	*B. tabaci*	*A. gossypii*
Levo	2.29 ± 0.62 [c]	1.62 ± 0.04 [c]	0.99 ± 0.67 [c]
Lambda Super	2.61 ± 0.07 [b]	1.99 ± 0.06 [b]	1.79 ± 0.19 [b]
Control	4.02 ± 0.10 [a]	3.44 ± 0.09 [a]	4.90 ± 0.27 [a]

Means with the same letter in a column are not significantly different from each other ($P < 0.05$, Tukey test)

3.2. Insect pests collected in the minor cropping season

Results similar to that obtained in the major cropping season were observed (Table 2).

Table 2: Mean number of insect pests collected on okra (*Abelmoschus esculentus* L. Moench) as affected by insecticides treatment in the minor cropping season in Kumasi, Ghana in 2013.

Mean number (± SEM) of insect per plant

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Treatment	*Podagrica* spp.	*B. tabaci*	*A. gossypii*
Levo	1.77 ± 0.03 [c]	1.99 ± 0.03 [c]	1.56 ± 0.07 [c]
Lambda Super	2.33 ± 0.04 [b]	2.24 ± 0.03 [b]	2.44 ± 0.10 [b]
Control	3.30 ± 0.06 [a]	2.76 ± 0.05 [a]	5.86 ± 0.21 [a]

Means with the same letter in a column are not significantly different from each other ($P < 0.05$, Tukey test)

3.3. Effects of insecticide treatments on defoliation of okra in the major and minor season

The damage by *Podagrica* species on okra leaves was significantly different among treatments plots in the major and minor cropping seasons (Table 3).

Table 3: Effects of insecticide treatments on defoliation of okra (*Abelmoschus esculentus* L. Moench) by *Podagrica* spp. in the major and minor cropping seasons in Kumasi, Ghana in 2013.

	Defoliation (%)	
Treatments	Major season	Minor season
Levo	18 [c]	17 [c]
Lambda super	26 [b]	21 [b]
Control	44 [a]	46 [a]

Means with the same letter in a column are not significantly different from each other ($P < 0.05$, Tukey test)

4.5. Yield of okra as affected by various treatments in the major and minor cropping seasons

There was no significant difference in the number of fruits per plant, mean fruit weight and yield between the control and the insecticide-treated plots in both cropping seasons. Percent fruit damaged, however, differed significantly among treatments (Tables 4 and 5).

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Table 4: Yield, yield components and mean damaged fruits of okra (*Abelmoschus esculentus* L. Moench) as affected by various insecticide treatments in the major cropping season in Kumasi, Ghana in 2013.

Treatment	Mean No. of fruits plant^{-1}	Mean % damaged fruits	Mean fruit weight (g)	Mean yield (kg ha^{-1})
Levo	88.50 ± 18.46 ^{a}	11.75 ± 1.65 ^{c}	0.86 ± 0.19 ^{a}	342.00 ± 74.81 ^{a}
Lambda super	77.00 ± 18.57 ^{a}	19.25 ± 3.84 ^{b}	0.71 ± 0.20 ^{a}	284.35 ± 81.91 ^{a}
Control	87.25 ± 6.57 ^{a}	28.75 ± 1.65 ^{a}	1.06 ± 0.08 ^{a}	422.79 ± 33.56 ^{a}

Means with the same letter in a column are not significantly different from each other (P < 0.05, Tukey test)

Table 5: Yield, yield components and mean damaged fruits of okra (*Abelmoschus esculentus* L. Moench) as affected by various insecticide treatments in the minor cropping season in Kumasi, Ghana in 2013.

Treatment	Mean No. of fruits plant^{-1}	Mean % damaged fruits	Mean fruit weight plant^{-1} (g)	Mean yield (kg ha^{-1})
Levo	55.50 ± 0.87 ^{a}	4.25 ± 0.48 ^{c}	0.65 ± 0.03 ^{a}	261.50 ± 13.11 ^{a}
L. super	50.00 ± 4.45 ^{a}	7.25 ± 0.95 ^{b}	0.58 ± 0.08 ^{a}	223.25 ± 29.93 ^{a}
Control	57.25 ± 3.30 ^{a}	10.75 ± 0.48 ^{a}	0.63 ± 0.04 ^{a}	252.50 ± 17.82 ^{a}

Means with the same letter in a column are not significantly different from each other (P < 0.05, Tukey test)

4. DISCUSSION

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Although synthetic pesticides are target specific and effective, their effect on the environment is mostly deleterious. Plant based pesticides contain active ingredients with low half-life period and their effects on the environment are not too detrimental making them more acceptable for pest management [15].

On okra, the results from the studies in both major and minor cropping seasons showed that Levo (botanical insecticide) was as effective as Lambda super in reducing whiteflies density as compared to the control (Tables 1 and 2), and this agrees with [16], who used neem seed extracts (botanical) against *B. tabaci* on okra and reported a reduced occurrence of the adults. The effectiveness of Levo against whiteflies may also be attributable to its possession of anti-feeding and repelling properties. [17] tested 2 g and 5 g leaf extracts of custard apple (*A. squamosa*) on *Tribolium castaneum* (Herbst) and reported that they were successful in controlling the infestation of *T. castaneum*, which they explained could be attributed to the repellent properties of the acetogenins in the leaf extracts. [18] also reported that the seed extracts of *A. squamosa* had repellent and anti-oviposition properties against *C. capitata.*

The results of the study showed that the abundance of *A. gossypii* on okra was significantly higher in the control plots than insecticide-treated plots in both major and minor seasons. Among the insecticides, Levo recorded lower numbers of *A. gossypii* as compared to Lambda super (Tables 1 and 2). This could be due to the over-dependence on Lambda super by farmers within the experimental area in controlling pests which might have contributed to the insects developing resistance to the insecticide. [19] observed that *A. gossypii* populations on eggplant are becoming resistant to commonly used insecticides in Ghana.

Two flea beetle species, *P. uniforma* and *P. sjostedti* were collected on the leaves of okra. *P. sjostedti* population was so negligible that no separate data was taken on it. Infestation of flea beetle started two weeks after the emergence of the okra and a mean of two per leaf was recorded on the plants before treatments applications were effected. Similar trends were recorded in the major and minor seasons except that plots treated with Lambda super harboured an increased density of 2.3 per leaf (Table 2). Again, the results showed that Levo was effective in controlling flea beetles and this could be attributed to a hostile environment created by Levo including hindering of feeding activities of the insects. [20] reported of the effectiveness of neem extract against the *P. sjostedii* and *P. uniforma* in a field trial. [21] however reported that, the application of neem-based pesticides against adult insects, for instance bugs and beetles, does not normally lead to obvious mortality, but may result in a substantial reduction in the

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fecundity of these insects, so that the following generation may be reduced below the economic threshold level.

Podagrica spp damage to okra leaves was low on all the insecticide-treated plots but high in the control plots in both seasons. Levo application reduced okra defoliation and this may be attributed to its anti-feedant and repellent property. [22] used neem extracts on okra and recorded a decreased defoliation and attributed it to the anti-feedant and repellent nature of the neem extracts. [23] also reported anti-feedant and repellent property of maize stover as being responsible for the significant reduction in damage caused by *Podagrica* species on okra leaves.

Low yields were recorded in both seasons but more pronounced in the minor season possibly as a result of the drier environmental conditions experienced during the later part of the minor season (Table 4 and 5). The defoliation caused by *Podagrica* spp., did not affect the yield (Tables 4 and 5), which is contrary to [6, 7] who reported significant yield losses in Nigeria and Ghana, respectively as a result of heavy defoliation of okra leaves but agrees with [24] who reported that despite heavy infestations of *Podagrica* spp, no significant yield loss was recorded in the untreated, control plots compared to the insecticide-treated ones. It is evident from the study that Levo applications were as effective as that of Lambda Super (lambda cyhalothrin) in reducing insect pests' aggregations and can therefore be a good substitute for the latter.

The study has shown that *Podagrica* spp*, B. tabaci,* and *A. gossypii* were the most important insect pests of okra in the study area. The incidence and abundance of these pests were found to have been reduced in all insecticides-treated plots. Yield of okra showed no significant difference between insecticide-treated and control plots. Damage caused by *Podagrica* spp. to okra leaves was low on all the insecticide-treated plots but high on the control in both seasons.

5. CONCLUSION

The study showed that Levo applications were as effective as that of Lambda Super (lambda cyhalothrin) in reducing insect pests' aggregations and damage and can therefore be recommended as a good substitute for the latter.

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