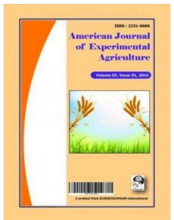

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Field Evaluation of Levo Botanical Insecticide for the Management of Insect Pests of Eggplant (*Solanum melongena* L.)

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Authors' contributions

This work was carried out in collaboration between both authors. Author JPNA performed the experiment, collected data, performed the analyses and did the write-up. Author EAO designed the experiment, guided data collection, analyses and write up. Both authors read and approved the final manuscript.

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ABSTRACT

Renewed interest in the use of botanical insecticides for the management of insect pests necessitated field experiments to be carried out during the major and minor cropping seasons in 2013 at the plantation crops section of the Department of Crop and Soil Sciences of the Kwame Nkrumah University of Science and Technology (KNUST), Ghana to evaluate the insecticidal potency of Levo botanical insecticide for the management of insect pests of eggplant (*Solanum melongena* L.). The study comprised the following treatments: (i) Levo (a.i. Oxymatrine) at 1.68 ml /0.5 litre water and (ii) Lambda-super (a.i. Lambda-cyhalothrin) (a check) at 1.5 ml /0.5 litre water; an untreated control (water only) was also maintained. *Leuninodes orbonalis* (Guen), *Bemisia tabaci* (Gennadius), *Aphis gossypii* (Glover), and *Eublemma olivacea* (Walker) were collected on eggplant in the study area. Significant differences (P<0.5) were observed among the treatments with respect to the abundance of *A. gosspyii,* L. *orbonalis, B. tabaci* and *E. olivacea* on eggplant during the major season. Similar results were obtained in the minor season. Significantly higher yields were obtained from the insecticide-treated eggplant plots. The study showed that Levo was

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as effective as Lambda super and can be a substitute in the management of insect pests of eggplant.

Keywords: Botanical; insecticide; eggplant; insect pests.

1. INTRODUCTION

Vegetables are important sources of vitamin, minerals and plant proteins in human diets throughout the world [1] and are rapidly becoming an important source of income for rural population [2]. Eggplant (*Solanum melongena* L.) is a popular vegetable crop grown in the subtropics and tropics [3]. According to [4], more than two million hectares are devoted to the cultivation of eggplant in the world. In Ghana it is one of the most important vegetable crops extensively cultivated especially in the forest zone, during both the major and minor seasons [5]. Eggplant is a potential export crop for Ghana, but only a very small share of the total production in Ghana is exported. However, its exports are on the ascendency. Exports of vegetables, including eggplant, have increased from 2,033 Mt in 2010 to 3,695 Mt by 2010 [6].

Despite its importance in terms of nutrition and export potential for foreign exchange, increasing damage by arthropod pest is affecting eggplant cultivation [2]. Eggplant is infested by a plethora of insect pests throughout the world. A survey of vegetable pests conducted by the world vegetable center (AVRDC) indicated *Leuninodes orbonalis* (Guen) is the most destructive pest in most major eggplant producing countries [2]. Other insect pests that severely constrain eggplant production in the tropics are; leaf lopper, whiteflies, thrips, aphid, spotted beetles, leaf rollers, stem borers and blister beetles [1].

The application of synthetic insecticides is the primary control strategy against insect pests of the crop. For instance, farmers in certain areas of Philippines spray chemical insecticides up to 56 times during a cropping season; the total quantity of pesticide used per ha of eggplant was about 41 litres of different brands belonging to the four major pesticide groups [7,8]. In Bangladesh, some farmers spray about 180 times during a cropping season [9].

Although synthetic pesticides application remains the primary agricultural pest control strategy, it is evident that society cannot continue to tolerate their harmful effects on the environment and non-target organisms. One way to manage this menace is to develop pest management systems that are based on judicious application of synthetic insecticides. Thus there is the urgent need for the development of alternative control strategies [10].

Recently, studies have been intensified on the use of naturally occurring pesticides for pest control. Many investigators isolated, identified and screened chemical compounds from leaves and seeds of many botanical families for insect deterrence and growth inhibition. Some of the anti-pest plants documented included Neem, Chrysanthemum, Annona, Mahogoni, Albizziaetc [11].

According to [12], 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 Levo (a. i. Oxymatrine) botanical was evaluated for its insecticidal activity against insect pests of eggplant.The specific objectives were to(i) identify the major insect pest species affecting eggplant in the study area, (ii) determine the effect of Levo botanical insecticide on the incidence of insect pests of eggplant, (iii) determine the effect of the insecticide on damage caused by the insects to eggplant, and (iv) determine the effect of the insecticide on fruit yield of eggplant.

2. MATERIALS AND METHODS

2.1 Experimental Site

The study was conducted in both major and minor crop growing seasons at the Faculty of Agriculture plantation site of the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana. The major growing season lasted June to September, 2013 while the minor season spanned late September to November 2013.

2.2 Source of Seeds

The variety of eggplant used was the local "A*woroworo*" 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 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 plot measured 5 m x 5 m with inter and intra-row spacing of 1 m x 0.5 m. The total plot size was 468.75 m^2.A 1.5 m alley was allowed between the plots so as to minimize spray drifts to adjacent plots.

2.3.1 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)

2.4 Transplanting of Seedlings

Eggplant seedlings were transplanted on 11^{th} July, 2013 and 9^{th} October, 2013 during the major and minor seasons, respectively at one seedling per stand. Replacement of dead seedlings was carried out a week after transplanting. Each plot contained five rows with 10 plants per row, giving a total of 50 plants per plot for both crops.

2.5 Sampling for Insect Pest Infestation on Eggplant Fields

Sampling for insect pests was done weekly between 0800 – 1100 h when the insects' build-up was high. Sampling was done on five plants randomly selected from the three middle rows per plot. For *B. tabaci*, sampling involved visual examination of each plant and the number of insects on two leaves were recorded. This was done for the first two weeks of sampling but thereafter three leaves were examined with the aid of a magnifying lens. For the other insects, namely *A. gossypii*, *E. olivacea,* and *L. orbonalis*, 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 using a stereo microscope. Insecticide application was done after sampling.

2.6 Cultural Practices on Eggplant and Okra Fields

The normal agronomic practices (e. g. weeding, irrigation, fertilization) were carried out.Manual weeding was done at three weeks interval. The field was 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 transplanting of eggplant at a rate of 10/g per plant while Urea (46% N) at 2.2 g per plant was applied three weeks later.

2.7 Estimation of Fruit Yield

Eggplant 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:

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

2.8 Yield and Yield Components Assessments

The following data were also recorded; number of fruits per plant and weight of fruits per plant and yield. Damaged fruits included eggplant fruits that had injuries or blemishes apparently caused by insects.

2.9 Data Analysis

Insect and other count data were transformed using square root transformation and percentages by arcsine transformation and then subjected to Analysis of Variance (ANOVA) using statistix software, version (9.0). The treatment means were separated using Tukey at 5% probability.

3. RESULTS

3.1 Insect Pests Collected on Eggplant in the Major Season in 2013

There were significant differences among treatments with respect to abundance of *B. tabaci* and *A. gossypii* (Table 1). There was also significant difference between insecticide-treated plots and the control in the densities of *L. orbonalis* and *E. olivacea*.

3.2 Insect Pests Collected in the Minor Season on Eggplant in 2013

The effect of the different treatments on the abundance of insect pests on eggplant in the minor season is presented in (Table 2). There were significant differences among treatments with respect to densities of *A. gosspyii*, *B. tabaci*, *L. orbonalis*, and *E. olivacea*.

3.3 Yield of Eggplant as Affected by Various Insecticide Treatments in the Major and Minor Seasons in 2013

Significantly more fruits per plant and fruit yield were obtained in the Levo-treated plots than the Lambda super and control plots in the major season (Table 3). The mean fruit weight of the fruits from the Levo-treated plots was significantly more than that from the Lambda Super and control plots. Significantly more damaged fruits were recorded from the Lambda Super and control plots than the Levo-treated plots. In the minor season, there were no significant differences among the treatments with respect to the mean number of fruits per plant and the fruit weight. Significantly more fruit yield was obtained from the insecticide-treated plots than the control plots. However, significantly more fruits from the control plots were damaged than from the insecticide-treated plots (Table 4).

Table 1. Mean number of insect pests collected on eggplant (*Solanum melongena* L) as affected by insecticides treatment in the major season in Kumasi, Ghana in 2013

	Mean number (± SEM) of insect per leaf			
Treatment	***A. gossypii***	***B. tabaci***	***L. orbonalis***	***E. olivacea***
Levo	1.17±0.07 c	1.67±0.05 c	0.88±0.28 b	0.80±0.02 b
Lambda Super	2.75±0.21 b	2.29±0.09 b	0.80±0.21b	0.85±0.25 b
Control	5.32±0.32 a	2.97±0.12 a	1.39±0.45 a	1.39±0.04 a

Means with the same letter in a column are not significantly different from each other (P< .05, Tukey test)

Table 2. Mean number of insect pests collected on eggplant (*Solanum melongena* L.) as affected by insecticides treatments in the minor season in Kumasi, Ghana in 2013

	Mean number (± SEM) of insect per leaf			
Treatment	***A. gossypii***	***B. tabaci***	***L. orbonalis***	***E. olivacea***
Levo	1.14±0.61 c	1.61±0.04 c	0.05±0.03 c	0.89±0.03 c
Lambda Super	1.88±0.11 b	2.22±0.04 b	1.32±0.05 b	1.06±0.04 b
Control	3.45±0.16 a	2.67±0.05 a	1.50±0.05 a	1.50±0.05 a

Means with the same letter in a column are not significantly different from each other (P<.05, Tukey test)

Table 3. Yield, yield components and mean damaged fruit of eggplant (*Solanum melongena* L.) as affected by various treatments in the major 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	56.50±5.04 a	2.55±0.95 b	2.44±0.27 a	997.38±109.06 a
Lambda super	42.50±1.32 b	7.75±0.63 a	1.61±0.05 b	643.73±21.55 b
Control	40.00±2.31 b	9.50± 0.50 a	1.41±0.06 b	562.60±25.35 b

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

Table 4. Yield, yield components and mean damaged fruits of eggplant (*Solanum melongena* L.) as affected by various treatments in the minor 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	71.75±7.93 ^{a}	7.00±0.82 ^{b}	2.77±0.50 ^{a}	1107.30±198.79 ^{a}
Lambda Super	71.75±9.84 ^{a}	9.25±1.25 ^{b}	2.44±0.35 ^{a}	974.00±139.17 ^{a}
Control	80.00±6.87 ^{a}	19.00±2.55 ^{a}	1.60±0.17 ^{a}	638.25±67.60 ^{b}

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

4. DISCUSSION

4.1 Effect of Insecticide Treatments on Insect Pests of Eggplant

Although synthetic pesticides are target specific and effective, their effects on the environment are 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 [14].

On eggplant, the results from the studies in both the major and minor seasons showed that Levo was effective against *B. tabaci* by keeping the mean number to about 1.6 per leaf, comparable to that of Lambda super (Tables 1 and 2). The effectiveness of Levo against whiteflies may be attributable to its possession of anti-feeding and repelling properties. [15] tested 2 g and 5 g leaf extracts of custard apple (*Annona 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. [16] also reported that the seed extracts of *A. squamosal* had repellent and anti-oviposition properties against *Ceratitis capitata* (Wiedemann).

The abundance of *A. gossypii* on eggplant was significantly higher in the control plots than insecticide-treated plots in both the major and minor seasons. Comparing the insecticides, lower numbers of *A. gossypii* were recorded on Levo-treated plots 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 for the control of pests which might have contributed to the insects developing resistance to the insecticide. [17] observed that *A. gossypii* populations on eggplant are becoming resistant to commonly used insecticides in Ghana.

Levo against *A. gossypii* was very effective (Tables 1 and 2). The effectiveness of botanical insecticides in controlling aphids was reported by [18], who detected that aqueous neem seed extract was very effective in reducing the number of cotton aphids infesting okra, particularly when applied as a foliar spray. According to [19], who also used neem extract to control aphids, the control of aphids resulted from the failure of nymphs to moult and from inhibition of adults to reproduce.

The results from the experiment for both crops in the major and minor seasons showed that *L. orbonalis* and *E. olivacea* densities throughout the experiment were lower compared with that recorded on the control plots. Thus Levo was as effective as lambda super in reducing *L. orbonalis* and *E. olivacea* densities on eggplant. [18] reported that lepidopterous insects are highly sensitive to neem compounds and that the order Lepidoptera, to which these insects belong, was classified as one group of the insects well controlled with many botanical insecticides. The report concluded that, the results held a promise for the management of the other members of this order, which attack okra and cotton.

All the insecticide-treated plots had increased yield of eggplant compared to the control. Levo-treated plots had yield of 997.38 kgha^{-1} followed by Lambda super, 643.73 kgha^{-1} and the control, 562.60 kgha^{-1}. The relatively higher incidence of insects might have accounted for the low yield on the untreated, control plots. Thus the significantly higher yields obtained from the insecticide-treated plots could be attributed to the marked decrease in the densities of insects collected from those plots in addition to reduced defoliation.

It is evident from the study that Levo application contributed to a yield similar to Lambda super and can therefore be a good substitute for the management of insect pests on the crop.

5. CONCLUSION

The study has shown that *A. gosspyii, B. tabaci, L. orbonalis,* and *E. olivacea,* were the most important insect pests of eggplant in the study area. The incidence and abundance of these pests were found to have been reduced in all insecticides-treated plots while yield increases were also recorded in all treated plots of eggplant. The study also showed that Levo was as effective as the Lambda Super and could be a substitute for the latter insecticide in the management of insect pests of eggplant.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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