JOURNAL OF SUSTAINABLE AGRICULTURE AND THE ENVIRONMENT
E-mail: jsae@mouau.edu.ng. Website: www.mouau.edu.ng.

Insecticidal Effects of Some Plant Leaf Extracts and Cypermethrin against Eggplant Shoot and Fruit Borer *Leucinodes Orbonalis* (Lepidoptera: Pyralidae) Infestation on Eggplant

K. C. Emeasor[1] and O. A. Uwalaka[2]

[1]*Department of Plant Health Management, College of Crop and Soil Sciences, Michael Okpara University of Agriculture, Umudike*
[2]*National Horticultural Research Institute, Mbato Substation, P.M.B. 1076, Okigwe, Imo State*

Corresponding Authors Email: mailuwalaka@yahoo.com

Abstract

Field trials were conducted on the damage assessment of *L. orbonalis* and effect of application of some plant leaf extracts and Cypermethrin on yield of eggplant at the Vegetable Research Farm of National Horticultural Research Institute, Mbato Substation, Okigwe, Imo State during the cropping seasons of 2013 and 2014. The experiments were laid out in Randomized Complete Block Design (RCBD) with three replicates of fourteen plots each. Treatments consisted of ethanolic leaf extracts of *Moringa oleifera* (Lam.), *Azadirachta indica* (A. Juss), *Tithonia diversifolia* (Hemsl.) and *Ocimum gratissimum* (L.) each at 50%, 75% and 100% concentrations. Cypermethrin (12.5% E.C.) was used as a standard check and distilled water as control. Eggplant seeds were sown in the nursery and six weeks after sowing, seedlings were transplanted at a spacing of 1m × 1m on the experimental plots of $9m^2$. Data were collected on the population of *L. orbonalis*, number of fruits of *S. gilo*, number of punctures on fruits and number of damaged fruits (% fruit damage). Results obtained indicated significant differences ($P<0.05$) between the treatments and control on the mean number of damaged fruits, with Cypermethrin recording the lowest (2.46%) and 100% *M. oleifera* extract (3.03%) for the two seasons. Mean number of fruits per plot significantly increased in all the tested plant extracts and Cypermethrin compared with the control at $P<0.05$. Their application reduced the *L. orbonalis* number and also caused increased fruiting, although their efficacies varied with plants that received 100% *Moringa oleifera* extract producing the highest (187.70) number of fruits/plant/plot and corresponding greater yield of $7033.33 kgha^{-1}$ while the control recorded highest (20.60) number of damaged fruits. Results also showed that the plant extracts applied as bio-insecticides were effective against *L. orbonalis* as their application significantly reduced the insect pest population, which resulted in the reduction in the number of holes/punctures on fruits compared to the control.

Keywords: Cypermethrin, Damage, Eggplant, *L. orbonalis*, Plant extracts

Introduction

Eggplant (*Solanum gilo* (L.) var. Ngwa large) is important in the Sub-Saharan Africa (SSA) region for food security, medicinal and traditional usages (Mwai *et al*., 2007). It is a good source of dietary fibre, vitamin A, potassium, phosphorus, calcium, copper, vitamin B folate and niacin (Whitaker and Sommel, 2003). The fruits are eaten raw, boiled or fried as ingredient of stew, soups and vegetable sauces. Their uses in indigenous medicine range from weight reduction to treatment of several ailments including asthma, nasal catarrh, skin infections, and swollen joint pains and constipation (Bello *et al.*, 2010). It has proven beneficial to patients suffering from anaemia because of its rich iron content. Frequent consumption of eggplant reduces intraocular pressure (glaucoma) and convergence insufficiency (Igwe *et al.*, 2003).

In addition, it prevents heart diseases and blood pressure (Okon *et al.*, 2010; Grubben and Denton, 2004). Medicinally, they are processed and used in the preparation of condiments and products used in treating different diseases and health problems (Bukill, 2005).

Eggplant production is one of the major sources of income to rural farmers and their household in Nigeria (Danguah-Jones, 2010). Pests and disease complex constitute major biotic factors militating against increased production of this crop. The insect pests are reported to account for reduced yield and losses of between 75-90% of the crop (Onekutu, 2011). Misra, (2008) also reported similar yield losses as high as 85-90% in India where these pests are also considered as key pests of *S. gilo*. Sudarshan and Pijush, (2011) observed that extreme losses are usually recorded during the rainy seasons when weather conditions interfere with the crop protection measures. The most important insect pest of this crop in southeastern Nigeria is the Eggplant Fruit and Shoot Borer (EFSB), *Leucinodes orbonalis.* It is found throughout the tropics in Africa and Asia. The larvae feed inside the eggplant fruit, making them unmarketable and unfit for human consumption.

Early indications of attack by *L. orbonalis* are the presence of larval feeding on flowers, flower buds and young shoot tips and stems. Final-instar larvae bore into the fruits. Infested fruits are characterized by small entrance holes closed by dried excrement. Wilting may occur in severe infestation. *L. orbonalis* may cause total yield loss. To control this pest in farms, farmers are currently using too many toxic chemicals and applying them too frequently to control the pest (Onekutu, 2011). Efforts have been made to control the associated insect pests of eggplant using synthetic insecticides such as Cypermethrin, Lambdacyhalothrin, Deltamethrin and promising results were obtained (Ibekwe, 1997). The hazardous effect of these insecticides has increasingly become a major source of concern to environmentalists. Thus other options for management of insect pests became imperative. The use of botanicals is more acceptable to the farmers because of general safety and ease of handling (Emeasor *et al.,* 2005). Increase in the production and yield of eggplant, by reducing infestation of *L. orbonalis* can be achieved through application of locally available plant materials that are environmentally friendly, cheaper and readily available.

The objectives of this study were to:

i. evaluate some plant extracts for the control of the *L. orbonalis* on eggplant
ii. determine the rate of application of the plant extracts that will be most effective in the control of the *L. orbonalis,* and give the best yield
iii. compare the effectiveness of the plant extracts with cypermethrin.

Materials and Methods

The experiments were conducted in the 2013 and 2014 cropping seasons at the experimental field of National Horticultural Research Institute (NIHORT), Mbato Sub-Station Okigwe, Imo State.

Table 1: Location statistics

Location	GPS	Mean Rainfall (mm)	Mean (R.H) (%)	Mean Temp. (^{0}C)	Wind speed (mi/h)
Okigwe	05^0 85'N and $07^0$31'E	2,200	75.87	29.5	3.8

Source: AccuWeather.com

The experiment was a Randomized Complete Block Design (RCBD). Treatments consisted of *Moringa oleifera, Azadirachta indica, Ocimum gratissimum* and *Tithonia diversifolia* leaf ethanolic extracts at 50%, 75% and 100% concentrations; Cypermethrin (12.5% E. C) was used as standard check while the plots that received distilled water served as control. The treatments were replicated three times.

Leaves of *Moringa oleifera, Azadirachta indica, Ocimum gratissimum and Tithonia diversifolia* were sourced from NIHORT premises, local markets and nearby bushes. These plant materials were thoroughly washed to remove soil and other debris, air dried for 5 - 6 days at room temperature and then ground into fine powder. A stock solution of the extracts was made by mixing 1kg each of the powdered plant materials with 5000ml of ethanol and left for 48hours. The compound mixture was sieved using muslin cloth placed in a funnel. From the stock solution, serial dilutions were made by adding appropriate proportion of water to obtain 50% and 75% concentrations of the plant extracts. The cypermethrin was purchased from an agro-chemical store. Two weeks after transplanting, treatment application commenced with a manually operated knapsack sprayer and were done fortnightly until the final harvest of fruits.

Data were collected on population of eggplant fruit and stem borer per plant per plot, number of fruits per plant per plot, number of insect pest punctures on fruits per plant per plot, number of damaged fruits per plant per plot was counted and expressed in percentage, percentage reduction in fruit damage by *L. orbonalis* due to treatment and percentage yield increase over control and fruit yield (kg/ha) were determined.

All data collected were subjected to analysis of variance (ANOVA) using GenStat Discovery Software Programme (2010). Significant means were separated using Least Significant Difference (LSD) at 5% probability level.

Results and Discussion

The results of the effect of application of selected plant materials and cypermethrin on the percentage fruit damage of *S. gilo* by *L. orbonalis* are presented in Table 2. The results indicated that plots treated with cypermethrin recorded the least mean percentage fruit damage of 3.22% and 1.71% in the two respective seasons, followed by 100% *M. oleifera* with 3.87% and 3.19%, 100% *O. gratissimum with* 4.96% and 9.01%, 75% *M. olefeira* with 5.20% and 6.38% and *A. indica* with 6.98% and 8.97% in that order for both years (Table 2). Recently, Onekutu *et al.* (2014) reported that insecticides are currently the main methods used in the control of this all important pest with farmers relying on them exclusively in order to be able to produce blemish-free fruits. Latif *et al.*

(2009) and Biradar *et al.* (2001) revealed that cypermethrin/deltamethrin combinations were most effective against *L. orbonalis*. Babu *et al*. (2002) also reported the effectiveness of Cypermethrin against *L. orbonalis* in an experiment conducted in India. However, the present results show that insecticides of plant origin, namely *M. oleifera, O. gratissimum, A. indica* and *T. diversifolia* applied at 100% ethanolic extract obtained very high percentage reduction in damage by *L. orbonalis.* Thus making plant derived insecticides complimentary to synthetic insecticide in the control of these insect pests. These findings agree with Ramos *et al.* (2006) who observed that leaf extracts of botanicals showed some degree of insecticidal properties (Ovicidal and Larvicidal) against insect pest population.

The results obtained also showed that mean percentage fruit damage of *S. gilo* was higher (19.09%) in 2014 season than in 2013 (18.44%), making an increase of 3.36% in mean percentage fruit damage (Table 2). The mean percentage fruit damage obtained from the control plots was found to be significantly different from other treatments. The control recorded up to 89.84% fruit damage between 2013 and 2014 cropping seasons (Table 2). This result agrees with the earlier findings of Onekutu *et al*. (2012) who reported steady increase in *L. orbonalis* on a weekly basis and that infestation increased progressively throughout the period of harvest.

Table 3 shows the effect of some plant materials and a synthetic insecticide on the mean number of punctures on fruits per plot of *S. gilo* by *L. orbonalis* in Okigwe Southeastern Nigeria. It was observed that there was no significant difference ($P>0.05$) between the number of holes per fruit per plot treated with cypermethrin (0.20) and 100% *M. oleifera* (0.47) in 2013, which means that their effect were the same and the trend was the same for cypermethrin (0.20), 100% *M. oleifera* (0.27), 100% *A. indica* (0.33), 100% *T. diversifolia* (0.33), 100% *O. gratissimum* (0.60) in 2014 (Table 3). Ibekwe *et al*. (2014) recorded similar result when they evaluated some plant extracts (*Piper guineense, Azadirachta indica, Jatropha curcas* and Castor seed oil) against insect pests of eggplant. They also observed that all aspects of leaf damage in plots sprayed with the plant extracts (botanicals) were not significantly different from that of the synthetic insecticide (Cyperforce) but were significantly different ($P<0.01$) from the control.

Larval population of *L. orbonalis* on eggplant was significantly lower on plants treated with plant extracts when compared to the control in both seasons (Table 4). *M. oleifera* (100%) was as good as the synthetic insecticide in larval population control. The effectiveness also increased with increase in concentration of the extracts, irrespective of the plant extract used. The results revealed that all the plant extracts evaluated against *L. orbonalis* on eggplant have substantial level of insecticidal effect as their application significantly ($P<0.05$) reduced the mean number of *L. orbonalis* larvae in fruits per plant per plot in 2013 and 2014 (Table 4). Cypermethrin (0.13) and 100% *M. oleifera* (0.13) were the most effective treatments against the larvae in 2013 while there was significant difference between the two treatments in 2014 with Cypermethrin recording the lowest mean number of larvae with 0.13 and 100% *M. oleifera* with 0.80 (Table 4). The plant extracts at higher concentrations used in this study also proved effective against *L. orbonalis* especially 100% concentrations of *M. oleifera, O. gratissimum, A. indica, T. diversifolia* and 75% *M. oleifera* and this could be attributed to the anti-feedant (Adukary, 1984) and repellency properties of the extracts (Jilani *et al.,* 1988) (Table 4). The application of the plant extracts were not phyto-toxic which is also in line with the report of Emeasor *et al.* (2005) that the use of botanicals is more acceptable to the farmers because of the general safety and ease of handling.

Table 2: **The effect of application of some plant extracts and cypermethrin on the mean percentage fruit damage of *S. gilo* by *L. orbonalis* in Okigwe Southeastern Nigeria**

Treatments	% Fruit damage by *L. orbonalis* 2013	2014	% Reduction in fruit damage by *L. orbonalis* due to treatment
50% *A. indica* Leaf Extract	22.41	17.67	79.61
75% *A. indica* Leaf Extract	11.66	17.75	84.57
100% *A. indica* Leaf Extract	6.98	8.97	91.70
50% *M. oleifera* Leaf Extract	12.71	17.70	84.11
75% *M. oleifera* Leaf Extract	5.20	6.38	93.99
100% *M. oleifera* Leaf Extract	3.87	3.19	96.40
50% *O. gratissimum* Leaf Extract	21.60	31.72	72.07
75% *O. gratissimum* Leaf Extract	17.50	12.89	84.59
100% *O. gratissimum* Leaf Extract	4.97	9.01	92.61
50% *T. diversifolia* leaf extract	20.94	24.07	76.69
75% *T. diversifolia* leaf extract	13.32	15.91	84.84
100% *T. diversifolia* leaf extract	7.33	11.51	90.10
Cypermethrin	3.22	1.72	97.53
Control	91.0	88.68	
Grand mean	18.44	19.09	
$LSD_{0.05}$	19.43	21.28	

Table 3: Effect of some plant extracts and cypermethrin on eggplant fruit damage by *L. orbonalis* in Okigwe Southeastern Nigeria

	Number of holes/fruits	
Treatments	**2013**	**2014**
50% *A. indica* Leaf Extract	1.93	1.00
75% *A. indica* Leaf Extract	0.93	0.40
100% *A. indica* Leaf Extract	0.67	0.33
50% *M. oleifera* Leaf Extract	1.20	0.67
75% *M. oleifera* Leaf Extract	0.67	0.47
100% *M. oleifera* Leaf Extract	0.47	0.27
50% *O. gratissimum* Leaf Extract	1.13	0.93
75% *O. gratissimum* Leaf Extract	2.20	0.87
100% *O. gratissimum* Leaf Extract	0.67	0.60
50% *T. diversifolia* leaf extract	1.47	1.00
75% *T. diversifolia* leaf extract	1.33	0.87
100% *T. diversifolia* leaf Extract	0.73	0.33
Cypermethrin	0.20	0.20
Control	4.20	2.47
Grand mean	1.27	0.74
$LSD_{0.05}$	0.46	0.48

Table 4: Mean population of *L. orbonalis* as affected by the application of some plant extracts and cypermethrin on *S. gilo* in Okigwe Southeastern Nigeria

	Mean population of *L. orbonalis*		
Treatments	**2013**	**2014**	**Mean**
50% *A. indica* Leaf Extract	1.27	1.60	1.43
75% *A. indica* Leaf Extract	1.00	1.27	1.13
100% *A. indica* Leaf Extract	0.53	1.00	0.77
50% *M. oleifera* Leaf Extract	1.47	1.53	1.50
75% *M. oleifera* Leaf Extract	0.93	0.80	0.87
100% *M. oleifera* Leaf Extract	0.13	0.80	0.47
50% *O. gratissimum* Leaf Extract	1.27	1.67	1.47
75% *O. gratissimum* Leaf Extract	0.93	1.20	1.07
100% *O. gratissimum* Leaf Extract	0.47	1.27	0.87
50% *T. diversifolia* leaf extract	1.73	1.60	1.67
75% *T. diversifolia* leaf extract	0.87	1.20	1.03
100% *T. diversifolia* leaf Extract	0.67	0.87	0.77
Cypermethrin	0.13	0.13	0.13
Control	2.93	2.60	2.77
Grand mean	1.02	1.21	
$LSD_{0.05}$	0.57	0.59	

Table 5: Mean number of fruits of *S. gilo* as influenced by the application of some plant leaf extracts and cypermethrin in Okigwe

Treatment	Number of Fruits per plot		Mean fruit number for two years
	2013	2014	
50% *A. indica* Leaf Extract	58.00	71.30	64.65
75% *A. indica* Leaf Extract	86.00	70.70	78.35
100% *A. indica* Leaf Extract	106.70	98.30	102.50
50% *M. oleifera* Leaf Extract	75.30	72.70	74.00
75% *M. oleifera* Leaf Extract	131.70	150.70	141.20
100% *M.oleifera* Leaf Extract	195.70	179.70	187.70
50% *O. gratissimum* Leaf Extract	48.70	42.00	45.35
75% *O. gratissimum* Leaf Extract	62.00	89.30	75.65
100% *O. gratissimum* Leaf Extract	124.50	121.00	122.75
50% *T. diversifolia* leaf extract	70.00	70.30	70.15
75% *T. diversifolia* leaf extract	108.00	88.30	98.15
100% *T. diversifolia* leaf Extract	124.70	86.70	105.70
Cypermethrin	161.70	144.70	153.20
Control	17.70	25.00	21.35
Grand mean	97.90	93.60	
$LSD_{0.05}$	32.83	49.31	

The mean number of fruits was significantly higher in all the tested plant extracts used as bio-insecticide and cypermethrin than in the untreated plots. This is in agreement with the findings of Uwalaka *et al*. (2012) that plant materials are not phyto-toxic to eggplant rather they resulted in greater plant growth and more vigorous yield by reducing the population of the insect pests on the crop. *M. oleifera* (100%) produced the highest mean number of fruits of 195.70 in 2013 and was significantly ($P<0.05$) higher than the control (Table 5). This may be as a result of the plant extracts serving as possible foliar nutrient to the crop. This may account for better yield recorded when compared to the control plots. In 2014, the trend was the same with the treatment 100% *M. oleifera* also producing the highest mean number of 179.70 fruits per plant per plot, 75% *M. oleifera* produced 150.70 fruits/plant/plot while cypermethrin gave 144.70 fruits/plant/plot (Table 5). There were no significant differences between 100% *M. oleifera* (150.70), Cypermethrin (144.70) and 75% *M. oleifera* (150.70) in terms of mean number of fruits per plant per plot, however, they were significantly different from all the other treatments (Table 5).

Generally, plant extracts and cypermethrin had significant effect on the yield of *S. gilo*, increasing the fruit yield (marketable) (Table 6) than the control in both seasons. There was significant differences in fruit yield between the treated plots. The highest yield of 7.03 t/ha was recorded in the 100% *M. oleifera* treatment in the first year and was significantly greater than all the other treatments including cypermethrin. The same trend was observed in 2014. The reduction in larval population may have been responsible for increased fruit yield as less number of fruits were infested leading to production of more marketable fruits. It is also possible that plant extracts contained some growth hormones or micronutrients which may have influenced growth. However, these assumptions were not investigated. The low fruit yield recorded on the untreated plots could be attributed to the high mean number of *L. orbonalis* recorded on the plots and the boring activities of *L. orbonalis* on the shoots of *S. gilo* which may have disrupted the uptake of nutrients from the soil to the growing parts of the crop.

Conclusion

Plant extracts tested, significantly ($P<0.05$) reduced the population of the insect borers and led to increased growth and yield of *S. gilo.* The findings of this study should be a premise on which further scientific investigations can be conducted on the formulation, dosage and preservation of bio-insecticides. Farmers should also be properly educated and trained on the basic technology of formulating bio-insecticides and their usage.

Table 6: The effect of the application of leaf extracts *A. indica, M. oleifera, O. gratissimum, T. diversifolia* and Cypermethrin on the mean marketable yield of *S. gilo* in Okigwe Southeastern Nigeria.

Treatment	**Marketable Yield (kgha^{-1})**			**Percentage yield increase over control (%)**
	2013	**2014**	**Mean for two seasons**	
50% *A. indica* leaf extract	1444.44	1688.89	1566.67	94.48
75% *A. indica* leaf extract	2477.78	2077.78	2277.78	182.76
100% *A. indica* leaf extract	2700.00	3200.00	2950.00	266.21
50% *M. oleifera* leaf extract	2366.67	2266.67	2316.67	187.76
75% *M. oleifera* leaf extract	4911.11	5033.33	4972.22	517.24
100% *M.oleifera* Leaf extract	7033.33	6588.89	6811.11	745.51
50% *O. gratissinum* leaf extract	1377.78	1322.22	1350.00	67.59
75% *O. gratissinum* leaf extract	2144.44	2522.22	2333.33	189.65
100% *O. gratissinum* leaf extract	4700.00	3600.00	4150.00	415.17
50% *T. diversifolia* leaf extract	1777.78	1266.67	1522.23	88.97
75% *T. diversifolia* leaf extract	3000.00	2144.44	2572.22	219.31
100% *T. diversifolia* leaf extract	3777.78	2866.67	3322.23	312.41
Cypermethrin	6033.33	5744.44	5888.89	631.03
Control	688.89	922.22	805.56	
$LSD_{0.05}$	1100.00	1445.56		

References

Adukary, S. (1984). Result of the field trails to control common insect pests of okra (*Abelmoschus esculentus* L.) in Togo by application of crude methanolic extraction of leaves and seed kernels of neem tree (*Azadirachta indica*) *Zang Ento* (4) 327 – 331.

Babu, B. S., Varaprasad, K. S., Anitha, K., Prasada Rao, R. D. V. J., Chakrabarty, S. K., Chandurkar, P. S., (2002) Brinjal shoot and fruit borer *(Leucinodes orbonalis*) status in coastal districts of Orissa. Resources management in plant protection during twenty first century, Hyderabad, India, Vol 2.Pp. 121-123.

Bello, S. O., Muhammad, B. Y., Gammaniel, K. S., Abdu – Agguye I., Ahmed, H., Njoku, C. H., Pindiga, U. H. and Salka, A. M. (2010). Preliminary Evaluation of the toxicity and some pharmacological properties of the Aqueous Crude Extract of *Solanum melongena*. *Res. J. Agric. Biol. Sci. 1(1), 1 – 9.*

Biradar, A.P., Teggelli, R.G., Patil D.R., Balikai R.A., (2001) Evaluation of cypermethrin 3 EC+ quinalphos 20 EC (23 EC) against brinjal shoot and fruit borer. *Karnataka Journal of Agricultural Sciences, 14(2):369-372.*

Bukill, H. M. (2005). The useful plants of West Africa. Royal Ecological garden vol 5. families S – Z croctograms and effectiveness of vegetable Tech. information packages by vegetable farmers in Adamawa State, *Nigeria J. Africa Res. 4(2) 65 – 70.*

Danquah – Jones, A (2010). Variation and correlation among agronomic traits of garden egg (*Solanum gilo* Radii). *Dept. of crop science, Accra, University of Ghana*, Legon. 30p.

Emeasor, K. C., Ogbuji, R. O. and Emosairue, S. O. (2005). Insecticidal activity of some seed powders agains *Callosobruchus masculatus* (F.) (Coleoptera: Bruchidae) on stored cowpea. *J. Plant Diseases and Protection, 112(1): 80-87.*

Grubben, G.J.H and Denton, O.A Eds, (2004). Plant Resources of tropical Africa II: Vegetables, Leoden, Wageningen, Backluys publishers. Pp.34, 41.

Ibekwe, H. N. (1997). Evaluation of different rates of decis (deltamethrin) in controlling *Epilachna hirta* and *Spodoptera littoralis* of Fadama Grown garden egg in Southeastern Nigeria. *Proceedings of the 15th Annual Conference of the Horticultural Society of Nigeria* (HORTSON) at Ibadan; 8-12th April, 1997. Pp. 171 – 173.

Ibekwe, H. N., Ogbu, J. U, Uwalaka, O. A, Ngede, S. O. and Onyegbule, U. N. (2014). Efficacy of plant derived insecticides for the control of insect pests of garden egg (*Solanum* spp) in Southeastern Nigeria. *International Journal of Scientific and Technological Research* 8: 371-376.

Igwe, S. A., Akunyili, D. N and Ogbogu, C. (2003). Effect of *Solanum melongena* (garden egg) on some functions of visually active Igbos of Nigeria. *Journal of Ethnopharmacology,* 86: 2–3.

Jilani, G., Saxena, R. C. and Rueda, B. P. (1988). Repellant and growth inhibiting effect of turmeric oil, sweet flag oil, neem oil and margosan – O on red flour beetle (Coleoptera: Tenebrionidae).

Latif, M.A., Raman M.M., Alam M.Z., Hossain M.M. and Solaiman A.R.M., (2009) Threshold based spraying of flubendiamide for the management of Brinjal shoot and fruit borer *Leucinodes orbonalis* (Lepidoptera : Pyralidae). *Jour,nal of Entomological Society of Iran 2009. 29(1)1-10.*,

Misra, H.P., (2008). New promising insecticides for the management of Brinjal shoot and fruit borer, *L. orbonalis* Guenee. *Pest Management Horticulture Ecosystem 14 (2): 140-147.*

Mwai, G. N, Onyango, J. C, Abukusta, M. O (2007). Taxonomic identification and characterization of African nightshades (*Solanum L.* section *solanum*). *African Journal of Food, Agriculture, Nutrition and Development.7 (4): 212-219.*

Okon, U. E, Etiete, A. A. and Bassey, N. E (2010). Technical efficiency and its determinants in Garden egg (*Solanum spp)* production in Uyo metropolis, Akwa Ibom State, Nigeria, *Field Action Science Report. Special Issue (1).Pp.12-19.*

Onekutu, A. (2011). Bioecology and Management of *Leucinodes orbonalis* Guenee on *Solanum gilo* Raddi. Unpublished PhD thesis, University of Ibadan, Nigeria.Pp.341.

Onekutu, A. and Omoloye, A. A. (2012). Planting date of garden egg Solanum gilo and egg fruit and shoot borer *Leucinodes orbonalis* infestation. Nigerian Journal of Horticultural *Science*. 17:14 – 19.

Onekutu, A., Omoloye A. A and Odebiyi J. A (2014). Integrated Pest Control of the Eggplant and shoot borer, *Leucinodes orbonalis* on the Garden Egg, *Solanum aethiopicum* L. in Southwest Nigeria. *International Journal of Scientific and Research Publications. 4 (7): 1-4.*

Ramos, M.V., Banderia, G.P., de Freitas C.D., Nogueria, N.A., Alencar N.M., de Sousa P.A.,

Carvalho A.F. (2006). Latex constituents from *Calotropis procera* (R.Br.) display toxicity upon egg hatching and larvae of *Aedes aegypti* (Linn.). *Memorius Do Instituto Oswaldo Cruz 101 (5): 503–510.*

Sudarshan, C. and Pijush, K. S. (2011). Management of *Leucinodes orbonalis* Guenee on Eggplants during the rainy season in India.*Journal of Plant Protection Research, 51 (4): 34-38.*

Uwalaka, O. A., Emeasor, K. C., and Nwanguma, E. I. (2012). Effect of some plant materials and some synthetic insecticides in the control of eggplant fruit borer (*Leucinodes orbonalis*). *In the proceedings of the 30th Annual Conference of the Horticultural Society of Nigeria*, held at the Federal University of Technology, Owerri, Imo State, Nigeria. 11-15th November, 2012. Pp. 163-165.

Whitaker, B. D. and Sommel, J. R. (2003). Distribution of hydroxyl cinnamic acid conjugates in fruit of commercial eggplant *(Solanum melongena L)* cultivar. *J. Agric Food Chem.51 (11) 3448 – 54200.*