BIU Journal of Basic and Applied Sciences 2(1): 24 – 33, 2016.

ISSN: 2563-6424

INSECT PEST CONTROL AND PRODUCTIVIVITY OF OKRO (*Abelmoschus esculentus*) TRAPPED IN BETWEEN COWPEA (*Vigna unguiculata*) AND ROSELLE (*Hibiscus sabdariffa*) PLANTS

***ADEBOLA, M.O.[1] AND GANA, J.[2]**
[1]Federal University of Technology, Department of Plant Biology Minna
[2]Ibrahim Badamasi Babangida University, Department of Biology, Lapai, Nigeria
*Corresponding author email: adebolamo@gmail.com

ABSTRACT
The use of trapped cropping system in the control of insect pest of okro was evaluated using cowpea and Roselle as the trapping plants. Insect population, plant growth and yields parameters were monitored. A total of four different types of insect pests (aphid (*Aphis gossypii*), leaf hopper (*Amarasca bigutulla)*, flea (*Podagrica sjostedti*) and cotton stainer (*Dysdercus cingulatus*) were observed throughout the period of study in all the plots. The relative abundance of the pests increased from week 5 to week 7 and decreased at week 9. Trapping system caused a significant reduction in insect population on trapped okro as compared to the control plot. At week 5 of cultivation, the results obtained revealed that okro trapped between cowpea and cowpea (TCC) had the highest average plant height (65.00±2.88cm) and number of flowers (16.00±1.15) which were significantly different ($P<0.005$) from other plots and control. The highest number of fruit (13.66±0.88) was harvested from the okro trapped between roselle and roselle (TRR) and the number of fruits (7.59±0.87) harvested from okro trapped between cowpea and roselle (TCR) was not significantly different from control (8.00±0.57). Throughout the period of study, okro in control shows the highest insect pest infestation and low yield. Roselle and Cowpea plants are effective as a trapped crop, control insect infestation to minimum and results in increase yield of okro plant. This result has revealed the importance of trap cropping, as an alternative option to management of insect pests by small holder farmers. Trapped cropping system should be encouraged as a means of reducing insect population and increase yield of the target plant.

Keywords: *Trap crop, Roselle, Target, Pest, Yield*

INTRODUCTION
Okro (*Abelmochus esculentus* (L.) Moench) belong to the family Malvaceae and is one of the most important vegetable crops grown in the tropics by peasant farmers usually in home gardens or in mixture with other cereal crops (Lombin *et al*., 1988). It is also a chief vegetable crop grown for its immature pods that can be consumed as a fried or boiled vegetable or may be added to salads, soups and stews (Kashif *et al.,* 2008). Varieties vary in height,

size of fruit, colour, early or late maturing (Udoh and Akpan, 2005).

Okro plays a significant role in human nutrition by providing carbohydrates, protein, fat, minerals and vitamins that are generally deficient in basic foods. Mature okro seeds are good sources of protein and oil and it has been known to be very important in nutritional quality (Oyelade *et al.,* 2003). Okro oil is rich in unsaturated fatty acids such as linoleic acid which is essential for human nutrition (Adesuyi *et al*., 2008) It has good nutritional value, especially high in vitamin C (30 mg/100 g), Ca (90 mg/100 g), Fe (1.5 mg/100 g) and other minerals such as magnesium and potassium, vitamin A and B, fat and carbohydrates (Muhammad, 2011). Industrially, okra mucilage is usually used for glace paper production and also has a confectionery use (Soranpong, 2013). Okra has found medical application as a plasma replacement or blood volume expander (Adetuyi *et al*., 2008; Kumar *et al.,* 2010) and it is said to be very useful against genito-urinary disorders, spermatorrhoea and chronic dysentery (Adesina, 2013)

Nevertheless, despite the great demand for okro due to its uses and importance, its production is being hampered by some major pests and diseases such as Flea beetles (*Podarica* sp.); cotton stainer (*Dysdercus superstitus*); white fly (*Bermisia tabaci*); and green stink bug (*Nezera viridula*) among others (Benson, 2004). Flea beetles (*Podagrica* species) have been reported to have caused economic damage (Fasunwon and Banjo, 2010) attack of the lamina of the foliage and matured leaves of the okro plant which result to reduction of the photosynthetic ability of the crop leaves. The insect is also responsible for transmission of mosaic virus, this infection could result to 20 - 50% yield reduction (Fanjinmi and Fanjimi, 2010**).** With piercing and sucking mouthparts, whitefly is able to feed effectively on plant sap causing okro leaf curl disease, geminivirus and yellow mosaic virus (Ali *et al.,* 2005).

In view of the aforementioned destructive activities of these insects, the control of field insect pests of okra remains a major production constraint of farmers in order to have a high yield. Conventionally, farmers are using various types of synthetic chemical insecticides to control insect pest of okro due to their quick action and long lasting effect.

Prior to the introduction of synthetic insecticides, trap cropping was a common method of pest control for several cropping systems. Trap crops have been defined as "plant stands grown to attract insects or other organisms like nematodes to protect target crops from pest attack, preventing the pests from reaching the crop or concentrating them in a certain part of the field where they can be economically destroyed" (Hokkanen, 1991). The two primary techniques utilized in trap cropping are: selecting of more preferred plant species or cultivar grown at the same time as the main crop and planting of the same species and cultivar as the main crop timed to be at the most preferred stage of development before the main crop.

Roselle plant *(Hibiscus sabdariffa* Linn.) belongs to the family Malvaceae and is one of the common flowering plants grown worldwide for its aesthetics. It is cultivated in tropical and subtropical regions for its jute-like fibre in India, East Indies, Nigeria and South America (Babatunde and Mofoke, 2006). Insect pests' infestation is one of the major factors affecting successful cultivation of roselle. The insect pest complex of roselle includes *Bemisia tabaci* (Genn.) *Aphis gossypii* Glover, *Podagrica* species, *Earias insulana* (Boisd.) *Empoasca* spp (Fasunwon and Banjo, 2010).

Therefore, this study was conducted to evaluate the effectiveness of Cowpea (*Vigna unguiculata)* and Roselle plants *(Hibiscus sabdariffa* Linn.) as trap crops in protecting okro plant from insect pest attacked. This will in a long way reduce damage to the crop, attract beneficial organisms, decreases the use of external inputs such as insecticide, herbicide and fungicide, enhance biodiversity and increase productivity in okro.

MATERIALS AND METHODS

Study Area

Field experiments were conducted between April and October, 2014 at experimental site of biological garden, Faculty of Natural Science, Ibrahim Badamasi Babangida University Lapai, Niger State. Lapai is situated in Southern Guinea Savannah agro-ecologial zone of Nigeria and lies along latitude 09°-02′N and longitude 06°-34′ E. The experimental area is under sub-tropical climate, which is characterized by distinct dry and wet seasons; the wet season starts from April - October and the dry season falls between November - March. The annual rainfall varies from 1,100mm in the northern part of the state to 1,600mm in the southern parts. The maximum temperature is 34.5°C (Tanko *et al.,* 2012).

Collection of Experimental Materials

The seed of okro, cowpea and Roselle were obtained from seed dealers in Central Market, Lapai, and brought to the Biological Garden of Ibrahim Badamasi Babangida University, Lapai Niger State Nigeria located at the main campus, beside the football pitch.

Preparation of Land and Sowing of Seeds

The land was cleared, ploughed and harrowed to render the soil loose. The experiment was laid out in a Randomized Complete Block Design (RCBD) in a total land area of 500m^2 measuring 25m x 20m; with three treatments and a control. Each treatment was replicated thrice. It was then partitioned into four blocks and each block was further divided into three 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. The rows were planted in pair with 12 holes in each replication. The intra-row spacing of 0.50 m and inter-row spacing of 0.80 m were maintained. Plots were separated by 2 m wide border margin and blocks by 3m (Clementine *et al.*, 2009; Adesina, 2013).

Treatments

Treatment I: The three rows of cowpea were planted on the left hand side and three rows of roselle on the right hand side of the trapped okro (TCR).

Treatment II: Three rows of cowpea were planted on the either sides of okro plot (TCC).

Treatment III: Three rows of roselle were planted on the either sides of okro plot (TRR).

Treatment IV: Three rows of okro were planted as control without being trapped with 2m wide border.

The cowpea and roselle were planted two weeks before the Okro. Also 7 g of NPK (15:15:15) was applied to each Okra stand at 15 days after germination. Thinning was done two weeks after planting to achieve two plants per stand and hoe weeding was carried out at three weeks interval throughout the duration of the experiment (Sorapong, 2013).

Estimation of the Insect Populations

Counting of insect pest population was done on 20 randomly chosen trapped crops in each plot and 20 from control plots at week 5, 7 and 9 between 6.00 a.m. and 10.00 a.m when the insects were less active. The numbers of adult pests caught on each occasion as well as their species identity were recorded. Insects were caught by hand picking since they were only capable of exhibiting limited flight within the circle of their environment (Benchasri, 2013).

Growth Parameters

The following growth parameter as described by Hokkaneen, (1991) were monitored: Plant height, Number of branches per plant and Number of flowers per plant were estimated on 20 randomly chosen trapped crop at 5, 7, and 9 week of cultivation. The mean of each parameter per plant was calculated.

Okra Yield (g plant^{-1})

Matured Okra fruits were removed and weighed. Mean yield was then calculated per plant. When the whole fruits were harvested, fruits of each replication were dried in sunlight and their one thousand (1000) seeds weight was recorded using electrical weighing balance.

Percentage Leaf Damage (%)

Damage on okro leaves was estimated on 20 randomly selected plants by scoring the percentage of defoliation.

Statistical Analysis

The data generated were subjected to analysis of variance (ANOVA) and means was separated by Duncan multiple range test at P=0.05

RESULTS AND DISCUSSION

In the present study, it was found that trapped cropping system was unable to control the insects totally. A total of four different types of insect pests aphid (*Aphis gossypii*), leaf hopper (*Amarasca bigutulla)*, flea (*Podagrica sjostedti*) and cotton stainer (*Dysdercus cingulatus*) were observed throughout the period of study in all the plots (Fig.1). These pests have been implicated by earlier work of Munthali and Mmapetla, 2008, Munthali and Tshegofatso, 2013). The relative abundance of the pests increased from week 5 to week 7 and decreased at week 9. These findings are in line with the findings of Yajuvendra *et al*. (2013) and Ogbalu and Ekweozor, (2002) who separately reported increase in leafhopper, aphid and whitefly populate as the age of okro increased. At week 5 the population of hopper was the highest (37.5%) in TCC followed by aphid and flea abundance of 25% each. In TCR flea was the highest (45.5%) followed by hopper (36.5%) while aphid and stainer were not significantly different (P<0.005). At week 7, (Fig. 1), the relative abundance of aphid increased from 9.0% to 40% in TCR plot while hopper, flea and stainer were reduced (from 36.5% to 20.0%, 45.5% to 33.3% and 9.0% to 6.7% respectively). In TCC plot, the relative abundance of hopper and flea were reduced from 37.5% to 28.6% and from 25.0% to 21.4% respectively while stainer increased slightly from 12.5% and 14.3%. In TRR and control, the relative abundance of aphid and hopper increased while flea and stainer reduced. At week 9, the relative abundance of hopper and stainer had increased from 20% and 6.7% respectively in week7 to 31.8 % and 13.6% respectively in week 9.

Figure 2 shows the comparison of relative abundance between the plots. In week 5 the population of aphid (31.6%) in control was the highest but not significantly different between TCC and TRR plots (29% each). Also the relative abundance of hopper was not significantly different (P<0.005) between TCR and TCC (32.2% and33.1% respectively). The highest population of hopper was recorded in TCC followed closely by TCR and least in TRR. The highest relative abundance of flea was in the order TCR>TRR>control.

At week 7, the relative abundance of all the pests in the plots has increased (Fig.2). The population of aphid in plot TCR was significantly different (P<0-05) from other plots. Plots TCC and control have the highest relative abundance of hopper while plot TCR and control have the highest relative abundance of flea. The relative abundance of stainer was observed to be very low in all the plots throughout the period of this study.

At week 9, the relative abundance of aphid was still high in plot TCR while plots TRR and control were not significantly different in relative abundance of aphid. The relative abundance of hopper was in the order plot TRR>control>TCR>TCC. However, Trapping system cause a significant reduction in insect population on trapped okro as compared to the control group. The presence of many alternative hosts for breeding of these insects may have caused their low populations in most of the trapped plots. It has been reported that the confusing olfactory and visual stimuli received from the host plant may disrupt normal feeding habits or mating behavior associated with intercropping studies (Uddin and Odebiyi, 2011). The result obtained in this study is similar to the result of Nwaogu and Echendu (2005) who reported that intercropping Ginger with Okra and Soyabeans reduced insect pest populations. Aliyu *et al*. (2011) also reported that Cotton-Cowpea intercrop supported lower populations of *A. craccivora* and *B. tabaci* than the sole Cowpea.

The ultimate aim of the farmers is to obtain a reasonably high yield which is directly related to environmental and physiological factors and the level of insect infestation (Hill and Waller, 1988). At week 5 of cultivation, the results obtained (Table 1) revealed that okro trapped between cowpea and cowpea (TCC) had the highest average plant height(65.00$\pm$2.88cm) and number of flowers(16.00$\pm$1.15) which were significantly different(P<0.005) from other plots and control. However, the control plot has the highest number of stem branches (14.33$\pm$1.45cm) and was not significantly different (P<0.005) from other plots except plot trapped between cowpea and roselle (TCR). The highest number of fruit (13.66$\pm$0.88) was harvested from the okro trapped between roselle and roselle (TRR) and the number of fruits (7.59±0.87) harvested from okro trapped between cowpea and roselle (TCR) was not significantly different from control (8.00±0.57).

At week 7 (Table 2) okro trapped between roselle and roselle has the highest height (62.00±4.16cm), number of stem branches (42.00±2.08cm) and number of fruit (33.00±1.73) which were significantly different ($P<0.005$)from other plots. Small quantity of fruits (11.66±0.33) was harvested from the okro trapped between cowpea and roselle and the control have the lowest number of fruits harvested (11.00±0.57). At week 9 (Table.3), the okro plants have reached the peak of their growth. The highest height (74.33±8.08cm) was recorded in okro plants trapped between roselle and roselle and was significantly different ($P<0.005$) from other plots and control. The results of seed weight (Table 4) showed that there was no significant difference ($P<0.05$) between all the plots but it increased with increasing in week of cultivation. TRR plot had the highest weight (32.33±0.15g) in week 5 but was not significantly different from other plots in week 7 and week9 while the seed weight in control plots was the least in all the weeks.

In this study the productivity of okro was related to the degree of infestation by the insect pests. Low yield of okro was obtained from the untreated okro (control) which had highest insect infestation. Among the two trapped crop used to attract insect away from the target okro, okro trapped between roselle was shown to be more effective as it attract more insect, followed by cow pea and roselle plots and least in okro trapped between cowpea. Throughout the period of study, okro in control shows the highest insect pest infestation and low yield. Usman (2004) reported that if the pests and diseases of fruit vegetables are not properly managed, it could have an economic impact on the level of production by reducing crop yield, quality and subsequently low return. Roselle plant and Cowpea plant are effective as a trapped crop control insect infestation to minimum and results in increase yield of okro plant.

This result has revealed the importance of trap cropping, as an alternative option to management of insect pests by small holder farmers. Trapped cropping system should be encouraged as a means of reducing insect population and increase yield of the target plant. Further studies should be conducted on controlling insect pest of okro using different crop species as trapped crop.

Table 1: Growth parameters of okro trapped and control at 5th week

Plot	Plant height (cm)	Number of Flower	Number of Branch	Number of Fruit
TCC	65.00±2.88^{c}	16.00±1.15^{c}	10.02±2.04^{b}	11.96±0.92^{b}
TCR	34.66±1.45$_{a}$	8.20±0.30^{a}	9.00±1.15^{a}	7.59±0.87^{a}
TRR	43.33±1.66^{b}	15.04±0.70^{b}	11.56±0.88^{b}	13.66±0.88^{c}
Control	40.00±0.0^{ab}	7.53±0.53^{a}	14.33±1.45^{b}	8.00±0.57^{a}

Data are Mean ± SEM of triplicate determination TCC=Trapped between Cowpea and cowpea; TCR= Trapped between Cowpea and Roselle; TRR= Trapped between Rosselle and Rosselle

Table 2: Growth parameters of okro trapped and control at 7th week

Plot	Plant height (cm)	Number of flower	Number of Branch	Number of Fruit
TCC	46.66±3.33^{a}	30.00±1.09^{b}	24.00±0.57^{b}	26.33±2.02^{b}
TCR	40.00±0.00$_{a}$	17.53±0.53^{a}	19.33±1.85^{a}	12.66±0.33^{a}
TRR	62.00±4.16^{b}	48.66±0.88^{b}	42.00±2.08^{c}	33.00±1.73^{b}
Control	40.00±0.00$_{a}$	17.62±0.33^{a}	18.33±1.45^{b}	11.00±0.57^{a}

Data are Mean ± SEM of triplicate determination TCC=Trapped between Cowpea and cowpea; TCR= Trapped between Cowpea and Roselle; TRR= Trapped between Rosselle and Rosselle

Table 3: Growth parameters of trapped okro and control at 9th week

Plot	Plant height (cm)	Number of flower	Number of Branch	Number of Fruit
TCC	41.66±1.66^{a}	22.00±0.57^{b}	28.66±0.88^{b}	28.66±2.02^{b}
TCR	52.00±7.57$_{a}$	14.90±0.85^{a}	25.00±1.15^{a}	11.68±0.53^{a}
TRR	74.33±8.08^{b}	30.35±0.88^{c}	48.00±1.00^{c}	27.00±1.15^{b}
Control	55.33±4.91$_{a}$	14.85±0.83^{a}	25.33±1.66^{a}	12.00±0.57^{a}

Data are Mean ± SEM of triplicate determination TCC=Trapped between Cowpea and cowpea; TCR= Trapped between Cowpea and Roselle; TRR= Trapped between Rosselle and Rosselle

Table 4: Seed weight (g/1000) in trapped okro and control

Plot	Week 5	Week 7	Week 9
TCR	30.34 +0.88a	48.00+1.00a	63.50+3.55a
TCC	31.42+1.66a	48.00+1.00a	63.50+3.55a
TRR	32.33+0.15a	48.00+1.00a	63.50+3.55a
Control	30.35+1.02a	47.00+0.55a	52.50+2.88b

Data are Mean ± SEM of triplicate determination
TCC=Trapped between Cowpea and cowpea; TCR= Trapped between Cowpea and Roselle; TRR= Trapped between Rosselle and Rosselle

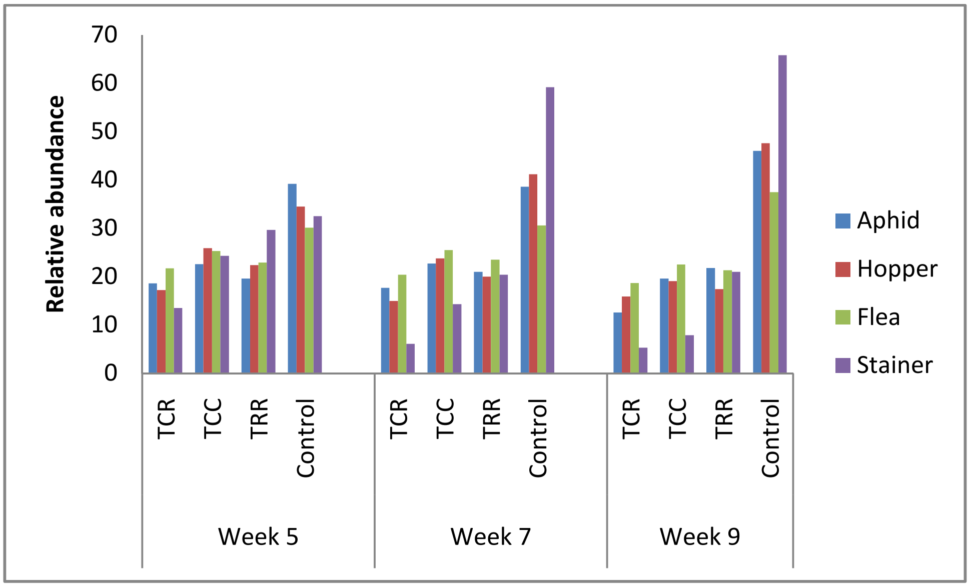

Figure 1: Relative abundance of insect pests within the plot over 9 weeks

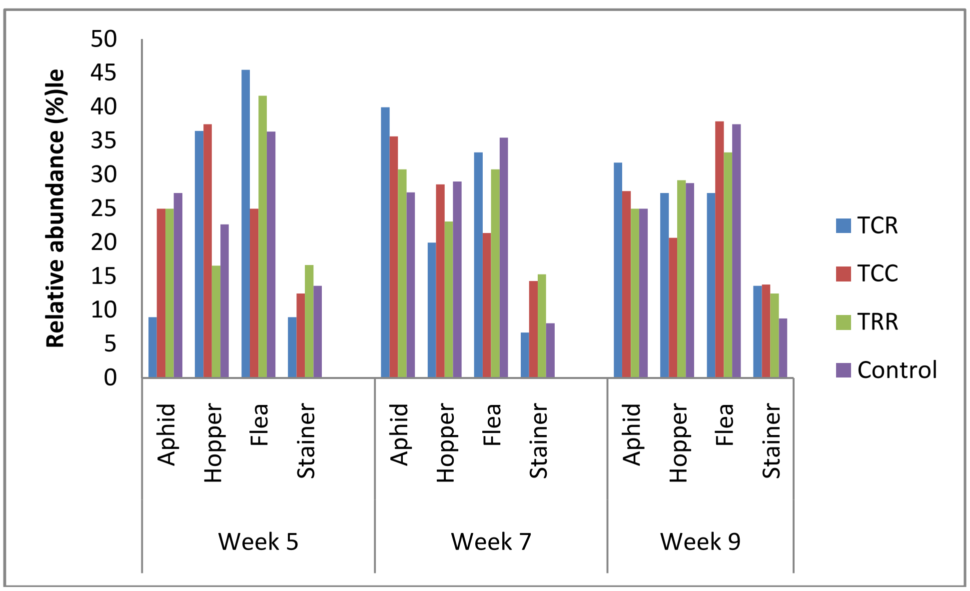

Figure 2: Relative abundance of insect pests in each of the plot over 9 weeks

REFERENCES

Adesina, J. M. (2013). Exploration of *Erythrina excelsa* Baker and *Aneilema beniniense* (P. Beauv.) Kunth Aqueous Extracts ForThe Management of Flea Beetles (*Podagrica* spp.) on Okra (*Abelmoschus esculentus*) *Nature and Science* 11(12):210-215.

Adetuyi, F. O, Osagie, A. U. and Adekunle, A. T. (2008). Effect of Postharvest Storage Techniques on the Nutritional Properties of Benin Indigenous Okra *Abelmoschus esculentus* (L) Moench. *Pakistan*

Journal of Nutrition 2008, 7: 652-657.

Aliyu, M., Ahmed, B. I. and Abdullahi, J. (2011). Effect of Intercropping patterns of Cotton/Cowpea on the Population of Cowpea Aphid (Aphis craccivora Koch) and Whitefly (*Bemisia tabaci* Genn.) on Cowpea (Vigna unguiculata [L.] Walp). *Savannah Journal of Agriculture* 6(1): 32-39.

Ali. M., Hossain, M. Z. and Sarkern, N. C. (2000). Response of two okra (*Abelmoschus esculentus* L. Moench) varieties to fertilizers: yield and yield components as influenced by nitrogen and Phosphorus application. *Euphytica,* 3: 205-209

Babatunde, F. E. and Mofoke, A. L. E. (2006). Performance of Roselle *(Hibiscus sabdariffa* L) as Influenced by Irrigation Schedules. *Pakistan Journal of Nutrition*, 5: 363-367.

Benchasri, S. (2013). Preliminary studies on incidence of insect pests on okro (*Abelmoschus esculentus* (l.) Moench) in Thailand. *Life Journal of Agriculture* 19: 209-215

Clementine, L., Dabiré-Binso, M. N. Ba, K. S. and Antoine, S. (2009). Preliminary studies on incidence of insect pest on okra, *Abelmoschus esculentus* (L.) Moench in central Burkina Faso. *African Journal of Agricultural Research*, 4(12): 1488-1492.

Fanjinmi, A.A. and Fanjimi, O.B. (2010). Incidence of okra mosaic virus at different growth stages of okra plants (*Abelmoschus esculentus* (L.) Moench) under tropical condition. *Journal of General and Molecular Virology* 2: 28 – 32.

Fasunwon, B. T. and Banjo, A. D. (2010). Seasonal population fluctuations of Podagrica Species on okra plant (*Abelmoschus esculentus*). *Research Journal of Agriculture and Biological Sciences*, 6: 283 – 288

Hill, D. S. and Waller, J. M. (1988). *Pests and Diseases of Tropical Crops*, Logman, New York, pp. 414

Hokkanen, H. M. T. (1991). Trap cropping in pest management. *Annual Review. Entomology.* 36:119–38

Kashif, S. R.., Yaseen, M., Arshad, M. and Ayub, M.. (2008). Response of okro (*Hibiscus esculentus* L.) to soil given encapsulated calcium carbide. *Pakistan Journal of Botany*. 40: 175-181

Kumar, S., Dagnoko, S., Haougui, A., Ratnadass, A., Pasternak, D. and Kouame, C. (2010). Okra (*Abelmoschus spp*.) in West and Central Africa: potential and progress on its improvement. *African Journal of Agricultural Research,* 5: 3590-3598.

Lombin, G. Owonubi, J. J. and Yayock, J. Y. (1988). Crop Science and Production in Warm Climate. Macmillan Intermediate Agric Science pp 214-216.

Muhammad, S. (2011). Potential of bioslurry and compost at different levels of inorganic nitrogen to improve growth and yield of okro (*Hibiscus esculetus* L.) A thesis submitted Faculty Of Agriculture University Of Agriculture Faisalabad, Pakistan

Munthali, D. C. and Mmapetla, Z. M. (2008). Assessment of field abundance of Aphis gossypii on okra varieties. *Botswana Journal of Agriculture and Applied Sciences.* 4: 203-209.

Munthali, E.,] and Tshegofatso, S. (2013). *Major insects of Okra in Sebele. Bots. Journal of Agriculture and. Applied. Science 9 (2) xx-xx*

Nwaogu, E. N. and Echendu T. N. C. (2005). Effect of Intercropping Ginger, Soybean / Okra in high degraded Ultisol of South – East Nigeria: NRCRI Annual Report.167 Pp.

Oyelade, O. J., Ade-Omowaye, B. I. O. and Adeomi, V. F. (2003). Influence of variety on protein, fat contents and some physical characteristics of okro seeds. *Journal of Food Engineering*. 57: 111-114.

Sorapong, B. (2013). Preliminary Studies on Incidence of Insect Pests on Okro (*Abelmoschus esculentus* (L.) Moench) in Thailand. *Bulgarian Journal of Agricultural Science,* 19(2): 209-215.

Tanko, L., Ajani, R. and Adeniji, O. B. (2012). Relative Technical Efficiency of Credit and Non Credit Users in Rice-Based Enterprises in Lavun Local Government Area, Niger State, Nigeria.*International Journal of Agricultural Economics* and *Rural Development* - 5 (1):83-92

Uddin II, R. O. and Odebiyi, J. A. (2011). Influence of Intercropping on the incidence, abundance and severity of Pest damage on Okra *Abelmoschus esculentus* (Linn.) Moench (Malvaceae) and chilli pepper *Capsicum frutescens* Linn. (Solanaceae) *Journal of Agricultural Science*, 3(3): 63-66.

Udoh, E. J. and Akpan, S. B. (2005). Measuring Technical Efficiency of Waterleaf (*Taliuum trangulare*) Production in Akwa Ibom State, Nigeria. *America. Journal of Agricultural Environment. Sci.* 2 (55): 522- 528.

Usman, I. (2004). Prospect and Problems of Vegetable Production under the Fadama Areas of Bauchi, Nigeria. *Nigeria Journal of Horticulture Science*. 9(1): 1118- 2733.

Yajuvendra, S., Aastik, J. H., Verma, S. V. K. and Singh, S. S. (2013). Population dynamics of sucking insect pests and its natural enemies on okra agro-ecosystem in Chitrakoot region. *African Journal of Agricultural Research*, 8(28): 3814-3819.