Growth and Yield Responses of Three Varieties of Okra (Abelmoschus esculentus L. Moench) to NPK fertilizer, Poultry manure and Moringa leaf

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Abstract

The continuous increase in cost of inorganic fertilizer has created a desired to seek for alternative nutrients sources for better performance in okra production. Consequent upon this, a pot experiment was conducted to investigate the response of three varieties of okra (Abelmoschus esculentus) to NPK 15-15-15 fertilizer (NPK), poultry manure (PM) and moringa leaf (FML (fresh) and DML (dry)) at the Teaching and Research farm of Ekiti State University, Ado-Ekit, Nigeria. Two seeds each of Clemson spineless, Cajun delight and Beck's big okra varieties were planted in each pot and seedling thinned to one two weeks after planting (WAP) laid out in a Completely Randomized Design (CRD) replicated three times. NPK, PM, FML and DML was added as a basal application at the rate of 250 kg/ha, 10 mt/ha and 1200 kg/ha separately to each set of okra variety. Data were collected on plant height, leaf length, leaf width and a number of leaves, a number of fruits and fruit fresh weight. All data were subjected to analysis of variance with mean separated using Duncan's multiple range test at 5 % level of probability. The three okra varieties response varies with the treatments applied. Beck's big okra was the tallest plant (62.8cm) and have highest number of leaves (6.33) in NPK application but DML has the highest total number of fruits per plant (17). The three varieties were not significantly different in fruit weight with all the treatments applied. FML and DML compete well with NPK and PM in growth and yield parameters despite the variation in the number of fruits produced. It shows that for cost effectiveness and availability, low income okra farmers can adopt the use of moringa leaves in okra production.

Key Words: *Moringa leaf, NPK fertilizer, Poultry manure, Clemson spineless, Cajun delight and Beck's big okra*

INTRODUCTION

The burgeoning population growth in developing country had resulted in higher demand for food which had put pressure on the soil fertility. This had led to the introduction of varying agronomy practices in order to boost food production. Farmers, particularly in the humid lowland region of Western Nigeria, depend on natural bush fallow method to build-up nutrient and soil organic matter (Olujobi and Ayodele, 2013). But this had fail as it cannot cope with the timid population, hence the introduction of organic and inorganic fertilizers. With the recent discoveries in health and economy challenges of developing countries, there is a need to look for a less expensive and environmental friendly alternative ways to boost food production.

Okra (Abelmoschus esculentus L. Moench) is a crop widely cultivated in the tropics for local consumption (Schipper, 2000). Okra originated in Asia and Africa and was domesticated in West and Central Africa. Okra is the most important fruit vegetable crop widely consumed in Nigeria as a source of calorie (4550Kcal/kg) for human (Babatunde et al., 2007) and it ranked third in term of consumption (Ibeawuchi, 2007). The immature okra pod is boiled for making soup while the dried form is used as soup thickener (Yadev and Dhanker, 2002). Fresh okra fruit is a good source of mineral, vitamins and plant proteins (Eke et al., 2008).

Okra is cultivated in most part of Nigeria by small scale farmers with limited capital resources to expand their production. Various varieties of Abelmoschus esculentus with varying maturation periods, fruit sizes, plant heights and colour are cultivated in Southwest Nigeria. (Udoh et al., 2005). Okra requires a good soil fertility for optimum growth and yield. Ayoola and Adeniyan (2006) observed that after a cropping season adequate nutrient level is rarely restored to sustain food production. In order to address this soil nutrients shortage, most local farmers in Southwest Nigeria adopted the use of bush fallowing and organic waste/manure to boost okra production. The high cost and scarcity of inorganic fertilizer makes it inaccessible to local farmers. Organic fertilizers such as poultry manure, sheep, and cattle manure had been found to boost okra yield and improve the soil physical qualities (Tiamiyu et al., 2012) but the bulky nature of organic fertilizers is a concern to many farmers. Application of organic, inorganic fertilizer and plant part residues had increased okra yield (Akande et al., 2010).

The use of plant residues as a compliment to

inorganic fertilizer and poultry manure in crop production has gain interest among local farmers. This can be traced to the increase in the cost of inorganic fertilizer and some of its negative effects on soil and crop ((Panayotov et al., 2010; Fawzy et al. 2012)). Moringa oleifera, a family of Moringaceae is a drought resistance fast growing tree native to southern foothills of the Himalayas in northwestern India, and widely cultivated in the tropical and subtropical areas where its young seed pods and leaves are used as vegetables. Today moringa tree is widely cultivated in Africa, Central and South America, Sri Lanka, India, Mexico, Malaysia, Indonesia and the Philippines (Ashfaq et al., 2011). Moringa tree is referred to as a 'miracle tree' because of its various uses. Fahey (2005) affirmed that all parts of moringa tree are used by human for food and other beneficial property. Moringa leaves contain zeatin, a natural plant growth promoting cytokinin, ascorbates, phenolic acid and mineral like Ca, K, Fe etc which stimulate plant growth resulting in better yield of crops (Nagar et al., 2006). The foliar spray of the crop with moringa leaf extract had accelerated growth of young plants, made the plant more resistant to pest and diseases, and increased yield by 20-35% (Ashfaq et al., 2011). Moringa can also be used as a green manure. The use of moringa leaves as a plant residue for the growth of plant have received little attention. But the quality of nutrient potentials possessed by moringa leaves cannot be ignored which have informed the interest in this work. This work therefore aimed to investigate the comparative effects of moringa leaves as a fertilizer and poultry manure and NPK fertilizer on three varieties of okra.

2. Materials and methods

2.1 Trial site

The study was conducted at the Teaching and Research Farm of Ekiti State University, Ado – Ekiti, Nigeria that lies within latitude 5°45' and longitude 8°15' of tropical rain forest agricultural zone of Nigeria.

2.2 Soil and materials collection and preparation

Top soil sample at a depth of 0-15cm was collected from the field, bulked and approximately 5kg of the soil sample measured into a 5-litre plastic bucket totaling 27 number. Moringa leaves and poultry manure were collected from the moringa plantation and poultry farm of the Teaching and Research Farm of Ekiti State University, Ado – Ekiti, air-dried and milled. NPK fertilizer was bought from a farm shop in Ado Ekiti. Seeds of three varieties of Abelmoschus esculentus, Clemson spineless, Cajun delight and Beck's big okra produced by Premier Seeds Nigeria LTD with the head office (Chikaji Industrial Estate, P O Box 1673, Zaria, Kaduna State, Nigeria).

2.3 Soil, poultry manure, and moringa leaf analysis

The pH was determined using a Jenway pH meter 3510 with a glass electrode in a ratio 1:1. The physical and chemical analysis was determined in accordance with the soil and plant analysis procedures described by the International Institute of Tropical Agriculture (IITA) (1989).

2.4 Pot trial

The pots were arraigned in a Completely Randomized Design (CRD). Two seeds each of the different okra variety were planted in each pot that was replicated thrice. The seedlings were thinned to one plant per pot two weeks after planting (WAP). NPK 15-15-15 fertilizer (NPK), poultry manure (PM), fresh moringa leaf (FML) and air-dried milled moringa leaves (DML) were added as basal application at the rate of 250kg/ha, 10mt/ha and 1200kg/ha separately to each set of okra variety two WAP. FML was applied as green manure to pot two weeks before seed planting. The pots were watered intermittently to keep the soil moist

2.5 Data collection

Data were collected at the 12 WAP for the growth parameter: plant height, leaf length, leaf width and number of leaves and the leaf area was determined by the graphical method of Pandey and Singh (2011). The yield parameter at harvest: the total number of fruits per plant and average fruit fresh weight were recorded 12 WAP at third harvest.

2.6 Statistical analysis

The data collected were subjected to Analysis of Variance (ANOVA) and mean separated using Duncan's multiple range test at 0.05 level of probability using SPSS (IBM v20).

3. Results

3.1. Soil sample and organic manure analysis

The physical parameters indicated that the soil was 74.24 % sand, 8.00 % silt and 17.76 % clay with pH 6.86 and contains, 2.76 % organic matter, 1.45 % N and 7.50 mg/kg available P. The contents of K, Mg, Ca, Zn, Fe and Mn respectively were 3.40, 3.96, 5.09, 1.98, 2.20 and 0.07mg/kg (Table 1).

The chemical analysis of poultry manure (PM), fresh moringa leaf (FML) and air-dried milled moringa leaf (DML) used indicated some slight differences in composition (Table 1). Moringa leaf have pH 6.37 with 4.51 % N, 7.16 mg/kg available P and 10.40 mg/kg, 2.20 mg/kg, 2.11 mg/kg exchangeable K, Mg, Ca, respectively. PM have pH 8.25 with 3.76 % N, 3.00 mg/kg available P, 0.09 mg/kg, 1.57 mg/kg and 0.13 mg/kg exchangeable K, Mg, Ca respectively while FML have pH 5.54 with 1.44 %, 1.66 mg/kg available P and 1.80 mg/kg, 1.00 mg/kg and 0.58 mg/kg exchangeable K, Mg, Ca respectively. PM was slightly alkaline while DML and FML were slightly acidic. DML was high in exchangeable K (10.40 mg/kg) to FML and PM that was very low (1.80 mg/kg and 0.09 mg/kg). PM was high in Fe content (7.10 mg/kg) compared to DML and FML (2.00 mg/kg and 2.30 mg/kg).

3.3. Plant height

Nutrients applied in form DML, FML, PM, and NPK affect plant height (Table 2). Beck's big was the tallest variety of all the treatments applied. NPK fertilizer gave the tallest okra plant at 12 WAP in all the varieties (beck's big variety (62.83 cm), Cajun delight (44.10 cm) Clemson spineless (45.00 cm). Although NPK gave the tallest plants in Cajun delight variety, they did not differ significantly from PM plants. The Cajun delight in FML and DML treated plants were the same. DML plants were taller than PM plants in beck's big and Clemson spineless varieties but are not significantly different. Beck's big variety was significantly different ($p < 0.05$) to Cajun delight and Clemson spineless in plant height in all treatments applied whereas Cajun delight and Clemson spineless plants were not significantly different (Fig. 1). The control in the three varieties was not significantly different despite the fact that Cajun delight and Clemson spineless plants were taller than beck's big plants (Fig. 1).

Table 1: Chemical analysis of soil and treatments used

ELEMENTS	SOIL	PM	DML	FML
pH	6.84	8.25	6.37	5.54
Organic Carbon (%)	1.60	21.35	51.87	21.95
Organic Matter (%)	2.76	36.81	89.42	37.84
N (%)	1.45	3.76	4.51	1.44
C:N (%)	1.10	5.68	11.50	15.24
P (mg/kg)	7.50	3.00	7.16	1.66
K (mg/kg)	3.40	0.09	10.40	1.80
Mg (mg/kg)	3.96	1.57	2.20	1.00
Ca (mg/kg)	5.09	0.13	2.11	0.58
Zn (mg/kg)	1.98	0.33	0.37	0.20
Fe (mg/kg)	2.20	7.10	2.00	2.30
Mn (mg/kg)	0.07	0.07	0.02	0.04
Physical Characteristics				
Sand (%)	74.24	-	-	-
Silt. (%)	8.00	-	-	-
Clay (%)	17.76	-	-	-
Soil texture	Sandy Loam	-	-	-

Milled Fresh Mornings Leaf (FML), Milled Dry Moringa Leaf (DML), Poultry manure (PM), Nitrogen(N), phosphorus(P), Potassium(K), Magnesium(Mg), Calcium(CA) Zinc(Zn), Iron(Fe), Manganese(Mn), Carbon/Nitrogen ratio (C:N).

Table 2: Effect of treatments on plant height (cm) of okra varieties at 12 weeks after planting

Treatment	Variety		
	Beck's big	Cajun delight	Clemson spineless
NPK	62.83a	44.10a	45.00a
FML	43.47c	36.67b	37.57c
DML	57.50b	37.90b	40.83b
PM	54.00b	43.00a	40.00b
Control	29.50d	34.50c	34.57d

Means showing different letter in the same column are significantly different at 5 % probability

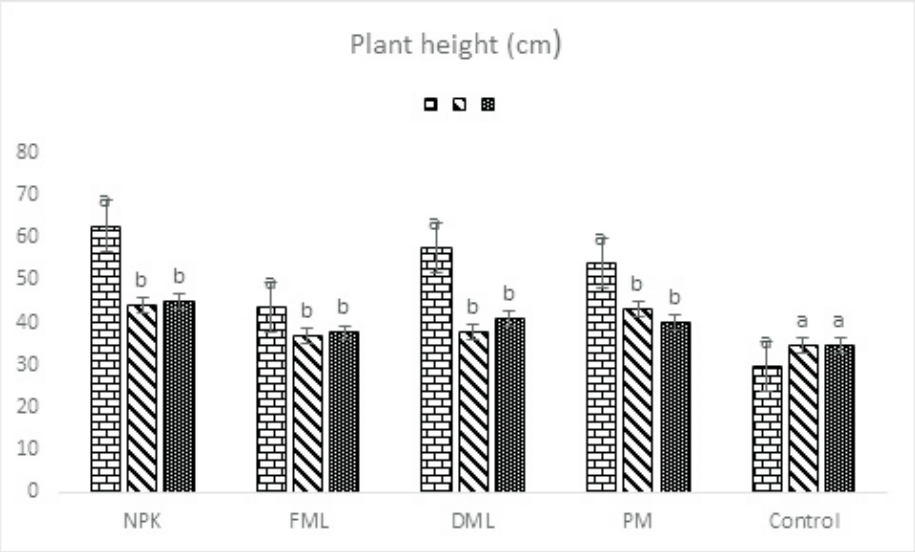

Fig. 1: Response of okra varieties to plant height at 12 weeks after planting as affected by treatments applied

Table 3: Effect of treatments on number of leaves of okra varieties at 12 weeks after planting

Treatment	Variety		
	Beck's big	Cajun delight	Clemson spineless
NPK	6.33a	6.00a	4.67a
FML	4.00bc	6.00a	3.67a
DML	4.33b	5.33a	4.00a
PM	5.00b	5.67a	3.67a
Control	3.00c	4.00b	2.67b

Means showing different letter in the same column are significantly different at 5 % probability

Fig. 2: Response of okra varieties to number of leaves at 12 weeks after planting as affected by treatments applied

3.5 Leaf area

Okra leaf area as affected by the treatments used in Table 4 shows that NPK plants gave the highest value of 0.96 m2plant-1 in Beck's big okra. NPK was significantly different from other treatments except in Cajun delight. The okra varieties respond significantly to all the treatments except in PM where beck's big and Cajun delight are not significantly different (Fig. 3).

3.6 Okra fruit yield

The yield obtained shows that nutrient supplied by DML gave the best fruit yield of okra varieties except in Clemson spineless (Table 5). The number of okra fruits produced per plant in okra treated with DML was the highest in the varieties except for Clemson spineless that NPK gave higher number of fruit produced. Cajun delight variety had the highest average fruit weight of 4.94 g with a total of 9.00 number of fruits per plant in NPK application while DML application with 14.00 number of fruits produced 4.65 g average fruit weight. Beck's big, Cajun delight and Clemson spineless varieties were not significantly different in fruit weight despite the differences in the number of fruits per plant produced. Although there were comparable fruit yield among treatments, there were significant differences in the number of fruits produced and fruit weight in the treatments (Fig.4). Cajun delight and Clemson spineless varieties did not differ in average fruit weight with all the treatments applied but were significantly different to Beck's big variety (Fig. 4).

Table 4: Effect of treatments on leaf area of okra (cm2) varieties at 12 weeks after planting

Treatment	Variety		
	Beck's big	Cajun delight	Clemson spineless
NPK	0.96a	0.40b	0.24a
FML	0.28c	0.41b	0.15b
DML	0.32c	0.59a	0.17b
PM	0.57b	0.48b	0.16b
Control	0.22d	0.24c	0.12c

Means showing different letter in the same column are significantly different at 5 % probability

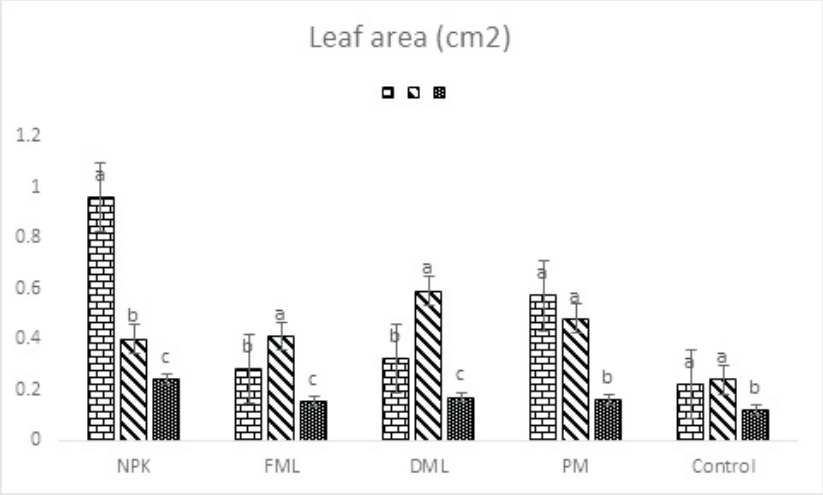

Fig. 3: Response of okra varieties to leaf area at 12 weeks as affected by treatments applied

Table 5: Effects of treatments on average yield of okra varieties

Treatment	Number of Fruit			Fruit weight (g)		
	Beck's big	Cajun delight	Clemson spineless	Beck's big	Cajun delight	Clemson spineless
NPK	13b	9c	9a	2.07	4.94	4.12
FML	7c	12b	8a	2.02	3.99	3.98
DML	17a	14a	6b	2.05	4.65	4.04
PM	12b	10c	6b	2.04	4.24	4.08
Control	4d	3d	3c	1.00	1.01	1.03

Means showing different letter in the same column are significantly different at 5 % probability

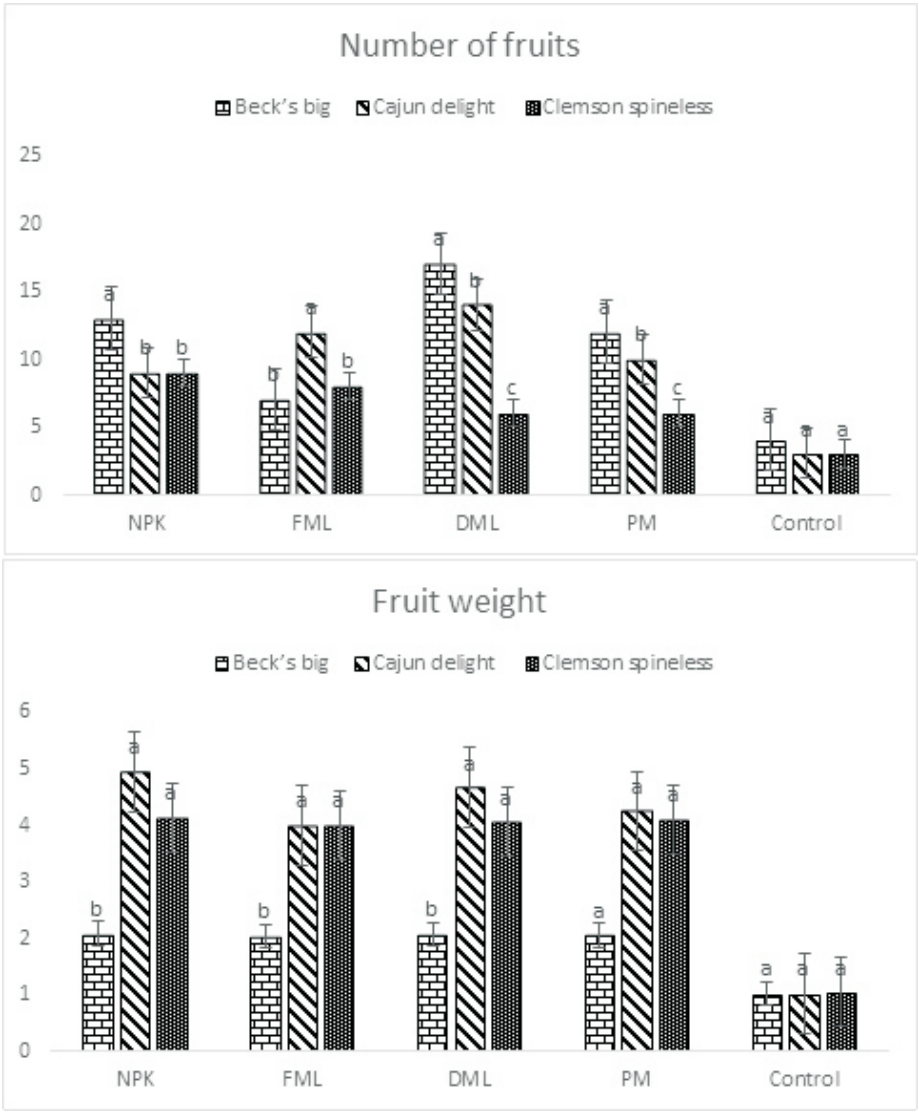

Fig. 4: Response of okra varieties to fruit yield as affected by treatments applied

4. Discussion

The use of fertilizer is an important input in crop production as it increases yield in quantity and quality. Organic materials application also increase crop yield and compete favourably with inorganic fertilizer. Most soils of southwest Nigeria are deficient in major plant nutrients (FMANR, 1990) hence the need for boosting with organic and inorganic fertilizer applications for crop better performance. But Adewole and Ilesanmi (2011) observed that there is no need for soil amendment for okra production in fertile soil.

The sole application of FML, DML, NPK, and PM to the three varieties of Okra (Beck's big, Cajun delight and Clemson spineless) improve the growth parameters (plant height, number of leaves and leaf area) of Okra (Table 2, 3 & 4). NPK fertilizer had been used to increase okra production in Ekiti state (Omotoso and Shitu, 2007; Akintomide and Osundare, 2015). The use of plant residues such as fertilizer have been observed by Akande *et* al. (2010) and Olujobi and Ayodele (2013). The use of moringa leaf compared significantly with NPK fertilizer and showed competing performance to PM. Moringa leaf extract had been observed to increases crop yield (Fahey, 2005; Aluko, 2016). The results showed that NPK fertilizer had the initial increase in the growth parameters which was as a result of its quick nutrients released to plant. This agreed with Akande *et* al.(2010); Olujobi and Ayodele (2013) that inorganic fertilizer act as an immediate response to plant but organic materials release its nutrients gradually. DML perform better than FML. This might be as a result of moisture content in FML. The responsiveness of okra to fertilizer applications varies in the varieties. Plant height increases as the growth period increases for all

varieties with all treatments but NPK fertilizer gave the tallest plant in Beck's big variety. Beck's big okra response better to treatments than Cajun delight and Clemson spineless that had the least response to treatments applied but are significantly similar. Crop varieties responded to treatment differently despite belonging to same species. There were significant differences within the varieties and between the treatments at the various stages at $P < 0.05$, despite the showing of varying responses among the three varieties tried. The application of the treatments were significant ($p < 0.05$) among the varieties with NPK fertilizer showing best performance. At 12 WAP, Beck's big variety gave the best performance in growth characters while Cajun delight produced the best quality yield.

Conclusion

The response of the three varieties of okra tried showed that the use of moringa leaf as nutrients source to grow the crop both as green manure and dried content, compete comparatively in growth and yield to NPK fertilizer and poultry manure. This indicated that moringa leaf can be used as organic manure in okra production. Therefore low-income farmers can adopt the used of organic materials such as moringa leaves to complement inorganic fertilizer to reduce the cost of production in okra.

References

Adewole, M. B., and Ilesanmi, A. O. (2011). Effects of soil amendments on the nutritional quality of okra (Abelmoschus esculentus [L.] Moench) Journal of Soil Science and Plant Nutrition, 2011, 11 (3), 45-55

Akande, M. O., Olueatoyinbo, F. I., Makinde, E. A., Adepoju, A. S. and Adepoju, I. S. (2010). The response of Okra to organic and inorganic fertilization. Nature and Science, vol. 8(11). pp 261-266

Akintomide, T. A. and Osundare, B. (2015). Growth and Yield Responses of Okra (Abelmoschus Esculentus)and Soil Fertility Status to NPK Fertilizer Application Regimes. International Journal of Research Studies in Agricultural Sciences (IJRSAS)Volume 1, Issue 3.PP 11-16

Aluko, M. (2016). Moringa leaf extract on the growth and yield of pepper (Capsicum annuum). APRN Journal of Agricultural and Biological Science. 11 (3): 106-109.

Ayoola, O. T. and Adeniyan, O. N. (2006). Influence of poultry manure and NPK fertilizer on yield and yield components of crops under different cropping systems in south west Nigeria. African Journal of Biotechnology Vol. 5(15), pp. 1386-1392. 12.

Ashfaq, M., Basra, S. M. and Ashfaq, U. (2011). 'Moringa' A miracle plant of agro forestry and southern Punjab, Pakistan. World Environmental Day 16th June 2011

Babatunde, R. O., Omotesho, O. A and Sholotan, O. S. (2007). Socio-economic Characteristics and Food security status of farming household in Kwara State, North – Central Nigeria. Pakistan Journal of Nutrition Vol. 6, No.1, p.16.

Eke, K. A., Essiens, B. A. and Ogbu, J. U. (2008). Determination of optimum planting time of okra in the derived savannah. Proc. of the 42nd Conf.of ASN at Abakaliki 17th – 23rd Oct. 2008. Pp. 242 – 245.

Fahey, J. W. (2005). Moringa oleifera: A Review of the Medical Evidence for Its Nutritional, Therapeutic, and Prophylactic Properties. Part 1. Tree for Life Journal. www.TFLJournal.org

Fawzy, Z. F., Abou El-magd, M. M., Yunsheng Li, Zhu Ouyang, and Hoda, A. M. (2012). Influence of Foliar Application by EM "Effective Microorganisms", Amino Acids and Yeast on Growth, yield and Quality of Two Cultivars of Onion Plants under Newly Reclaimed Soil. Journal of Agricultural Science. 4(11), 26-39.

Federal Ministry of Agriculture and Natural Resouces, (FMANR, 1990). Literature review on soil fertility investigations in Nigeria (in Five Volumes). Federal Ministry of Agriculture and Natural Resources, Lagos Nigeria. Federal University of Technology Meteorological Unit, Owerri, Nigeria

Ibeawuchi, I. K. (2007). "Intercropping a food production strategy for resource poor

farmers," Nature and Science, vol. 5, no. 1, pp. 46–49.

International Institute of Tropical Agriculture (IITA) (1989). Automated and semi-automated methods of soil and plant analysis. Manual Series. No 7, IITA, Ibadan, Nigeria.

Nagar, P. K., Iyer, R. I. and Sircar, P. K (2006). Cytokinins in developing fruits of Moringa pterigosperma Gaertn. Physiol Plant. 55: 45-50.

Olujobi, O. J., and Ayodele, O. J. (2013). Growth and yield of okra (Abelmoschus esculentus) in response to tree legume manure and urea fertilizer. IJAFS 4(12): 502- 509

Omotoso, S. O., and Shittu, O. S. (2007). Effect of NPK fertilizer rates and method of application on growth and yield of okra (Abelmoschus esculutus (L.) Moench) at Ado-Ekiti. Southwestern, Nigeria. International Journal of Agricultural Research. 2(7). pp 614-619

Pandey, S. K., and Singh, H. (2011). A Simple, Cost-Effective Method for Leaf Area Estimation. Journal of Botany. vol. 2011; 6 pgs

Panayotov Nikolay, Mladen Najdenov, Yordanka Kartalsak, and Krasimira Sapundjieva (2010). Influence of Some Beneficial Microorganisms on the Development of Pepper Seedling. BALWOIS 2010- Ohrid, Republic of Macedonia-25, 1-6.

Schipper, R. R. (2000). African Indigenous Vegetables: An Overviewof the Cultivated Species, Natural Resource Institute. E.U. Technical Centre of Agriculture and Rural Cooperation, Chatham, UK.

Tiamiyu, R. A., Ahmed, H. G. and Muhammad, A. S. (2012). Effect of Sources of Organic Manure on Growth and Yields of Okra (Abelmoschus esculentus L.). Nigerian Journal of Basic and Applied Science, 20(2): 213-216

Udoh, D.J.,Ndon, B.A., Asuquo, P.E and Ndaeyo, N.U. (2005). Crop production techniques for the tropics. Concept publisher, Lagos, Nigeria.PP 223-247.

Yadev, S. K., and Dhanker, B. S. (2002). "Performance of 'Varsha Uphar' cultivar of okra as affected by sowing dates and plant geometry," Vegetable Science, vol. 27, pp. 70–74.