GLOBAL JOURNAL OF BIO-SCIENCE AND BIOTECHNOLOGY

www.scienceandnature.org

# EVALUATION OF SOME GROWTH AND YIELD INDICES OF FIVE VARIETIES OF TOMATO (*LYCOPERSICON ESCULENTUM* MILL) IN ASABA AREA OF DELTA STATE, NIGERIA

Enujeke, E.C. & Emuh, F.N.
Department of Agronomy, Delta State University, Asaba Campus, P.M.B 95074, Asaba, Nigeria.
Corresponding Author's email: enujeke@yahoo.com

**ABSTRACT**
Field experiments were conducted in 2011 and 2012 cropping seasons in the Teaching and Research Farm of Delta State University, Asaba Campus, Asaba, Nigeria. The aim was to assess some growth and yield indices of five varieties of tomato (DT97/215A, UC82B, Roma VF, Kwale and Asaba Local) in Asaba area of Delta State, Nigeria. The experiments were carried out in a Randomized Complete Block Design (RCBD) with three replicates. Parameters assessed to achieve the objectives of the study were plant height, number of leaves/plant number of flowers/plant number of fruits/plant and fresh fruit weight at maturity. The results of the 2years investigation showed that hybrid variety UC82B was superior to other varieties tested with mean height of 52cm, mean number of leaves /plant of 53cm, mean number of flowers/ plant of 26cm, mean number of fruits/plant of 27cm, and mean fresh fruit weight of 18.5 tons/ha. Based on the findings of the study, it was recommended that farmers should grow tomato hybrid variety UC82B for increased growth and yield in Asaba area of Delta State, Nigeria.

**KEYWORDS:** Growth and yield indices of five tomato varieties, Asaba, Nigeria.

## INTRODUCTION

One of the important vegetable crops cherished and grown throughout the world today is tomato (*Lycopersicopcon esculentum* mill) with an average yield of about 100 million tons from 3.7 million hectares of cultivated land (www.growtomatoes.com) tomato ranks second following potato in term of area cultivated, but first as a processing crop (Enujeke 2013, Alawathugoda and Dehanayake, 2014). As a palatable and succulent crop, tomato is used in vegetarian and non-vegetarian dishes. In Nigeria, it is used in the preparation of pasta salads, snacks, sandwich and cocktails. Tomato is rich in Vitamins A and B complex which helps to prevent eye and skin diseases. It is also rich in potassium which is helpful in controlling the rate of heart beat, heart diseases and stroke (Enujeke, 2013). The numerous uses of tomato notwithstanding, production in Nigeria is not enough for local demand. Besides the problem of declining soil fertility which affects the level of productivity, it is most suitable to each agro-ecological zone with a view to increasing production. Iken and Anusa (2004) suggested that because of the differences in the yield potentials of different ecological zones, testing of new varieties of crops across the country must be adopted and established as a practice in plant breeding. The repot further argued that through the high yielding crop varieties can only express their full genetic resources, the yield advantages and special traits of hybrid appears to s8ufficiently large enough to attract the attention of farmers. The report also recommended the right choice of site, timely and appropriate establishment, nutrition, disease and pest control, proper harvesting procedure and produce disposal and/or storage. Crop growth and yield are usually affected by varietal differences. Majambu *et al*. (1996) and Sajjan *et al.* (2002) reported that growth characters of crops such as plant height, leaf area, number of leaves or branches and fruit yields were influenced by genetic factors of different varieties. Ibrahim *et al.* (2000) reported that the differences in growth indices of crops are normally influenced by their genetic constitution. Ray and Sinclair (1997) attributed differences between the growth character of crop genotypes to photosynthesis activity of leaves, plant and leaf arrangement, differences in stomatal conductance value. Clark *et al.* (1997) reported that the genotype differences in yield and its components may be due to variation in genetic structure, mineral concentration and potentials to transport photosynthetic materials within plant. Costa and Campos (1990), Gardner *et al.* (1990) and Zaki *et al.* (1999) attributed yield differences in crop cultivars to stomatal conductance value and to differences between genotypes in partitioning of photosynthetic materials towards economic yield. Odeleye and Odeleye (2001) suggested that since crop varieties differ in their growth characters, yield and its components, breeders must select the most promising combiners in their breeding programmes. At present, no variety of tomato has been identified as best adapted or most suitable for Asaba area of Delta State, Nigeria. The objectives of this study therefore was to assess the growth indices of five different varieties of tomato with a view to identifying the best adapted or most suitable variety for increased yield in the study area.

## MATERIALS & METHODS

Field experiments were carried out at the Teaching and Research Farms of the Delta State University, Asaba Campus. The experimental site is located within latitude

06°14'N and longitude 06°49'E of the equator. The experiment was conducted during the 2011/2012 cropping seasons in a typical humid environment that is characterized by a bimodal rainfall pattern with peaks in July and September and an interrupted dry spell in August otherwise called (Harmattan). The annual mean rainfall is about 1,650 mm, the mean annual temperature is 37.3°C and a mean relative humidity of 73.2% (NIMET, 2011). By nature of its geomorphological settings, the study area falls within the classification of Ancient metamorphic crystalline basement complex formation which are more acid than base (Egbuchua, 2007). They are essentially gneisses and pegmatites that gave rise to coarse-textured soils that are deficient in dark ferromagnessium minerals (Egbuchua, 2007). The topography is undulating with pockets of hills and land use is typically based on rain - fed agriculture with root, tuber, spices, pulses and vegetables prominently cultivated. The vegetation is of rainforest origin but has been drastically reduced to derived savanna due to continuous use of the land. The land measured 388.85 $m^2$ (38.5 m x 10.1m). It was ploughed and harrowed using a tractor, and marked out according to the experimental layout. Eighteen plots of 6.0m x 2.7m each were made and composite samples collected from the plots at 0-15 cm depth in order to assess the initial physio-chemical properties of the soil. The composite soil samples collected from the individual plots were air-dried in a room temperature of 27°C for three days, crushed and sieved using 2mm aperture. The parameters evaluated include the particle size distribution by hydrometer method (Gee and Bauder, 1986). The pH was determined using Pye Unican model MK2 pH meter in a 1:2:5 soil/water suspension ratio. Organic carbon was determined by Walkley-Black wet oxidation method (Nelson and Sommers, 1982). Total nitrogen was determined by micro-Kjeldahl distillation technique as described by Breminer and Mulvaney (1982). Available phosphorus was determined by Bray No. 1 method (IITA, 1979). Exchangeable potassium was determined by flame photometer, while cation exchange capacity (CEC) was determined by Amnonium acetate saturation method (Roades, 1982). The experiments were carried out in a Randomized Complete Block Design (RCBD) with three replicates. Three hybrid varieties of tomato (DT97/215A, Roma VF, UC82B) and two local varieties (Asaba local and Kwale local) obtained from an agro-allied company Ibadan were planted. The nursery beds were prepared and watered regularly using a watering can and checked for seedling emergence which started on the $5^{th}$ day after sowing. The nursery plots were mulched to avoid poor germination and prevent excessive heat. Transplanting of tomatoes seedlings into their respective plots in the field took place four weeks after sowing (WAS) early in the morning after a heavy rainfall (Adelana, 1976). N.P.K (15-15- 15) fertilizer was applied at the rate of 120 kg/ha three weeks after transplanting (WATP) to boost the growth of the crops. The fertilizer was applied by ring placement into drills 5cm deep and 7.5cm away from the plant and covered with soil. Three weeding operations were carried out on the field at two weeks interval. Also, crop management includes spraying with cymbush at 2, 4 and 6 weeks after transplanting against defoliating pests (Vimala, 1978).Fourteen middle stands were used as sample population. Data collected were plant height, number of leaves/plant, number of flowers/plant, and fresh fruit weight at maturity. Plant height was measured with tape from the base to the growing tip of the plant. Number of leaves/plant and number of flowers/plant were determined by direct counting. Fruit weight was measured using a weighing scale. Data collected was subjected to analysis of variance (ANOVA) and means were separated using Duncan Multiple Range Test (DMRT) according to Wahua (1999).

## RESULTS & DISCUSSION

### Initial Soil Properties

The data on the initial physico-chemical properties of the soils used for the study is presented in Table 1. The particle size fracture showed that the soils were sandy loam in texture and low in fertility as reflected by the low content of organic matter (15.5 $gkg^{-1}$), and total nitrogen (0.87 $gkg^{-1}$). Soil pH was strongly acid with a mean value of 5.3. The available phosphorus (P) and water soluble, potassium (K) with mean values of 5.35 $mgkg^{-1}$ and 0.17 $cmolkg^{-1}$ were seemingly low based on the ratings of FMANR, (1996) for the ecological zone. The low fertility status of the soils is a true reflection of most ultisols of humid environment that are strongly weathered of low activity clay mineralogy and high acidity due to intense precipitation with its associated erosion and leaching in the environment.

**TABLE 1:** Initial phyisco-chemical properties of the soils used for the study

| Parameters Measured | Values obtained |
|---|---|
| Particle size fractions | (%) |
| Sand | 85.0 |
| Silt | 9.6 |
| Clay | 4.4 |
| Textural class | Sandy loam |
| pH ($H_2O$) | 5.3 |
| Organic matter $gkg^{-1}$ | 15.5 |
| Total Nitrogen ($gkg^{-1}$) | 0.87 |
| Available P ($mgkg^{-1}$) | 5.35 |
| Exchangeable K ($Cmolkg^{-1}$) | 0.17 |
| CEC ($Cmolkg^{-1}$) | 10.13 |

**Plant height of five tomato varieties at different weeks after planting in 2011 and 2012**

The plant height of five tomato varieties at 4, 6 and 8 weeks after planting in 2011 and 2012 is shown in table 2. There were significant differences in plant height of the varieties in both years of evaluation. During the 4th week after planting in 2011, hybrid variety UC82B had the highest plant height (36cm), while Kwale local variety had the lowest plant height (16cm). Similar trend was observed in 2012 where hybrid varieties UC82B had the highest plant height (38cm), and Kwale local variety also had the lowest plant height (18cm). In week 6 of 2011, hybrid variety UC82B had the highest plant height (40cm) while Kwale local variety had the lowest plant height (20cm). The trend did not change in 2012 where hybrid variety UC82B with plant height of 48cm grew taller than other varieties, while Kwale local variety had the lowest plant height (24cm). During the 8th week of 2011, highest plant height of 50cm was recorded by hybrid variety UC82B, while Kwale local variety had the lowest plant height (24cm). Similar trend was observed in 2012 where variety UC82B had the highest plant height of 54cm while Kwale local variety had the lowest plant height of 28cm. The superiority in order of plant height based on variety was UC82B>DT97/Roma VF>Asaba Local>Kwale Local.

**TABLE 2:** Plant hieght (cm) of five tomato varieties at different weeks after planting in 2011 and 2012

| | Weeks after sowing | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 4 | | | 6 | | | 8 | | |
| | Plant height (cm) | | | | | | | | |
| | 2011 | 2012 | Mean | 2011 | 20012 | Mean | 2011 | 20012 | Mean |
| **Varieties of tomato** | | | | | | | | | |
| DT97/215A | $28_b$ | $30_b$ | $29_b$ | $34_b$ | $38_b$ | $36_b$ | $44_b$ | $48_b$ | $46_b$ |
| Roma VF | $24_c$ | $26_c$ | $25_c$ | $30_c$ | $36_c$ | $33_c$ | $36_c$ | $42_c$ | $39_c$ |
| UC82B | $36_a$ | $38_a$ | $37_a$ | $40_a$ | $48_a$ | $44_a$ | $50_a$ | $54_a$ | $52_a$ |
| Asaba local | $20_d$ | $24_d$ | $23_d$ | $24_d$ | $28_d$ | $26_d$ | $30_d$ | $34_d$ | $32_d$ |
| Kwale local | $16_e$ | $18_e$ | $17_e$ | $20_e$ | $24_e$ | $22_e$ | $24_e$ | $28_e$ | $26_e$ |

Means with the same letter(s) under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range test (DMRT).

**Number of leaves per plant of five tomato varieties at different weeks after planting in 2011 and 2012**

The number of leaves/plant of five tomato varieties at 4, 6 and 8 weeks after planting in 2011 and 2012 is shown in table 3. There were significant differences in number of leaves/plant of the varieties in both years of evaluation. During the 4th week after planting in 2011, hybrid variety UC82B had the highest number of leaves/plant (40) while Kwale local variety had the lowest number of leaves/plant (14). The trend did not change in 2012 where variety UC82B had the highest number of leaves/plant of 44, and Kwale local variety had the lowest number of leaves/plant of 18. During the 6th week of 2011 the variety of tomato that had the highest number of leaves/plant was UC82B while Kwale local variety had the lowest number of leaves/plant (20). Similar trend was observed in 2012 where variety UC82B had the highest number of leaves/plant (54) and Kwale local variety had the lowest number of leaves/plant (24). At 8 weeks after planting in 2011, the highest number of leaves/plant (52) was recorded in variety UC82B plants while Kwale local variety had the lowest number of leaves/plant (24). The trend did not change in 2012 where variety UC82B had 54 leaves/plant and Kwale local had lowest number (28). The order of superiority in number of leaves/plant based in varieties of tomato tested was UC82B>DT97/215A>Roma VF>Asaba local>Kwale local.

**TABLE 3:** Number of leaves/plant of five tomato varieties at different weeks after planting in 2011 and 2012

| | Weeks after planting | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 4 | | | 6 | | | 8 | | |
| | Number of leaves/plant | | | | | | | | |
| | 2011 | 2012 | Mean | 2011 | 20012 | Mean | 2011 | 20012 | Mean |
| **Varieties of tomato** | | | | | | | | | |
| DT97/215A | $24_b$ | $28_b$ | $26_b$ | $30_b$ | $34_b$ | $32_b$ | $36_b$ | $38_b$ | $37_b$ |
| Roma VF | $20_c$ | $24_c$ | $22_c$ | $26_c$ | $30_c$ | $28_c$ | $32_c$ | $36_c$ | $34_c$ |
| UC82B | $40_a$ | $44_a$ | $42_a$ | $48_a$ | $54_a$ | $51_a$ | $52_a$ | $54_a$ | $53_a$ |
| Asaba local | $18_d$ | $22_d$ | $20_d$ | $24_d$ | $28_d$ | $26_d$ | $28_d$ | $32_d$ | $30_d$ |
| Kwale local | $14_e$ | $18_e$ | $16_e$ | $20_e$ | $24_e$ | $22_e$ | $24_e$ | $28_e$ | $26_e$ |

Means with the same letter(s) under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range test (DMRT).

**Number of flowers/plant of five tomato varieties in 2011 and 2012**

The number of flowers/plant of five tomato varieties in 2011 and 2012 is shown in table 4. There were significant differences in number of flowers/plant in both years of evaluation. In 2011, hybrid UC82B had the highest number of flowers/plant (24) while Kwale local variety had the lowest number of flowers/plant (6). Similar trend was observed in 2012 where variety UC82B had the highest number of flower/plant (28) while Kwale local

variety had the lowest number of flowers/plant (8). The order of superiority in number of flowers/plant of tomato based on variety was UC82B>DT97/215A>Roma VF>Asaba local>Kwale local.

**TABLE 4:** Number of flowers/plant of five tomato varieties in 2011 and 2012

| | Number of flowers/plant | | |
|---|---|---|---|
| | 2011 | 2012 | Mean |
| **Varieties of tomato** | | | |
| DT97/215A | $18_b$ | $20_b$ | $19_b$ |
| Roma VF | $12_c$ | $14_c$ | $13_c$ |
| UC82B | $24_a$ | $28_a$ | $26_a$ |
| Asaba local | $20_d$ | $14_d$ | $12_d$ |
| Kwale local | $6_e$ | $8_e$ | $7_e$ |

Means with the same letter(s) under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range test (DMRT).

**Number of fruits/plant of five tomato varieties in 2011 and 2012**

The number of fruits/plant of five tomato varieties in 2011 and 2012 is shown in Table 5. There were significant differences in the number of fruits/plant of tomato in both years of evaluation. In 2011, hybrid UC82B had the highest number of fruits/plant 26 while Kwale local variety had the lowest number of fruits/plant (8). The trend did not change in 2012 where variety UC82B had the highest number of fruits/plant (28) while Kwale local variety had the lowest number of fruits/plant (10). The order of superiority in number of fruits/plant of tomato based on variety was UC82B>DT97/215A>Roma VF>Asaba local>Kwale local.

**TABLE 5:** Number of fruits/plant of five tomato varieties in 2011 and 2012

| | Number of fruits/plant | | |
|---|---|---|---|
| | 2011 | 2012 | Mean |
| **Varieties of tomato** | | | |
| DT97/215A | $20_b$ | $22_b$ | $21_b$ |
| Roma VF | $16_c$ | $18_c$ | $17_c$ |
| UC82B | $26_a$ | $28_a$ | $27_a$ |
| Asaba local | $12_d$ | $14_d$ | $13_d$ |
| Kwale local | $8_e$ | $10_e$ | $9_e$ |

Means with the same letter(s) under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range test (DMRT).

**Weight of fresh fruits of five tomato varieties in 2011 and 2012**

The weight of fresh fruits of five tomato varieties tested in 2011 and 2012 is shown in Table 6. There were significant differences in weight of fresh fruits of five tomatos in both years of evaluation. In 2011, hybrid UC82B had the highest number of fresh fruits weight (18.2tons/ha), while Kwale local variety had the lowest fresh fruit weight (6.0tons/ha). Similar trend was observed in 2012 where variety UC82B proved superior with fresh fruit weight of 18.8tons/ha while Kwale local variety had the lowest fresh fruit weight of 6.2tons/ha. The order of superiority in fresh fruits weight based on variety was UC82B> DT97/ 215A>Roma VF>Asaba local>Kwale local.

**TABLE 6:** Weight of fresh fruits of five tomato varieties in 2011 and 2012

| | Weight of fresh fruit (tons/ha) | | |
|---|---|---|---|
| | 2011 | 2012 | Mean |
| **Varieties of tomato** | | | |
| DT97/215A | $14.0_b$ | $16.2_b$ | $15.1_b$ |
| Roma VF | $12.8_c$ | $13.2_c$ | $13.0_c$ |
| UC82B | $18.2_a$ | $18.8_a$ | $18.5_a$ |
| Asaba local | $8.4_d$ | $8.8_d$ | $8.6_d$ |
| Kwale local | $6.0_e$ | $6.2_e$ | $6.1_e$ |

Means with the same letter(s) under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range test (DMRT).

**DISCUSSION**

**Plant height of five tomato varieties at different weeks after planting**

The higher value obtained in plant height of hybrid variety UC82B over other varieties may be attributed to differences in genetic constitution with respect to higher growth rate and suitability of Asaba agro-ecological conditions for the variety. This is consistent with the findings of Majambu *et al.* (1996), Ibrahim *et al.* (2000) and Sajjan *et al.* (2002) who reported that genetic constitution of crop varieties influence growth characters which they express. It is also similar to the findings of Iken and Anusa (2004) that attributed the growth and yield

differences of crop varieties to right choice of suitable agro-ecological zone.

**Number of leaves/plant of five tomato varieties at different weeks after planting**

The number of leaves/plant of hybrid UC82B was higher than the other varieties investigated possibly because variety UC82B had superior leaf arrangement, better distribution of leaf surface, higher chlorophyll content and higher photosynthetic activities. This is in harmony with the findings of Ray and Sinclair (1997) and Enujeke (2013) that attributed the differences in growth characters of crop varieties to differences in distribution of leaf surface and crop canopy, leaf arrangement, differences in chlorophyll content and photosynthetic activities and activity of photosynthetic enzymes.

**Number of flowers/plant of five tomato varieties**

Hybrid variety UC82B had higher number of flowers/plant over other varieties tested possibly because of its genetic resources, special reproductive traits and favourable or right choice of site. This is in harmony with the findings of Iken and Anusa (2004) who attributed the growth and yield differences of crop varieties to genetic resources, special traits of the cultivar and favourable or right choice of site.

**Number of fruits/plant of tomato varieties**

The higher number of fruits/plant observed in hybrid variety UC82B over other varieties investigated may be attributed to the higher number of flowers that developed into fruits. Unlike other varieties whose 50% of their flowers dried up and fell off or formed tiny fruits which shriveled up and fell off without further development, flowers of variety UC82B successfully developed in more fruits possibly because of better genetic constitution. This is in harmony with the findings of Adelana (1975) and Olaniyi *et al.*(2010) who reported that only 50% of flowers produced developed into fruits, thus sink size (genetically controlled) influences fruit production in tomato. It may also be attributed to better genetic structure and higher potentials to transport photosynthetic materials towards economic yield as reported by Clark *et al.* (1997) and Zaki *et al.* (1999).

**Weight of fresh fruits of different tomato varieties**

The higher weight of fresh fruit obtained from hybrid UC82B over other varieties investigated may be attributed to possibility of possession of higher stomatal conductance, better partitioning of photosynthetic materials towards economic yield, better genetic structure and higher potential to transport photosynthetic materials within plants. This is similar to the findings of Costa and Campos (1990), Gardner *et al.* (1990) and Zaki *et al.* (1999) which attributed the yield differences in crop cultivars to stomatal conductance value and to differences in partitioning of photosynthetic materials towards economic yield. It is also in harmony with the findings of Clark *et al.*, (1997) who attributed the differences in yield and its components between crop genotypes to variations in genetic structure, mineral concentration and potentials to transport photosynthetic materials within plants.

## CONCLUSION & RECOMMENDATION

The study was carried out to evaluate some growth and yield indices of five varieties of tomato in Asaba area of Delta State, Nigeria. The results obtained showed that hybrid variety UC82B was superior in the parameters tested in 2011 and 2012. Based on the findings of the study, it was recommended that farmers grow UC82B for increased growth and yield of tomato in the study area.

## REFERENCES

Adelana, B.O. (1978) Effect of flower removal in the tomato. *India J. Horti*. 35(1):29-39.

Alawathugoda, C. J. and Dahanayake, N. (2014) Effects of Mycorrhizae as a substitute for inorganic fertilizer on growth and yield of tomato (*Lycopersicon esculentum* L.) and Soybean (*Glycin max* L.) and soil microbial activity. *Tropical Agricultural Research and Extension* 16(4):107-112.Faculty of Agriculture, University of Ruhuna, Srilanka.

Bremmer, J. M. and C. S. Mulvaney (1982) Total nitrogen In: Page A. L. Miller, R. H. and Keeney, D. R. (ed.) Methods of soil analysis. Part 2. *Agron* 9, Madison. W.I. p. 149-157.

Clark, R.B., Zeto, S.K., Baligar, V.C. and Ritchey, K.D. (1997) Growth traits and mineral concentrations of maize hybrids grown on unlimed and limed acid soil. *Journal of Plant Nutrition* 20 (12): 1773-1795.

Costa, J.G. and Campos, D.A.J.S. (1990) Maize cultivars recommended for the state of Acre. Counica de Tecnico unidade d'Exeecuo de Numbito Estand. No. 56, 4pp (c.f. Field Crop Abstracts 1991, volume 44, No.12).

Egbuchua, C. N. (2007) Pedological characterization and fertility evaluation of some wetlands soils in Delta State. Ph.D Thesis (unpublished).Delta State University, Abraka, Nigeria.

Enujeke E.C**.** (2013) Effects of variety and spacing on growth characters of hybrid maize. *Asian Journal of Agriculture and Rural Development.* 3(5): 296-310. Asian Economic and Social Society, Pakistan

FMANR – Federal Ministry of Agriculture and Natural Resources (1996) Soil fertility investigation (in 5 volumes); fertility ratings. Produced by the Federal Ministry of Agriculture, Lagos, Nigeria.

Gardner, F.P., Alle, V. and McCloud, D.E. (1990) Yield characteristics of ancient roses of maize compared to modern hybrid. *Agronomy Journal.* 82 (5): 864-868.

Gee, G. W and J. W. Bauder (1986) Particle size analysis p. 404-407. In A Klute (ed) Methods of soil analysis. Part 1 (2nd ed.) *Agron. Monogr*. 9. ASA and SSSA. Madison W.I. USA.

Growing Tomatoes (2012) Tomato world production statistics, Retrieved September 10, 2012, from www.growtomatoes.com.

Ibrahim, K. Amans, A. and Abubakar, I.U. (2000) Growth indices and yield of Tomato (*Lycopesicon esculentum karest*) varieties as influenced by crop spacing at samaru. *Proceedings of the 18th HORTSON Conference Proceedings* (1):40-47.

IITA International institute for Tropical Agriculture (1979) Laboratory manual for soil and plant analysis. Manual series 7, IITA, Ibadan, Nigeria.

Iken, J.E. and Anusa, A. (2004) Maize Research and Production in Nigeria. *African Journal of Biotechnology*. 3(6): 302-307.

Majanbu, I.S., Ogunlella, V.B. and Ahmed, M.K. (1996) Responses of Two Okro *(Abelmoschus esculentus (L)* Moench*)* varieties to fertilizer growth and nutrient concetration as influenced by nitrogen and phosphorus applications. *Fertilizer Research* 8:3, 297-306.

Nelson, D. W. and Sommers, I. E. (1982) Organic Carbon. In Page A.L. Miller, R. H. and Keeney, D. R. (ed) Methods of Soil analysis. Part 2 *Agron, Monogr*. 9 ASA and SSSA, Madison, W.I. USA.

NIMET-Nigerian Meteorological Agency (2011) Climate information Bulletin (2011-2012) Asaba, Delta State, Nigeria.

Odeleye F.O. and Odeleye, M.O. (2001) Evaluation of morphological and agronomic characteristics of two exolic and two adapted varieties of tomato *(Lycopersicom esculentum)* in South West Nigeria. *Proceedings of the 19th Annual Conference of HORTSON. (1):140-145.*

Olaniyi, J.O., Akanbi, W.B., Adejumo, T.A. and Akande, O.G. (2010) Growth, fruit yield and nutritional quality of tomato varieties. *African Journal of Food Science 4(6):398-402.*

Ray, J.D. and Sinclair, T.R. (1997) Stomatal closure of maize hybrid in response to drying soil. *Crop science* 37(30):803-807.

Roades, J. D. (1982) Cation Exchange Capacity. In Page, A. L. Miller, R. H. and Keeney, D.R. (eds) Methods of soil analysis. Part 2 Agron. Monogr. ASA, SSSA, Madison, W.I. USA.

Sajjan, A.S., Shekhargounda, M., and Badanur (2002) Influence of data of sowing, spacing and levels of nitrogen on yield attributes and seed yield of Okro. Ikamataka *Journal of Agricultural Science* 15:2, 267-274.

Vimala, P., Ting, C.C., Sabia, H., Ibrahim, B. and Ismail, L. (1999) Biomas production and nutrient yields of four green manure and their effects on the yield of cucumber. *Journal of Tropical Agric. and Food Science,* 27:47-55.

Wahua, T.A.T (1999) Applied statistics for scientific studies. Afrika-Link Books, Nigeria, pp. 250 -287.

Zaki, N.M. El-Gazar, M.M.; El-Din, K.M.G. and Ahmed, M.A. (1999) Partition and migration of photosynthates in some maize hybrids. *Egypt Journal of Applied Sciences* 14(6): 117 – 139.