# EVALUATION OF WEST AFRICAN OKRA (*A. caillei*) VARIETIES FOR AGRONOMIC TRAITS IN UMUDIKE IN SOUTH-EASTERNNIGERIA.

**L. N. CHINATU, P. I. OKOCHA AND M. J. EKA.**
**Email:** lawrencechinatu@yahoo.com
Department of Agronomy, College of Crop and Soil Sciences, Michael Okpara University of Agriculture, Umudike. P.M.B. 7267, Abia State, Nigeria.

**Abstract**

Seven improved and two local varieties of okra (*A.caillei* (A.Chev) were evaluated for yield and other agronomic traits in 2009 and 2010 cropping seasons. The field experiments were conducted in a randomized complete block design with three (3) replications using varieties as treatment. The seeds were sown in early May of each cropping season and data were taken on plant height, number of leaves/ plant, number of lateral branches / plant, number of flowers/plant, number of pods/ plant, length of pods, weight of pods, 100-seed weight and fresh pod yield/ hectare. The data collected were subjected to analysis of variance (ANOVA).The ANOVA showed plant height, number of leaves/plant, number of lateral branches, number of flowers, number of pods, pod length, weight of pods, 100 seed weight and fresh pod yield differed significantly (P<0.05) in eachyear. In2009, fresh pod yield/ ha had positive, strong and significant (P<0.01) correlation coefficients with plant height (0.944**), number of leaves/ plant (0.923**), number of lateral branches/ plant (0.919**), number of pods/ plant (0.9577**) weight of pods (0.768**) and 100-seed weight (0.691**).In2010, fresh pod yield/ haalso had positive, strong and significant (P<0.01) correlation coefficients with plant height (0.926**), number of leaves/ plant (0.951**), number of lateral branches/ plant (0.946**), number of pods/ plant (0.944**) weight of pods (0.800**) and 100-seed weight (0.697**). Fresh pod yield also recorded positive but weak (P> 0.5) correlation coefficients with length of pods in 2009 (0.345) and 2010 (0.322).The varieties which performed better vegetatively had more assimilates /photosynthates which led to higher reproductive characters performance. In 2009, NGAE-96-012-1 and NGAE-96-0067 had fresh pod yield of 7123.79 and 6382.84kg/ha, while in 2010 yield was 7052.98 and 6163.50kg/ ha, respectively. Very highfresh pod yields confirm that the improved varieties NGAE-96-012-1 and NGAE-96-0067 could be released to farmers in Umudike for improvement in okra fresh pod production.

**Keywords.**Okra,varieties, performance attributes, Humid tropics.

**Introduction.**West Africa okra (*Abelmoschuscaillei*) belongs to the family *Malvacease*, and is an important vegetable crop of the tropical and subtropical world (Arigo, 1993 and Kehinde 1999). It is a short day plant generally with green stem,(Ariyo, 1993 and Adenij*iet al.* ,2007),with slight traces of red pigmentation in some accessions (Adeniji, 2003). It is cultivated for fresh pods, leaves and seeds. Singh and Bhatnagar (1985) and Siemonsma (1982) reported that West African okra contained 194 diploid chromosomes as against 130 of the conventional okra *A.esculentus* thereby indicating that *A.caillei* constitutes a new okra species. Due to its high yield and hardiness, it has become a major source of okra pods in Nigeria and its cultivation is progressively replacing the conventional types (Kehinde, 1999). It has been shown that *A.caillei* has the potential forindustrial, nutritional and biomedical purposes in the developing countries, but is under-utilized in the sub-Saharan Africa ( Adenij*iet al.,* 2007).Ariyo(1993), Kehinde (1999), Adeniji and Kehinde(2004) reported that west African okra is photoperiodic, which stand as one of the most striking differences between *A. caillai* and *A. esculentus*.

Okra contains moderate levels of some essential minerals and vitamins which are important for body metabolic processes that utilize carbohydrates, proteinsand fats (Tindall, 1983). Okra is useful in many ways.The immature fruits are eaten in soup either fresh or prepared by boiling or frying, and used in soup and stews,(Okocha and Chinatu,2008).Savello*et al.* (1980)showed that okra seed contains 21% protein,14% lipids and 5% ash.The stem could serve as pulp and full in paper pulp and textile manufacturing industries (Yamaguchi, 1983).Dietary portfolio studies to maximize reduction of low-density lipoprotein cholesterol have indicated that plant- based diets (rich in viscous fibers) may be an effective strategy for the prevention ofhyperlipidemia. Fortunately okra along with eggplant is considered by medical experts as the most important vegetable sources of viscous fiber (Usman, 2001). A summary of the potentials and limitations of the plant is presented in Table 1.

**TABLE 1: Potentials of *A. esculentus*and*A.caillei***

| Species | Cytogenetics | Contrasting traits |
|---|---|---|
| ***A. esculentus*** | | |
| (common okra) 95% cultivated Area | Amphidiploid (2n = 130-140) | Poor adaptation to humid zone. More susceptible to biotic stresses. Less vigorous. Short life cycle.Usually day neutral.Cultivated in both rainy(rain fed) and dry (irrigated) seasons. |
| ***A. caillei*** | | |
| (West African okra) 5% cultivated | Amphidiploid (2n = 190-200) | Better adaptation in humid zone. Tolerant to biotic stress. More vigorous. Longer life cycle. Photoperiod sensitive cultivated across the entire season. |

Source: Kumar *et al*., 2010

Since indigenous okra varieties are predominantly cultivated by the local farmers in Umudikeand that due to their high yield and hardiness, they have become the major source of okra pods in Nigeria (Kehinde, 1999) research works need to be carried out on them. This study sought to identify and select high yielding varieties from the improved and unimproved varieties of *A. caillei*, which if introduced to the existing local types would lead to increase in okra fresh pod production in Southeastern Nigeria.

**Materials and methods.**

**Study Site.**

The field experiments were conducted in 2009 and 2010 cropping seasons, at the Research Farm of Michael Okpara University of Agriculture, Umudike which lies within longitude $07^{0}34$' and latitude $05^{0}29$'N and is 122M above sea level (National Root Crops Research Institute Meteorological Station, Umudike). In the two years of study, South-east region had two peaks of rainfall; first peak was in May in both years, while second peak was in September and October in 2008 and 2009 respectively. Other information on the weather conditions are shown in Table 2.

**Table 2: Meteorological information for Umudike, Nigeria ( May – November) 2009 and 2010.**

| Months | Average Monthly Rainfall(mm) | Average Monthly temperature ($^{0}$C) | | Average Relative humidity (%) |
|---|---|---|---|---|
| 2009 | | Maximum | Minimum | |
| May | 396.1 | 32.4 | 23.0 | 75.0 |
| June | 237.5 | 31.5 | 22.5 | 7s7.5 |
| July | 300.9 | 29.9 | 22.3 | 82.5 |
| August | 287.4 | 29.4 | 22.4 | 83.0 |
| September | 205.3 | 30.3 | 23.0 | 79.0 |
| October | 305.3 | 30.4 | 22.5 | 77.0 |
| November | 23.7 | 32.0 | 22.2 | 66.0 |
| December | 00.0 | 34.6 | 22.4 | 60.5 |
| 2010 | | | | |
| May | 138.5 | 32.2 | 24.2 | 77.0 |
| June | 427.0 | 30.1 | 23.6 | 82.3 |
| July | 310.2 | 29.6 | 23.0 | 81.6 |
| August | 376.7 | 29.5 | 23.0 | 82.8 |
| September | 303.3 | 29.5 | 22.8 | 82.0 |
| October | 349.0 | 30.8 | 22.8 | 82.2 |
| November | 77.8 | 31.0 | 23.4 | 79.3 |
| December | 6.4 | 32.7 | 21.8 | 62.1 |

**Table 3: Physico-chemical properties of soil at the Umudikeexperimental site in 2009 and 2010.**

| **Parameter** | **2009** | **2010** | **Method of analysis** |
|---|---|---|---|
| **Type of soil: sandy- loam, ppm: part per million, A.A.S: Atomic Absorption Spectrometer.** | | | |
| Organic matter | 1.94% | 2.90% | Walkley and Black Method (1934) |
| Total N | 0.05% | 0.06% | Kjeldahl Method (1983) |
| Av.P | 0.96ppm | 11.01ppm | Flame photometric (Kjeldahl, 1983) |
| K | 0.12% | 0.13% | Oxidation (Kjeldahl, 1983) |
| Ca | 3.10(cmol/Kg) | 2.95(cmol/Kg) | A. A. S. (Kjeldahl, 1983) |
| Mg | 1.40(cmol/Kg) | 1.40(cmol/kg) | A. A. S. |
| % Sand | 81.80% | 80.11% | Hydrometer (Jackson, 1962) |
| % Silt | 6.80% | 7.60% | Hydrometer |
| % Clay | 12.20% | 12.40% | Hydrometer |
| pH ($H_2O$) | 5.26 | 5.58 | pH Meter |

The topsoil of the experimental site was sandy-loam. Soil samples were collected from the study site before planting and soil analysis was carried out at National Root Crops Research Institute, Umudike to determine the nutrient level of the soil. Nitrogen, Phosphorus, Potassium, Calcium and Magnesium were obtained using the Kjeldahl(flame photometric, oxidation and atomic absorption spectrophometer) methods (Kjeldahl, 1983), respectively. Organic matter was obtained using Walkley and Black (1934) method, while % Sand, % Silt, % Clay and pH in water were obtained using the Bouyoucos hydrometer (Jackson, 1962) and pH meter methods respectively.

**Experiment.**

Nine (9) West African okra (*A.caillei*) varieties obtained from National Center for Biotechnology (NACREB) were used in the study. They included the local and improved varieties. Local (unimproved) varietieswere OWODE and OJA-OBA4, while improved varieties were NGAE-96-O12-1, NCRI-O2,NGAE-96-0068, NGAE-96-0062, CEN-012, NGAE-96-0061, and NGAE-96-0067.The field experiments were carried out in 2009 and 2010 cropping seasons at the MichaelOkpara University of Agriculture Research Farm, Umudike. The study location has an average rainfall of 220mm per annum, and lies within longitude $07^0$34'and latitude $05^0$29'N and is 122m above sea level ( National Root Crop Research Institute Meteorological Station, Umudike).

The experiment was a randomized complete block design (RCBD) with three replications. A total of 27plots each measuring 2.25x1.50m, with a distance of 0.75m separating the plots and 1m separating the blocks was used. Each plot had 3 rows and each row was 2.25m long. The total experimental area was 21.50X8.25m or 177.38$m^2$.

In 2009 and 2010, three seeds of the okra varieties were sown 3and later thinned down to 1 per hole at a spacing .75m by .75m. Plants were thinned down to 1 per stand, 3 weeks after seed emergence, giving a total plant population of approximately 17777.78 plants per hectare. Poultry dropping was incorporated into the soil two weeks before planting at the rate of 5tons / hectare while NPK(20:10:10) was applied at the rate of 500kg\ha, four weeks after seed emergence, using ring method of application. Weeding was done manually using hoe. Karate (*Lambda-cyhadrothrin*, containing 25g of *lambda-cyhadrothrin* per liter) brand of insecticide was applied to control insect pest (*Podagricaspp*) attack, (Agunloye, 1986). Data were collected on the following attributes, plant height, number of leaves| plant, number of lateral branches |plant, number of flower | plant, number of pods | plant, length of pods | plant, weight of pods |plant, 100 seed weight and fresh pod yield |hectare was deduced.Data was analysed by one way analysis of variance using the Genstat Discovery Edition 3 for each season.

**Results and discussion.**

The weatherand soil data shown on Tables 2 and 3respectively impliedthat Umudike is conducive for okra growth and yield.Total Nitrogen and exchangeable Potassium were low while available Phosphorus was of medium level in both years. Organic matter content was low, while pH in water was slightly acidic (Table 3). Application of NPK(20:10:10) improved the Nitrogen, Potassium and Phosphorus level of the soil. The rise in Organic matter, total Nitrogen and available phosphorus in 2010 was due to the residual effects of application poultry droppings.

The results of the experiments are presented on Tables4,5, 6 and 7. The plant height varied from 108.77 to 208.93cm in 2009 and from 109.00 to 205.86cm in 2010. Ariyo(1993), Adeniji and Kehinde(2004) reported a mean plant height of 109.9 and 108.5 respectively for unimproved genotypes they used in their works. In 2009 and 2010, the varieties NGAE-96-012-1,NGAE-96-0067 and NGAE-96-0061 were significantly taller ($P<0.05$) than the other varieties (Tables 4 and 5).

**Table 4: Performance of 9 Varietiess of *A. caillei* under Umudike conditions in 2007 cropping season.**

| Plant Attribute | OWODE | NGAE-96-012-1 | NCR1-02 | NGAE-96-0068 | NGAE-96-0062 | CEN-012 | NGAE-96-0061 | NGAE-96-0067 | OJA-OBA 4 | FLSD 0.05 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 Plant height (cm) | 131.40 | 208.93 | 135.93 | 136.67 | 132.33 | 141.17 | 180.77 | 198.17 | 108.77 | 36.48 |
| 2 Number of leaves/plant | 95.33 | 155.93 | 97.33 | 98.33 | 90.93 | 101.33 | 130.33 | 143.77 | 70.67 | 21.42 |
| 3 Number of lateral branches/plant | 4.00 | 9.67 | 4.00 | 3.67 | 3.67 | 4.67 | 6.67 | 8.00 | 3.33 | 2.59 |
| 4 Number of flowers/plant | 18.67 | 24.33 | 18.67 | 19.67 | 17.33 | 19.33 | 21.00 | 21.67 | 16.83 | 3.39 |
| 5 Number of pods/plant | 12.00 | 18.10 | 11.67 | 12.17 | 10.07 | 11.67 | 13.23 | 17.07 | 9.50 | 2.87 |
| 6 Length of pods(cm) | 10.77 | 11.27 | 11.23 | 10.17 | 9.33 | 10.90 | 10.23 | 10.90 | 9.37 | 0.90 |
| 7 Weight of pods (g) | 20.57 | 22.61 | 18.40 | 18.08 | 17.43 | 20.10 | 19.70 | 21.08 | 17.31 | 1.02 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 8 I00 seed weight (g) | 9.12 | 9.46 | 8.43 | 8.22 | 7.45 | 8.43 | 7.76 | 9.21 | 6.88 | 0.47 |
| 9 Fresh pod yield (kg/ha$^{-1}$) | 4134.56 | 7123.79 | 4027.26 | 3845.04 | 3269.98 | 4142.46 | 4656.29 | 6382.84 | 2989.99 | 931.80 |

**Table 5: Performance of 9 Varieties of *A. caillei* under Umudike conditions in 2008 cropping season.**

| Plant Attribute | OWODE | NGAE-96-012-1 | NCRI-02 | NGAE-96-0068 | NGAE-96-0062 | CEN-012 | NGAE-96-0061 | NGAE-96-0067 | OJA-OBA 4 | FLSD 0.05 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Plant Height (cm) | 123.50 | 205.86 | 133.00 | 125.83 | 116.83 | 139.46 | 178.33 | 197.50 | 109.00 | 36.34 |
| 2 . Number of leaves/plant | 95.66 | 164.33 | 97.33 | 90.33 | 87.76 | 99.66 | 129.83 | 149.50 | 76.66 | 17.43 |
| 3. Number of lateral branches/plant | 4.00 | 9.00 | 4.33 | 3.66 | 3.00 | 4.33 | 6.66 | 8.00 | 3.33 | 2.49 |
| 4. Number offlowers/plant | 17.66 | 23.06 | 19.26 | 19.60 | 16.66 | 17.73 | 19.00 | 21.33 | 16.50 | 3.02 |
| 5. Number of pods/plant | 11.33 | 17.83 | 12.33 | 12.16 | 10.56 | 11.60 | 13.33 | 15.73 | 9.73 | 3.01 |
| 6. Length of pods (cm) | 11.03 | 11.23 | 11.43 | 10.33 | 8.66 | 10.63 | 10.43 | 10.43 | 8.90 | 0.75 |
| 7. Weight of pods (g) | 19.86 | 21.91 | 18.45 | 18.37 | 17.36 | 19.43 | 19.30 | 20.98 | 16.88 | 1.26 |
| 8. I00 seed weight (g) | 9.06 | 9.38 | 8.21 | 8.13 | 7.52 | 8.25 | 8.26 | 9.08 | 7.34 | 0.59 |
| 9.Fresh pod yield (kgha$^{-1}$) | 4195.55 | 7052.98 | 3809.77 | 3765.51 | 2330.51 | 3928.76 | 4532.33 | 6163.50 | 2835.26 | 1024.36 |

In both years, plant height had strong, positive and highly significant association (P<0.01) with fresh pod fresh yield and other agronomic characters except pod length (Tables 6 and 7). Brown (1989) reported that plant height is closely correlated with flowering, fruit perimeter and structure in *A. esculentus* (L) Moench. He used the correlation coefficients to pick the high yielding varieties. In this study, positive and high correlation coefficients of 0.924 and 0.926 (P<0.01) in 2009 and 2010 respectively between plant height and fresh pod yield/ hectare were obtained, (Table 6 and 7). The finding from this work showed that fresh pod yield of the varieties was affected by plant height (Table 4, 5,6and7). Moniruzzaman*et al*. (2007) in Bangladesh reported that plant height had significant effect on fresh pod yield/hectare.

The number of leaves/ plant varied from 70.67 to 155.93 and from 76.66 to 164.33 in 2007 and 2008 respectively. The varieties NGAE-96-012-1 and NGAE-96-0067 produced largest number of leaves which in each year differed significantly (P<0.05) from those produced by the other varieties. Number of leaves/plant also associated positively, strongly and significantly (P<0.05) with fresh pod yield (Tables 6 and 7). It was observed that NGAE-96-012-1 and NGAE-96-006 produced fresh pod yields/hectare that were significantly higher than those of other varieties in both years(Tables 6 and 7).

Number of lateral branches / plant varied from 3.30 to 9.67 and from 3.00 and 9.00 in 2007 and 2008 respectively. The varieties differed significantly(P<0.05) with respect to lateral branching, (Tables 4 and5). Adeniji and Aramu (2007) and Chinatu and Okocha (2006) reported that branching had significant effect on fresh pod yield of*A. caile*i and*A.esculentus* respectively. The findings from this work also *A.caillei* varieties studied (Table 4 and 5).

Vegetative characters (plant height, number of leaves and number of lateral branches) according to Oseni 1994, Ajibade and Morakinyo (2000) and Okocha and Chinatu (2008),determine the amount of photosynthates available to plants forgrowth and fresh pod yield. Tenebe*et al.*, (1995) had reported that growth parameters (plant height, number of leaves and number of lateral branches) are strong yield parameters. Adeniji and Aremu (2007) reported that the proportion ofthe photosynthates allocated to the reproductive parts during flowering and fruit set go a long way to determine the number of pods, weight of pods, number of seeds and weight of seeds of okra varieties. The findings from this work is that the varieties with better vegetative (plant height, number of leaves and lateral branches) growth recorded higher fresh pod yield,(Table 4, 5, 6 and 7).

**Table 6: Linear correlation matrix between eight agronomic characters and fresh pod yield of nine varieties of *A.caillei*(okra)under Umudike conditions in 2009 cropping season.**

| | PH | NL | NLB | NF | NP | PL | WP | SW | FPY |
|---|---|---|---|---|---|---|---|---|---|
| **PH** | 1.000 | 0.956** | 0.925** | 0.927** | 0.956** | 0.291 | 0.638** | 0.587** | 0.924** |
| **NL** | | 1.000 | 0.925** | 0.901** | 0.928** | 0.350 | 0.716** | 0.640** | 0.923** |
| **NLB** | | | 1.000 | 0.901** | 0.919** | 0.246 | 0.696** | 0.572** | 0.919** |
| **NF** | | | | 1.000 | 0.947** | 0.176 | 0.597** | 0.514* | 0.891** |
| **NP** | | | | | 1.000 | 0.258 | 0.645** | 0.600** | 0.957** |
| **LP** | | | | | | 1.000 | 0.652** | 0.716** | 0.345 |
| **WP** | | | | | | | 1.000 | 0.779** | 0.768** |
| **SW** | | | | | | | | 1.000 | 0.691** |
| **FPY** | | | | | | | | | 1.000 |

[xx] Implies highly significant difference ($p<0.01$) [x] Implies significant difference ($p<0.05$)
Symbol : Connotation
PH = Plant height, LP = Length of pod, NP = Number of pods/ plant, NLB = Number of lateral branches/plant
NL = Number of leaves/plant WP = Weight of pods, NF = Number of flowers/ plant, FPY = Fresh pod yield

**Table 7: Linear correlation matrix between eight agronomic characters and fresh pod yield of nine varieties of *A. caillei (*okra) under Umudike conditions in 2010 cropping season.**

| | PH | NL | NLB | NF | NP | PL | WP | SW | FPY |
|---|---|---|---|---|---|---|---|---|---|
| **PH** | 1.000 | 0.963** | 0.963** | 0.855** | 0.949** | 0.367 | 0.707** | 0.616** | 0.926** |
| **NL** | | 1.000 | 0.947** | 0.813** | 0.818** | 0.356 | 0.786** | 0.705** | 0.951** |
| **NLB** | | | 1.000 | 0.867** | 0.935** | 0.349 | 0.738** | 0.667** | 0.946** |
| **NF** | | | | 1.000 | 0.941** | 0.304 | 0.555* | 0.512* | 0.846** |
| **NP** | | | | | 1.000 | 0.310 | 0.671** | 0.577** | 0.944** |
| **LP** | | | | | | 1.000 | 0.626** | 0.673** | 0.322 |
| **WP** | | | | | | | 1.000 | 0.935** | 0.800** |
| **SW** | | | | | | | | 1.000 | 0.697** |
| **FPY** | | | | | | | | | 1.000 |

[xx] Implies highly significant difference ($p<0.01$) [x] Implies significant difference ($p<0.05$)
Symbol : Connotation
PH = Plant height, LP = Length of pod, NP = Number of pods/ plant, NLB = Number of lateral branches/plant
NL = Number of leaves/plant WP = Weight of pods, NF = Number of flowers/ plant, FPY = Fresh pod yield

The results for the number of flowers / plant and number of pods /plant are presented on Table (4 and 5). The varieties differed significantly ($P<0.05$) with respect to each character in 2009 and 2010.Number of pods/ plant varied from 9.50 to 18.10 and from 9.73 to 17.83 in 2009 and 2010 respectively, (Tables 4 and 5).Kehinde, (1999) reported an average of 8 to15 pods/ plant on 6 lines of *A.caillei* at Abeokuta, while Okocha and Chinatu(2008) reported an average of 5-9 pods /plant on *A.esculentus* at Umudike . These show that *A.caillei* rate of production is much higher than that of *A. esculentus*. In both years the varieties NGAE-96-012-1 and NGAE-96-0067 produced fresh pod yield /hectare that were significantly ($P<0.05$) higher than yield of other varieties. Number of pods /plant also had positive strong and significant ($P<0.05$) associating with fresh pod yield in 2009 and 2010 (Table 6 and 7). This also agreed with the works of Katung(2007) and Abdelmageed (2010) who reported that number of pods/ plant influenced fresh pod and seed yield / hectare of okra more than other individual reproductive characters studied.

The results of length of pod, dry pod weight and 100 seed weight are presented on Table 4 and 5. The varieties differed significantly ($P<0.05$) with respect to each character (length of pod, pod weight and 100 seed weight) in each year (Tables 4 and 5). Pod weight and 100 seed-weight associated positively, strongly and significantly ($P<0.05$) with fresh pod yield/ hectare. Length of pod associated weakly and non significantly( $P<0.05$) with fresh pod yield / hectare in each year.

Akorod*a et al.*(1987) reported that length of pod is significantly a distinctive feature due to its contribution to yield that it could serve as the basis of classification of okra genotypes of *A. esculentus*. The findings from this work did not agree with their

report, since length of pod did not influence significantly (P> 0.5) fresh pod yield of the *A. caillei*varieties used in this study and cannot serve as a distinctive feature among West African okra varieties. Weight of fresh pod and weight of seeds influenced fresh pod yield significantly (Tables 4, 5, 6 and 7).

The varieties also differed significantly (P<0.5) with respect to fresh pod yield/ hectare. Fresh pod yield also correlated positively and significantly with vegetative and reproductive characters with the exception of length of pod. Robinson (1974) and Usman (2001) reported that seeds which store enough food in their cotyledons start off very, and if other conditions are not limiting in the environment will shoot them ahead till harvest. This implied that the food reserve of the varieties NGAE-96-012-1; NGAE-96-0067 and NGAE-96-0061in both 2009 and 2010 empowered them for early good start; hence, they had highest vegetative performance. The higher volume of assimilates produced due to higher photosynthetic and absorptive capacities of these varieties led to higher reproductive performance which resulted to high fresh pod yield/ hectare.

**Conclusion.**

The improved varieties (NGAE-96-012-1 and NGAE-96-0067) performed better than local varieties (OWODW and OJA-OBA 4) in both cropping seasons. It is recommended that NGAE-96-012-1, NGAE-96-0067 and NGAE-96-0061 be released to farmers in Umudike for improved okra (*A. caillei*) fresh pod production.

**References**


Abdelmageed, A. H.A., 2010. Mode of Inheritance of pod spines in okra, (A. esculentus. (L) Moench). Tropical and Sub-tropical Agroecosystem.12; 405-409. (USDA) New Orleans

Adeniji, O.T. 2003. Inheritance studies in West African okra (*A. caillei*). M. Agric. Thesis. University of Agriculture. Abeokuta, Nigeria, 98p

Adeniji, O.T andAremu, C.O.2007. Interrelationships among characters and path analysis for pod yield components in West African Okra (Abelmoschuscaillei(A.Chev) Stev). J. Agron. 6(1) 162-166. http//dx.doi.org/10.3923/ja.2007.162.166 ..

Adeniji, O.T. and Kehinde, O.B. 2004. Diallel analysis of earliness in West African Okra. J. Gen. Belg. 58: 191-195

Adeniji, O.T., Kehinde, O.B., Ajala, M.O. and Adebisi M.A. 2007. Genetic studies on seed. Agric and Food Chem..28:1163-1166

Agunloye,O. 1986.Effects of Cypermetrin on the population of *Podagricauniforma* and *Podagricasjostedi* on the yield of okra. Tropical pest management32(1)Pp55-56.

Ajibade, S.R. and Moraking, J.A. 2000. Heritability and correlation studies in cowpea,(*Vignaunguiculata*(L) Walp. Nigeria J.Genet 15 (2000): 29-33.

Akoroda, M.O., Alice, P.O., Atiri, G.I, and Babatola, J.O. 1987. Diversity in 265 Accessions of okrafrom 12 countries . NIHORT, Ibadan p5.

Ariyo, D. J. 1993. Genetic diversity in West African Okra (*A. caillei*), Multivariate analysis of morphological and agronomic characteristics.Genet. Res. and crop Evolution 40:25-32.

Brown, F.1989. The use of plant genetic resources. USA. Cambridge University Press, pp174-195.

Chinatu, L.N.andOkocha, P. I.2006. Prospects of increased fresh pod production in cowpea. V*ignaunguiculata (*L) Walp. J. of Agric. Research. 11:43-47.

Jackson, M. L. 1962. Soil chemical and particle size analysis: Prentice Hall, Ince. Eagle wood cliffs 10p.

Kjeldahl, J. 1983. The Kjeldahl determine of Nitrogen: retrospect and prospect. Trends in Analytical Chemistry, Vol.13, No. 4,138p

Katung,M.D. 2007. Productivity of okra varieties as influenced by seasonal changes in Northern Nigeria. Not. Bot.Hort. Agrobat. 35(1):65-71.

Kehinda, O.B.1999. Floral Biology of West African okra Nig. J. of Genetics.14:14-17.

Kehinde , O.B .2001. Crossability studies in the Genus Abelmoschus.Nig. Journal of Horticultural Sci.Vol.5 Pp 37-42.

Kumar, S.; Sokona, D; Adamou, H; Alain, R; Dov, P and Christophe, K 2010. Okra (*Abelmoschus spp.*) in West and Central Africa: potential and progress on its

improvement. African Journal of Agricultural Research Vol.5 (25), pp.3590-3598.

Martin, F.W. and Ruberte, R. 1978. Vegetables for humid Tropics. Part 2 okra, (*Abelmoschusesculentus*). Sciences and Education Administration, United States department of Agriculture 160.

Moniruzzaman, M., Uddin, M.Z., and Choudhury, A.K.2007. *Response of okra seed crop to Morphological and Agronomic characteristics. Genetic Resource and crop Evolution 40: 25-32.*

*Okocha, P.I.andChinatu, L.N. 2008. Evaluation of okra cultivars and breeding lines for Agronomic traits South-eastern Nigeria. Global J. of Agric. Sciences,Vol 7.No1: pp11-16*

*Oseni, T.O.1994. Correlation* and path- coefficient analysis of height component on grain yield in cowpea. V*ignaunguiculata (*L) Walp. Samaru. J. of Agric. Research. 11:43-47

Oyelu ,C. 2002. Variability in photoperiodic response of okra (*Hibiscus esculentus* L.) ActaHorticulture 52: 207-215.

Robinson, R.C.1974. Sunflower performance relative to size and weight of achenes planted. Crop Sci. 14:61-68.

Savello, P.A., Martin, F.W. and Hill. J.M. 1980. Nutritional composition of okra seed meal. J. Agric and Food Chem.28:1163-1166

Siemonsma, J.S.1982. West African okra; Morphological and Cytological indications for the existence of a natural amphidiploids of *Aesculentus* L. Moench and *A. manihot L*. Medikus. Euphytica 31:240-242.

Siungh, H.B. and Bhatnagar, A.1975. Chromosomes number of okra from Ghana. Indian J. Genet. Plant Breed. 36: 24-27 Southeastern Nigeria. J. of Sust. Trop. Agric. Research.Vol.17: 66-7152: 207-215. sowing time and plant spacing in south eastern hilly region of Bangladash. Bangaladash journal of Agriculture, Research 32(3):393-402.

Tenebe, V.A., Yusuf, Y., Kaiagama, B.K. and Asenime I.E.O. 1995. The effect of source and level of phosphorus on the growth and yield of cowpea, (*Vignaunguiculata*(L.) Walp) varietiesTropical sci. 35:223-228.

Thamburaj, S. 1972. Response of okra, (*Abelmoschusesculentus,* (L.) Moench) to Thermo and Photoperiods. Madras Agric. Journal 59(6):339-346.

Tindall,H.D.1983.Vegetables in the Tropics,1st edition, Macmillian publishers, Hong Kong, Pp325-327.

Usman, S.D. 2001. Seed production and quality of okra affected by sowing time. Seed Research 29(1): 47-51.

Walkley, A. and Black 1934. A critical Examination of a Rapid method for determination of organic Carbon in Soils-Effect of variations indigestion conditions and inorganic soil constituents. Soil Sci.37:29-37.

Yamaguchi, M., 1983. World Vegetables. Principles and Nutritive values. The Avi publishing company Inc, West port Connecticut, PP 368-377.yield of West African okra (*A. caillei* (A.Chev) Stevel). Journal of Trop. Agric45(1-2):36-41.