Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.4, No.13, 2014

Effects of Sowing Dates and Genotypes on Vegetative, Reproductive Traits and Fresh Pod Yield of West African Okra (*Abelmoschus caillei* (A.Chev) Stevels in Southeastern Nigeria

Lawrence Chinatu*, Peter Okocha and Mathias Eka
Department of Agronomy, College of Crop and Soil Sciences, Michael Okpara University of Agriculture, Umudike. P.M.B. 7267, Abia State, Nigeria
*Email: lawrencechinatu@yahoo.com

Abstract
The effects of genotypes and sowing dates on vegetative character, reproductive characters and fresh pod yield/ hectare of okra (*A. caillei*) were evaluated at the Research Farm of Michael Okpara University of Agriculture Umudike in 2009 and 2010 cropping seasons. The field experiment was laid out in split-plot in a randomized complete block design replicated 3 times, with sowing dates (May, June, July and August) as main plots and genotypes (OWODE, NGAE-96-012-1, CEN-012, NCRI-02 and NGAE-96-0067) as sub-plots making a total of twenty treatments combinations. At maturity, data were taken on vegetative (plant-height, number of leaves/plant and number of lateral branches/ plant) and reproductive characters (number of flowers/plant, number of pods/ plant, length of pods, weight of pods) as well as fresh pod yield/ hectare. The genotypes NGAE-96-012-1 and NGAE-96-0067 performed significantly higher (P <0.01) than others in vegetative character, reproductive character and fresh pod yield/hectare of 7361.17 and 6779.93Kg/ha in 2009 and 7511.35 and 6737.28Kg/ha in 2010 respectively. The vegetative characters, reproductive characters and fresh pod yield/hectare of crops sown in May were significantly higher (P<0.01) than those sown in later months. May sowing date fresh pod yield/ hectare was significantly higher than the yield of the June, July, and August sowings by 30.41; 87.08 and 125.71% in 2009 and 30.26; 66.38 and 115.54 in 2010 cropping seasons. The drastic reduction in yield associated with delayed sowing by one month is due to photoperiod sensitivity of *A.caillei*, since, irrespective of sowing date the genotypes flowered almost the same week. Interaction between variety and sowing date was also highly significant (P<0.01). LSD was used to separate the means. NGAE-96-012-1 and NGAE-96-0067 sown in May performed significantly higher (P< 0.01) than other genotypes vegetatively, reproductively and in fresh pod yield in 2009 and 2010. NGAE-96-012-1 and NGAE-96-0067 could be released to farmers in Umudike to plant in May to boost fresh pod production and enhance welfare of farmers in Southeastern Nigeria after they have been released as varieties.

1.0 Introduction.

West African okra (*Abelmoschus caillei* (A.Chev) Stevels, belongs to the family *Malvacease* and is an important vegetable crop of tropical and subtropical world (Ariyo, 1993 and Kehinde 1999). It is a short day plant generally with green stem, (Ariyo, 1993 and Adeniji*et al.* 2007), with slight traces of red colour (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 type (*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 type (Kehinde, 1999). 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*. It has been stated that *A.caillei* has the potential for industrial, nutritional and biomedical purposes in the developing countries, but is under-utilized in the Sub-saharan Africa (Adeniji *et al.* 2007).

Different crops have different sowing dates that will produce optimum yields under favourable climatic conditions (Van Rheenen, 1979). According to Weiss (1971) environmental influences, especially rain determines the extent to which the genetic potential of a variety is expressed or suppressed. The adverse impact of the environment is expected to increase as planting is delayed beyond the optimum time (Adeyemo and Ogunwolu, 1996). As at the time of this report, data on time of planting of *A. caillei* in Southeastern Nigeria is scarce if not unavailable. The number of months *A. caillei* takes to complete its life cycle (at least 8 months, Kehinde, (2001) at some areas in Southeastern Nigeria militate against increase in its cultivation especially areas that people do not use it in any form of staking.

It is reported that okra contains moderate levels of some essential minerals and vitamins which are important for body metabolic processes that utilize carbohydrates, proteins and fats (Tindall, 1983, Siemonsma and Kouame, 2004). 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).The fruit can be dried and stored or milled into powder and used as flavoring agent,(Tindall, 1983, Kumar *et al*. 2010).The young shoots and leaves are eaten or used as herbs. The foliage can act as source of fodder for livestock. The seed of okra has been simply demonstrated as potential high oil and oil protein crop for the temperate zone and tropics. Okra seed contains protein, lipids and ash (Savello *et al*.1980) .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 of hyperlipidemia. Fortunately okra along with eggplant is considered by medical experts as the most important vegetable sources of viscous fiber (Usman, 2001, FAOSTAT, 2008).

In Umudike, indigenous okra varieties are predominantly cultivated by the local farmer and due to high yield and hardiness of the indigenous varieties, they have become the major source of okra pods in Nigeria and their cultivation is progressively replacing the conventional type(*A. esculentus* (L) Moench (Kehinde, 1999). This study sought to identify and select high yielding genotypes for subsequent introduction to the existing local types to enhance okra fresh pod production in Southeastern Nigeria. The effect of date of planting on fresh pod yield, vegetative and reproductive characters will provide ample information on when best to plant *A. caillei*.

1.1 Materials and Methods.

Study Site. The field experiments were conducted during the 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 Crop Research Institute Meteorological Station, Umudike). Umudike had two peaks of rainfall. First peak occurred in May in both years, while second peak was in September and

October in 2009 and 2010 respectively. Other information on the environment are shown on Table 1.

Table 1: Meteorological information for Umudike, Nigeria (May – November) 2009 and 2010

Months	Average monthly Rainfall (mm)	Average Temperature	Monthly (^{0}C)	Average Relative Humidity (%)	Solar Radiation (hr)
2009		Minimum	Maximum		
May	306.1	32.4	23.0	78.9	4.6
June	237.5	31.5	22.5	84.0	3.2
July	300.9	29.9	22.3	87.3	1.9
August	287.4	29.4	22.4	87.6	2.8
September	205.3	30.3	24.0	85.3	1.5
October	305.3	30.4	22.5	82.3	3.8
November	23.7	32.0	22.2	75.0	5.1
December	0.0	32.0	22.0	52.0	5.6
2010					
May	138.5	32.2	24.2	70.3	3.6
June	427.0	30.1	23.6	78.3	3.7
July	310.2	29.6	23.0	76.8	2.2
August	376.7	29.5	23.0	77.8	2.5
September	303.0	29.5	22.8	75.6	3.1
October	349.0	30.8	22.8	78.0	3.9
November	77.8	31.0	23.0	70.6	4.2
December	8.9	33.0	22.0	58.5	5.3

National Root Crop Research Institute Meteorological Station, Umudike.

The top soil of the experimental site was sandy-loam. Soil samples collected from the study site before planting were analyzed at Soil Science laboratory, National Root Crop Research Institute, Umudike, Abia State, Nigeria, 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, while organic matter was obtained using Walkley-Black method (Walkley and Black, 1934), % sand, % silt, % clay and pH in water were obtained using the Bouyoucos hydrometer (Jackson,1962) and pH meter methods, respectively.

Table 2: Physico-Chemical properties of soil at the Umudike (South-east) experimental site in 2009 and 2010 .

Parameter	Soil analytical data 2009	2010	Method of analysis
Organic matter	1.94%	2.90%	Walkley- Black method (1947)
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

Type of soil: sandy- loam, ppm : part per million, A.A.S: Atomic Absorption Spectrometer.

1.1.1 Experiment.

Five (5) West African okra (*A.caillei*) genotypes obtained from National Center for Biotechnology (NACREB) Ibadan, Nigeria, were used. The experiment was a split-plot laid out in a Randomized Complete Block Design (RCBD) with sowing date as the main plot and varieties as the sub plot treatments. The main plot was four (4) planting dates (May, June, July and August), while the sub plot treatment was five (5) varieties;OWODE, NGAE-96-012-1; CEN-012; NCRI-02; and NGAE-96-0067. Altogether, there were twenty treatment combinations, which were randomly allocated to each plot in three blocks.

The seeds of the okra genotypes were planted three (3) per hole and later thinned down to one (1) at two weeks after planting (2WAP). A spacing of 0.75M by 0.75M within and between rows was used; giving a population density of 17,777.78 plants/ hectare. Organic manure (poultry dropping) was incorporated into the soil 2weeks before planting, at the rate of 5tons/ hectare (Ayola and Adeniyan, 2006).Compound fertilizer (N: P: K, 15: 10: 10) was used to top dress towards flowering at the rate of 500 Kilograms per hectare. Weeding was done manually. Karate (*Larmda- cyhadrothrin*) brand of insecticide was applied at the rate of 800ml/ha to control insect pests (*Podagricas pp*). Data was collected on plant height, number of leaves/plant, number of lateral branches/ plant, number of flowers/plant, number of pods, length of pods, weight of pods and fresh pod yield/ hectare. Data was analyzed following the procedure outlined by Obi (2001) for split-plot laid out in Randomized Complete Block Design. Comparison of treatment means and significant differences between treatment means were separated using Fisher's least significant difference (LSD) as outlined by Gomez and Gomez (1984).Genstat Discovery Edition 3 was used for the analyses of data.

1.1.2 RESULTS AND DISCUSSION

A. caillei genotypes and sowing dates significantly ($p < 0.001$) affected plant height in 2009 and 2010,as expressed by Fisher's least significant difference (FLSD) which was used in separating the means, (Table 3). Delaying sowing by one month resulted in significant ($p<0.001$) decrease in height of the genotypes in each year. The May sowing date gave plants which were significantly taller than the plants of June, July and August sowings by 36.92, 78.05 and 120.03% respectively in 2009. Similar trend was observed in 2010 (Table3). In both years, interactions between genotypes and sowing dates were significant ($p<0.05$). NGAE-96-012-1 with May sowing date produced the tallest plants, (Table 3). NGAE-96-012-1and NGAE-96-0067 were significantly taller than other genotypes.

Table 3: Effect of *Abelmoschus caillei* (okra) Genotypes and Sowing Dates on Plant height in 2009 and 2010 cropping seasons.

	2009					2010				
	Plant Height					Plant Height				
Okra Genotypes	Dates				Genotypes Means	Dates				Genotypes Means
	May	June	July	August		May	June	July	August	
CEN-012	128.33	90.98	71.41	64.37	88.77	131.27	94.70	77.83	67.9	92.93
NGAE-96-012-1	197.73	138.17	108.10	88.17	133.04	203.83	149.12	119.56	97.58	142.52
OWODE	137.07	103.60	76.97	63.87	95.38	137.98	108.53	94.00	78.97	104.87
NGAE-96-0061	160.07	120.73	91.10	67.87	109.94	168.37	122.50	99.07	82.57	118.13
NGAE-96-0067	179.47	132.70	103.20	80.50	123.97	189.90	145.56	119.23	97.03	137.93
Dates means	160.53	117.24	90.16	72.96	110.22	166.27	124.08	101.93	84.81	119.27

2009
LSD 0.05 Genotypes = 11.330
LSD 0.05 Dates = 10.130
LSD 0.05 Genotypes x Dates = 22.650

2010
LSD 0.05 Genotypes = 9.070
LSD 0.05 Dates = 8.120
LSD 0.05 Genotypes x Dates = 18.150

A.caillei genotypes and sowing date significantly ($p<0.001$) affected number of leaves/ plant in 2009 and 2010 (Table 4). NGAE-96-012-1 produced significantly higher number of leaves/plant than other genotypes except NGAE-96-0067. Delaying sowing by a month resulted in significant reduction in number of leaves/ plant in each year. In 2009, the May sowing date which had the highest number of leaves/ plant, was significantly higher than the June, July and August sowings by 30.71, 82.27 and 126.13% respectively. In 2010, the same trend was observed (Table 4). In 2009 and 2010, the interactions between genotypes and sowing dates were significantly different ($P< 0.5$). In both years, the genotypes NGAE-96-012-1 and NGAE-96-0067 with March sowing date produced significantly higher number of leaves/ plant than other genotypes.

Table 4: Effect of *Abelmoschus caillei* (okra) Genotypes and Sowing Dates on Number of Leaves /plant in 2009 and 2010 cropping seasons.

	2009					2010				
	Number of leaves/plant					Number of leaves/plant				
Okra Genotypes	Dates				Genotypes Means	Dates				Genotypes Means
	May	June	July	August		May	June	July	August	
CEN-012	96.06	74.83	49.10	46.00	66.50	99.15	80.15	50.22	47.67	69.30
NGAE-96 -012-1	152.13	108.00	80.03	70.17	102.58	159.03	125.30	88.87	74.60	111.95
OWODE	102.50	83.77	54.67	46.33	71.82	103.42	85.33	71.43	58.36	79.64
NGAE-96-0061	123.60	100.35	67.33	50.60	85.47	126.03	103.35	76.00	62.03	91.85
NGAE-96-0067	143.70	105.87	78.87	60.20	97.16	149.30	119.37	86.52	78.85	108.51
Dates Means	123.60	94.56	66.00	54.66	84.71	127.39	102.70	74.61	64.30	92.25

2009
LSD 0.05 Genotypes = 8.400
LSD 0.05 Dates = 7.510
LSD 0.05 Genotypes x Dates =16.800

2010
LSD 0.05 Genotypes = 5.661
LSD 0.05 Dates = 5.064
LSD 0.05 Genotypes x Dates = 11.322

Genotypes and sowing dates also significantly affected ($p<0.001$) number of lateral branches/ plant in both years (Table 5). In both years, NGAE-96-012-1 and NGAE-96-0067 had more branches than the other genotypes. Delaying sowing by one month also led to significant ($p<0.001$) decrease in number of lateral branches by each genotype. In 2009, May sowing date which had the highest number of lateral branches /plant, was significantly higher than the June, July and August sowings by 53.25, 120.83, 150.39%. The same trend was observed in 2010 (Table 5). In both years, interactions between genotype and sowing date were significant, with the highest number of lateral branches/ plant produced by the genotype NGAE-96-012-1 in May sowing date.

Table 5: Effect of *Abelmoschus caillei* (okra) Genotypes and Sowing Dates on Number of Lateral Branches / plant in 2009 and 2010 cropping seasons.

	2009					2010				
	Number of Lateral Branches per plant					Number of Lateral Branches per plant				
Okra Genotypes	Dates				Genotypes Means	Dates				Genotypes Means
	May	June	July	August		May	June	July	August	
CEN-012	4.17	3.08	2.00	1.97	2.81	4.63	2.83	2.13	2.13	2.93
NGAE-96-012-1	8.80	5.10	3.87	3.30	5.27	10.07	5.40	4.50	3.67	5.91
OWODE	4.57	3.30	2.2	2.10	3.04	5.03	3.40	3.30	2.70	3.61
NGAE-96-0061	5.97	4.33	2.83	2.37	3.88	7.80	4.33	3.72	2.90	4.69
NGAE-96-0067	8.27	4.93	3.50	2.97	4.92	9.23	5.07	4.37	3.57	5.56
Dates Means	6.36	4.15	2.88	2.54	3.98	7.35	4.21	3.60	2.99	4.54

2009	2010
LSD 0.05 Genotypes = 0.787	**LSD 0.05 Genotypes = 0.541**
LSD 0.05 Dates = 0.704	**LSD 0.05 Dates = 0.483**
LSD 0.05 Genotypes x Dates = 1.574	**LSD 0.05 Genotypes x Date = 1.081**

The number of flowers/plant was influenced significantly ($p < 0.001$) by genotypes and sowing dates in both years (Table 6). NGAE-96-012-1 bore significantly higher number of flowers/plant ($p<0.001$) than other genotypes. In both years, May sowing dates number of flowers was significantly ($P< 0.01$) higher than those of other sowing dates. In 2009, the May sowing dates produced the highest number of flowers /plant which was significantly higher than the June, July and August sowing dates by 30.10, 47.57 and 73.35% respectively (Table 6). In 2010, the same trend was observed. In both years, interaction between genotypes and sowing dates was significant, with $P \leq 0.014$ and $P < 0.001$ in 2009 and 2010 respectively. Highest number of flowers was produced by the genotypes NGAE-96-012-1 in May sowing dates in both cropping seasons (Table 6).

In 2009, NGAE-96-012-1 and NGAE-96-0067 bore significantly ($P<0.01$) higher number of pods/plant than the number of pods produced by other genotypes, (Table 7). In both years, May sowing date produced the highest number of pods which were significantly ($P<0.001$) different from number of pods produced by other dates. In 2009, the May sowing date also produced the highest number of pods/ plant which was significantly higher than the June, July and August sowing dates by 18.65, 44.33 and 80.33% respectively. In both years, interaction between genotypes and sowing dates was significant ($P<0.01$). The highest number of pods/ plant was produced in May sowing date by the genotypes NGAE-96-012-1 and NGAE-96-0067 in 2009; while in 2010, May sowing date,

Table 6: Effect of *Abelmoschus caillei* (okra) Genotypes and Sowing Dates on Number of Flowers / plant in 2009 and 2010 cropping seasons.

	2009					2010				
	Number of Flowers/ plant					Number of Flowers/ plant				
Okra Genotypes	Dates				Genotypes Means	Dates				Genotypes Means
	May	June	July	August		May	June	July	August	
CEN-012	17.17	15.00	13.38	11.40	14.24	18.55	15.28	13.78	12.29	14.98
NGAE-96-012-1	26.28	18.12	15.75	13.37	18.38	25.98	20.60	17.33	14.90	19.70
OWODE	18.80	15.17	13.35	11.70	14.75	20.23	17.63	14.79	13.47	16.53
NGAE-96-0061	21.83	16.82	14.76	12.41	16.46	20.22	18.40	16.18	14.10	17.22
NGE-96-0067	23.57	17.65	15.70	13.20	17.53	21.25	19.44	17.00	14.73	18.11
Dates Means	21.53	16.55	14.59	12.42	16.27	21.25	18.27	15.82	13.90	17.31

2009
LSD 0.05 Genotypes = 1.273
LSD 0.05 Dates = 1.139
LSD 0.05 Genotypes x Dates = 2.547

2010
LSD 0.05 Genotypes = 0.674
LSD 0.05 Dates = 0.603
LSD 0.05 Genotypes x Dates = 1.347

NGAE-96-012-1 recorded the highest pod yield/ plant, (Table7).

Table 7: Effect of *Abelmoschus caillei* (okra) Genotypes and Sowing Dates on Number of Pods / plant in 2009 and 2010 cropping seasons.

	2009					2010				
	Number of Pods					Number of Pods				
Okra Genotypes	Dates				Genotypes Means	Dates				Genotypes Means
	May	June	July	August		May	June	July	August	
CEN-012	11.96	10.32	7.03	6.67	9.00	12.90	10.74	8.87	7.25	9.94
NGAE-96-012-1	18.45	14.63	9.63	8.15	12.72	18.77	15.57	12.71	9.57	14.16
OWODE	13.48	10.68	7.87	6.97	9.75	13.53	11.76	9.42	8.03	10.69
NGAE-96-0061	13.73	12.02	8.78	7.55	10.52	14.53	12.44	10.70	8.55	11.56
NGAE-96-0067	17.53	14.28	9.62	8.32	12.44	17.25	14.43	11.67	9.32	13.18
Dates Means	15.03	12.39	8.59	7.53	10.89	15.40	12.99	10.67	8.54	11.91

2009
LSD 0.05 Genotypes = 0.921
LSD 0.05 Dates = 0.824
LSD 0.05 Genotypes x dates = 1.842

2010
LSD 0.05 Genotypes = 0.477
LSD 0.05 Dates = 0.427
LSD 0.05 Genotypes x Dates = 0.956

The pod length was significantly ($P<0.001$) affected by genotypes and sowing dates in both years (Table 8). In both years, NGAE -96-012-1 pods were significantly longer than the pods of other genotypes. In 2009, May sowing dates bore pods which were significantly longer than pods from June, July and August sowing dates by 9.12, 14.81 and 17.38% respectively. In 2010 a similar trend was observed. The longest pods were recorded for the NGAE-96-0067 in the May sowing date for both years.

Pod weight was affected significantly ($P<0.001$) by genotypes and sowing dates in 2009 and 2010. LSD was used to separate the varietal and sowing dates means (Table 9). The genotype NGAE-96-012-1 yielded pods that were significantly heavier than pods from others. May sowing date yielded pods, which were significantly heavier than pods from the June, July and August sowing dates by 6.78; 10.63; 14.66% respectively in 2009. In 2010, similar trends were observed. Interactions between variety and sowing date were significant ($P<0.001$) in both years. LSD was also used to separate the means, (Table 9). The heaviest pods/plant was recorded for the genotype NGAE-96-012-1 in May sowing dates in both years.

Table 8: Effect of *Abelmoschus caillei* (okra) Genotypes and Sowing Dates on Pod- length in 2009 and 2010 cropping seasons.

	2009					2010				
	Pod- length					Pod - length				
Okra Genotypes	Dates				Genotypes Means	Dates				Genotypes Means
	May	June	July	August		May	June	July	August	
CEN-012	10.90	9.93	8.67	8.73	9.56	11.13	10.52	9.87	9.78	10.33
NGAE-96-012-1	11.97	11.43	10.40	10.10	10.98	11.82	11.28	11.10	10.60	11.20
OWODE	10.27	9.83	8.93	8.83	9.47	10.10	10.03	9.77	9.53	9.86
NGAE-96-0061	9.83	10.10	9.93	9.50	9.84	10.33	10.59	9.80	9.27	10.00
NGAE-96-0067	12.07	9.17	10.00	9.75	10.25	11.98	11.39	10.45	10.07	10.97
Dates Means	11.01	10.09	9.59	9.38	10.02	11.07	10.76	10.20	9.85	10.47

2009		2010	
LSD 0.05 Genotypes	**= 0.362**	**LSD 0.05 Genotypes**	**= 0.226**
LSD 0.05 Dates	**= 0.323**	**LSD 0.05 Dates**	**= 0.202**
LSD 0.05 Genotypes x dates	**= 0.723**	**LSD 0.05 Genotypes x dates**	**= 0.453**

Table 9: Effect of *Abelmoschus caillei* (okra) Genotypes and Sowing Dates on Pod -weight in 2009 and 2010 cropping seasons.

	2009					2010				
	Pod- weight (g)					Pod- weight (g)				
Okra Genotypes	Dates				Genotypes Means	Dates				Genotypes Means
	May	June	July	August		May	June	July	August	
CEN-012	21.59	20.30	19.65	18.02	19.89	21.94	20.43	19.29	17.61	19.82
NGAE-96-012-1	22.68	20.91	20.33	19.74	20.92	22.55	20.87	19.95	19.28	20.66
OWODE	21.94	20.35	20.07	19.66	20.51	22.26	29.69	18.58	18.32	19.71
NGAE-96-0061	22.29	20.87	19.90	19.23	20.58	22.54	20.25	19.23	19.01	20.26
NGAE-96-0067	21.80	20.86	19.73	19.54	20.48	22.06	20.05	19.13	18.67	19.98
Dates Means	22.06	20.66	19.24	19.24	20.46	22.27	20.26	19.24	18.58	20.09

2009		2010	
LSD 0.05 Genotypes	**= 0.336**	**LSD 0.05 Genotypes**	**= 0.241**
LSD 0.05 Dates	**= 0.300**	**LSD 0.05 Dates**	**= 0.215**
LSD 0.05 Genotypes x Dates	**= 0.671**	**LSD 0.05 Genotypes x Dates**	**= 0.481**

Fresh pod yield/ hectare was affected significantly ($P<0.001$) by genotypes and sowing dates in both years. LSD was used to separate the genotypes and sowing date means, (Table 10). In both years, the fresh pod yield of NGAE-96-012-1 per hectare was significantly higher than the yield of the other genotypes. May sowing date fresh pod yield/ hectare was significantly higher than the yield of the June, July and August sowings by 30.41; 87.08 and 125.71% in 2009 and 30.26; 66.38; and 115.54% in 2010 respectively.

Interactions between genotypes and sowing dates were significant ($P<0.001$) in both years. LSD was also used to separate the means, (Table 10). The highest fresh pod yield/ hectare was recorded for the genotype NGAE-96-012-1 in May sowing dates for in both years.

Table 10: Effect of *Abelmoschus caillei* (okra) Genotypes and Sowing Dates on fresh pods yield / hectare in 2009 and 2010 cropping seasons.

	2009					2010				
	Fresh Pod Yield ($kgha^{-1}$) Dates					Fresh Pod Yield ($kgha^{-1}$) Dates				
Okra Genotypes	May	June	July	August	Genotypes Means	May	June	July	August	Genotypes Means
CEN-012	4591.53	3677.85	2448.17	2133.01	3212.64	5023.52	3889.73	3029.93	2268.94	3553.03
NGAE-96-012-1	7361.17	5395.00	4455.67	3054.81	4966.66	7511.35	5764.74	4547.20	3271.06	5273.59
OWODE	5255.69	3846.19	2799.32	2431.75	3583.24	5340.49	4106.65	3098.58	2604.37	3787.52
NGAE-96-0061	5547.38	4449.15	3104.66	2579.24	3920.11	5800.59	4459.41	3648.77	2881.99	4197.69
NGAE-96-0067	6779.93	5279.98	3379.99	2886.74	4581.66	6737.28	5128.10	3954.73	3083.81	4725.98
Dates Means	5907.14	4529.63	3157.56	2617.11	4052.86	6082.65	4669.73	3655.84	2822.03	4307.56

2009		2010	
LSD 0.05 Genotypes	**= 300.300**	**LSD 0.05 Genotypes**	**= 171.200**
LSD 0.05 Dates	**= 268.600**	**LSD 0.05 Dates**	**= 153.100**
LSD 0.05 Varieties x Dates	**= 500.600**	**LSD 0.05 Varieties x Dates**	**= 342.300**

Sowing date had significant ($P < 0.001$) effects on performance of vegetative characters, reproductive character and fresh pod yield per hectare in both 2009 and 2010.The May sowing date plants and August sowing date plants started flowering at about the same time(ending of September and early October) with a difference of 7 days. Ariyo(1993), Kehinde (1999), Adeniji and Peters (2005) and Adeniji and Aremu (2007) had reported that *A.caillei* (WAT) is photoperiod sensitive. Hence, delaying sowing date by a Month led to significant ($P < 0.001$) and drastic reduction in vegetative phase, which resulted in reduction in vegetative character performance. Various effects due to reduction in vegetative phase included;

I: **Reduction in plant height** also led to reduction in number of leaves and number of lateral branches/plant. This occasioned the reduction in the number of photosynthetic surfaces leading to reduction in accumulation of assimilates/ photosynthates. Since the proportion of photosynthates allocated to the reproductive parts during flowering and fruit set go "a long way to determine the number and weight of pods, (Adeniji and Aremu, 2007), reduction in length of vegetative phase also resulted in reduction in number of pods/plant and reduction in weight of pods. This accounted for the decrease in number and weight of pods with delayed sowing.

II: **Reduction in number of nodes** due to reduction in plant height.

Since reduction in length of vegetative phase led to reduction in plant height in both years, the shorter plants had fewer nodes which invariably led to less number of flowers and pods. This led to reduction in number of pods/ plant.

III: **Reduction in the number of lateral branches** also resulted in reduction in number of leaves and number of nodes. This also accounted for the decrease in the number of pods produced as sowing date was delayed.

1V: **Drastic reduction in fresh pod yield/hectare**. The reduction (variation) was so significant and sharp that those sown in August recorded about 126 and 116% reduction in fresh pod yield per hectare in 2009 and 2010 respectively. This showed the great influence vegetative characters have on yield. The shorter the length of the vegetative phase, the higher the percentage loss of fresh pod yield/ hectare.

V. **Reduction in life cycle**: Flowering occured almost at the same time irrespective of date of planting, and the crops completed their life cycle the same period. This led to the reduction of the life cycle of the plants/crops which were sown later. Hence crops sown in May enjoyed a longer vegetative phase that spanned up to three (3) months, in both years. Delaying sowing by one month interval from May to August resulted in reduction in vegetative phase as well as significant decrease in fresh pod yield in both 2009 and 2010, (Table 10).

Iremiren and Okiy (1986), Ezeakunne (2004) and Anonymous (2010) recorded high vegetative character performance of okra sown early and attributed it to adequate amount of rainfall recorded during the period before flowering. Thamburaj (1972) recorded taller plants and higher fruit yield at maximum temperatures of 34.4 – 35C and minimum temperatures of 22.5 – 23.5^{0}C. According to Yamaguchi (1983) okra will perform best when the minimum and maximum temperatures are 18.90 to 35^{0}C respectively. Oyelu (2001) recorded a critical day length of 121/2 hours for flower initiation and fruit yield. Katung (2007) reported that temperatures of 30.5^{0}C

and 31.8^{0}C during vegetative phase of okra with conducive rainfall led to high vegetative character performance, and consequently, more assimilate production that led to better yield in okra. Similar findings by Randhawa, (1967), have been reported. The monthly weather observations recorded from the Meteorological Station, National Root Crops Research Institute, Umudike (Table1) revealed ample favourable monthly rainfall, relative humidity, temperature and Sunshine hours that provided most conducive environment to May sowing date, which allowed for better expression of the genetic potentials of the varieties thereby eliciting higher vegetative character performance, significantly above performance recorded for June, July, and August sowing dates.
Njoku, (1958) and Adelusi, *et al*., (2006) reported that for many plants growing around the equator, a difference of 15 minutes in photoperiodism (sunshine) might mean flowering or vegetative growth. Ariyo (1993), reported that the production of *A. caillei* (WAT) is limited to the four months of September to December because of its photoperiodism. Anonymous, (2010) and Usman, (2001) reported that it is accumulation of enough thermal units that induce flowering *A. caillei*.This photoperiodic response (flowering) greatly affected yield. Okigbo, (1981) reported that plant spacing, genotype, canopy types, time of maturity, root system of various species have different demands on environmental factors at different growth stages, and these factors contribute in several ways to the over all growth, development and productivity of crops. Time of flowering played significant role, since those that were planted earlier (May, June), had higher vegetative character performance and consequently, more assimilate production (Katung, 2007), that induced higher reproductive character performance. Hence, the progressive decrease in the reproductive character performance associated with delay in sowing, (Tables 3, 4 and 5).
Usman, (2001) and Oyelu, (2002), reported yield decreases of okra variety V-25 due to delayed sowing date. Iremiren and Okiy (1986) observed progressive yield decreases for each month of delayed sowing of okra variety v-25. Ezeakunne (2004), also reported that the yield components of okra variety v-25, such as number of pods, pod-length, pod diameter, weight of pod and yield were relatively higher when sown early. Alfredo *et al.,*(1999), Hossain*et al*., (2001), Moniruzzaman *et al*.,(2007) and Anonymous, (2010) reported significant reduction in reproductive characters performance due to delayed sowing. In this work all the reproductive characters (number of flowers/plant, number of pods/plant, pod-length, and weight of pods/plant) had reduction in performance with delay in sowing due to reduction in vegetative phase occasioned by photoperiodic response of *A. caillei*. This led to significant sharp decline of about 126 and 116% reduction in fresh pod yield per hectare in 2009 and 2010 respectively, between May and August sowing dates. Hence, early planting of *A. caillei*, (first week of May) is recommended. The interactions also showed that the genotypes NGAE-96-012-1 and NGAE-96-0067 gave highest vegetative and reproductive character performance, which led to highest fresh pod yield in the May sowing date indicated genetic superiority of these varieties in Umudike environment over other genotypes studied.

1.1.3 Conclusion: NGAE-96-012-1 and NGAE-96-0067 genotypes performed better than other genotypes, but their highest yield was recorded in the Month of May. These genotypes with further work could be released as varieties to farmers in Umudike for increased fresh pod production. *A. caillei* has always been sown between March to May and harvested from October but this work has shown that one could sow in August and harvest from October also, the same duration most *A. esculentus* takes to complete their life cycle. The reduction of *A.caillei* life span (basically vegetative phase) from over 8 months to 4 months (August to November) led to 116% reduction in okra fresh pod yield but also made these *A.caillei* genotypes share the same period of completion of life with *A. esculentus*.

References

Adelusi, A.A., Makinde, A.M., and Folorunso, A.E. 2006.Comparative studies of physico. biochemical parameter in *Abelmoschusesculentus* and *A. moschatus* (Moench). Research Journal of Botany 1(2): 104-109.
Adeniji, O.T. 2003. Inheritance studies in West African okra (*A. caillei*). M. Agric. Thesis. University of Agriculture. Abeokuta, Nigeria, 98p.
Adeniji, O.T and Aremu, 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) 162166 .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. and Peters, J.M. 2005. Stepwise regression analysis of pod and seed yield characters in segregating F_2 population of West African okra (*A.caillei*). Proc. 30th annual conf. Genet.Soc., Nig. pp 250- 258.
Adeniji, O.T., Kehinde, O.B., Ajala, M.O. and Adebisi M.A. 2007. Genetic studies on seed yield of West African okra (*A. caillei* (A. Chev) Stevel). Journal of Trop. Agric 45(1-2):36-41.
Adeyemo, M.O. and Ogunwolu, E.O. 1996. Planting date and varietal influences on development and seed yield of sesame (Sesamunindicum L.)in a Southern guinea savanna environment. J. Agric Tech. (4) 1:19-25

Alfredo, S.O.M. and Arturo, D.F. 1999. Productivity of okra cultivars in four planting dates at Rio Bravo. Tameulipas, Mexico. Agrociencia 33:44-46.
Anonymous, 2010. Productivity of okra (*Abelmoschuscscnlentins*(L.) moench) at varying sowingdates in Markurdi, Nigerian J. of Appl.Biosci.32:2015-2019.
Ariyo, O.J. 1993. Genetic diversity in West African okra (*Abelmoschuscaillei* (A.Chev) Stevels).Multivariate analysis of morphological and agronomic characteristics.Genetic Resource and crop Evolution 40:25-32.
Ayoola, O.T. and Adeniyan, O.N. 2006. Influence of poultry manure and NPK manure on yield and yield components of crops under different cropping seasons in South West Africa. Africa J. Biotech, 5:15-20
Ezeakunne, C.O. 2004. Large scale fruit and vegetable production in Nigeria. Extension bulletin, Ahumadu Bello University, Zaria, 20p.
FAOSTAT, 2008. Food and Agricultural Organization of the United Nations. On-line and Multilingual Database http://faostat.fao.org/faostat/
Gomez, K.A and Gomez, A.A. 1984.Statistical Procedures for Agric. Reseaech 2nd edition, New York, John Willey and Sons. 680p.
Hossain, M.D., Salam M.A., Islam, M.S., and Masud M.A.T. 2001. Yield and quality of okra seed as influenced journal of Agriculture by time sowing. Bangladesh Journal of Seed Science Technology 3 (1-2):83-87
Iremiren, G.O. and Okiy, D.A.1986. Effect of sowing dates on the growth, yield and quality of okra in Southern Nigeria. Journal of Agric. Sci. 106(1):21-26
Jackson, M. L. (1962). Soil chemical and particle size analysis: Prentice Hall, Ince. Eagle wood Cliffs, 10p.
Katung, M.D. 2007. Productivity of okra varieties as influenced by seasonal changes in Northern Nigeria. Agrobat. 35(1):65-71.
Kehinde, O.B. 1999. Floral Biology Of West African okra (*Abelmoschuscaillei* (A.Chev) Stevels). Nigeria J. Genet : 14(1999) 95-97.
Kjeldahl, J. (1983). The Kjeldahl determine of nitrogen: retrospect and prospect. Trends in analytical Chemistry, Vol.13, No. 4 ,138p
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) :3590-3598, December 2010. http//www. academic journals. Org/AJAR.
Martin, F.W. and Ruberte, R. 1978. Vegetables for humid Tropics. Part 2 okra, (*Abelmoschus esculentus*). Sciences and Education Administration, United States department of Agriculture (USDA) New Orleans, 160p
Moniruzzaman, M., Uddin, M.Z., and Choudhury, A.K. 2007. Response of okra seed crop to sowing time and plant spacing in south eastern hilly region of Bangladash.Bangaladash journal of Agriculture, Research 32(3):393-402.
Njoku, E. 1958. The photoperiodic response of some Nigeria plants. J. West African Sci. Associ. 4:99-111.
Obi, I. U. 2001. Introduction to Factorial Experiments for Agricultural, Biology and Social Sciences Research.Second Edition. Optimal publishers Nsukka, Nigeria, Pp78-82
Okigbo, B.N.1986. Welcome address. In: Tropical grain legume bulleting. Processing World Cowpea ResearchConference, 5-9 Nov. 1986.32:5-9.
Okocha, P.I. and Chinatu, L.N. 2008. Evaluation of okra cultivars and breeding lines for Agronomic traits in Umudike in south Eastern Nigeria.Global J. of Agric. Sci. vol 7,.NDI.P 11-15.
Oyolu, C. 2002. Variablity in photoperiodic response of okra, (*Hibiscus esculentus* (L.)Acta Horticulture 52: 207-215
Randhawa, G.S. 1967. Growth and development in okra, (*Abelmoschusesculentus* (L.) Moench) as influenced by time of sowing and row spacings. J.Res. Ludhiaria4:365-369.
Savello, P. A., Martin, F.W. and Hill, J,M. 1980. Nutritional composition of okra seed meal. J. Agric and Food Chem.;28;113-1166.
Siemonsma, J.S. 1982. West African okra; Morphological and Cytological indications for the existence of a natural amphidiploids of *A esculentus* L. Moench and *A. manihot L.* Medikus.Euphytica 31:240-242.
Siemonsma, J.S., Kouame, C 2004. Abelmoschus esculentus (L) Moench. Internet record from protabase. Grubben G.J.H, Denton, O.A. (eds), PROTA (Plant Resources of Tropical Africa, Wageningen, Netherlands. http://database.prota.org/search.htm.
Siungh, H.B. and Bhatnagar, A. 1975. Chromosomes number of okra from Ghana. Indian J.Genet.Plant Breed. 36: 24-27
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 tropics.Hong Kong. The Macmillan press Ltd. PP 225-337.
Usman, S.D.2001. Seed production and quality of okra affected by sowing time. Seed Research 29(1): 47-51.
Van Rheenen, H.A. 1979. Major problems of growing sesame in Nigeria.Communication Agric. Univ.,Wageningen, Holand. 130p.

Walkley, A and Black, I. A. 1934. An Examination of Degtjareff method for determining soil organic matter and a proposed modification of the Chronic Acid Titration method. Soil Sci. 37:29-37

Weiss, E. A. 1971. Castor, Sesame and Safflower. Leonard Hill, London. 901: Pp182-272.

Yamaguchi, M.,1983.World Vegetables. Principles and Nutritive values. The Avipublishing companyInc, West port Connecticut, PP 368-377.