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Full Length Research Paper

Effects of decapitation on dry fruit and seed yield of early (*Abelmoschus esculentus*) and late okra (*Abelmoschus caillei*) cultivars in South Eastern Nigeria

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The effects of decapitation and non-decapitation on dry fruit and seed production by 12 cultivars of early and late okra cultivars were studied for two cropping seasons. The analysis of variance showed that year was very highly significant while decapitation-non decapitation, as well the interaction between year and decapitation- non decapitation, for the four treatments for both early and late okra types, were not significant. The highly significant difference in years was attributed to the differences in the rainfall distribution patterns as well relative humidity, air and soil temperatures for the two cropping seasons. Though the differences in seed and dry fruit yield between early and late okra was not statistically significant, late okra showed greater promise for okra seed production in the region. The non-significant differences in dry fruit and seed yield between the early and late okra types as well as between the decapitated and non-decapitated plants were attributed to the physiological and reproductive attributes of both okra types. Comparatively, the seed yield of the evaluated cultivars showed that yield was below the optimum reported for some other okra growing regions of the world, hence the urgent need for more intensified effort to improve the seed yield of the promising cultivars. It was concluded that decapitation as a horticultural practice may not be an effective way of increasing dry fruit and seed yield in okra in South Eastern Nigeria.

Key words: Okra, early, late, decapitation, non-decapitation, dry fruit, seed production.

INTRODUCTION

Okra is a multipurpose crop due to its various uses (Martin, 1982; Adeniji et al., 2007). It is grown in many countries and cultivars from different countries have certain adapted distinguishing characteristics specific to the country to which they belong (Dhankhara and Mishrab, 2005).

In the West African region, two distinct species of okra exist; *Abelmoschus esculentus* (L.) Moench, which is the conventional or early okra and *Abelmoschus caillei* (A. Chev) Stevels, late okra (Siemonsma and Hamon, 2004). Late okra is also called the West African okra, since its distribution is restricted to the West African region (Njoku, 1958; Martin et al., 1981, Siemonsma, 1982; Hamon and Hamon, 1991). The major difference between the two okra types lies in their physiological response to changes in natural photoperiods (Njoku 1958; Oyolu, 1977; Nwoke, 1980; Siemonsma, 1982; Udengwu, 1998).

Okra is a kind of special vegetable, which is rich in amino acids, vitamins, minerals, polysaccharides, flavonoids and unsaturated fatty acids, with multiple nutritional and health-care functions (Dong and Liang, 2007). Notwithstanding the great value of okra, information on characterization is either not accessible or simply unavailable. Characterization and evaluation of crops is done to provide information on diversity within or among crops. This permits the identification of unique entries (accessions) necessary for curators of gene banks and plant breeders (Torkpo et al., 2006).

The world today is concerned with exploitation of alternative sources of clean energy in a bid to stem global pollution occasioned by the burning of fossil fuel. As the demand for vegetable oils is rapidly increasing due to the growing human population and the expanding oleo-chemicals industry, the exploration of some

Non-conventional and newer resources of vegetable oils is of much concern (Anwar et al., 2011). Studies with okra had been concentrated more in the direction of its production, improvement and utilization as a vegetable crop (Martin and Ruberte 1978; Mangual-Crespo and Martin, 1980), with little attention paid to its huge potentials as a seed and oil crop. Karakoltsidis and Constantinides (1975) stimulated interest in okra as a seed crop, yielding protein and oil, which had previously been unrecognized. Crossley and Hilditch (1951), Martin and Ruberte (1979), Mangual-Crespo and Martin (1980) and Anwar et al. (2010) have written on the importance of okra as both an oil and protein crop.

The economic and nutritive importance of the oil, proteins and amino acids of dehulled okra seeds have been highlighted by Camciuc et al. (1998), Savello et al. (1980) and Oyelade et al. (2002). Okra seeds contain gossypol or gossypol-like phenolic compound, which has been used effectively as an anti-male sterilant in China and the USA (Karakoltsides and Constantinides, 1975; Martin et al., 1979; Martin and Ruberte, 1981; Martin, 1982; Martin and Rhodes, 1983; Fogg, 1984). Consequent, upon the enormous economic potentials of okra seed, especially for the poverty stricken sub-Saharan African region, serious attention to germplasm documentation, evaluation, characterization and development of effective production protocols for large scale production is considered as an urgent research imperative.

Techniques for production of okra as a vegetable are so different from those for the production of seeds (Mangual-Crespo and Martin, 1980). “Topping” or decapitation is an ethno-agricultural practice, often carried out by local farmers to increase the yield potentials of their crops. Incidentally, hardly any reports exist about scientific investigations into the potential contributions or otherwise of such a practice to dry fruit and seed production in okra in the region. Udeogalanya and Muoneke (1985) as well as Udengwu (2009) reported on the effects of this ethno-agricultural practice on the production of marketable fresh fruits in okra.

This present study reports on the comparatively evaluation of the dry fruit and seed yield potentials of 12 cultivars of the two okra species, adopting the decapitation or topping ethno-agricultural practice, over a two-year period, in South Eastern Nigeria; with a view to determining its suitability for large scale okra seed production, which is necessary for the exploitation of the neglected economic potentials of the crop.

MATERIALS AND METHODS

Field studies on dry fruit and seed yield of twelve cultivars of early and late okra

Germplasm used for the studies

Seeds of the 12 early and late okra cultivars (Figures 12 and 13), which form part of the germplasm retrieved mostly from local farmers were used for the studies. The early okra cultivars were- Awgu early, “Ogba mkpi”, “Ogbu oge”., Iloka, Nnobi fat and Lady finger(exotic okra) while the late okra cultivars included, “Ogolo”, “Oru ufie”, “Alanwaghoho”, “Ojo ogwu”, “Ebi ogwu” and “Tongolo”.

Land preparation

Tractor ploughing as well as the first harrowing of the soil took place at the onset of the early rains, in March/April of the first year, 2002 after earlier preliminary studies in the late nineties. The second harrowing was carried out at the onset of the steady rains. Well-cured poultry dropping was worked into the soil at the rate of 13.5 t ha^{-1}. Due to the acidity of the soil, in the experimental area, lime was broadcast at the rate of 20 t ha^{-1}. After two days of application, the lime was worked into the soil with the third harrowing.

Design and general layout of experiment

A split plot, in randomized complete block (RCBD) was the experimental design used for the two years studies. The total experimental units were 12 with 4 treatments each and three replications. The following treatments were applied- early non-harvest (ENH), early nipped (decapitated), non harvest (ENiNH), late non harvest (LNH) and late nipped (decapitated) non harvest (LNiNH). Fisher’s table of random numbers was used for the assignment of each of the experimental units. The cultivars were likewise randomly assigned within each sub plot.

Field planting

Pre-germination of seeds

Only pre-germinated seeds were used for the plantings for the two years, as a measure to overcome the problem of uneven seed germination, caused by possession of hard and impenetrable seed coats by some seeds, especially the late okra cultivars. The seeds with thin seed coats were soaked in tap water for two days with the water being changed every day. At the end of the second day, the radicle of all viable seeds emerged. The seeds of the cultivars with hard seed coats were scarified either by treatment with concentrated H_2SO_4 for 15 min and then washed several times in running tap water to wash off all the acids or cutting off a small portion of the seed coat (on the broader end of the seeds only) using the conventional nail cutter. In each case, the seeds were later soaked in water for the same two days for the radicles of the viable seeds to emerge.

Pre-planting application of Furadan

Consequent upon the high incidence of insect pests and nematode in the area, l.5 g of Furadan, a combined nematicide and insecticide, was introduced into each of the planting holes at the depth of about 2.5 cm. The pre-germinated seeds were introduced into the planting holes after covering the applied Furadan with 1 cm thick layer of soil.

Planting procedure

Three pre-germinated seeds were introduced into each prepared planting hole and covered with soil. Thinning down to one plant per stand took place two weeks after planting. There were six plants per row. The within and between row spacing were each 30 cm. In each experimental plot or unit, there were 36 plants belonging to 6 different cultivars. For the entire experimental area, there were 432 plants excluding discard border plants.

Table 1. ANOVA table for dry weight (ENH, ENiNH, LNH and LNiNH treatments) for 2 years.

Parameter	df	MS	VR
Total	23	840.020	
Block	2	230.430	2.077^{NS}
Year (Y)	1	16986.889	153.170***
Treatment (T)	3	16.095	-
Y x T	3	90.410	-
Error	14	110.940	

Significant levels used. ***P<.001; **P<.01; *P<.05; NS, Not significant. LNiH, Late nipped (decapitated) harvest; ENH, early non harvest; ENiNH, early nipped (decapitated) non harvest; LNH, late non harvest; LNiNH, late nipped (decapitated) non harvest.

Decapitation of terminal buds to induce branching in cultivars of early and late okra

Removal of apical bud or nipping was carried out, using a pair of secateurs, to allow for at least two weeks of vegetative growth for all the cultivars prior to the initiation of flower buds. Preliminary studies had shown that this was a good stage to decapitate leading to the formation of not too tall branches that can bear fruits without staking or support, which will increase labour in-put.

Nipping for late okra cultivars was carried out in mid August, because of their critical day length (CDL) of 12¼ h. Flower initiation in late okra usually took place early in September when natural day length usually shortened considerably to 12¼ h or less.

Harvesting of dry fruits

Harvesting of dry fruits for the four treatments was done using a pair of secateurs once the fruits turned yellowish brown in colour and exhibited the characteristic longitudinal splits along the ridges of the fruits.

For standardization of dry weight, fruits harvested from the field were dried in a Gallenkamp oven at a temperature of 35°C for 24 h before the dry weights were recorded on per plant basis. The seeds were later shelled and seed yield estimated as 50% of the dry fruit weight, following the method of Akoroda (1986). Dry seeds were stored in the deep freezer or dessicator using anhydrous Calcium chloride pellets for other studies.

Meteorological data collection

The following meteorological data were collected from the University of Nigeria Meteorological Centre for the two years of studies: Mean monthly relative humidity, mean monthly air temperature, mean monthly soil temperature and monthly rainfall (Figures 8 to 11).

Field studies repeated over time only

Field studies, as were earlier described, were repeated on another location within the same experimental farm during the planting season of the following year. All the protocols followed in the previous year were precisely repeated for this second planting.

The data for the two years planting were combined and analyzed employing the analysis of variance (ANOVA) statistical method and bar charts with standard errors to compare the fruit dry weight and seed yield among the cultivars of each okra species and between cultivars of the two species for the two years of study.

RESULTS

Analysis of yield of dry weight of fruits produced by 12 cultivars of both early and late okra cultivars for 2 years for 4 treatments; ENH, ENiNH, LNH, and LNiNH

From the ANOVA in Table 1, the difference between years was highly significant (P < 0.001). The treatment effect was not significant while the interaction between year (Y) and treatment (T) was also not significant. Additionally, Figure 1 shows that the yield for the first year was very much higher than the second year for all the treatments, with the cultivars differing in their responses. For some cultivars, decapitation resulted to production of more fruits than the non- decapitated ones. In some other cases, reverses were observed, these differences were however not significant.

Analysis of dry weight produced by 6 early okra cultivars for 2 treatments, ENH and ENiNH, for the 2 years of study

The ANOVA (Table 2) showed that year was very highly significant (P < 0.001) while treatment was not significant. Cultivar was highly significant (P < 0.01), while the interaction between year (Y) and cultivar (C) was very highly significant, the interaction between year and treatment was not significant. The interaction between cultivar and treatment (C × T) was very highly significant (P< 0.001), while the interaction (Y × C × T) was significant. Figure 2 indicates that yield for the first year was higher than the second year, for both treatments for all the cultivars except Lady finger, the only exotic okra. It showed little variation in performance for the non-harvest and nipped non-harvest treatments for the two years. Non significant differences were observed in the performance of the non-harvest and nipped non-harvest treatments for the two years for other cultivars. For yield measured as total number of fruits (Figure 3), the number of fruits produced for the first year, for both ENH and ENiNH treatments were significantly much higher than the second year, for Nnobi fat, "Ogba mkpi", Awgu early and "Ogbu oge". Decapitation resulted to higher number of fruit production by Nnobi fat, "Iloka" and "Ogbu Oge". Lady finger, the exotic okra, showed slight variation.

Analysis of dry weight produced by 6 late okra cultivars for 2 treatments, LNH and LNiNH, for the 2 years of study

The ANOVA shown in Table 3 indicate that year was very highly significant (P < 0.001), while treatment and cultivar were not significant. The interaction between year and cultivar (Y × C) was very highly significant (P<0.001), while the interaction between year and treatment (Y × T); cultivar and treatment (C × T) as well as between year, cultivar and treatment (Y × C × T) were all none significant.

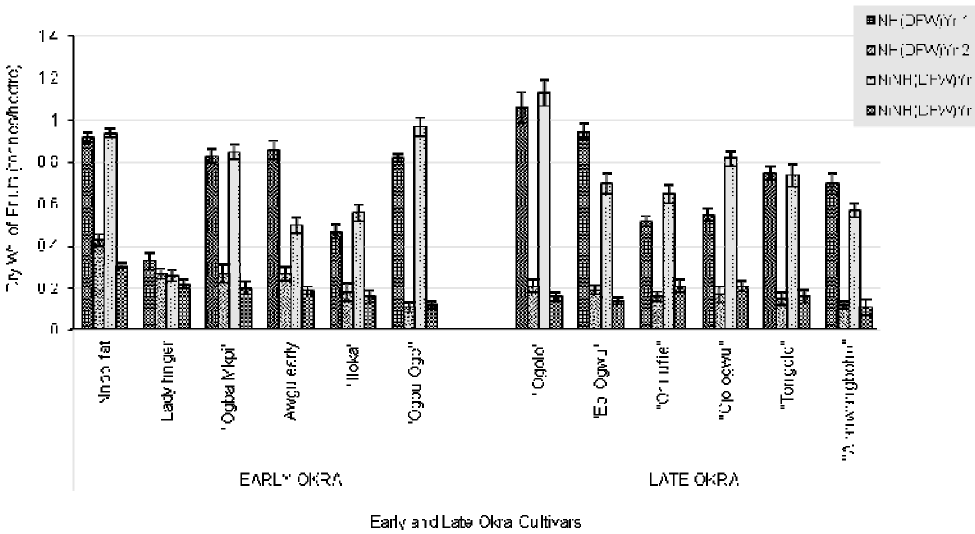

Figure 1. Yield of dry fruits (tonnes per hectare) by 12 cultivars of early and late okra cultivars over 2 planting seasons for 2 treatments (Non harvest and non nipped harvest).

Table 2. ANOVA based on fruit dry weight of 6 cultivars of early okra for 2 treatments (ENH and ENiNH) for 2 Years (Log_{10} data transformation).

Source	df	SS	MS	F cal.	5%	1%	0.5%
Total	71	6.92	0.097				
Block	2	0.018	0.009	-	3.23	5.18	6.07
Year (Y)	1	3.915	3.915	391.5***	4.08	7.31	8.83
Treatment (T)	1	0.064	0.064	3.368 NS	4.08	7.31	8.83
Cultivar (C)	5	0.361	0.072	3.789**	2.45	3.51	3.99
Y x C	5	0 .632	0.126	6.631***	2.45	3.51	3.99
Y x T	1	0.012	0.012	-	4.08	7.31	8.83
C x T	5	0.732	0.146	7.684***	2.45	3.51	3.99
Y x C x T	5	0.300	0.060	3.157*	2.45	3.51	3.99
ERROR	46	0 .886	0.019				

Significant levels used. ***P<.001; **P<.01; *P<.05; NS, not significant.

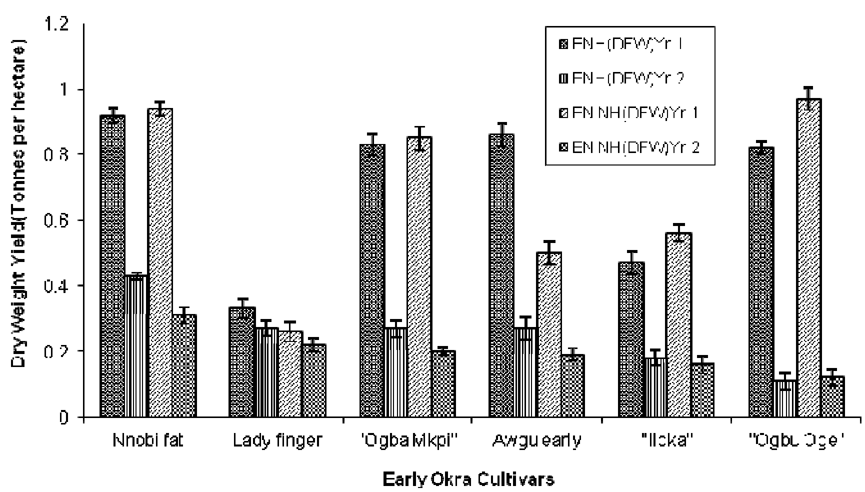

Figure 2. Yield of dry fruits (tonnes per hectare) by 6 cultivars of early okra for 2 treatments (ENH and ENINH) for 2 cropping seasons.

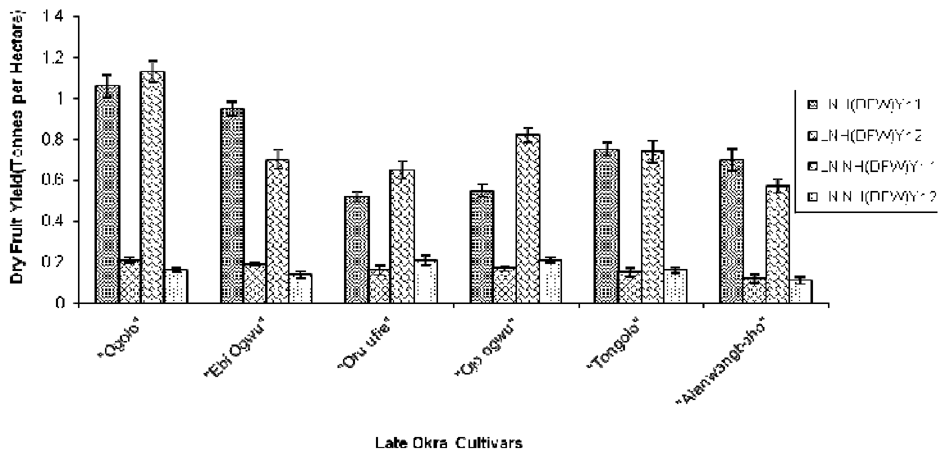

Figure 3. Yield of dry fruits (tonnes per hectare) of 6 late okra cultivars for 2 treatments (LNH and LNINH) for 2 cropping seasons.

Table 3. ANOVA based on fruit dry weight of 6 cultivars of late okra for 2 treatments (LNH and LNiNH) for 2 Years (Log_{10} data transformation).

Source	df	SS	MS	F cal	5%	1%	0.5%
Total	71	8.917	0.125				
Block	2	0 .103	0.051	4.25*	3.23	5.18	6.07
Year (Y)	1	7.696	7.696	641.33***	4.08	7.31	8.83
Treatment(T)	1	0.000094	0.000094	-	2.45	3.51	3.99
Cultivar (C)	5	0.090	0.018	1.50 N.S	4.08	7.31	8.83
Y × C	5	0.310	0.062	5.166***	2.45	3.51	3.99
Y × T	1	0.00168	0.016	-	4.08	7.31	8.83
C × T	5	0.082	0.012	1.33 N.S	2.45	3.51	3.99
Y × C × T	5	0.064	0.012	1.00 N.S	2.45	3.51	3.99

Significant levels used. ***P<.001; **P<.01; *P<.05; NS, not significant.

From Figure 4, the yield of dry fruit for the first year was significantly much higher than the second year. In the first year, while decapitation resulted to more fruit yield in Ogolo, Oru Ufie, Ojo ogwu, the reverse was the case for Ebi ogwu and Alanwangboho. Tongolo showed no difference in yield for the two treatments for the two years. For the decapitated and non-decapitated plants for all the cultivars for the second year planting, there were no significant differences in yield. Figure 5 shows that fruit production (based on total number of fruits) for the first year was much higher than the second year. Decapitation resulted to production of more fruits for both treatments for the two years. This was significant, very much higher for the first year when compared with the second year.

Analysis of yield of dry seed produced by 12 cultivars of both early and late okra cultivars for 2 years for 4 treatments; ENH, ENiNH, LNH, and LNiNH

The ANOVA on Table 4 showed that year was very highly significant, while treatment and the interaction (Y × T) were all non-significant. Seed yield for ENH treatment for the first year ranged from 170 to 430 kg ha^{-1}, while for ENiNH, it ranged from 180 to 490 kg ha^{-1}. For the second year planting, seed yield for ENH ranged from 60 to 230 kg ha^{-1}, while for ENiNH, it ranged from 60 to 160 kg ha^{-1}. For LNH, seed yield for the first year ranged from 260 to 530 kg ha^{-1} while for LNiNH, it ranged from 290 to 570 kg ha^{-1}. For the second year planting, it ranged from 60 to 110 kg ha^{-1} for both LNH and LNiNH treatments (Figures 6 and 7). For the ENH and ENiNH treatments, seed yield was much higher for the first year than the second year (Figure 6). This was however not the case with the exotic okra, Lady finger, which showed slight higher increase in seed production for the first year than the second year for both treatments. The lowest seed yield for ENH was 170 kg ha^{-1} for first year while it was 60 kg ha^{-1} for the second year. The highest seed yield for ENH for the first year stood at 430 kg ha^{-1} while it was 160 kg ha^{-1} for the second year (Figure 6).Figure 7 shows that seed yield for the two treatments, for the first year, for all the cultivars, was significantly higher than that of the second year. The lowest seed yield for LNH and LNiNH for the first year stood at 260 and 290 kg ha^{-1}, respectively, while the

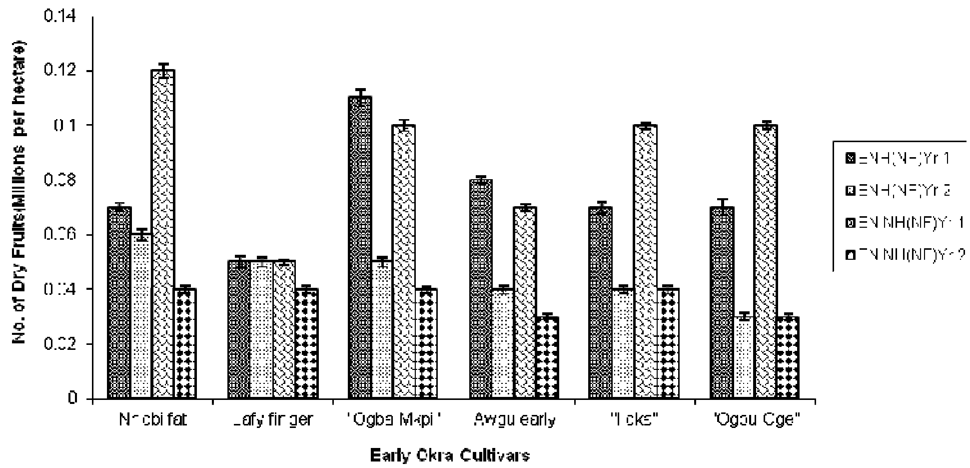

Figure 4. Yield of dry fruits as total no. of fruits (millions per hectare) of 6 early okra cultivars for 2 m treatments (ENH and ENINH) for 2 cropping seasons.

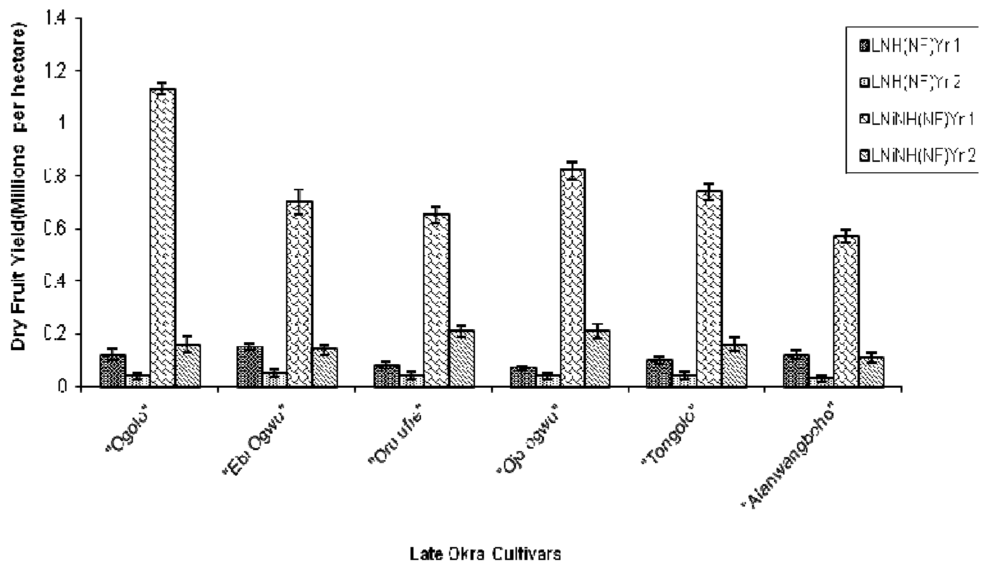

Figure 5. Dry fruit yield (millions of fruit per hectare) of 6 late okra ciltivars for 2 treatments (LNH and LNINH) for 2 planting seasons.

highest yield for both treatments was 530 and 570 kg ha^{-1}, respectively (Figure 7). Differences in seed yield between the decapitated and the non-decapitated plants were not significant, for each of the years.

DISCUSSION

Dry fruit yield

The non significance of the four treatments ENH, ENiNH, LNH and LNiNH for the two years of planting can be ascribed to the limited number of flowers buds that set fruit and attain maturity when okra fruits are grown for seed production as against the numerous fruits produced when okra is grown for fresh fruits, with regular fruit very highly significant variance ratio for year which is an indication of the very sensitive nature of okra to changes in mean monthly soil temperature, mean monthly air temperature, mean monthly relative humidity and mean monthly rainfall, abiotic environmental conditions that were monitored for the two years. The most dramatic fluctuation was in the annual rainfall. While the distribution for the first year started in March (75 cm) and showed an almost normal distribution that of the second year started in April (5 cm) and showed wide fluctuations. The first year rainfall rose steadily and eventually peaked in July (352 cm), which is normally the peak of rainy season in the South Eastern part of Nigeria, before ending in December.The second year, on the other hand, showed a decline in July (146 cm) and a much lower and unusual peak (250 cm) in September, with a sharp drop (80 cm) during the August break, much lower than that of

Table 4. ANOVA table for dry seed weight for (ENH, ENiNH, LNH and LNiNH) treatments for 2 Years.

Parameter		MS	VR
Total	23	421.5	
Block	2	116.25	2.077NS
Year (Y)	1	8443.44	151.587***
Treatment (T)	3	8.067	-
Y x T	3	46.35	-
Error	14	55.47	

Significant levels used. ***P<.001; **P<.01; *P<.05; NS, not Significant LNiH, late nipped (decapitated) harvest; ENH, early non harvest; ENiNH, early nipped (decapitated) non harvest; LNH, late non harvest; LNiNH, late nipped (decapitated) non harvest.

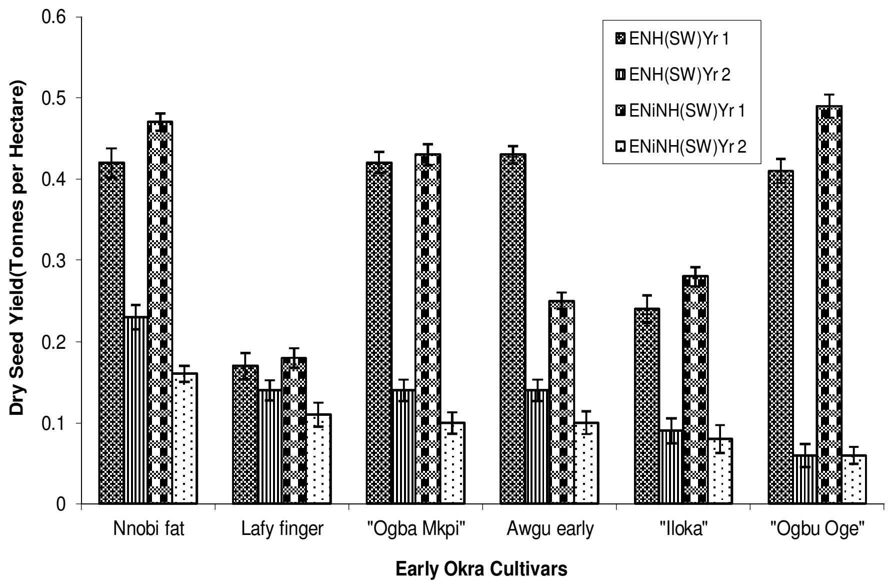

Figure 6. Dry seed yield (tonnes per hectare) by 6 early okra cultivars for 2 treatments for 2 cropping seasons.

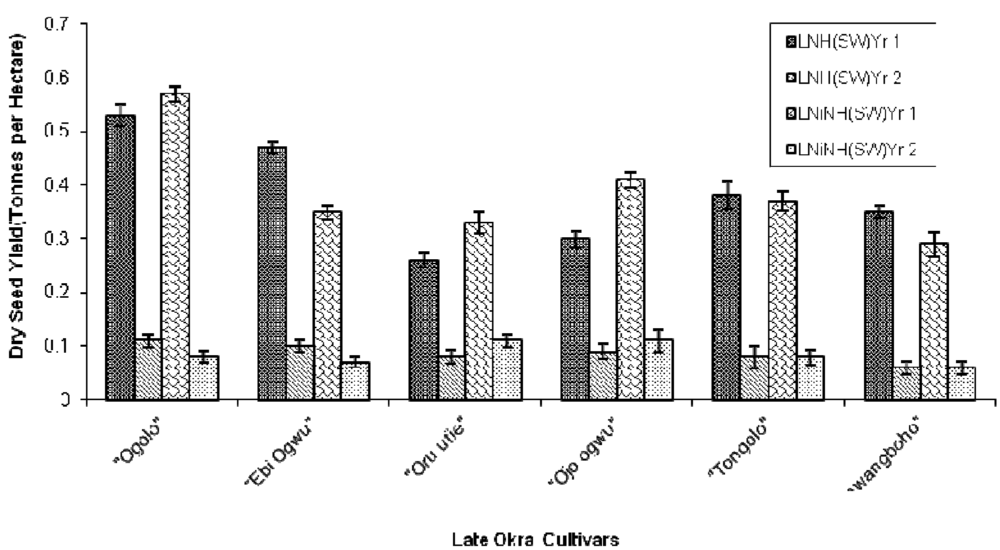

Figure 7. Yield of dry seed (tonnes per hectare) for 2 treatments (LNH and LNINH) for 2 cropping seasons.

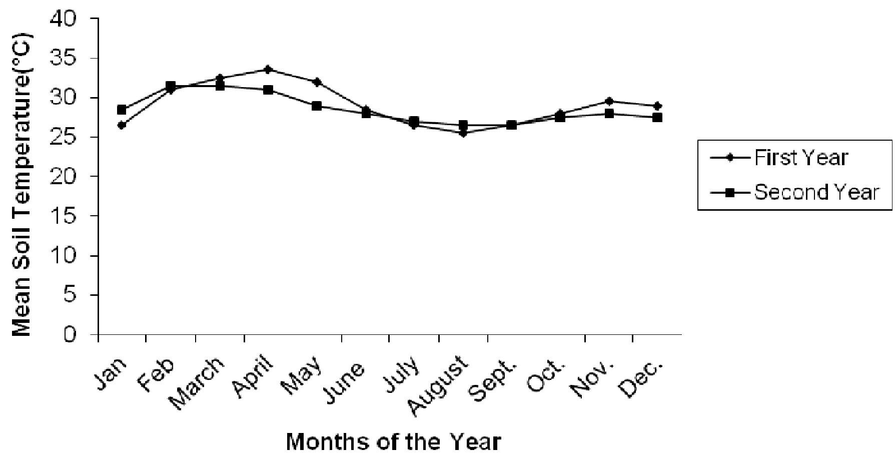

Figure 8. Mean monthly soil temperature at Nsukka for the two different years.

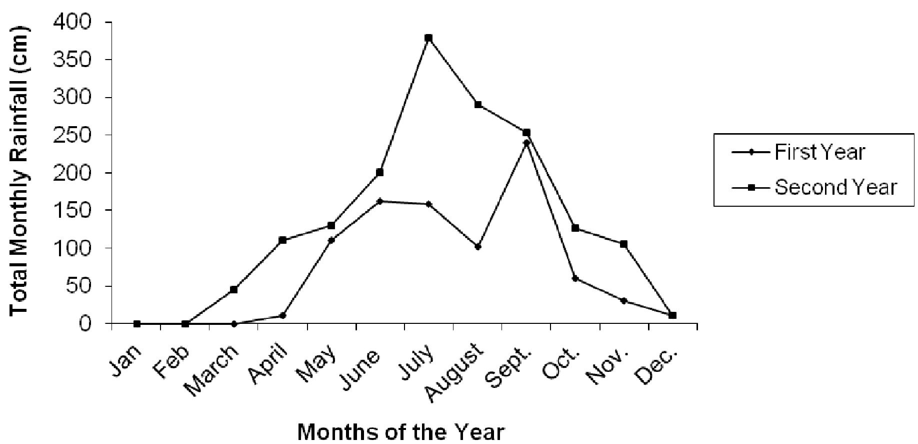

Figure 9. Total monthly rainfall at Nsukka for the 2 different years.

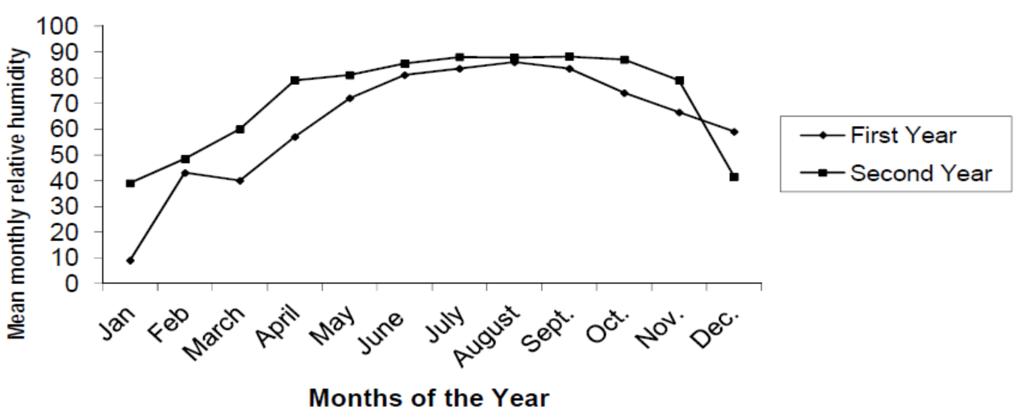

Figure 10. Mean monthly relative humidity at Nsukka for the 2 different years.

harvesting (Akoroda, 1986; Udengwu, 2009). There are the previous year (255 cm). These observations are similar to the findings of Asif and Greig (1972), Adelana (1985) and Zimmerman (2006). Of special interest is the yield pattern of Lady finger, an introduced exotic *Abelmoschus esculentus*, cultivar popularly grown in the region. For the harvest and non harvest treatments, as well as the decapitated and nondecapitated treatments, there were no observable differences in the yield of seed fruits by this cultivar for the two years of study. Most

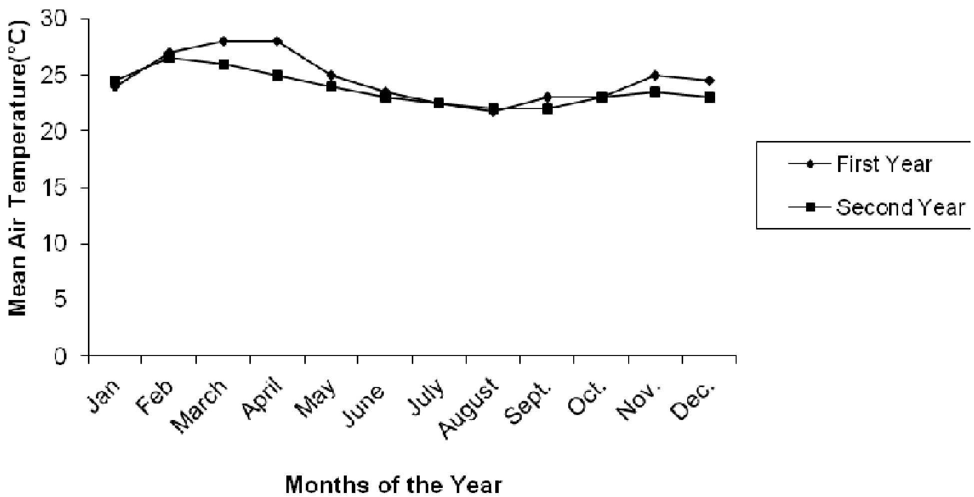

Figure 11. Mean monthly air temperature at Nsukka for the 2 different years.

Figure 12. A typical early okra, *Abelmoschus esculentus* (L.) Moench cultivar.

Figure 13. A typical late okra, *Abelmoschus callei,* cultivar.

probably, this cultivar believed to be an introduction from America might have been bred to withstand diverse environmental conditions. Further simulated experiments over different environmental conditions will be carried out to determine whether it can serve as a possible source of the much needed genes for the improvement of local okra cultivars for resistance to changing environmental conditions.

Martin (1982) reported that okra is adapted to climates with relatively short rainy season, hence its special acceptance in north-east Brazil where it is considered a crop that never fails. This however differs from the situation in South Eastern Nigeria, where under natural conditions normal duration of rainfall which ranges from March/April to October/November, is ideal for okra growth under the tropical rain forest condition. It is suspected that late okra evolved under this environmental condition.

Okra ecotypes therefore does exist and it is necessary for different areas to carry out *in situ* research to develop okra cultivars that will suite their conditions. Uncontrolled introduction of okra germplasm into any area may result to pollution rather than improvement of the local germplasm.

The highly significant difference between the *A. esculentus* cultivars as well as the very highly significant difference between the interactions (Y × C) and (C × T) as well as the significant difference between (Y × C × T) are indicators of a high degree of variation among the cultivars used which resulted to different responses to the changes in the environmental conditions over this study years as well as the decapitation and non decapitation treatments. Fatokun et al. (1979) and Akoroda (1986) had hinted on the existence of a wide range genetic variability in okra germplasm in Nigeria. Such variability was found to be higher and significantly different from those found in exotic okra which provides further evidence to support Harlan (1971) submission that West Africa is a centre of diversity for okra.

The response of late okra cultivars differed from that of the early okra cultivars. The reasons for the very highly significant variance ratio for year for late okra are similar to what has been discussed under early okra. The non significant variance ratio of cultivar is indicative of the existence of less variation among the late okra cultivars used in the studies. This is a curious development because it appears that the higher chromosome number of 197 for late okra as against the 130 for early okra (Singh and Bhatnagar, 1976), does not necessarily result to higher degree of variation and diversification of late okra. Further studies are needed to understand why such a phenomenon could exist among other peculiarities of late okra which is restricted in distribution to the West African region. However, it has been introduced to many okra growing regions of the world as a source of genes for resistance against okra viral diseases (Siemonsma and Hamon, 2004). Udengwu (2009) reported that the duration for the production of fresh marketable fruit by early okra cultivars ranged from 7 to 12 weeks while that of late okra cultivars ranged from 3 to 8 weeks under natural planting conditions in South Eastern Nigeria. This marked difference in duration of fresh fruit production was linked to the greater sensitivity of the late okra cultivars to changes in natural photoperiod due to their 12¼ h Critical Day Length. Invariably, late okra spends most of its time on vegetative growth and has very short time for reproductive growth. It is suspected that the genes responsible for photoperiodic control in late okra may be epistatic in nature, compelling the cultivars to get into the reproductive phase once the CDL of 12¼ h is reached.

Dry seed yield

The non significant response of both early and late okra cultivars to the decapitation of non harvest treatments over the two years, as well as the interaction between year and treatment (Y × T) can be attributed to the limited number of seed fruits the plants could produce because of serious competition for assimilates by the retained old fruits on the plant (Akoroda, 1986; Udengwu, 2009).

Dry seed yield by early okra cultivars equally indicate slight variation in the performance of Lady finger for the two treatments over the two growing seasons, thus confirming the stability of the cultivar over varying abiotic environmental conditions. The exotic okra cultivar is therefore a potential source of genes for the improvement of the other early okra cultivars which are sensitive to changing environmental conditions. Other cultivars showed little difference between seed yield for ENH and ENiNH treatments suggesting again that the treatments may not be quite suitable for early okra cultivars. The cultural practice of nipping or decapitation should therefore be limited to the production of fresh marketable fruits (Udengwu, 2009). Similar views were expressed by Kolhe and Chavan (1965).

The response of late okra cultivars is equally similar to that of early okra with narrow differences between the LNH and LNiNH treatments for the two years. The determinate nature of okra growth coupled with the photoperiodic sensitivity of late okra cultivars meant that once the CDL is reached, irrespective of treatment, fruit production will commence and once the optimum number of fruits is produced; whether on the main axis or on the induced branches, no more fruits will be produced because all subsequent fruits will abort.

From the results of seed yield, for the early okra cultivars, three groups of seed yielders stood out based on the first year planting which was more promising and the focus of this discussion. Awgu early, Nnobi Long, Ogba mkpi and Ogbu Oge belong to the first group of fairly good yielders (FGY), with production up to 400 kg ha^{-1} while Iloka belongs to the group of the fairly medium yielders (FMY) with up to 200 kg ha^{-1}. Lady finger belongs to the poor yielder (PYD) group with up to 170 kg ha^{-1}. The same trend was repeated for the ENiNH treatment with the exception of Awgu early which yielded 250 kg ha^{-1}.

For the LNH treatment, three categories of seed yielders equally emerged. Ogolo and Ebi Ogwu with 530 and 470 kg ha^{-1}, respectively, are viewed as the FGH group, while Tongolo (380 kg ha^{-1}), Alanwangboho (350 kg ha^{-1}) and Ojogwu (300 kg ha^{-1}) belong to the FMY group. Oru ufie (260 kg ha^{-1}) is classified as a PYD. For the LNiNH treatment, Ogolo (570 kg ha^{-1}) and Ojo ogwu(410 kg ha^{-1}) are classified as FGY, while Ebi ogwu (350 kg ha^{-1}), Tongolo (370 kg ha^{-1}) and Oru ufie (330 kg ha^{-1}) are considered the FMY group. The cultivar, Alanwagboho (290 kg ha^{-1}) is considered a PYD. In West Africa, information on okra seed yield is limited because of the long negligence of the crop as a seed crop at the expensive of its production as a fruit crop. Mangual-Crespo and Martin (1980) reported that seed yield in eight *A. esculentus* cultivars ranged between 422 to 1032 kg ha^{-1}., depending on plant density.

Their average seed yield at 30.5 cm spacing was 558 kg ha^{-1}, compared to 713 kg ha^{-1} for the 23 cm spacing. In this present report at a planting distance of 30 cm, the highest seed production by the FGY for early okra was 400 kg ha^{-1} and for late okra, 530 kg ha^{-1} for the ENH and LNH treatments. These figures are comparable to the lowest seed yielders (422 kg ha^{-1}) reported by Mangual Crespo and Martin (1980).

Though late okra cultivars showed greater promise for seed production in the region, seed yield as reported in this present study is low when compared with yield from other reports in advanced okra production areas, selections could still be made to identify cultivars that will be involved in further breeding studies for enhanced okra seed production in the region. In their own report, Siemonsma and Hamon (2004) reported that seed yield in okra in West Africa was in the range of 500 to 1000 kg ha^{-1}.

This equally indicates that the yield of the cultivars used in this present study were low and calls for an urgent need to search for better seed producers in the region for broader selection of elite high yielding cultivars. The better performance of the late okra cultivars (which are restricted to the West African region) over the early ones is indicative of the fact that greater attention should be given to this okra group for commercial seed production in the region. This view is supported by the Siemonsma and Hamon (2004), who noted that selection and breeding of West African okra have not been carried out by the commercial sector, but African farmers have selected an enormous diversity of forms which fit into a great variety of cropping systems.

The stable performance of Lady finger (an introduced exotic early okra cultivar) over the recorded changing environmental conditions during the two years of study suggests that it could be a potential source of environmental stable gene(s) that could be used to stabilize the environmentally unstable cultivars. Further simulated changing environmental studies will however be needed to confirm this. The following four late okra cultivars have been ear marked for further seed yield improvement studies, Ogolo, Ebi Ogwu, Tongolo, and Ojogwu. The elite late okra cultivar, “Ogolo” outperformed all others cultivars by the production of the highest number of fruits due to decapitation. Subsequent studies will show the best age and height of decapitation for higher fruit production by the cultivar. For early okra also four cultivars, Awgu early, Nnobi Long, Ogba mkpi and Ogbu Oge, have been selected for further seed yield improvement programme while further search for better performers continues.

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