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# Impact of spacing on the growth and yield characteristics of okra (*Abelmochus esculentus (L) Moench*) in southern region of Nigeria

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**Abstract**
A research work was carried out to determine the impact of plant spacing on the growth and yield characteristics of okra (*Abelmoschums esculentus (L) moench*) in the Southern Region of Nigeria. The variety used was NHEA47-4 and one factor (plant spacing) was involved. The experiment was conducted at the Teaching and Research Farm of the Department of Crop and Soil Science of Ignatius Ajuru University of Education, Ndele Campus, Rivers State, Nigeria. The treatments were laid out as factorial arrangement in a Randomized Complete Block Design (RCBD) replicated three times. Results from the study showed that while the closest plant spacing (45x30cm) resulted in the highest height, plant spacing (60x45cm) was the best as it gave significant difference in stem diameter, number of leaves, leaf area, number of pod, pod length, pod weight and also seed weight. The planting spacing (60x60cm) was considered undesirable because it favoured more vegetative characteristics but less yield. It is therefore recommended that okra farmers in the Southern Region of Nigeria should adopt plant spacing of (60x45cm) for efficient, attractive and marketable okra pods.

**Keywords:** impact, okra, yield, characteristics, plant spacing, NHAE47-4.

## Introduction

Vegetables play a vital role in the diet of people in the southern Region of Nigeria and the world at large. Most vegetables associated with traditional farming systems are grown as components of multiple-cropping systems. The main types of vegetables found in the Southern Region of Nigeria include; leafy vegetables (e.g. *Amaranthus spp. Telfaria occidentallis* (seeds are also eaten), water leaf (*Talinum trangulare*), bitter leaf, etc. Vegetable with edible fruits like tomato, okra, pepper, pumpkins, garden eggs, green beans; the bulbs, roots and tubers (e.g. Onions and carrots) (Norman, *et al.*, 2004) [21].

Okra (*Abelmochus esculentus (L) Moench*) is one of the vegetable crops with great importance. It is an annual vegetable crops of high level of benefits to the general populace (Adesina and Wiro, 2020) [2]. Okra is an herbaceous plant of the family malvacea, indigenous to tropical Africa and cultivated all over West Africa (Schipper, 2000). It plays a vital role in subsistence food production in both advanced and developing countries (Adeoye, *et al.,* 2005) [1]. The cultivation of okra in intercropping tends to give higher yield than sole crops greater yield stability and efficient utilization of the available nutrients in the soil (Seren and Brintha, 2009) [25]. In the Southern Region of Nigeria, Okra is grown by peasant farmers usually in home gardens or in mixture with cereals and other leguminous crops (Lombin, *et al.,* 2008) [18], Market gardens for okra are common around urban centers. These gardens are often located in valley bottoms and river banks where there is either residual moisture or access to irrigation facilities to support vegetable cultivation during the dry season. Most of the vegetables grows in these farms or gardens are the same as those found in the main farm with okra playing a significant role (Chacko and Reddy 1981) [10]. Okra is a wonder crop in crop cultivation because of its presence does not affect the growth of another crop in any inter-cropping system. Okra is one of the most widely known and utilized species among the crops in the family Malvaceae and an economically essential vegetable crop grown in tropical and sub-tropical parts of the world (Oyeladee*t al.,* 2003). It ranks first among other vegetable crops and had a production proportion of about 6.0 percent of the total staple food production in Nigeria within the period of 1970 – 2003). The production of okra has been widely practiced because of its usefulness to the economic development and can be found in almost all markets in Africa (Babatunde *et al*., 2007) [8]. The nutritional composition of okra includes mineral salts such as calcium, protein, oil, carbohydrate, iron, magnesium, phosphorus, vitamins and minerals and a reasonable quantity of water (Ngbede *et al*., 2014) [20]. Okra production worldwide is estimated at about six million tonnes yearly as India is rated as the highest producer, followed by Nigeria and then Sudan (Varmudy, 2011) [28]. Okra Leaves are considered good for livestock feeds, but this is seldom comparable with the primary use of the plant. It has medically been noted as a plasma replacement or blood volume expander (Kumar *et al*. 2010) [17]. Okra is grown primarily because of its slimy, drawing characteristics which constitute its selling quality and which gives okra soup its viscous quality relished in swallowing garri or fufu by Nigerians (Jannink *et al*., 2000). Young fruits of okra can be eaten raw as fruit. The quantity of oil in the okra seed could be considered to be as huge as that found in poultry eggs and soybean (Akinfasoye and Nwanguma, 2005) [6]. The pods and the leaves are eaten in the southern Region of Nigeria. Okra possesses both essential and non-essential amino-acids which are as large as that contained in cucumber (*Cucumis sativus*), hence it performs a significant function in the nutritive value of man's consumption. Akende *et al*., (2006) [5], stated that

okra is a vital vegetable food item in human nutrition supplying minerals, vitamins, some hormones, protein and energy. Okra flowers can be very attractive and sometimes used in internal decoration of living rooms (Schippers, 2000). The fruits of okra are exported by some African and Caribbean countries to Europe and America where there is a ready demand from the resident ethnic groups from tropical and sub-tropical countries such as West Africans, Indians, Pakistanis, etc (Adetula and Denton, 2003) [3]. In the Southern Region of Nigeria, the limiting factors in okra production and other vegetables include lack of appropriate spacing, weed infestation, poor soil fertility, tillage practices, low yielding varieties, environmental and climatic conditions (Dikwahal, *et al.,* 2006, Adeyemi*et al.,* 2008). Among the great factors confronting the small holder farmers who cultivate okra in southern Region of Nigeria is low productivity due to lack of appropriate plant spacing. This factor tends to discourage farmers from the production of okra on a large scale. Wiro and Ansa (2019) [19], observed that for the peasant (small scale) farmers, the quantity of crop yield and financial earnings realized from their farming operations are adequate to attract them to remain in the farming business. Ansa and Wiro (2018) [7] also reported that the provision of credit facilities by government and other agriculturally based establishment are also necessary to enable farmers to acquire improved farm inputs such as fertilizers, herbicides and farm machinery to increase production capacity of crops. Therefore, research on the adequate planting spacing for okra is essential to boast huge productivity of the crop such that the farmers' earnings will be enhanced. Plant spacing effects population and hence plant competition. The wider or closer the plant spacing, the lower or higher is the plant population respectively. Application of appropriate plant spacing leads to desirable growth, development and high yield productivity while on the contrary, inappropriate plant spacing result to poor performance of crops, thus low quantity and quaintly fruits (Madisa *et al.,* 2015) [19]. Ekwu and Nwokwu (2012) [12], stated that reasonable rigorous tall plants, poor fruit quality and low yield per plant occurred due to intra-specific competition with closer plant spacing than wider plant spacing. Appropriate plant spacing leads to high growth and yield production whereas too low plant spacing or too high plant spacing could result in poor quality and quantity of production respectively (El Naim*et al.,* 2011). Kamalanathan (1989) [16] stated that plant population obtained by inter and intra row spacing is among the factors that contributed to efficient and profitable crop growth, yield and land use. Palanisamy and Ramaswamy (1993) noted that higher plant density achieved through a closer spacing (60x20cm) resulted in higher pods and seed yield in okra than using a wider spacing. Research conducted by Ogbaji, (2001); Asiegbu (1997) and Kamalanathan, 1989) [16] showed that appropriate plant spacing achieved by closer spacing resulted in efficiency and light interception for crops such as okra and eggplant. Also greater lighter interception often increases dry matter production and crop yield. Appropriate plant spacing is therefore a panaceas upon which the desirability of the growth, development and yield of crops is anchored on. This research is aimed at finding the most appropriate planting distance for okra with a view to boosting its production. The research will also add to the available data on okra production in general and its planting distance in particular.

## Materials and Methods

The research study was conducted at the Teaching and Research Farm of the Department of Crop and Soil Science, Ignatius Ajuru University of Education, Ndele Campus, Rives State, Nigeria which is $4^{O}58N$ and longitude $6^{O}48N$. The site was covered with certain vegetation which was removed to give room for the research work. The okra seed used was NHAE47-4 variety which was exotic variety capable of maturing within fifty-five (55) days after planting. The seeds were obtained from the National Horticultural Research Institute (NIHORT) Ibadan, Nigeria. Planting of these okra seeds was carried out on 30th April, 2019. Three (3) seeds were planted per hole at a depth of 2-3cm. germination occurred within four days after planting. Thinning was carried out after two weeks and only one seedling was left per stand. Weeding was done manually after four weeks of planting to keep the field weed free. The experiment involved one factor (plant spacing) comprising four okra spacing.

## Data Collection

Growth and yield characteristics (parameters) of okra were collected and determined. The growth parameters collected were plant height, stem thickness, leaf area, days to flowering, number of branches per plant and number of leaves per plant.

Yield parameters (characteristics) collected and determined were number of flowers per plant, number of flower aborted per plant, pod length, pod yield and seed yield per plant.

## Statistical Analysis

All the data collected (both vegetative characteristics and yield characteristics) of okra were subjected to statistical analysis using the procedure for analysis of variance (ANOVA). Significance mean were compared using the Duncan's New Multiple Range Test (DMRT) at 5% level of significance.

## Soil Analysis

The soil analysis result (table 1) showed that the soil was predominantly sandy loam, an indication of a good water and nutrient holding capacity. The soil was acidic with pH of 6.2. The available phosphorous (mg/kg) was 8.9%. The experimental site showed nitrogen content of 0.9 and the organic carbon and organic matter contents were 0.5% and 1.4% respectively.

**Table 1:** Physico-chemical properties of the experimental site

| Physical characteristics | 2019 |
|---|---|
| Sand (%) | 83.20 |
| Silt (%) | 11.40 |
| Clay (%) | 5.40 |
| Textural class | Loamy sand |
| Chemical properties | |
| pH ($H_2O$) | 6.2 |
| Organic carbon (%) | 0.5 |
| Total nitrogen (%) | 0.9 |
| Available potassium (mg $Kg^{-1}$) | 8.9 |
| Exchangeable K (cmol $kg^{-1}$) | 0.2 |
| Exchangeable Ca (cmol $kg^{-1}$) | 1.4 |
| Exchangeable Mg (cmol $kg^{-1}$)* | 0.7 |
| Effective caution exchange capacity (cmol $kg^{-1}$) | 2.5 |
| Base saturation (g/kg) | 92.30 |

***Source:*** Department of Agronomy University of Ibadan, May, 2019.

## Results and Discussions

**Table 2:** Impact of spacing on the vegetative growth characteristics of okra

| Treatment | Plant Height ($cm^2$) | Stem Thickness ($cm^2$) | No. of Leaves | Leaf Area ($cm^2$) | No. of Branches | No. of days to flowering |
|---|---|---|---|---|---|---|
| 45x30cm | $34.6^a$ | $3.6^d$ | $6.7^d$ | $3.9^d$ | $5.4^a$ | $40^a$ |
| 60x30cm | $30.1^b$ | $4.1^c$ | $8.8^c$ | $4.4^c$ | $4.3^b$ | $45^b$ |
| 60x45cm | $25.3^c$ | $5.6^b$ | $10.7^b$ | $5.6^b$ | $3.6^c$ | $45^b$ |
| 60x60cm | $20.2^d$ | $6.0^a$ | $11.3^a$ | $6.2^a$ | $3.1^d$ | $48^c$ |
| Mean | 27.6 | 4.8 | 9.2 | 5.0 | 4.1 | 44.5 |
| SE± | 13.8 | 2.4 | 4.6 | 2.5 | 2.1 | 22.3 |

***Source*:** Research work 2019

Result showed that plant spacing significantly (P<0.05) influenced the growth and development characteristics of okra (Table 2). The closest plant spacing 60x30cm significantly (p<0.05) increased plant height as compared to the widest plant spacing (60x60cm). This observation was also reported by Madisa *et al.,* (2015) [19]. This behavior of the closer plant spacing might be due to the competition for growth resources especially sunlight among the crowded plants of the closer plant spacing plants grow taller because of struggle to receive enough sunlight from upper region. These results are in consonance with the observations of Ekwu and Nwokwu (2012) [12] who reported significant noticeable tall plants with closer plant spacing than wider plant spacing due to competition with other okra plants.

Plant spacing also had a significant impact on the number of leaves per plant and stem thickness. The highest number of leaves per plant (11.3) was recorded in the wider plant spacing (60x60cm) and the least number of leaves per plant (6.7) was observed in the closer plant spacing (45x30cm). this is indicated in table 3. The low competition for light, nutrient space, water and air as well as reduced overlapping from nearby okra plants within the canopy of the wider spacing (60x60cm) enabled the plants to efficiently use the available resources for maximum reproduction of larger leaf area as shown in table 3 above where the leaf area for 45x30cm and 60x60cm is 3.92 and 6.22 respectively. Also, okra plants of the close spacing had very thin stems in the experiment (3.6) in 40x35cm okra spacing while 60x60cm okra spacing resulted in (6.0) stem thickness. The same improvement and record on growth characteristics of okra plants and its enhancement in photosynthesis and usage of available resources in the metabolic activities have been observed by Bhatt *et al.,* (2011) [9] and Parmar *et al.,* (2013) [23].

**Table 3:** Impact of spacing on the yield characteristics of okra

| Treatment | No. of flowers | No. of flowers aborted | Pod length | Pod weight | Seed yield per plant | Pod diameter |
|---|---|---|---|---|---|---|
| 45x30cm | $6.8^c$ | $2.9^c$ | $5.0^c$ | $15.1^c$ | $82.0^c$ | $1.6^c$ |
| 60x30cm | $7.6^b$ | $2.7^b$ | $6.9^b$ | $18.3^b$ | $90.4^b$ | $2.0^b$ |
| 60x45cm | $8.1^a$ | $2.0^a$ | $7.4^a$ | $20.0^a$ | $100.1^a$ | $2.7^a$ |
| 60x60cm | $5.9^d$ | $4.0^d$ | $4.4^d$ | $12.4^d$ | $75.8^d$ | $1.2^d$ |
| Mean | 7.1 | 2.9 | 4.7 | 16.5 | 87.1 | 1.9 |
| SE± | 3.6 | 1.5 | 2.4 | 8.3 | 43.6 | 1.0 |

***Source:*** Research work 2019

Spacing also played a significant function in the yield characteristics of the crop. Okra pod diameter, pod length, pod weight and even seed weight were all significantly different as observed in the experiment. Plant spacing of 45x30cm resulted in (5.0cm) pod length, (15.1g) of pod weight and (82.0g) seed weight. Okra spacing of 60x30 resulted in a better yield characteristics of okra than the 45cmx30cm. but the best yield components of okra was observed in spacing of 60x45cm with (7.4cm) pod length, (20.0g) pod weight and (100.1g) of seed weight. Fruit size in the closer plant spacing (45x30cm) was small, unattractive and not very marketable. The high plant density associated with the closer plant spacing gave room for high competition of the available resources for growth development and yield was highest. This situation of high plant competition was unhealthy for okra growth and yield development. These results are in conformity with Ijoyah *et al.,* (2010) [14], Madisa *et al.,* (2015) [19] that application of appropriate plant spacing gave rise to palatable and desirable growth, development and optimum fruit yield of okra. Okra fruit yield increased with increasing plant spacing. The findings of Paththinige *et al.,* (2008) [24] and Uddin *et al.,* (2006) [27] supported the findings of this research study.

But the okra spacing of (60x60cm) gave more vegetative growth because the excess nutrients available were utilized in vegetative characteristics rather than yield of the crop.

## Conclusion

Based on the result of this research, okra (NHAE47-4) could be produced at maximum yield per plant with the adoption of appropriate plant spacing. The highest yield was recorded at the spacing of 60x45cm while the plant spacing of 45x30cm (closer spacing) resulted in the worst productivity of small, unattractive, unpalatable and unmarketable pods. The okra farmers in the Southern Region of Nigeria are therefore advised to adopt the plant spacing of 60x45cm for maximum production of okra. This advice (recommendation) will give a huge return on their investment.

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