EFFECTS OF DIFFERENT PLANT POPULATION DENSITIES AND SPACING ON GROWTH AND YIELD OF OKRA

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Abstract

An experiment was carried out to investigate the effects of different plant spacing and population densities on growth and yield of Abelmoschus esculentu.s in Agbor, Ika South Local Government Area Delta State. The experiment was conducted in Randomized Complete Block Design and was replicated three times. Plant spacing were 120 cm x 100 cm, 100 cm x 80 cm, 80 cm x 60 cm, 60 cm x 40 cm and 40 cm x 30 cm. The plant densities were 11 plants/stand, 9 plants/stand, 7 plants/stand, 5 plants/stand and 3 plants/stand. The variables measured were plant height, number of leaves, flowers and weight of harvested pods. Data were collected at six weeks after emergence. The data collected were subjected to analysis of variance (ANOVA) and the means obtained were separated using Duncan Multiple Range Test (DMRT). The results revealed that plants planted at population density of 11 plants/stand and planting spacing of 40 cm x 30 cm 13 cm harvesting height were superior over others in in plant height, while those planted at plant density of 3 and 5 plants/stand and plant spacing of 80 cm x 60 cm out yielded others in number of leaves, flowers and weight of pods. It is therefore, recommended that the plant should be planted at a plant spacing of 80 cm x 60 cm and plant population density of 5 cm.

Keyword: Okra, plant spacing, density, growth, yield

Introduction

Okra (Abelmoschus esculentus) belongs to the family Malvaceae. It is an annual plant, which possibly of Ethiopian origin and is grown for its edible pods. It is commonly grown in the tropics especially tropical Asia, Africa and Caribbean (Dominica and Bassey, 2016). Okra is popular vegetable worldwide. The fruits and young leaves are sliced and used in various delicacies in different parts of the world. In Nigeria, it is popular for soups and sauces that are prepared for eba, fufu and amala. Okra is a source of vitamins and minerals. The abundant of antioxidants and polyphenols present in the plant help to support the storage of the glycogen in the liver and increase the energy levels and reduce fatigue. In most pharmaceutical companies, the extract of the plant is used as a tablet binder and suspending agent in medicine. It is used for the treatment of irritation and inflammations. The consumption of it helps to prevent constipation, lower blood sugar and cholesterol as a result of very low fat and carbohydrate contents. In some poor countries, it is a source of protein (Obi, 2015).

There are different varieties of okra, which vary in plant height, size of fruit, colour and duration of maturity. The plant does not do well in tight, waterlogged soils, but will tolerate a soil pH range of from 6.0 to 7.5. It performs well when grown on soil that is incorporated with organic matter. Okra requires warm climates adequate sunshine and evenly distributed moderate rainfall for growth. The quality and quantity of these growth resources received by plants depend on the plant population density and spacing. When crops are grown at closed plant spacing and high population density below recommendation, it may result to low yield because the carrying capacity is high as more crops will be depending and competing for these limited resources. Moreover, if plants are grown on wider plant spacing at lower population density above recommendation, these could lead to wastage of growth resources as there would be fewer population of plants/ha. Therefore, the objective of this work is to determine the appropriate plant population density and spacing suitable for the growth of okra.

MATERIALS AND METHODS

Experimental Site: The field work was conducted in the Agbor. Agbor is in Ika South local Government Area, Delta State, Nigeria.

THE DESCRIPTION OF THE AREA OF STUDY

Soils of the area of study: On the basis of FAO genetic classification scheme, Agbor soils are classified ferralsols. The soil are deeply weathered red and yellowish brown soils with abundant free iron oxides but generally without a lateritic iron plan layer. The ferralsol are mostly loams, their nature makes them easy to cultivate, they suffer from excessive internal drainage and intensive leaching, given them a very strong acid reaction (Ideh, 2006).

Vegetation and Climate: Agbor lies in the tropical rainforest zone and it is one of the towns in the dissected upland physiographic areas. The upland physiographic nature of the land is the most important hydrographic center in

Delta State. Agbor river called Orogodo river is one of the sources of the major rivers in Delta state. Agbor lies on latitude $6^{o}26^{/}$ North, longitude $6^{o}18^{/}$ East of the equator at 153 m elevation above the sea level. It is characterized rainfall ranging from 1300 to 1649 mm. (Okafor, 2010). The high humidity over 80 % and the long wet season 8 to 10 months ensures adequate supply of water and the continuous presence of moisture in the air. The mean daily temperature for northeastern zone of Delta state where Agbor is located ranges from 26 to 35°C with an average of 26°C in August when skies are heavily overcast and cloudy.

Pre-planting soil analysis: Representative soil (0 cm – 15 cm) was collected with sampling augur. The samples were air dried at room temperature (25 ^{O}C) for five days and pulverized to pass through a 2 mm mesh sieve. The sample was analyzed to determine the physical and chemical properties of the soil.

Seed procurement and planting: Seeds were obtained from the local market.

Experimental site preparation: The experimental sites were cleared with cutlass. The debris was gathered bundle out and the site measured marked and divided into three portions as replicates. Each plot was measured 5 m by 5 m separated 0.5 m apart between plots and 1 m between replicates.

Experimental design: This experiment was Randomized Complete Block Design (RCBD), replicated three times. There were a total of 25 plots. The various treatments consist of plant population densities of 11, 9, 7, 5, and 3 seeds/stand and plant spacing of 120 cm x 100 cm, 100 cm x 80 cm, 80 cm x 60 cm, 60 cm x 40 cm and 40 cm x 20 cm. The variables measured were plant height, which was measured with metal rule, number of leaves, flowers and pods were by direct counting and weight of pod, which was by weighing the pods on electronic weighing machine. Data were collected at weekly interval after emergence except the number of flowers, pods and weight of pods that were collected from the fifth to eighth week. The data collected were subjected to analysis of variance (ANOVA) and the means obtained were separated using Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

1 Pre – planting soil physical and chemical properties of the experimental site

The texture of the soil of the experimental site was sandy loam due to the effects of the parent material from which the soil was formed and the weather condition of Ika land. Probably the soil was formed from sand stone and quartz parent material these give a feature of sand texture to the soils. The high sand content of the soil may be as a result of high content of quartz in the parent materials (Bill, 2009).

The weakly acidic nature of the soil of the area may be traced to the marked leaching of exchangeable bases resulting from high rainfall associated with the environment and disassociation of strong and functional group in the organic matter. This is in accordance with the findings of Osagie (2004). The low organic matter content of the experimental site could be due to the effects of erosion that was very common in the area as a result of the topography of the soil. It could also be as a result indiscriminate seasonal bush burning which takes place in early January to April annually, continuous cropping which tends to deplete organic matter accumulation in the soil or leaching of nitrate by torrential rainfall prevalent in the area (Tessy, 2004). The low level of total nitrogen could be possibly due to low organic matter content of the soil which is a major contributor to soil nitrogen (Okoh, 2000 and Umezie, 2002). The low level of phosphorus in the soil may be attributed to the parent material in which the soil was formed from which probably is low in phosphorus or farmers failing to replenish the soil with phosphorus soil amendment materials during the cropping season (Wilfred, 2014). The low level of exchangeable cation may be attributed to the leaching of bases from the top soil to the layers where plant roots cannot reach them due to the prevailing high rainfall in Ika area. The low cation exchange capacity attributed to the parent material from which the soil is formed and low organic matter content of the soil as well as the low C.E.C of the soil (Udenwa, 2001). The exchangeable acidity was low probably because of leaching of basic cations by torrential rainfall, bush burning and plant uptake. The result is in accordance with the findings of Victor (2002) who reported that most soils of Southern Nigeria are poor in nutrients due to intense rainfall, soil erosion, nutrients depletion through leaching and continuous cultivation of land without adequate replenishment of used soil nutrients.

Table 1. Physico-chemical properties of experimental site

Soil properties	Soil values
Sand (%)	86.7
Clay (%)	3.3
Silt (%)	10.0
Textural class	Sandy loam
Soil pH	
H_2O	5.8
KCl	4.0
Organic carbon (g/kg)	1.0
Organic matter (g/kg)	1.5

Total N (g/kg)	0.1
Available P. (mg/kg)	9.1
Exchangeable bases (cmol/kg)	
K	0.8
Mg.	0.9
Na	0.4
Fe	80.0
Ca	0.7
Exchangeable acidity (cmol/kg)	
Cation Exchange Capacity	4.1
Effective Cation exchange capacity (ECEC)	3.6

Plant height declined with higher plant population and wider plant spacing. The plant height of plants grown at plant spacing of 11 plants per stand at 40 cm x 20 cm were taller than others, followed by those of 9 plants per stand at 60 cm x 40 cm plant spacing. (Fig.1).This may be due to the competition for sunlight among the plants planted at closest plant spacing and high population density which they required for photosynthesis. This is in line with Huber, Kluze and Yetley, (2011) who reported that plants grow rapidly taller as a mechanism to avoid shade when they are overcrowded because they are closely planted or if the planting density per stand is high. Messi (2006) stated that competition for light endangers the survival of plants growth and reproduction of the individual plants in a closed stands. Plants that do not receive sufficient light may not produce enough carbohydrate through photosynthesis and often die. Light is derived from only one resource, which is the sun. Taller plants tap more sunlight and prevent the rays of the sunlight with their overlapped leaves from reaching the shorter competitors.

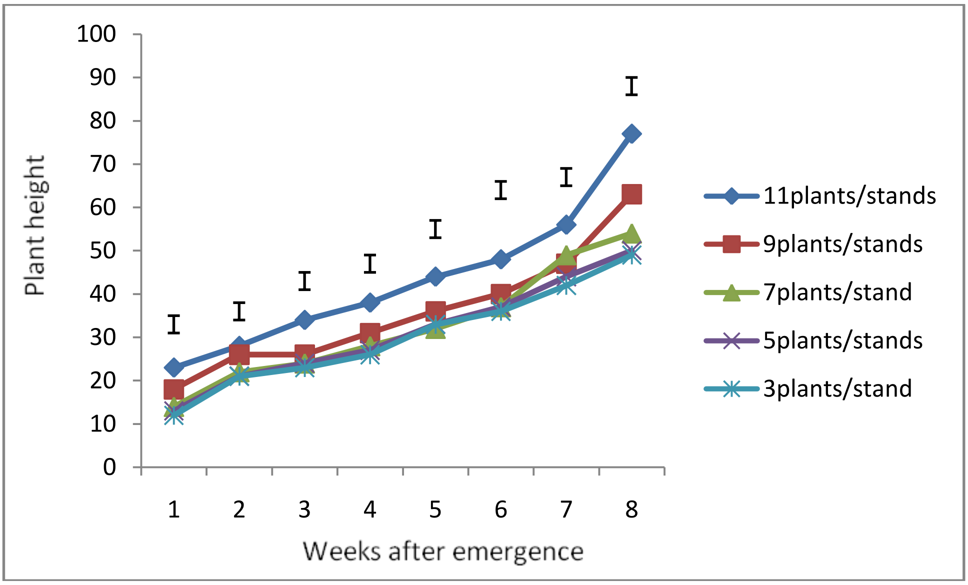

Fig. 1 Effects of different plant population densities on plant height (cm) of Okra. The bar represents LSD at 5% level of probability.

There was significant difference among the plant population per stand in the number of leaves. Plants grown at 5 plants per stand had more number of leaves than others with an average value of 27 followed by 3 plants per stand with a value of 23 (Fig. 2). With respect to plant spacing, those planted at 80 cm x 60 cm had more number of leaves than others, followed by 80 cm x 60 cm. This could be as a result of effect of competition they faced especially for growth resources caused by overcrowding. This corroborates the findings of Aghedo (2001) who reported that when the number of plants per hectare exceeds what it ought to be per hectare, the plants will experience difficulties in receiving direct sunlight from the sun. This may adversely affect the production of leaves in plant. (Nishimura,*el al* 2010). Izuchukwu (2002) stated that with increase in plant densities, there will be reduction in the number of leaves per plant, expansion of leaf and individual plant canopy.

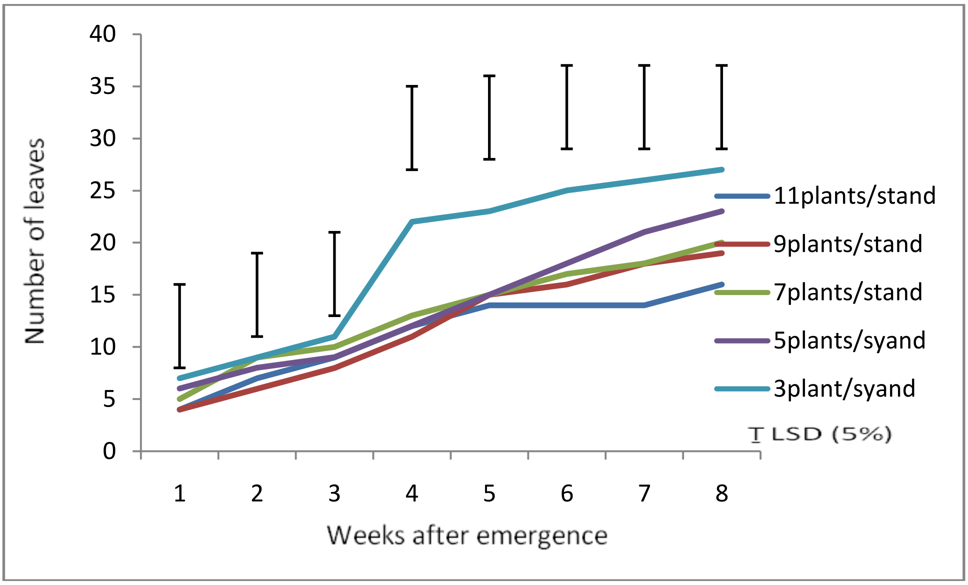

Fig. 2. Effects of different plant population densities on number of leaves of Okra. The bar represents LSD at 5% level of probability.

The number of flowers is presented in Fig. 3. It showed that there was significant difference in the number of flowers produced by the plants grown in different plant spacing and densities. Plants grown in population density of 5 plants/stand had more number of flowers at the eighth week than others with value of 22/stand, followed by those of 3 plants/stand which had value of 15 flowers/stand, while the least was those of 11 plants/stand with average value of 7 flowers. With respect to plant spacing, those planted at plant spacing of 80 cm x 60 cm exhibited superiority over others. This was followed by those of 60 cm x 40 cm. This could be attributed to the fact that the carrying capacity of the land is capable of providing sufficient growth resources for plant at such plant spacing and population density. This is similar to Idoye and Kola (2003) which stated that when plants are grown in suitable plant spacing and population density, it increases the vigour and hence productivity.

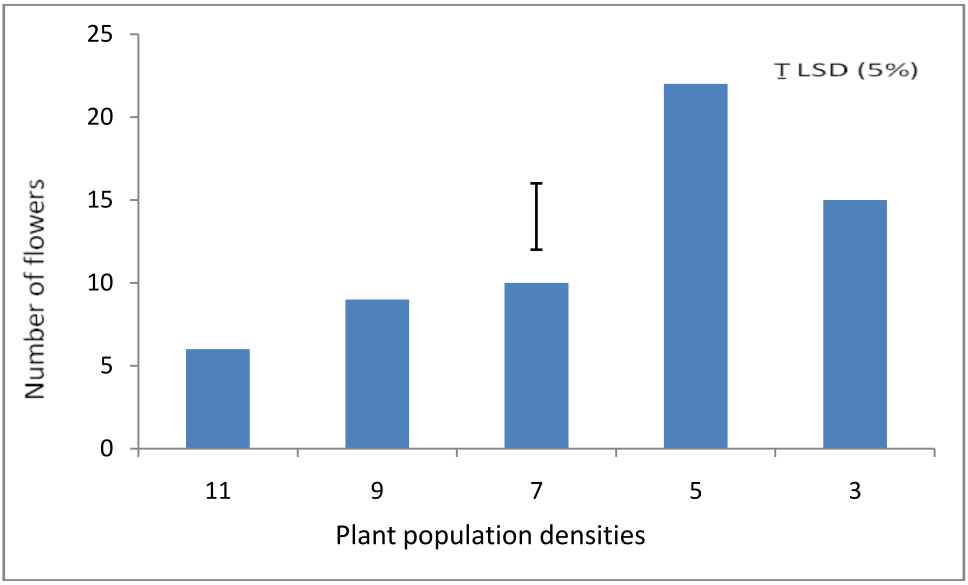

Fig. 3. Effects of different plant population densities on number of flowers of Okra. The bar represents LSD at 5% level of probability.

The results of weight of freshly harvested pods revealed that plants grown at plant spacing 120 cm x 100 cm and 100 cm x 80 cm were not significantly different from each other, but were significantly different ($P<0.05$) from others. With regard to the plant density, plants grown at 3 plants/stand and 5 plants/stand were similar in weight of freshly harvested pods and they exercised superiority over others. Evidence from the experimental work showed that there was lesser competition among the plants for growth resources. The result is similar to the findings of Bando *et al* (2000) that *Okra* plant pods weight heavier if plants are not planted closely or in a highly populated density per stand. This is because there is no competition among them which could equally affects the vigour of the plant hence weight of pods.

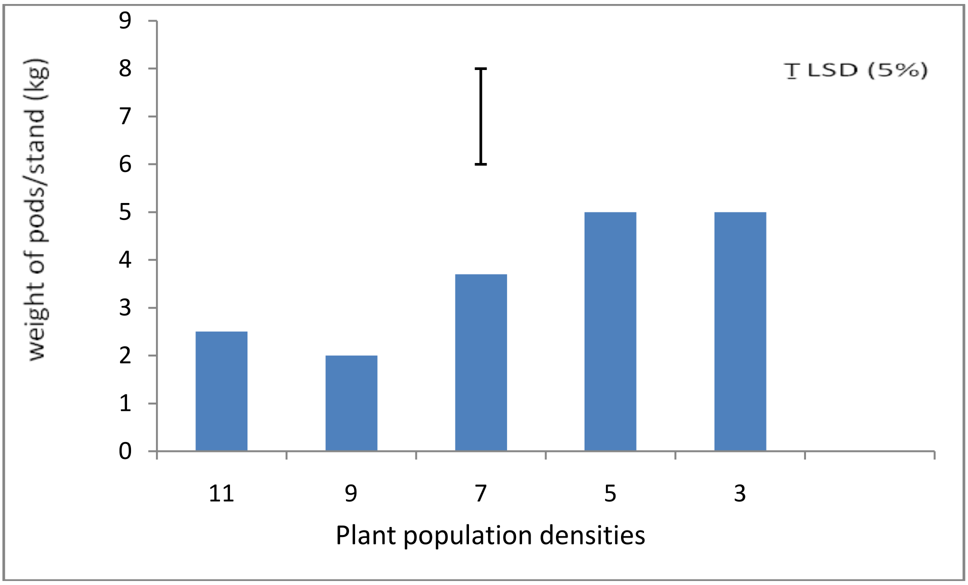

Fig. 4. Effects of different plant population densities on weight of pods of Okra. The bar represents LSD at 5% level of probability.

Conclusion

The research on the effects of different plant spacing and population densities on the growth and yield of okra plant showed that with exception of plant height, number of leaves, flowers and weight of pods are favoured by wider plant spacing and fewer number of plants/ stand.

This study has elucidates information on decline in okra production with increase in plant densities and reduction in plant spacing. It is therefore, recommended that okra should be planted at 3 to 5 plants/stand at plant spacing of 120 cm x 100 cm or 100 cm x 80 cm for effective use of growth resources.

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