COMPARISON OF WEED SUPPRESSION ABILITY AND YIELD OF TWO OKRA CULTIVARS AND WITH DIFFERENT PLANTING DENSITY †

[COMPARACIÓN DE LA CAPACIDAD DE SUPRESIÓN DE MALEZAS Y RENDIMIENTO DE DOS CULTIVARES DE OKRA CON DIFERENTE DENSIDAD DE PLANTAS]

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SUMMARY

Background: Planting density, resulting in specific population can be a determining practice in the cultivation of Okra (*Abelmoschus esculentus* [L] Moench). **Objective:** Field experiments were conducted at the Federal University of Agriculture, Abeokuta, Nigeria to study the effects of planting density on weed suppression, growth and pod yield of Okra Cvs: NHAe 47-4 and LD 88 during the early and late growing seasons of 2013. **Methodology:** Plants were established at 100 x 50 cm at densities of 1, 2 and 3 plants.stand^{-1} (25,000; 50,000 and 75,000 plants.ha^{-1}). **Results:** Okra plants were generally taller in the late season, relative to the early season but were comparable with planting density with both cultivars in the two seasons. Number of leaves.plant^{-1} was also similar with the cultivars but reduced with increasing plant density. Leaf area was higher with 1 plant.stand^{-1} in the early season but comparable with higher densities in the late season. Okra growth was generally higher with NHAe 47-4. LD 88 gave a higher cummulative pod yield than NHAe 47-4. **Conclusion:** LD 88 is better sustained with 3 plants.stand^{-1} but cultivation of NHAe 47-4 is better sustained with 1 or 2 plants.stand^{-1} density. LD 88 controls weed growth better than NHAe 47-4. Plating density does not affect weed growth.
Keywords: *Abelmoschus esculentus;* cultivars; pod yield; weed growth.

RESUMEN

Antecedentes. La densidad de siembra, que resulta en una población específica, puede ser una práctica determinante en el cultivo de la okra (*Abelmoschus esculentus* [L] Moench). **Objetivo**. Se realizaron experimentos de campo en la Universidad Federal de Agricultura de Abeokuta, Nigeria, para estudiar los efectos de la densidad de siembra en la supresión de malezas, el crecimiento y el rendimiento de vainas de Okra Cvs: NHAe 47-4 y LD 88 durante las temporadas de crecimiento temprano y tardío de 2013. **Metodología**. las plantas se establecieron a 100 x 50 cm en densidades de 1, 2 y 3 plantas.poceta^{-1} (25,000; 50,000 y 75,000 plantas.ha-1). **Resultados.** las plantas de okra fueron generalmente más altas al final de la temporada, en relación con la temporada temprana, pero fueron comparables entre las densidad de siembra con ambos cultivares en las dos estaciones. El número de hojas.planta^{-1} también fue similar entgre los cultivares, pero se redujo al aumentar la densidad de la planta. El área de la hoja fue mayor con 1 planta.poceta^{-1} en la temporada temprana, pero comparable con densidades más altas en la temporada tardía. El crecimiento de okra fue generalmente mayor con NHAe 47-4. LD 88 dio un rendimiento de vaina acumulativo más alto que NHAe 47-4. **Conclusión**. LD 88 se sostiene mejor con 3 plantas.poceta^{-1} pero el cultivo de NHAe 47-4 se sostiene mejor con 1 o 2 plantas.poceta^{-1}. LD 88 controla el crecimiento de malezas mejor que NHAe 47-4. La densidad no afecta el crecimiento de malezas.
Palabras clave: *Abelmoschus esculentus*; cultivares; rendimiento de vaina; crecimiento de malezas.

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INTRODUCTION

Okra, [*Abelmoschus esculentus* (L.) Moench] is a popular vegetable grown for its immature fruits and young leaves throughout the tropical and sub-tropical parts of the world and consumed all over the world (BSADP, 1995). In west and central Africa, okra is often grown in compound gardens alone or in mixtures with other staple crops (Yayock et al., 1988). The importance of okra lies in the "draw" or mucilaginous properties of the immature fruits and young leaves which aid easy consumption of bulky staple foods. Okra is a good source of protein, vitamins and mineral elements needed for the development and maintenance of the human body. The immature fruits are eaten either fresh or cooked by boiling or frying. The immature young leaves are used for preparing soups and a good source of gum (Martin, 1982). The mature stems contain crude fibre which is used in decorating living rooms (Schippers, 2000). Okra is a popular health food due to its high Fiber, Vitamin C and folate content. Okra is also known for being high in antioxidants. It is also a good source of calcium (Duvachelle, 2011). Greenish yellow edible okra oil is pressed from okra seeds. It has a pleasant taste and odour, and is high in unsaturated fats such as oleic acid and linoleic acid (Martin, 1982). The seeds are utilized potentially as a good source of oil in the tropics. Okra variety NHAe 47-4 is a day-neutral plant, with deep green, broad leaves and moderate canopy length. It is popular for its early maturity (60 days) and high pod yield. It is an open pollinated line. It is short-growing (45 cm), early flowering (40-50 days), stout, with deep green spiny fruits with good drawing quality. Average fruit weight is about 11.7 g. Its pods are prized for their unique flavor, high mucilagenous content and moderate size. These attributes are highly acceptable to most farmers and they are valued by customers in south western Nigeria. The variety is moderately resistant to okra mosaic virus (Alegbejo, 2003). LD 88 is a variety with green long leaves. The leaves are not as broad as that of NHAe 47-4. The fruits are spineless and also thinner and longer. It is a late-maturing crop. It is an open pollinated line, tall growing (65 cm), medium maturing and takes 50-66 days to flowering. It has deep green smooth fruits with good drawing quality. Average fruit weight is about 12g. Fruits are suitable for export. Okra production is greatly influenced by agronomic practices, among them; plant population, as a result of density is one of the important factors that greatly influence the growth and yield. One of the constraints to okra production is the low adoption of improved management practices in the small scale production systems most often characterized by extensive cultivation technology (Grubben and El-Tahir, 2004) due to inadequacy of agronomic research base to address the yield- limiting problems. There is inadequate information on planting density that would contribute to the expected high yield in large scale production systems. Muoneke and Asiegbu (1996) observed significant decreases of pod yield per plant and yield components with increasing plant density. Increasing plant population may result in growth and yield decreases due to inter and intra specific plant competition for growth factors. Planting density is a management variable that affects the production and quality of most crops. Increasing planting density usually results in the production of more but smaller roots or fruits. Planting density can influence maturity (Edmisten, 2007). Low plant populations may also result in delayed maturity (Siebert and Stewart, 2006) and reduce harvesting efficiency due to increased branching (Gannaway et al., 1995). Weed infestations are known to reduce crop growth and yield. Planting density can affect crop growth and consequently affect weed growth.

The study was conducted to evaluate the ability of two okra varieties to suppress weeds at various planting densities. It also evaluated the effects of planting density on yield of the two okra varieties.

MATERIALS AND METHODS

The experiment was conducted at the Federal University of Agriculture, Abeokuta, Nigeria (latitude 7º 15′ N; longitude 30º 25′E; altitude 100 m above sea level), during the wet season (April to August) and repeated in the early dry season (October to December) in 2013.The site is characterized by bimodal rainfall pattern with a long rainy season from late March to July followed by a short dry spell in August. The short rainy season extends from September to early November. The two varieties (NHAe 47-4 and LD 88) were sourced from the National Institute of Horticultural Research (NIHORT), Ibadan, Oyo State, Nigeria. Mechanical ploughing was done twice, at two weeks interval and harrowed after another two weeks. The field was thereafter laid out and marked into main and sub-plots. The experiment was laid out in a split-plot arrangement fitted in a randomized complete block design, with three replicates. Main plot was okra variety (NHAe 47-4 and LD 88). Planting density (1, 2 and 3 plants.stand^{-1}) was assigned to the sub-plots. Main plots were 48 x 18 m and sub plots were 3 x 5 m. Sowing of okra seeds was done in June in the wet season and October in the dry season of 2013 at 100 x 50 cm spacing.1 plant.stand^{-1} (20,000 plants.ha^{-1}); 2 plants.stand^{-1} (40,000 plants.ha^{-1}); 3 plants.stand^{-1} (60,000 plants.ha^{-1}). Thinning was carried out at two weeks after planting (WAP) to achieve the required number of plants.stand^{-1}. Basal fertilizer application of 400 kg.ha^{-1} NPK 15-15-15 was carried out at 2 WAP by drilling method (IAR&T, 1991). Weeding was carried at 2, 4 and 6 WAP using West African hoe to ensure full crop establishment, without weed interference. Foliar pests were controlled with application of 400 mL/ha Cymbush® 10EC (containing 100 g/L Cypermethrin in 500 L of water) at 6 WAP.

Five sample plants were randomly selected per plot from four inner rows for various parameter measurements at weekly interval from 3 to 8 WAP to determine plant height, number of leaves per plant, and leaf area to assess plant growth. Plant height was measured from the ground level to the growing tip. Numbers of fully expanded leaves were counted. Leaf area was estimated by the non-destructive method of Olasantan and Salau (2008). Days to first pod harvest, number of harvests, and duration of harvest were determined. Fruit harvest of green immature pods was done at three days interval, commencing from 8 WAP over a period of 5 weeks in the early season and 4 weeks in the late season. Weed samples were taken from 50 x 50 cm quadrat at the middle of the plots. Weed density was taken with the use of a 50 x 50 cm quadrat. Weeds within the quadrat were counted, weighed fresh and then oven dried at 70 °C to get the constant weight for dry matter determination.

Data obtained were subjected to Analysis of Variance (ANOVA) using SAS (Statistical Analysis System, 1990) while treatment mean separation was done by the use of Least Significant Difference (LSD) at 5% level.

RESULTS

Total rainfall during the early season was 294 mm but was 127 mm during the late season. Relative humidity range was between 70 and 77 % in the early season but between 58 and 60 % in the late season. Maximum temperature was 30ºC in the early season but 33.0 ºC in the late season while minimum temperature was 21.1ºC in the early season but 24.2 ºC in the late season. The longest sunshine duration was 5.2 hrs in the early season but 6.4 hrs in the late season.

Both cultivars, at all the planting densities were comparable in height, ranging between 27 and 32 cm. In the early season, LD 88 planted at 1 plant.stand^{-1} had the thickest stems of 17 mm (Table 1) that were thicker than 14. 5 mm from NHAe 47-4 planted at 1 plant.stand^{-1}. Planting LD 88 at 3 plants.stand^{-1} had the thinnest stems (7.2 mm); thinner than 9.3 mm from NHAe 47-4 planted at 3 plants.stand^{-1} (Table 1). In the late season, NHAe 47-4 planted at 1 plant.stand^{-1} had the thickest stems (20.8 mm) that were thicker than with planting at 2 plants.stand^{-1} (14. 6 mm) and with planting at 3 plants.stand^{-1} of both varieties (Table 1). In the early season, LD 88 planted at 1 plant.stand^{-1} had the highest number of leaves.plant^{-1} (8.5) that was comparable with NHAe 47-4 also planted at 1 plant.stand^{-1} (8.3). However, in the late season, NHAe 47-4 planted at 1 plant.stand^{-1} had the highest number of leaves.plant^{-1} (11.5) that was higher than from LD 88 planted at 1 plant.stand^{-1} (10.4). Planting at either 2 or 3 plants.stand^{-1} for both varieties had lower number of leaves.plant^{-1} (Table 1). NHAe 47-4 planted at 1 plant.stand^{-1} had the highest leaf area (324 cm^2) that was comparable with planting at 2 plants.stand^{-1} (217 cm^2) and also with LD 88 planted at 1 plant.stand^{-1} (282 cm^2). Others had lower leaf areas (Table 1). In the late season, leaf area was similar with both varieties at the 3 planting densities.

In the early season, planting LD 88 at 3 plants.stand^{-1} gave the highest pod yield of 1105 kg.ha^{-1} (Table 2). Planting at 2 plants.stand^{-1} gave a lower yield of 808 kg.ha^{-1} that was comparable with 697 kg.ha^{-1} yield from planting at 1 plant.stand^{-1}. Planting NHAe 47-4 at 2 plants.stand^{-1} gave a yield of 611 kg.ha^{-1} which was only comparable with the lowest of 697 kg.ha^{-1} from planting LD 88 at 1 plant.stand^{-1}. Planting NHAe 47-4 at either 1 or 3 plants.stand^{-1} gave lower yields (Table 2). In the late season, LD 88 planted at 3 plants.stand^{-1} gave its highest yield of 715 kg.ha^{-1}, while cultivating NHAe 47-4 at 1 plant.stand^{-1} gave its highest yield of 589 kg.ha^{-1} (Table 2).

In the early season, the smallest pods of 7.06 mm girth from LD 88 at 2 plants.stand^{-1} were comparable with the biggest pods of 9.48 mm from NHAe 47-4 at 2 plants.stand^{-1} (Table 2). In the late season, the biggest pods of 8.59 mm girth were bigger than the lowest of 6.65 mm pods of LD 88 cultivated at 2 plants.stand^{-1}. Others were comparable with both the biggest and the smallest pods. Cultivating LD 88 at either 1 or 3 plants.stand^{-1} had pods about 52 cm long that were comparable with cultivating NHAe 47-4 at 1 plant.stand^{-1} that had pods 43 cm long, in the early season. In the late season, cultivating both varieties at 2 plants.stand^{-1} had pods 43 cm long which were comparable with cultivating LD 88 at 3 plants.stand^{-1} that had pods 49 cm long (Table 2).

Table 1. Interaction of variety and planting density on growth of okra at 6 WAP*.

		Early season			Late season	
Variety	Planting density	Stem girth (mm)	No. of leaves.plant^{-1}	Av. Leaf area (cm^2)	Stem girth (mm)	No. of leaves.plant^{-1}
NHAe 47-4						
	1 plant.stand^{-1}	14.47	8.30	324.00	20.77	11.50
	2 plants.stand^{-1}	10.53	7.20	217.00	14.59	7.70
	3 plants.stand^{-1}	9.3	6.2	146.0	11.7	6.8
LD 88						
	1 plant.stand^{-1}	17.00	8.50	282.00	18.50	10.40
	2 plants.stand^{-1}	10.40	6.70	137.00	15.65	6.80
	3 plants.stand^{-1}	7.20	6.40	150.00	14.96	6.90
LSD (0.05)		3.2	1.1	152.3	5.8	0.9

*Weeks after planting

Table 2. Interaction of variety and planting density on fruit yield and yield attributes of okra.

		Early season			Late season		
Variety	Planting density	Yield (kg.ha^{-1})	Fruit girth (mm)	Fruit length (cm)	Yield (kg.ha^{-1})	Fruit girth (mm)	Fruit length (cm)
NHAe 47-4	1 plant/stand	238.00	8.33	42.90	589.00	8.21	43.10
	2 plants/stand	611.00	9.48	48.70	360.00	8.50	43.00
	3 plants/stand	380.00	8.46	44.90	481.00	8.59	45.40
LD 88							
	1 plant/stand	697.00	8.56	52.50	366.00	7.48	47.40
	2 plants/stand	808.00	7.06	45.30	520.00	6.65	43.00
	3 plants/stand	1105.00	8.40	52.30	715.00	7.61	49.50
LSD (0.05)		242.5	3.6	11.4	368.0	1.9	10.6

Planting LD 88 at 3 plants.stand^{-1} in the early season, had its lowest weed density of about 11 weed plants.m^2 and its highest of 13 weed plants.m^2 at 2 plants.stand^{-1} while planting NHAe 47-4 at either 2 or 3 plants.stand^{-1} had about 15 weed plants.m^2 when 1 plant.stand^{-1} had about 16 weed plants.m^2 (Table 3). Cultivating LD 88 at 3 plants.stand^{-1} in the late season had its lowest of 9 weed plants.m^2 and its highest of 11 weed plants.m^2 from 2 plants.stand^{-1}, while cultivating NHAe 47-4 at 1 plant.stand^{-1} had its highest of about 13 weed plants.m^2 and its lowest of 12 weed plants.m^2 from either 2 or 3 plants.stand^{-1} (Table 3). In the early season, LD 88 planted at 3 plants.stand^{-1} gave the lowest weed biomass of 16.7 g.m^2, followed by NHAe 47-4 at 2 plants.stand^{-1} that gave a weed biomass of 17.0 g.m^2. The highest of 21.0 g.m^2 was from NHAe 47-4 at 1 plant.stand^{-1} that was followed by 20.3 g.m^2 weed biomass with LD 88 at 2 plants.stand^{-1} (Table 4). In the late season, weed biomass range of 12.0 – 16.3 g.m^2 were all similar (Table 3).

Weed dry matter partitioning to the leaves, petiole and stem in the early season was similar (Table 4). Partitioning to the root was higher with both cultivars at 1 plant.stand^{-1}. In the late season, partitioning to the leaf was higher from NHAe 47-4 at 3 plants.stand^{-1} but from 1 plant.stand^{-1} with LD 88. Root dry matter partitioning was similar, regardless of either the variety or the planting density (Table 4).

DISCUSSION

Weather condition was more favourable for Okra growth in the late season, relative to the early season. The higher total rainfall during the early season was not advantageous. The lower relative humidity in the late season along with the relatively longer sunshine duration was more favourable for optimum Okra growth. These will account for the observed taller plants in the late season; plants with thicker stems and higher leaf areas, relative to the performance in the early season. Establishing Okra at a planting density of 1 plant.stand^{-1} that had plants with thicker stems; higher number of leaves.plant^{-1} and higher leaf area was a reflection of low competition for growth resources due to the low plant population. Okra Leaf area and number of leaves.plant^{-1} had been observed decreased as planting density increases (Salau and Makinde, 2015). High plant populations result in reduced plant growth and yield per plant due to competition for space and other growth resources (Muoneke and Asiegbu, 1996). Cv. NHAe 47-4 has shown to be a better cultivar than LD 88 in growth, as expressed by the relatively taller plants; higher number of leaves/plant and leaves with higher areas, at each planting density. Variety has been reported to have significant influence on the growth and yield of Okra (Aliyu and Ajala, 2016). The heavier and wider distribution of rainfalls of the early season enabled Okra a longer vegetative growth period and so, a longer period to attain both 1st and 50% flowering. This is against lower rainfall and narrow distribution of the late season that initiated flowering much earlier. Against the report of Edmisten, (2007) that planting density can influence maturity, flowering was shown not to be affected by the density of planting or by the cultivar, in the late season, which makes fruiting synchronized and consequently possibility of easier large scale mechanized harvesting. Against the growth of Okra that was generally more favourable in the late season, cummulative yield was higher in the early season, indicating that resources were too much utilized for growth in the late season and not enough left for fruit formation. However, in the early season, the resources were more utilized for fruit formation.

The nature of the two cultivars were expressed in cummulative fruit yields as expressed with lower yields from Cv. NHAe 47-4 which is an early maturing cultivar. Cv. LD 88 was a late maturing cultivar that fruits over a longer period than the early maturing cultivar. This accounts for its higher yield. With the late maturing LD 88, the high plant population, resulting from 3 plants.stand^{-1} density accounts for the higher pod yield, relative to the lower densities, with lower populations. Maximum yield of okra due to increased densities has been reported with other cultivars in different environments (Khan and Jaisal, 1988; Pandey and Singh, 1979; Sarnaik et al., 1986). Low plant populations have been reported may result in delayed maturity (Siebert and Stewart, 2006) and reduce harvesting efficiency due to increased branching (Gannaway et al., 1995). However, the early maturing nature of Cv. NHAe 47-4 could not sustain the high population of 3 plants.stand^{-1} in the late season, with reduced moisture supply. This accounts for the high yield observed from 1 plant.stand^{-1} in the late season but from 2 plants.stand^{-1} in the early season.

Weed growth was generally more favoured in the early season due to the higher rainfalls and wider distribution. The early nature of Cv. NHAe 47-4 gave way earlier for weed growth more than LD 88 that kept longer on the field and so, subdued weed growth better. This accounts for the lower weed density with LD 88 in the early season. The drier weather condition of the late season could not bring out the differences in the cultivars. The high population of the 3 plants.stand^{-1} density gave a relatively lower weed infestation. The generally lowest infestation with LD 88, cultivated at 3 plants.stand^{-1} is a reflection of the complementary effects of its longer duration of growth along with high population. The generally high weed biomass from the leaves and stems, relative to the roots is an indication that effective weed control is attained by the removal of the aerial portion of the weeds, with regular slashing. A tangible amount of organic materials harvested from the aerial growth can be incorporated to recycle plant nutrients and to mulch the soil surface in Okra cultivation.

Table 3. Interaction of Okra variety and planting density on weed growth.

Variety	Planting density	Early season			Late season		
		Weed density (No. of plants.m^2)	Weed fresh weight.m^2 (g/)	Weed dry weight.m^2 (g)	Weed density (No. of plants.m^2)	Weed fresh weight.m^2 (g/)	Weed dry weight.m^2 (g)
NHAe 47-4							
	1 plant/stand	16.00	110.00	21.00	13.33	82.70	14.33
	2 plants/stand	15.33	102.00	17.00	12.00	92.70	14.00
	3 plants/stand	15.33	112.00	19.70	12.00	94.70	16.33
LD 88							
	1 plant/stand	12.00	113.00	19.00	10.00	92.00	15.67
	2 plants/stand	13.33	104.00	20.30	11.33	83.70	12.00
	3 plants/stand	11.33	101.00	16.70	9.33	78.70	13.00
LSD (0.05)		5.9	67.4	13.6	6.6	47.4	7.7

Table 4. Interaction of Okra variety and planting density on weed dry matter partitioning (g/plant).

Variety	Planting density	Early season				Late season			
		Leaf	Petiole	Stem	Root	Leaf	Petiole	Stem	Root
NHAe 47-4	1 plant/stand	23.00	3.67	19.30	10.00	5.67	0.67	15.67	7.00
	2 plants/stand	14.00	2.33	10.70	4.00	7.67	1.00	13.00	6.30
	3 plants/stand	17.33	3.00	13.70	8.00	11.33	1.33	12.00	5.60
LD 88									
	1 plant/stand	21.67	3.67	18.70	11.67	10.00	0.67	27.67	7.60
	2 plants/stand	16.67	4.00	16.30	7.00	9.33	0.67	18.00	5.60
	3 plants/stand	19.67	3.00	16.30	6.67	7.33	0.33	21.00	6.00
LSD (0.05)		11.6	2.8	10.8	3.4	4.9	1.0	7.2	4.2

CONCLUSION

Cv. NHAe 47-4 gives higher growth than LD 88 and is more appropriate in cultivation for consumption of fresh succulent leaves and pods. Cv. LD 88 gives a higher cummulative pod yield than NHAe 47-4 and is more appropriate for large scale/commercial production of the pods. Cv. NHAe 47-4 is more appropriately cultivated with 1 plant.stand^{-1} while LD 88 is better sustained with 3 plants.stand^{-1}. Cv. LD 88 gives better weed control, relative to Cv. NHAe 47-4.

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Compliance with Standards of Ethics. The research hereby reported did not involve any measurement with animals or humans. The study site is not considered a protected area. The study did not involve endangered or protected species. No permissions were required for any activity.

Data availability. Data are available with the corresponding author (eamakinde@yahoo.com) upon reasonable request.

REFERENCES

Alegbejo, M.D., 2003. Okra cultivars with moderate resistance to okra mosaic virus. Genus Tymovirus. *Nigerian Journal of Horticultural Science* 8:3-8.

Aliyu, U.and Ajala, A.A., 2016. Effect of Variety and Plant Density on Growth and Yield of Okra. *Journal of Agriculture and Veterinary Science* 9(2): 38 – 42.

Bauchi State Agricultural Development Programme – BSADP. 1995. Basic Strategic Application Design Production. Survey Report of Insect Pests and Diseases of Irrigated Crops Grown in Fadama Areas, *Annual Report* 16 pp.

Duvachelle, J., 2011. Okra nutrition information livestrong. com. 351-Okra-nutrition-information/Retrieved 24 June, 2012.

Edmisten, K.L., 2007. Planting decisions. *In:* Edmisten, K (ed.) Cotton Information. Publ. AG-417. p. 24-26.

Gannaway, J.R., Hake, K and Harrington, R. K., 1995. Influence of plant population upon yield and fiber quality. *In:* Proc. Beltwide Cotton Prod. Res. Conf. San Antonio, TX. 4-7 Jan. 1995. pp. 551-556.

Grubben, G.J.H. and El-Tahir, I.M., 2004. *Capsicum annuum* L. In: Grubben, G.J.H. and Denton, O.A. (Eds). Plant Resources of Tropical Africa 2. Vegetables. PROTA Foundation, Leiden, Netherlands/CTA, Wageningen, Backhuys Publishers. pp. 154-163.

Institute of Agricultural Research and Training (IAR&T)., 1991. The fourteenth package of recommendations for food crops and livestock production in South Western Nigeria. 74pp

Khan, A.R. and Jaisal, R.C., 1988. Effects of nitrogen, plant spacing and green fruit pickings in the seed production of okra. *Vegetable Science*. 15(1): 8 – 14.

Martin, Franklin W. 1982. Okra, potential multiple-purpose crop for the temperate zones and tropics. *Economic Botany* 36 (3): 340-345.

Muoneke, C.O and Asiegbu, I.E., 1996. Effect of planting density on growth, dry matter accumulation, distribution and yield of okra in a tropical ultisol, p. 83–90. In: A. Adebanjo, S. F. Adedoyin, and D. A. Alabi (eds.), Proc. 14th HORTSON Conference. 1–4 April. 1996, Ago-Iwoye, Nigeria.

Olasantan, F. O and Salau, A. W., 2008. Effects of pruning on growth, leaf yield and pod yields of okra. *Journal of Agricultural Science*. 146:93–102

Pandey, U.C. and Singh, I. J., 1979. Effect of nitrogen, plant population and seed moisture regimes on seed production of okra. *Vegetable Science*. 6(2):81–91.

Salau, A.W and Makinde, E. A., 2015. Planting density and variety on Okra growth, yield and yield duration. *International Journal of Vegetable Science*. 21: 363-372.

Sarnaik, D.A., Baghel, B. S. A. and Baghel, K., 1986. Response of okra seed crop to varying inter row and intra row spacings. *Journal of Farming System.* 2(3–4):13–15.

Schippers, R.R., 2000: African Indigenous Vegetables. An overview of the cultivated species. Chatham, U.K., National Resources Institute A.C.D.E.U. Technical Centre for Agriculture and Rural Crop. Pp 105-117

Siebert, J. D and Stewart, A.M., 2006. Influence of plant density on cotton response to mepiquat chloride application. *Agronomy Journal.* 98: 1634-1639.

Statistical Analysis System., 1990. Statistical Analysis System SAS/STAT users' guide. Ver. 6, 4th Ed. SAS Institute, Cary, NC.

Yayock, J. Y., Lombin, G and J. J. Owonubi, J. J., 1988. Crop Science and Production, In: Ochapa, C. O (Ed.). Warm Climates, Macmillan Publisher, Lagos, Nigeria. pp. 53-214.