Effect of Plant Growth Response of *Ocimum species* to Diverse Population Densities in Southern Nigeria

*Obianokwalu, E. O.[1], Igili, D. N.[2], Ngonadi, E. N.[2] and Uko, I.[3]**

[1]*Agricultural Development Programme (ADP) Awka, Anambra State, Nigeria*
[2]*Department of Crop Science and Horticulture, Chukwuemeka Odumegwu Ojukwu University, Igbariam, Nigeria*
[3]*Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Awka, Nigeria*

KEYWORDS

Growth parametres. Ocimum gratissimum; Ocimum sanctum nursery, Plant population density,

***CORRESPONDING AUTHOR**

i.uko@unizik.edu.ng

ABSTRACT

A field study was conducted to evaluate the growth performance of Ocimum species at five population densities at the research farm of Agricultural Development Programme (ADP) Awka, Anambra State, The research was a 2 x 5 factorial experiment laid out in randomized complete block design (RCBD) which was replicated three times. Two species of Ocimum spp (Ocimum sanatum and Ocimum gratissium) represented the main factor while the sub-factor consisted of five population densities (60,000 plant/ha, 100,000 plant/ha, 200,000 plant/ha, 300,000 plants/ha and 400,000 plant/ha The nursery was done on 3rd of May 2021 while transplanting was done on the 29th of May 2021 at a plant spacing of 50 x 33.3cm, 50 x 10cm, 25 x 20cm, 33.3 x 10cm and 25 x 10cm. Data were collected on plant height (cm), number of leaves, number of branches, leaf area (cm^2), stem girth (cm). Data collected were subjected to analysis of variance (ANOVA) using GENSTAT release 7.2DE Statistical software and means were separated using Fishers least significant difference (LSD). Plant density of 400,000 plants/h (25 x 10cm plant spacing) significantly improved biomass attribute of Ocimum gratissium and Ocimum Sanctum. While under the plant density of 300,000 plants/ha (33.3cm x 10cm plant spacing) gave best performance for the growth parameters measuerd. Ocimum sanctum grew more luxuriantly and performed better than Ocimum gratissimum; in all the growth parameters measured.

INTRODUCTION

The wellbeing of human is directly proportional to the wellbeing of botanicals around them, including agricultural, horticultural and ornamental plants as well as forest products, Gbadamosi *et al.* (2009). In recent years, the effluxion of many diseases which have developed resistant to many synthetic drugs and the effect of many organic waste (including crude oil) have called for planting of large production of botanicals. It is believed that plants that are medicinal contained numerous phytochemicals (Ngonadi and Awodoyin, 2019, Ade-Ademiilua and Obi, 2013). Researchers have concentrated more on plant species with medicinal values as exploitatory means of disease control and public awareness of the values associated with them; especially *Ocimum gratissium* and *Ocimum Sanctum* are increasing rapidly (Du Plooy *et al.*, 2012).

Ocimum is a genus of 35 species of aromatic annual and perennial herbs and shrubs in the family Laminaceae found in the tropics and subtropics, both wild and cultivated (Ojeifo and Denton, 1993). *Ocimum gratissimum* and *Ocimum sanctum* are important members. Their leaves ad distinctive flavour to many foods and are listed

among species that have a long history as culinary herbs (Eze *et al.,* 2006). The antioxidants like present in high concentration in the plants makes them important botanicals in the prevention of various diseases; including upper respiratory tract infections, diarrhoea, headache, diseases of the eye and skin, pneumonia, cough, fever and conjunctivitis (Adebolu and Salau, 2005; Sidhu *et al.,* 2007). The oil extracted from the plants clearly shows antimicrobial, insect repellent and anti-helmet potential (Oboh, 2008). The flowers and leaves of the plants are rich in essential oils, and so it is used in preparation of teas and other infusions (Rabelo *et al.,* 2003). Based on the above mentioned qaulities about ocimum, there is the need to multiply and propagate them in large quantities in order to meet the public demands (Du Plooy *et al.*, 2012). In Nigeria, the full potential and leaf yield of the plant to meet the need of the increasing demands have not been attained because plant population densities are at the discretion of the farmers. Thus, there is need to determine the suitable plant density for Ocimum to reduce inter or intra-specific competition between the plant and weed which reduce yield (Barros *et al.,* 2004).

Materials and Methods

The experiment was conducted at Agricultural Development (ADP) farm, Anambra State. ADP is located at Awka which lies between latitude 7º 00' and 7º10'N and Longitude of 6º5' and 6º15'E in the rain forest zone of Nigeria. The area experienced bimodal rainfall pattern that peaked in June and subsequently decreased with a daily temperature range of 20ºC – 30ºC. The study was a factorial experiment laid out in a randomized complete block design (RCBD) and replicated three times. Ocimum seeds were obtained from Agricultural Development Programme (ADP) Center, Anambra. The experimental area was cleared of other vegetation, ploughed and harrowed on the 1st of May, and seedlings transplanted on the 29th May, The field was marked out into blocks of 3x3m^2 covering (93m^2). Cured poultry droppings was applied in each plot and sub plots at 1100g. Weeding was done manually using hoe twice, to keep the plots weed free, at 4WAP and 6WAP. Insecticide (scorpion) was sprayed to control insect pest at 3ml to 15 litres of water at 8WAP. Morphological differences between *Ocimum gratissimum* and *Ocimum sanctum* include leaf shape and size: *O. gratissimum* has broader leaves with serrated edges, while *O. sanctum* has narrower leaves with smooth edges (Adedapo *et al*., 2020).

Data Collection

- **Plant Height***:* The height was measured with a meter rule from ground level to the stem apex in site. Five middle row plants per plot were tagged and used for record at 4, 6, 8 and 10 weeks after planting (WAP).
- **Number of leave:** Number of leave per tagged plants was counted at 4, 6, 8 and 10 weeks after planting (WAP).
- **Number of branches:** Number of branches per tagged plants was counted at 4, 6, 8 and 10 weeks after planting (WAP).
- **Leaf Area:** leaves of the tagged plants was measured with a meter rule to obtain the Leaf area, actual measurement was obtained by multiplying the Leaf area by a factor 0.715 (Koyama *et al*., 2022) and was recorded at 4, 6, 8 and 10 (WAP).
- **Stem girth:** stem girth of the tagged plant in each plot was measured above the ground level of the plant using rope which was later measured out using a meter rule to get the accurate reading and record.

Data Analysis:

Data collected were subjected to Analysis of Variance (ANOVA) using Gen-stat release 10.3 statistical soft wear. While the mean were separated using Least Significant Difference at 5% probability level.

RESULTS

Ocimum height

The interaction effect of species and plant spacing on the height of Ocimum at 4, 6, 8 and 10 WAP is presented in Table 2. The results obtained showed that the height of *Ocimum* species and plant spacing at 4, 6, 8 and 10 WAP were significant ($P<0.05$). Whereas, the interaction between species and plant spacing was

only significant at 10 WAP. At 4 WAP, *O. sanctum* under 25 x 10 cm significantly had the tallest plants (23.2cm) followed by *O. sanctum* under 33.3 x 10 cm plant spacing (22.4cm). While the significantly shortest plants were recorded by *O. gratissium* under 50 x 10 cm plant spacing. At 6 WAP, *O. sanctum* under 33.3 x 10 cm plant spacing had the highest plant height (48.2cm) followed by *O. sanctum* under 25 x 10 cm plant spacing (47.8cm). Whereas, *O. gratissium* under 50 x 10 cm plant spacing had the lowest plant height (22.5cm). At 8 WAP, plant height followed similar trend as observed at 6 WAP. The plant species at the same plant spacing as observed at 6 WAP had the highest (89.4 cm) and the lowest plant heights (41.4 cm). At 10 WAP, *O. sanctum* under 33.3 x 10 cm plant spacing recorded the highest plant height (119.3cm) followed by *O. sanctum* under 25 x 10 cm plant spacing (112.4cm). While, *O. gratissium* under 50 x 10 cm plant spacing recorded the lowest plant height (62.3 cm).

Table 1. Physical and chemical properties of soil of the experimental site

Parameters	Value
Clay	230 (g/kg)
Silt	210g (g/kg)
Fine sand	420 (g/kg)
Coarse sand	160 (g/kg)
Textural class	Sandy clay loam
Bulk Density	1.39gm-3
Total porosity	48.92 (%)
Moisture Content	20.52 (%)
Dispersion Ratio	0.87 (%)
Aggregate Stability	17.02 (%)
Hydraulic conductivity	4.59 (cmhr-1)
pH (H2O 1:1)	5.98
Nitrogen	0.055 (%)
Available Phosphorus	3.89mgkg-1
Ca2+	1.5(cmolkg-1)
Mg2+	1.3 (cmolkg-1
Na+	0.24 (cmolkg-1)
EC	4.99 (cmolkg-1)
B S	87 (%)

Source: Agricultural Development Programme (ADP) Soil Laboratory Unit.

Ocimum number of leaf

The interaction effect of species and plant spacing interaction on the number of leaf of *Ocimum* at 4, 6, 8 and 10 WAP is presented in Table 3. The results obtained showed that the number of leaf of *Ocimum* species and plant spacing at 4, 6, 8 and 10 WAP were significant ($P<0.05$). Whereas, the interaction between specie and plant spacing was only significant at 10 WAP. At 4 WAP, *O. sanctum* under 25 x 10 cm significantly had highest number of leaves (34.5cm) followed by *O. sanctum* under 33.3 x 10 cm plant spacing (33.5cm). While the significantly shortest plants were recorded by *O. gratissium* under 25 x 20 cm plant spacing. At 6 WAP, *O. sanctum* under 25 x 10 cm plant spacing had the highest number of leaves (98.1 cm) followed by *O. sanctum* under 50 x 33.3 cm plant spacing (86.4 cm). Whereas, *O. gratissium* under 33.3 x 10 cm plant spacing had the lowest number of leaves (19.4 cm). At 8 WAP, plant number of leaf followed similar trend as observed at 6 WAP. The plant species at the same plant spacing as observed at 6 WAP had the highest (170.6 cm) and the lowest number of leaves was recorded in 50 x 10 spacing (31.9 cm) under *O. gratissium*. At 10 WAP, *O. sanctum* under 25 x 10 cm plant spacing recorded the highest number of leaf (199.5 cm) followed by *O. sanctum* under 50 x 33.3 cm plant spacing (189.6 cm). While, *O. gratissium* under 50 x 10 cm plant spacing recorded the lowest number of leaves (46.3 cm).

Table 2: Interaction effect of species and plant spacing on plant height (cm) of Ocimum at 4, 6, 8 and 10 weeks after planting (WAP).

Weeks / Ocimum species	50x33.3cm	50x10cm	Plant spacing 25x20cm	33.3x10cm	25x10cm	Mean
At 4WAP						
grattissium	7.14	6.67	7.55	9.97	9.53	**8.17**
O. sanctum	18.2	14.4	17.2	22.4	23.2	**19.1**
Mean	**12.7**	**10.54**	**12.41**	**16.22**	**16.40**	**13.3**
At 6WAP						
O. grattissium	23.44	22.50	25.69	25.95	25.97	**24.72**
O. sanctum	37.1	39.2	40.3	48.2	47.8	**42.5**
Mean	**30.28**	**30.86**	**33.03**	**37.10**	**36.89**	**33.63**
At 8WAP						
O. grattissium	51.8	41.4	58.2	57.0	57.0	**53.1**
O. sanctum	62.5	67.3	68.9	89.4	71.2	**72.9**
Mean	**57.2**	**54.4**	**63.6**	**73.3**	**64.1**	**62.5**
At 10WAP						
O. grattissium	81..2	62.3	92.6	77.3	77.3	**78.4**
O. sanctum	99.1	107.1	103.7	119.3	112.4	**108.4**
Mean	**85.4**	**84.7**	**98.2**	**98.4**	**94.8**	**93.2**
				Weeks after planting (WAP)		
			4	6	8	10
LSD (0.05)	For 2species	mean	1.74	3.20	6.39	5.72
LSD	5plant spacing	mean	2.75	5.07	10.10	9.04
LSD	5plant spacing	X specie	ns	ns	ns	12.78

Note: WAP= Weeks after planting, ns= not significant

Table 3: Interaction effect of species and plant spacing on number of leaves of Ocimum at 4, 6, 8 and 10 weeks after planting (WAP).

Weeks / Ocimum species	50x33.3cm	50x10cm	Plant spacing 25x20cm	33.3x10cm	25x10cm	Mean
At 4WAP						
O, grattissium	9.44	7.39	9.0	11.5	11.1	**9.7**
O. sanctum	34.3	19.7	27.5	33.5	34.5	**29.9**
Mean	**21.8**	**13.58**	**18.3**	**22.5**	**22.8**	**19.8**
At 6WAP						
O. grattissium	24.3	20.5	22.6	19.4	19.6	**21.3**
O. sanctum	86.4	74.6	67.3	75.5	98.1	**80.4**
Mean	**55.4**	**47.6**	**44.9**	**47.5**	**58.8**	**50.8**
At 8WAP						
O. grattissium	56.0	31.9	43.2	45.7	45.6	**45.5**
O. sanctum	156.7	127.5	11.7	128.4	170.6	**140.6**
Mean	**107.8**	**79.7**	**79.9**	**87.1**	**108.1**	**92.5**
At 10WAP						
O. grattissium	73.8	46.3	70.6	71.4	71.4	**66.7**
O. sanctum	189.6	154.3	142.8	154.7	199.5	**168.2**
Mean	**131.7**	**100.3**	**106.7**	**113.1**	**135.5**	**117.4**
				Weeks after planting (WAP)		
			4	6	8	10
LSD (0.05)	For 2species	mean	2.96	12.7	12.5	12.5
LSD	5plant spacing	mean	4.6	ns	19.8	19.8
LSD	5plant spacing	X specie	ns	ns	ns	28.0

Note: WAP= Weeks after planting, ns= not significant

Ocimum number of branches

The interaction effect of species and plant spacing interaction on the number of branches of *Ocimum* at 4, 6, 8 and 10 WAP is presented in Table 4. The results obtained showed that the number of branches of *Ocimum* species and plant spacing at 4, 6, 8 and 10 WAP were significant (P<0.05). Whereas, the interaction between specie and plant spacing was only significant at 4, 8 and 10 WAP. At 4 WAP, *O. sanctum* under 33.3 x 10 cm significantly had highest number of branches (9.27 cm) followed by *O. sanctum* under 25 x 10 cm plant spacing (8.61 cm). (While the significantly shortest plants were recorded by *O. gratissium* under 50 x 10 cm plant spacing.) At 6 WAP, *O. sanctum* under 33.3 x 10 cm plant spacing had the highest number of branches (16.7 cm) followed by *O. sanctum* under 25 x 10 cm plant spacing (13.9 cm). Whereas, *O. gratissium* under 50 x 10 cm plant spacing had the lowest number of branches (1.8 cm). At 8 WAP, plant number of branches was highest at 50 x 33.3 spacing (19.6 cm) followed by *O. santum* under 33.3 x 10 (19.0 cm) and the lowest number of branches was recorded in 50 x 10 cm spacing (1.8 cm) under *O. gratissium*.

At 10 WAP, *O. sanctum* under 50 x 33.3 cm plant spacing recorded the highest number of branches (25.7cm) followed by *O. sanctum* under 33.3 x 10 cm plant spacing (25.4cm). While, *O. gratissium* under 50 x 10 cm plant spacing recorded the lowest number of branches (6.4 cm).

Ocimum stem girth

The interaction effect of species and plant spacing interaction on the stem girth of *Ocimum* at 4, 6, 8 and 10 WAP is presented in Table 5. The results obtained showed that the stem girth of *Ocimum* species and plant spacing at 4, 6, 8 and 10 WAP were significant (P<0.05). Whereas, the interaction between specie and plant spacing was only significant at 4 WAP. At 4 WAP, *O. sanctum* under 25 x 10 cm significantly had the highest stem girth (2.3 cm) followed by *O. sanctum* under 33.3 x 10 cm plant spacing (2.2 cm). While the significantly shortest plants were recorded by *O. gratissium* under 50 x 33.3 cm plant spacing. At 6 WAP, *O. sanctum* under 25 x 10 cm plant spacing had the highest plant height (3.7 cm) followed by *O. sanctum* under 33.3 x 10 cm plant spacing (3.6 cm). Whereas, *O. gratissium* under 50 x 10 cm plant spacing had the lowest plant height (2.1 cm). At 8 WAP, plant stem girth was highest at 50 x 33.3 spacing (5.4 cm) followed by *O. santum* under 25 x 20 (5.2 cm) and the lowest stem girth was recorded in 50 x 10 cm spacing (2.8 cm) under *O. gratissium*.

At 10 WAP, *O. sanctum* under 33.3 x 10 cm plant spacing recorded the highest stem girth (9. 0 cm) followed by *O. sanctum* under 50 x 10 cm plant spacing (6.8 cm). While, *O. gratissium* under 50 x 10 cm plant spacing recorded the lowest plant height (3.5 cm).

DISCUSSION

This research evaluated two species of *Ocimum* for growth performance under five population densities in tropical rainforest zone. The result of this study varied with previous results obtained from other *Ocimum* species and other vegetables like black cumin (*Nigella sativa).* Kafi, (2003) reported that *Ocimum basilium*, has average of 1551kg/ha-1 green herb yield in terms of number of leaves. The growth of *Ocimum minimum* is 1320kgha-1 and highest number of leaves was reached using 15cm between rows. Since the higher the number of leaves results in greater yield, Gill and Randhawa, (1992) indicated that the high drug herb was obtained from 40 x 20cm plant density. According to Serin and Ozguven, (1997) drug leaves yield of *Ocimum* was 173.78 kg/ha-1. On the other hand, Tani and Nacar, (1999) reported that the yield was possible 571.52 kg/ha-1. Also, Ahmed and Haque, (1986) studied the effect of row spacing (15, 20, 25 and 30cm) on growth and yield of black cumin (*Nigella sativa*) in Bangladash, they found that closer row spacing (15cm) was the best for higher yield of black cumin.

Generally, *O gratissium* and *O sanctum* under the plant density of 30 plants/m2 of population density of 300,000 plants/ha with spacing of 33.3cm x 10cm gave good performance for the growth parameters *O. sanctum* grew more luxuriantly than *O gratissium;* it performed better in all the growth parameters. The number of leaf per branch is affected by environmental, field management and varies under varying plant densities. Kafi, (2003) also reported that the weight of Ocimum varied in different experiments. It ranges from 2.79g to 2.99g under varying plant densities. And interaction between specie and population densities was significant at various parameters.(No data on leaf weight)

CONCLUSION

Ocimum species should be grown under the population density of 400,000 plants/ha with plant spacing of 25cm by 10cm for high leaf yield in terms of number of leaves especially the *O. gratissimum* (edible specie). While *O. sanctum* (wild species) has tolerance based on all the growth parameters. Ocimum species should be harvested at 12 weeks and at 2 weeks intervals with appropriate agronomic practices.

RECOMMENDATION

Further studies is needed to be conducted to investigate the economic viability of increased plant density in relation to cost of seedling or cuttings.



Plate 1: *Ocimum sanctum*



Plate 2: *Ocimum gratissimum*

REFERENCES

Ade-Ademilua E.O, Obi H.O, Craker L.E (2013). Growth and essential oil yield of African basil, *Ocimum gratissimum*, under light and water stress. *Journal of medicinally active plants* 1(4): 143 – 149.

Adebolu, T.T., Salau A.O. (2005). Antimicrobial activity of leaf extracts of *Ocimum gratissium* on selected Diarrhiea causing bacteria in Southwestern Nigeria. *African Journal of Biotechnology* 4: pp 682-684.

Adedapo, A. A., Ololade, Z. S., and Olatunji, G. A. (2020). Morphological and phytochemical diversity of Ocimum species in Nigeria. *Journal of Herbs, Spices and Medicinal Plants*, 26(2), 183-198.

Ahmed, N.U and Haq, K.R. (1986). Effect of row spacing and time of sowing on the yield of black cumin (Nigella Carvi L.). *Bangladsh, Journal of Agriculture* 1: pp 21-24.

Barros, J.F.C., Carvalho M.D. and Baseh G. (2004). Response of sunflower (helianthus annus L.) to sowing date and plant density under Mediterranean conditions .*Europen. Journal of Agronomy*. 21: pp 347-356.

Du Plooy, C.P., Maboko M.M., van den Heever E. and Chiloane S. (2012). Research and technology transfer by the Agricultural Research Council to sustain the South African hydroponic industry. *Acta Horticulture.* 947: pp 147–151.

Eze, S.C., Asiegbu, J.F., Mbah, B.N., Orkwor, G.C., Asiedu, R. (2006). Biocontrol of storage insect and use of fungicide were explored-agro science 5 (1) 8-12.

Gbadamosi; A.E, Okere A.U, Ogungbite O.C (2009). Growth of Khaya iyorensis (A. Chev) as influenced by different light regimes.

Gill, B.S and G.S. Randhawa (1992). Effect of transplanting dates and stage of harvesting on the herb and oil yields of fresh basil (O. basilicum L.). Indian perfumer, 36: pp 102-110.

Kafi, M. (2003). Basil production and processing. Mashhad: Ferdowsi University, Mashhad Publication; p. 195.

Koyama K, Smith DD. (2022). Scaling the leaf length-times-width equation to predict total leaf area of shoots. Ann Bot. 130(2):215-230. doi: 10.1093/aob/mcac043. PMID: 35350072; PMCID: PMC9445601.

Ngonadi, E.N. and Awodoyin, R.O. (2019). Evaluation of Allelopathic potential of *Lantana camara* and *Tithonia diversifolia* on seed germination Attribute of cowpea (*Vigna unguiculata* (L) walp). *Journal of Environmental Science, Toxicology and Food Technology.* 13 (5) 11: 34 – 38.

Oboh G (2008). Antioxidative potential of ocimum gratissim and ocimum canum leaf polyphenols and protective effects on some pro-oxidants induced lipid peroxidation in rat brain, Anin vitro study. *American Journal of food technology.* 325-334.

Ojeifo, I.M. and Dento, L.I. (1993). Growing *Ocimum gratissium* in Nigeria. Outlook on the botany, economic importance cultivation and research strat egies.

Rabelo M, Souza EL', Soares PMG, Miranda AV, Matos FJA, Criddle DN, (2003). Antinociceptive Properties of the Essential oil of *Ocimum gratissimum* L. (Labiatae) in Mice. *Brazilian Journal of Medicine and Biological Research*.36: pp 521-524.

Serin, F.D. and M. Ozguven (1997). Cukurova kooullarinda ikifarkli kokenlifeslen (*OcimumBasilicumL*.) in verim ve ucucuyalari uzerinde araotirmalar. *Cukurova universitesi ziraat fakultesi dergisi,*12: pp145-154.

Sidhu, K., Kaur, J, Kaur, G., Pannu, K. (2007). Prevention and cure of digestive disorders through the use of medicinal plants. *Journal of Human Ecology* 21(2): pp 113-116.

Tansi, S. and S. Nacar (1999). The herb yield and essential oil composition of Bush Basil *(Ocimum minimum L.)* grown in Turkey. *Turkey Journal of Field Crops*, 4: pp 11-74.