American International Journal of Agricultural Studies
Vol. 4, No. 1; 2021
ISSN 2641-4155 E-ISSN 2641-418X
Published by American Center of Science and Education, USA

EFFECT OF GROWING SUBSTRATE ON YIELD OF RADISH IN NIGERIA UNDER RAINFED AND HAND WATERING CONDITIONS

Ossai C. Okolie
Research Supervisor
YIIFSWA Project
International Institute of Tropical Agriculture, Ibadan, Nigeria
E-mail: c.ossai@cgiar.org

Stephanie Clara Akpeji
Graduate Student
Microbiology Department
University of Ibadan, Ibadan, Nigeria
E-mail: akpejistephanie@gmail.com

E. Martha Olorode
Research Fellow
Biochemistry Unit
Forestry Research Institute of Nigeria
E-mail: efeandrew@yahoo.com

Ogbole Samson
Graduate Student
Biochemistry Department
Federal University of Agriculture, Abeokuta, Nigeria
E-mail: ogbolesamson@gmail.com

S. Oye Azeez
Seed Delivery Officer
YIIFSWA Project
International Institute of Tropical Agriculture, Ibadan, Nigeria
E-mail: o.azeez@cgiar.org

ABSTRACT

Radishes (Raphanus sativus L) have high nutritive and medicinal values, and are predominantly cultivated in the temperate regions of the world. With the high malnutrition rate in Nigeria, domesticating radish is necessary. However, despite being successfully cultivated using the hydroponics system with cocopeat substrate in Nigeria, the adaption to the soil type is an important factor to consider. Seeds of three genotypes of radish were grown in cocopeat substrate and topsoil under rainfed and hand watering conditions. The experiment was set up as a 3 (genotypes) by 2 (substrates) by 2 (watering methods) factorial laid in a completely randomized design with three replicates. Data were collected on the plant height, number of leaves, leaf area, and the tuber and leaf weights respectively. Data collected were analyzed

using ANOVA (SAS 9.0 version) and differences in treatment means were separated using least significant differences at 5 % significance level. Results obtained showed that the tuber weight of White Icicle Radish (21.35±3.32) was significantly heavier than the rest genotypes, and the hand watering system also encouraged the production of heavier tuber size (17.79±2.71) than the rainfed system (7.9.6±2.71). However, the planting substrate was insignificant in all parameters considered.

Keywords: Raphanus Sativus, Substrate, Cocopeat, Topsoil, Rainfed, Water.

JEL Classification Codes: Q15

INTRODUCTION

Radishes (Raphanus sativus L) belong to the Cruciferae family and are quick and easy to grow (Abdel, 2011). Different varieties of radish exist, with the local red and black varieties predominantly cultivated in Asia where it originated (Abdel, 2011). Radishes are mainly cultivated for the tuber parts which can be eaten raw as salad or cooked; however, it also has several medicinal uses (Bakhsh et al., 2006), with high minerals and vitamins A and C contents (Baloch, 1994). Radish can thrive under temperate and tropical climatic conditions, as well as on different soil types especially under moist rich soils (Bakhsh et al., 2006). However, reports of its production are largely skewed in favor of the temperate climate with low humidity level (Wan & Kang, 2005; Ossai et al., 2020).

In Nigeria, Radish is an exotic vegetable as there are little or no report of its cultivation and consumption. Although, owing to the above nutritive and medicinal characteristics of radish and the rate of malnutrition in Nigeria, there is need to exploit this vegetable for consumption due to its quick rate of production (Ossai et al., 2020). However, being a crop that requires cool climatic conditions for optimum yield, timing of the plant period is required as Nigeria has two main season; the wet and dry.

The predominant farming system operational in Nigeria is the fallow system, and the planting period is timed to the onset of rain (Hula, 2013). Although, for a plant that is being introduced to a new environment, adequate care is given in the planting environment to provide all the necessary soil, water, temperature and nutrient requirements. The soil type and planting substrates in case of hydroponics system plays an important role in making moisture and nutrient available to the plant (Hoang, 2020). However, with the first report of radish production in Nigeria using the hydroponics system using the cocopeat substrate (Ossai et al., 2020), it is important to investigate the growth rate of radish in the natural soil condition of Nigeria in comparison to the cocopeat substrate under a rain-fed and hand watering regime, hence; the objective of this study.

MATERIALS AND METHODS

Seeds of three varieties of radish were sourced from the Soilless Farmlab, Abeokuta, Ogun State, Nigeria. The seeds were raised in a dissolved cocopeat substrate in a hydroponics trough for a week. The cocopeat substrate was purchased in block form from Afri-Agri company, Lagos, Nigeria. The buffered cocopeat blocks were dissolved in water and poured into 12 hydroponics troughs (8 litres capacity with 4 segments of 2 litres each). Also topsoil was dug from a dumping ground, and used to fill 12 troughs. The 1 week old radish seedlings were transplanted into the cocopeat substrates and the topsoil at the rate of 1 plant per segment of the trough.

6 of the 12 troughs containing cocopeat and topsoil respectively were kept outside to be irrigated by natural rainfall during the period of the radish growth, while 6 of the troughs containing cocopeat and topsoil respectively were irrigated manually every 3 days interval. Poultry dropping was sourced from Ajayi farm, Ibadan, Nigeria. The poultry manure was allowed to dry for one week, ground into fine particles and liquefied by dissolving 1 g in 1 litre of water over a period of 3 days. The liquefied poultry manure was used in fertigating each plant at a rate of 100 ml per plant every week till harvest.

Experimental design, data collection and statistical analysis: The experiment was 3 varieties (Cherry Red Radish, Cherry Belle Radish and White Icicle Radish) x 2 substrates (cocopeat and topsoil) x 2 watering method (Rainfed and Hand watering) factorial experiment laid in a completely randomized design with four replicates. At bi-weekly intervals, data were taken on the plant height, number of leaves and leave area, while at harvest, the harvested tubers and leaves (fresh biomass) were weighed and recorded. Data collected were analyzed using ANOVA (SAS 9.0 version) and differences in treatment means were separated using least significance differences at 5 % level of significance.

RESULTS AND DISCUSSIONS

The results obtained from this study has shown that the genotypic effect on the plant height, number of leaves at 4 weeks after planting and the tuber weight were significant, while the method of watering the plants had a significant effect on the height of the plants at 2 weeks after planting and the tuber weight respectively (Table 1).

At 4 weeks after planting, the height of the CBR genotype was 13.05±0.31 which was significantly taller than CRR (10.95±0.31) and WIR (10.47±0.31) respectively. Also at 4 weeks after planting, the number of leaves produced by the CBR and CRR genotypes was 5.50±0.18 respectively, and this was significantly higher than the 4.92±0.18 produced by WIR. While the area of the leave produced at 4 weeks after planting was insignificant. However, the weight of the tuber produced by WIR (21.35±3.32) was significantly heavier than CBR (7.97±3.32) and CRR (7.15±3.32) respectively (Table 2).

Table 1. The effects of genotypes, substrates and watering methods and their interactions on the growth and yield of radish

Source of variation	Plant height (cm)		Number of leaves		Leaf area (cm^2)			
	Week2	Week4	Week2	Week4	Week2	Week4	TW(g)	LW(g)
Gen	37.14**	22.63**	0.58ns	1.36*	0.78ns	0.71ns	762.84**	189.07ns
Subs	1.40ns	0.16ns	0.03ns	0.03ns	1.32ns	0.16ns	27.39ns	139.63ns
WM	12.84**	2.35ns	0.69ns	0.25ns	0.78ns	3.00ns	1142.44**	31.17ns
Gen*Subs	3.37*	4.30*	0.53ns	0.03ns	0.45ns	3.46ns	23.35ns	45.50ns
Gen*WM	4.59*	6.95**	1.36*	0.08ns	7.77**	1.61ns	211.39ns	28.99ns
Subs*WM	0.02ns	0.54ns	0.69ns	0.69ns	0.03ns	1.69ns	135.39ns	43.78ns
Gen*Subs*WM	10.20*	6.89**	0.19ns	0.19ns	1.34*	0.58ns	58.46ns	30.04ns

Gen: Genotypes, Subs: Substrates, TW: Tuber weight and LW: leaf weight, WM: watering method

Table 2. Growth and yield performance of three varieties of radish in hydroponics and loamy soil

	Plant height (cm)		Number of leaves		Leaf area (cm^2)			
Genotypes	**Week2**	**Week4**	**Week2**	**Week4**	**Week2**	**Week4**	**TW(g)**	**LW(g)**
CBR	10.94a	13.05a	4.17a	5.50a	7.13b	12.00a	7.97b	14.95a
CRR	8.08b	10.95b	3.83a	5.50a	7.37ab	11.93a	7.15b	13.72a
WIR	6.66c	10.47b	3.75a	4.92b	7.63a	12.38a	21.35a	21.13a
$LSD_{(0.05)}$	0.54	0.92	0.49	0.53	0.48	1.21	9.69	6.87
SE	0.19	0.31	0.17	0.18	0.17	0.42	3.32	2.88

Means with the same alphabet down the group are not significantly different from each other at 5 % significance level. LSD: Least Significant Differences, SE: Standard error. TW: Tuber weight and LW: leaf weight. CRR: Cherry Red Radish, CBR: Cherry Belle Radish and WIR: White Icicle Radish.

The result obtained on the effect of substrates used in this study on the agronomic and yield parameters was insignificant (Table 3). However, at 2 weeks after planting, the height of the plants grown by watering the plants by hand at 3 days interval (9.16±0.15) was significantly taller than the rainfed plants (7.96±0.15), and the weight of the tubers produced by the hand watered plants (17.79±2.71) was also statistically heavier than the rainfed plants (6.52±2.71), while the watering method was insignificant on the number of leaves produced, the leaf area and leaf weight respectively (Table 4).

Table 3. Effect of different substrate sources on the growth and yield of radish

	Plant height (cm)		Number of leaves		Leaf area (cm2)			
Substrates	**Week2**	**Week4**	**Week2**	**Week4**	**Week2**	**Week4**	**TW(g)**	**LW(g)**
Loamy soil	8.76a	11.56a	3.89a	5.33a	7.57a	12.04a	13.03a	18.57a
Cocopeat	8.36a	11.42a	3.99a	5.28a	7.18a	12.17a	11.28a	14.63a
$LSD_{(0.05)}$	0.44	0.75	0.4	0.43	0.4	0.99	7.92	6.87
SE	0.15	0.26	0.14	0.15	0.14	0.34	2.71	2.35

Means with the same alphabet down the group are not significantly different from each other at 5 % significance level. LSD: Least Significant Differences, SE: Standard error. TW: Tuber weight and LW: leaf weight.

Table 4. Effect of different substrate source on the growth and yield of radish in hydroponics system

Watering methods	Plant height (cm)		Number of leaves		Leaf area (cm2)			
	Week2	**Week4**	**Week2**	**Week4**	**Week2**	**Week4**	**TW(g)**	**LW(g)**
Hand watering	9.16a	11.74a	4.06a	5.39a	7.52a	12.39a	17.79a	17.53a
Rainfed	7.96b	11.23a	3.78a	5.22a	7.23a	11.82a	6.52b	15.67a
LSD(0.05)	0.44	0.75	0.4	0.43	0.39	0.99	7.92	6.87
SE	0.15	0.26	0.14	0.15	0.14	0.34	2.71	2.35

Means with the same alphabet down the group are not significantly different from each other at 5 % significance level. LSD: Least Significant Differences, SE: Standard error. HW: Hand watering, TW: Tuber weight and LW: leaf weight.

Radish is grown for two reasons; the tuber part, which is grown for the purposes of salad making, and the leafy part used for medicine (Bakhsh et al., 2006). The agronomic performances of the three genotypes used in this study showed that the three genotypes can be effectively cultivated for the leafy vegetable purposes. However, there is more efficient transfer of photosynthate assimilates (net photosynthetic conversion) from the leaves of WIR genotype to the roots which undergoes secondary enlargement to form the tubers (Evans & Poorter, 2001). Although, cool environment favour tuber formation in radish (Sirtautas et al., 2011), this condition cannot be guaranteed in Nigeria as the climatic conditions is not stable (fluctuation between cold and more of hot weather). This implies that the WIR genotype adapts better to the environmental fluctuations.

The first report of radish production in Nigeria was carried out using the cocopeat substrate effectively (Ossai et al., 2020). However, in this study, the difference in performance of the genotypes in both cocopeat and top soil in terms of the agronomic and yield parameters was insignificant. On the other hand, while simulating the production of radish to the natural environmental condition, where rainfall distribution also varies, the consistent supply of water to the plants every 3 days encourages tuber production than the rainfed system. This is because there are periods the plants will be starved of water in rainfed system due to the plants high rate of evapotranspiration (Wan & Kang, 2005), and the plants will be stressed before regaining its good condition by the reoccurrence of rain. This situation validates the work of Bakhsh et al. (2006) and that stated that radish thrives better in a moist rich soil.

CONCLUSIONS

The nutritive and medicinal components radish makes radish introduction to Nigeria important as majority of the populace are malnourished in many essential nutrients. The results of this study had shown that radish can be effectively grown on the soil type of Nigeria as in cocopeat system. However, the practice of irrigation system is more favorable for the cultivation as rainfall distribution varies and local farmers mostly lack the means to study the weather condition. Thus both the agrometerological and extension agencies will play a vital role in the weather forecasting and dissemination of the weather condition to the local farmers, as this will help the farmers in planning their cropping system to improve their harvest.

REFERENCES

Abdel, C. G. (2011). Improving the production of radish (Raphanus sativus L.cv. local black) by Fe-EDDHA and carrots (Daucus carrota L. var. sativus cv. nates) by indole-3-butyric acid (IBA). *African Journal of Agricultural Research*, *6*(4), 978-985

Bakhsh, K., Ahmad, B., Ahmad, Z. and Gill, H. S. (2006). Estimating Indicators of Higher Yield in Radish Cultivation. *Int J Agric Biol, 8*(6), 783-787

Baloch, A. F. (1994). Vegetable Crops. Horticulture, National Book Foundation, Islamabad

Evans, J. R., & Poorter, H. (2001). Photosynthetic acclimation of plants to growth irradiance: the relative importance of specific leaf area and nitrogen partitioning in maximizing carbon gain, Plant, Cell and Environment, *24*, 755-767

Hoang, M. (2020). Effects of growing substrates and seed density on yield and quality of radish (Raphanus sativus) microgreens. Research on Crops. *21*. 579-586.

Hula, M. (2013). Exploring the relationship between farming practices and vegetation dynamics in Benue State, Nigeria. *World Journal of Agricultural Sciences, 1*, 232-240.

Ossai, C. O., Ogbole, S., Balogun, M. O., & Akpeji, S. C. (2020). Production of Radish (Raphanus sativus L.) in Nigeria Using the Hydroponics System. *Journal of Environmental and Agricultural Studies, 1*(2), 6-9.

Sirtautas, R., Samuoliene, G., Brazaitytė, A. & Duchovskis, P. (2011). Temperature and photoperiod effects on photosynthetic indices of radish (Raphanus sativus L.). Zemdirbyste, *98*, 57-62.

Wan, S. & Kang, Y. (2005). Effect of drip irrigation frequency on radish (Raphanus sativus L.) growth and water use. *Irrig.* Sci. *24*, 161-174.