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Production of Radish (*Raphanus sativus L.)* in Nigeria Using the Hydroponics System

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ABSTRACT

Radish (Raphanus sativus L.) is an exotic vegetable cultivated in the temperate regions of the World. Hence tropical countries have to rely on importation to consume them. However, little or no attempt has been made to domesticate this crop in tropical regions of the World. But the acclimatization of this vegetable will require growing them in a controlled system for easy study. This study therefore involves the cultivation of three different varieties of radish in the hydroponics system during the rainy and dry seasons in Nigeria. The seeds of three varieties were grown in a hydroponics system with cocopeat and a mixture of cocopeat and sandy soil (50:50 ratio) and fertigated with 100 ml of liquefied poultry manure (1 mg/ml concentration) every 7 days and watering was done every 3 days till harvest. It was a factorial experiment laid in a completely randomized design with 3 replicates. At bi-weekly interval, data were taken on the number of leaves, plant height, leaf area, while at harvest; the fresh tuber weight and fresh leaf weight were collected. Data collected were analyzed using ANOVA and differences in the treatment means were separated using least significant differences (LSD) at 5 % level of significance. Results obtained showed the agronomic performance and the fresh leaf weight of the varieties were same, but the fresh tuber weight of White Icicle Radish (WIR) (23.32±0.24) was significantly higher than both Cherry Berry Radish (CBR) (15.32±0.24) and Cherry Red Radish (CRR) (14.17±0.24) varieties. Also the tuber weight of the varieties in the rainy season (23.03±1.83) was significantly higher than the dry season (12.18±1.83), while both the tuber weight (22.59±1.83) and leaf weight (33.94±2.39) of the cocopeat substrate was significantly higher than the equal mixture of cocopeat and sharp sand in a ratio of 50:50.

1. Introduction

Radish (*Raphanus sativus* L.) is a member of Brassicaceae family. It is of two classes based on the seasons; the short seasoned (annual) and long seasoned types (biennial) (Pierce, 1987). It is an important commercial vegetable in the Europe and Asia (Salerno *et al*., 2015) were it is predominantly cultivated. Apart from food, it has been reportedly used in treating cancer due to its antimicrobial and antiviral properties (Guttierrez and Perez, 2004). However, little or no effort is made in Africa to domesticate this vegetable for different commercial purposes.

The sub-Saharan Africa comprises of tropical agro-climate with hotter temperatures than the temperate region where both Europe and Asia falls in andradish originated from, and it is being cultivated in a commercial scale (Salerno *et al.,* 2015). Nigeria predominantly carry out their farming activities in an open field, and being that the crop of interest (radish) has not been fully acclimatized in this region of the World, it is important to start cultivating this crop in an enclosed farming system

to gradually adjust the crop to be fully exploited in Nigeria. Also considering the performance differences of different genotypes of radish (Fernando *et al*., 2019), this study however considers the cultivation of radish in a hydroponics system to check the performance of three different genotypes of radish in both dry and rainy seasons in Nigeria.

2. Materials and Methods

Three varieties of radish seeds and twenty-four troughs of drip system hydroponics troughs were purchased the Soilless farmlab seed company, Abeokuta. Cocopeat in block form was purchased from Afri-Agri company, Lagos. The buffered cocopeat blocks was dissolved in water. The cocopeat was divided into two part. One part was used to fill in 12 hydroponics troughs with perforations beneath for drainage purposes, while the second part of the cocopeat was mixed with sharp sand at a ratio of 50:50 respectively. The substrates were poured into the hydroponics troughs (8 litres capacity with 4 segments of 2 litres capacity each). Poultry droppings was sourced from Ajayi farm, Ibadan. The poultry manure was allowed to dry for one week, 1 g of the poultry manure was ground into fine particles and liquefied by soaking them in 1 Litre of water for two days. For the plants fertigation, 100 ml of the nutrient was used to fertigate each plant once per week and watering was done every 3 days till harvest. 2 litre capacity buckets were filled with the cocopeat and the radish seeds were sown directly, it was watered at 3 days' interval and inspected daily for the germination of the radish seeds. At one week interval, the germinated seedlings were transferred to the hydroponics set up. The experiment was conducted twice (May to July and August to September, 2020). The experiment was a 2 (season) by 2 (substrates) by 3 varieties (Cherry Berry Radish (CBR), Cherry Red Radish (CRR) and White Icicle Radish (WIR)) factorial laid in a completely randomized design (CRD) with 3 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 analysed using ANOVA (SAS 9.0 version) and differences in treatment means were separated using least significance differences at 5 % level of significance.

3. Results and discussions

The genotypes evaluated was significant in the number of leaves (NOL) at 2 weeks after planting (2WAP), leaf area (LA) at 2 and 4 WAP respectively, plant height (PH) at 4 WAP and the tuber weight (g) (Table 1).

Table 1: Interactions between seasons, genotypes and substrates in the growth and yield of radish in hydroponics system

Sources	PH2	NOL2	LA2	PH4	NOL4	LA4	TW(g)	LW(g)
S	1.40ns	1.36*	8.70**	6.42**	1.00ns	62.15**	1058.42**	318.62ns
V	0.04ns	1.19*	42.23**	0.01ns	1.00ns	42.98**	298.09*	217.43ns
Sub	21.31**	10.03**	1.10ns	0.01ns	5.44**	0.05ns	898.00**	1311.65**
S*V	3.63ns	0.36ns	3.81ns	2.33ns	0.33ns	5.64ns	501.39**	272.90ns
S*Sub	0.47ns	0.03ns	2.30ns	4.27*	0.01ns	0.02ns	132.25ns	31.17ns
V*Sub	2.09ns	0.19ns	8.97**	2.93*	1.44ns	17.84*	63.87ns	182.31ns
S*V*Sub	0.16ns	0.03ns	4.98*	0.61ns	0.33ns	4.73ns	81.03ns	231.75ns

S: Season, V: Varieties, Sub: Substrates, PH2: Plant height at 2 weeks after planting, PH4: plant height at 4 weeks after planting, NOL2: Number of leaves at 2 weeks after planting, NOL4: number of leaves at 4 weeks after planting, LA2: Leaf area at 2 weeks after planting, LA4: leaf area at 4 weeks after planting, TW: Tuber weight and LW: leaf weight.

At 2WAP, there were no significant differences between the NOL of CBR (4.08±0.16) and WIR (4.00±0.16), but both genotypes were significantly higher than CRR (3.50±0.16). However, at 4 WAP, they were all significantly same. The PH at 2 and 4WAP was not significant between the genotypes. The LA of CBR (9.79±0.32) at 2WAP was significantly higher than CRR (6.10±0.32) and WIR (7.37±0.32) respectively. However, it was the LA of CRR (14.17±0.57) that was significantly higher than the rest genotypes at 4 WAP. The WIR produced the heaviest tuber weight (23.32±0.24) which was significantly higher than both CBR (15.32±0.24) and CRR (14.17±0.24) which were statistically same. However, there were no significant differences between the genotypes evaluated in the fresh leaf weight (Table 2).

Table 2: Growth and yield performance of three varieties of radish in hydroponics system

Varieties	PH2	NOL2	LA2	PH4	NOL4	LA4	TW(g)	LW(g)
CBR	9.56a	4.08a	9.79a	12.65a	6.50a	10.41b	15.32b	28.64a
CRR	9.45a	3.50b	6.10c	12.69a	6.00a	14.17a	14.17b	31.74a

WIR	9.50a	4.00a	7.37b	12.64a	6.50a	11.90b	23.32a	23.33a
$LSD_{(0.05)}$	1.01	0.47	0.92	0.72	0.58	1.66	6.53	8.54
SE	0.34	0.16	0.32	0.25	0.19	0.57	0.24	0.92

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. PH2: Plant height at 2 weeks after planting, PH4: plant height at 4 weeks after planting, NOL2: Number of leaves at 2 weeks after planting, NOL4: number of leaves at 4 weeks after planting, LA2: Leaf area at 2 weeks after planting, LA4: leaf area at 4 weeks after planting, TW: Tuber weight and LW: leaf weight. WIR: White Icicle Radish, CBR: Cherry Berry Radish and CRR: Cherry Red Radish.

The result obtained showed that season of planting was significant on the number of leaves (NOL) and leaf area (LA) at 2 weeks after planting (WAP), plant height (PH) and leaf area at 4WAP, tuber and leaf weights at harvest (Table 1). At 2 WAP, the NOL produced by the genotypes was highest in the period of August to October (4.06±0.13) was significantly higher than the ones produced within May to July (3.67±0.13), but there were no significant differences between the two seasons at 4 WAP. However, at 4 WAP, the leaf area of the May to June planting season (13.47±0.46) was significantly higher than the August to October (10.84±0.46) planting season. Also, on the weight of tuber produced, the May to July (23.03±1.83) produce was statistically heavier than the August to October (12.18±1.83) produce, but their leave weight was statistically same (Table 3).

Table 3: Seasonal effect on the growth and yield of radish in the hydroponics system

Season	PH2	NOL2	LA2	PH4	NOL4	LA4	TW(g)	LW(g)
M-J	9.70a	3.67b	8.24a	13.08a	6.50a	13.47a	23.02a	30.88a
A-O	9.31a	4.06a	7.26b	12.24b	6.17a	10.84b	12.18b	24.93a
$LSD_{(0.05)}$	0.82	0.38	0.75	0.59	0.47	1.35	5.33	6.97
SE	0.28	0.13	0.26	0.2	0.16	0.46	1.83	2.39

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. M-J: May to June, A-O: August to October. PH2: Plant height at 2 weeks after planting, PH4: plant height at 4 weeks after planting, NOL2: Number of leaves at 2 weeks after planting, NOL4: number of leaves at 4 weeks after planting, LA2: Leaf area at 2 weeks after planting, LA4: leaf area at 4 weeks after planting, TW: Tuber weight and LW: leaf weight.

The substrates evaluated in this study showed significant differences in both the agronomic and yield data (Table 1). At 2 WAP, the PH (10.27±0.28) and NOL (4.39±0.13) of the cocopeat substrate was significantly higher than the mixture of cocopeat and sharp sand (50:50) which had 8.73±0.28 and 3.33±0.13 respectively. Also at 4 WAP, the NOL of the cocopeat substrate (6.72±0.16) was significantly higher than the mixture of cocopeat and sharp sand (5.94±0.16). While at harvest, both the tuber weight (22.59±1.83) and leaf weight (33.94±2.39) of the cocopeat substrate was significantly higher than the equal mixture of cocopeat and sharp sand which had 12.61±1.83 and 21.87±2.39 respectively (Table 4).

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

Substrates	PH2	NOL2	LA2	PH4	NOL4	LA4	TW(g)	LW(g)
CP	10.27a	4.39a	7.58a	12.67a	6.72a	12.12a	22.59a	33.94a
CPSS	8.73b	3.33b	7.93a	12.66a	5.94b	12.19a	12.61b	21.87b
$LSD_{(0.05)}$	0.82	0.38	0.75	0.59	0.47	1.35	5.33	6.97
SE	0.28	0.13	0.26	0.2	0.16	0.46	1.83	2.39

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. CP: Cocopeat, CPSS: Cocopeat + Sharp sand (50:50), PH2: Plant height at 2 weeks after planting, PH4: plant height at 4 weeks after planting, NOL2: Number of leaves at 2 weeks after planting, NOL4: number of leaves at 4 weeks after planting, LA2: Leaf area at 2 weeks after planting, LA4: leaf area at 4 weeks after planting, TW: Tuber weight and LW: leaf weight.

Nigeria is blessed with varieties of vegetables that are nutritive, some of which are highly exploited, while some are underutilized (Kadiri and Olawoye, 2015). However, this doesn't give a limitation in the exploitation and domestication of exotic fruit vegetables. Radish is one of the exotic vegetables that is highly gaining recognition due to its food and medicinal

properties (Guttierrez and Perez, 2004). However, the domestication of this crop requires gradual study of the suitable planting season, genotypic evaluation (Fernando *et al*., 2019) to understand the ones more adapted to the peculiar agro-ecological zone and last but not the least, should the crop be introduced directly to an open field with our soil types or better produced in hydroponics form.

In this study, the agronomic yield performance of the three genotypes evaluated varies. Despite the higher agronomic performance of CRR and CBR, it was the WIR that produced the heaviest tubers. This might be that the WIR has better net photosynthetic conversion that translated to the tuber yield than the rest two varieties Evans and Poorter, 2001). However, being both the leaves and tubers are of important, the two varieties that produced more leaves can be recommended if broad leaves are of special interest.

However, being a novel crop, the period of cultivation becomes absolutely necessary. The findings of this research shows that the period corresponding to peak rainfall in Nigeria (May to July) is more suitable for the production of radish. Coincidentally, this period corresponds to a lower temperature in the country. However, if in need of the leaves, period of planting is inconsequential as there was no difference between the performances of the 2 seasons. According to Sirtautas *et al*., (2011), radish thrives better in a cool environment, and environmental condition plays a significant role in regulating the root and shoot biomass.

The novel application of the hydroponics system has made the cultivation and experimentation easier in agriculture as there is no competition arising from weed interference. However, for farmers who could not afford the vertical farming system due to initial financial requirement, radish is said to be easily grown on all types of soil (Bakhsh *et al*., 2006). Although, in this study, the cocopeat substrate performed better than the mixture of cocopeat and sandy soil.

Figure: A: Cherry Be adish at 4 weeks after plant B: Cherry Red Radish at 4 wee ter planting and C: White Icicle Radish at 4 weeks after planting.

4. Conclusions

From the findings of this study, radish, like other exotic vegetables, can adapt and survive in the tropical environment all year round; however, the productivity is enhanced during rainy season. Although, vertical farming with cocopeat substrate was used for this study which performed better than the mixture of cocopeat with sandy soil, it is important to evaluate the performance of radish using the topsoil and compare its productivity with cocopeat.

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