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GROWTH, YIELD AND NUTRITIONAL QUALITIES OF ONION (*Allium cepa* L.) AS INFLUENCED BY DIFFERENT GROWTH MEDIA

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ABSTRACT
Experiment on growth, yield and nutritional qualities of onion as influenced by growth media was conducted at the Department of Crop Science Teaching and Research Farm, University of Nigeria, Nsukka. The growth media were formulated on volume basis in the following ratios: M1: Top soil (TS)+ Poultry manure (PM)+ River sand (RS) (2:1:1), M2: TS + PM + Rice hull (RH) (2:1:1), M3: TS + PM + Sawdust (SD) (2:1:1) and M4: TS + PM + RS + RH + SD (2:1:1:1:1). The media were laid out in a completely randomized design (CRD) with five replications. Minerals, vitamins and moisture content were determined using standard analytical procedures. Analysis of variance indicated significant effect of growth media on plant height, leaf length, bulb height and shoot weight. Plants grown in M2 performed better in some of the growth and yield parameters measured. Growth media only influenced vitamin B_{12} and vitamin A. Vitamin B_{12} (0.027 mg/100g) was highest in M4. Highest vitamin A (0.041 mg/100g) was attributed to M3, which was statistically similar to 0.040 mg/100g recorded in M1. Growth media influenced only iron and phosphorus among the minerals, with M4 having more iron (0.36 mg/100g) and M3 yielding more phosphorus (57.050 mg/100g). M2 that exhibited superiority in growth and yield might be appropriate for containerized onion production in homes.

Keywords: Onion; containerization; growth media; nutritional qualities; food security

INTRODUCTION
Onion (*Allium cepa* L.) is one of the important vegetable crops belonging to the family Alliaceae. It is grown in the temperate regions (Edet *et al.*, 2015) and is one of the most cultivated vegetable crops worldwide. It is known as 'Ayo' in Igbo, 'Ayim' in Ibibio, 'Albasa' in Hausa, and 'Alubasa' in Yoruba (Edet *et al.*, 2015; Ogbonna *et al.*, 2016) in Nigeria. Onion produces various bulb sizes such as small, medium and large and also has different colours viz white, yellow and red. Various shapes such as flattened, round and globular have been seen. The onion is characterized as short days and long days' plant, which relies on day length requirement (Ali *et al.*, 2018). To produce bulb and seed, onion needs high temperature and long photo-period (Baloch, 1994). The bulb is pungent due to the volatile oil (allyl propyl disulphide) it contains (Malik, 1994). Widely cultivated as a commercial vegetable crop, eaten globally as cooked vegetable or part of savory dishes, but can also be eaten raw (Patricia, 2006).

Medicinal attributes as found in onion are used in the treating ailments such as coughs, snakebite and hair loss. Additionally, it is used by athletes to rub down their muscles to make it firm, for blood balance, as well as to improve bowel movement and erection in men (USPO, 2011; Adeyeye *et al.*, 2017). Griffiths *et al.* (2002) evaluated the health benefits of onions and reported them to have antithrombotic activity, antiasthmatic and antibiotic effects. According to Micheal (2006), onion is among the food plants to which moderate level of anticancer activities is attributed. Ken and Addy (2013) reported that the pungent juice of onions has been used as insect repellant as well as dyes used in fabric industries. Paul (2006) documented that onion like other vegetables provide vitamins such as vitamins A and C including a good amount of mineral elements to the human body.Continuous calorie deficit affects approximately 795 million malnourished people in the world (FAO, IFAD and WFP, 2015). Furthermore, sustainable crop production is threatened due to exponential population growth, climate change and limited natural resources. One of the ways out of this impasse is the formulation of less cumbersome media that can support the growth of onion to ensure food security. Therefore, it has become imperative to secure safe and sufficient supply of affordable but nutritious food rich in vitamins and minerals to feed the populace. Developing horticultural techniques for growing crops in pot using growth media could reduce farmer-herder clash in Nigeria and enable the urban dwellers to raise crops in their compound with ease (Baiyeri *et al.*, 2015). A good growing media would provide anchorage, nutrients, aeration and conserve water (Abad *et al.*, 2002). The composition of media influences seedling quality (Abirami *et al*., 2010). There is scanty information on the effect of growth media on growth, yield and nutritional composition of onion in the study area. Hence the need to formulate different growth media in order to determine the efficacy of each on growth, yield and nutritional qualities of onion. The objective of this study was to determine growth, yield and nutritional qualities of onion as influenced by different growth media.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Department of Crop Science Teaching and Research Farm, University of Nigeria, Nsukka (07°29'N, 06°51'E, 400 m a.s.l.), Enugu State, Nigeria, between October 2021 and February 2022. The area is located in the derived Savanna zone and is characterized by lowland humid conditions with bimodal annual rainfall distribution that ranges from 1155 – 1955 mm. It has a mean annual temperature of 29 - 310C and relatively humidity ranging from 69 - 79% (Uguru *et al.,* 2011).

Media preparation:

Four growth media were formulated on volume basis from topsoil (TS), poultry manure (PM), river sand (RS), rice hull (RH) and sawdust (SD). The media were formulated as follows:
M1 = TS+PM+RS (2:1:1)
M2 = TS+PM+RH (2:1:1)
M3 = TS+PM+SD (2:1:1)
M4 = TS+PM+RS+RH+SD (2:1:1:1:1)
They were composted for four weeks before onion seedlings were transplanted into them.

Analysis of growth media

Prior to transplanting of seedlings, samples were collected from each growth media for physio-chemical analysis. The analysis was conducted at the laboratory of the Department of Soil Science, Faculty of Agriculture, University of Nigeria, Nsukka (Table 1).

Experimental design and planting

Onion seeds were sourced from a local market in Gombe State and nursery bed was prepared to raise the seedlings for five weeks before transplanting into the pots. The seeds were planted in the nursery in early October, 2021 and one plant/pot was transplanted late November 2021. The different media were thoroughly mixed on a flat surface accordingly and were filled into a perforated polythene pots with diameter 38.5 cm and length 48 cm.. The experiment was laid out in a completely randomized design (CRD) with five replicates.

Data collection

Plant height (cm) was taken from the plants in each replication from the treatments at harvest using measuring tape and the average from five samples recorded. Number of leaves was counted and the average recorded. Leaf length (cm) was measured using measuring tape and the average recorded. Bulb diameter was measured using venier caliper and then average was worked out. For average bulb weight, bulbs were weighted in each replication and the average was taken. Harvested onion bulbs were named according to the media used and triplicate samples of the bulbs were packaged in paper envelopes and taken to Simuch Scientific Analytical Laboratory, Nsukka for minerals, vitamins and moisture content analysis.

Analysis of Minerals

The official method of AOAC (2007) was adopted for the mineral analysis of the samples. Two gram of each ground sample was weighed into a silica dish, then placed in a muffle furnace and heated at 600°C for three hours, allowed to cool in a desiccator and weighed. The samples were dissolved with HCl and prepared for reading using atomic absorption spectrometer (AAS). Calcium, sodium, iron and potassium were determined using atomic absorption spectrometer (AA-7000) and absorbance read at 422.7 kk-nm, 589.0 kk-nm, 248.3 kk-nm and 766.5 kk-nm wavelength respectively. Vanado-Molybdate Calorimetric method was used to determine phosphorus using spectrophotometer (752P) at a wavelength of 92.25 nm. Moisture content was determined; 5 g of the ground sample was dried to a constant weight at 60°C in a hot air circulating oven. The moisture was calculated as the difference in weight after drying.

Vitamins Determination

Vitamins were determined following the analytical procedure of AOAC (2007). Vitamin A was determined by weighing 2.0 g of sample into a set of conical flasks.

The sample was saponified, extracted with 10 ml of xylene-kerosene mixture, shaken for 30 minutes and centrifuged for 25 minutes. The supernatant was run on the spectrometer at 328 nm and 460 nm, respectively. Concentration of vitamin B_{12} was determined using Spectrophotometer (Labomed spectronic 21D) and the absorbance of samples was read at a wavelength of 510 nm. At a wavelength of 460 nm, absorbance, the standards and samples were read using fluorescent spectrometer to determine vitamin B_2. Spectrophotometer (Spectronic 21D) at a wavelength of 15 seconds and 30 seconds was employed to determine vitamin C. At wavelength of 540 nm, vitamin B_6 was determined using Spectrophotometer (752P).

Statistical data analysis

Data collected were subjected to the analysis of variance (ANOVA) in completely randomized design (CRD) using GENSTAT Discovery edition 3 Release 7.22 DE (16). Significant treatment means were compared using least significant difference (LSD) at 5% level of probability.

RESULTS

Table 1 shows the results of physico-chemical properties of the growth media used for the experiment. The result indicated that variation exists in both the physical and chemical properties of the media as a result of the different types and proportions of component in each. The distinct variability in both physical and chemical properties of the media will explain differential plant growth and yield performance recorded as function of the media. Growth media had significant ($P < 0.05$) effect only on plant height and leaf length but number of leaves and plant girth did not vary statistically (Table 2). The tallest plant height (51.6 cm) and longest leaf (28.0 cm) was obtained from plants grown in M2. The shortest plant height and the shortest leaf were recorded in M4 with respective values of 36.2 and 15.9 cm. Number of leaves and stem diameter followed the same trend.

Table 3 showed that growth media significantly ($P > 0.05$) influenced bulb diameter, bulb height and shoot weight but bulb circumference and bulb weight did not differ statistically. However, it is pertinent to know that M2 had the widest bulb diameter (13.86 cm), bulb height (6.32 cm), bulb circumference 14.04 cm, heaviest shoot weight (44.60 g) and highest value for bulb weight (47.80 g). The least bulb diameter, bulb height and bulb circumference were obtained in M4 with respective values of 8.24, 3.70 and 9.00 cm while M1 had the least shoot weight and bulb weight of 11.00 and 20.60 g, respectively. Table 4 showed that vitamins B_{12} and A varied significantly with the media but other vitamins were statistically similar across the growth media. Highest vitamin B_{12} (0.027 mg/100g) was obtained in bulbs grown in M4, which was statistically similar to 0.023 mg/100g recorded in M1. The least vitamin B_{12} (0.015 mg/100g) was recorded in M3. The highest vitamin B_2 (0.158 mg/100g) was obtained in M3 while M1 had the least of 0.075 mg/100g. Vitamin B_6 content (3.470 mg/100g) was highest in M2 and lowest (2.320 mg/100g) in M3. Conversely, M3 had more concentration of vitamin A with 0.041 mg/100g; this value was not statistically different from 0.040 mg/100g obtained in M1. The least value (0.020 mg/100g) was recorded in M4. Regarding vitamin C, M3 took the lead with 2.370 mg/100g while the least was recorded in growth media M1 (1.060 mg/100g).

On Table 5 are showed the influence of growth media on mineral and moisture contents of onion bulbs. Growth media significantly ($P < 0.05$) influenced only iron and phosphorus. Bulbs collected from M3 gave the highest calcium (30.50 mg/100g) and sodium (0.073 mg/100g) values; the least calcium content was obtained in M4 (21.20 mg/100g) while the least sodium value was recorded in M1 with 0.030 mg/100g. Iron was more abundant (0.367 mg/100g) in M4, followed by M2 (0.300 mg/100g) and M3 (0.145 mg/100g) while M1 gave the least value of 0.028 mg/100g. Potassium (7.710 mg/100g) and moisture content (38.500%) were more deposited in onion bulbs grown in M1 but plants raised in M4 had the least with respective values of 6.790 mg/100g and 23.400%. Phosphorus was more pronounced in plant grown in M3 (57.050 mg/100g), M1 had less concentration (47.940 mg/100g).

DISCUSSION

Growth: Growth media influenced most of the growth parameters measured in this study. Notably, M2 that had rice hull and poultry manure in its composition manifested superiority in enhancing growth characters of onion. The better performance of this media could be associated with higher N (Table 1) and probably due to more nutrients released from the media. Ugese (2010) reported superior performance of sawdust-based media in seedling characters of tamarind in Makurdi, which is at variance with the result of this present study. The result obtained in this study corroborates Baiyeri and Mbah (2006) who reported that rice hull media were superior to the soil based media. Yeng *et al.* (2012) found that potting media that consists of rice hull improved the growth of domestically grown oyster mushroom. Similarly, the findings as reported herein is also in agreement with the results obtained by Baiyeri (2005) in the weaning of banana/plantain plantlets where the rice hull based media were better than the saw dust based ones. Rice hull decays more slowly and easily incorporates into media where it impacts positively on the physical properties of drainage and aeration (Baiyeri, 2005). The rice hull based media had the highest nitrogen value when compared with other mix (Table 1). The rice hull based media probably did not suffer from nitrogen deficiency within the experimental period, thereby outperformed other media with respect to growth parameter evaluated.

Table 1: Physico-chemical properties of growth media evaluated for onion growth, yield and nutritional qualities in Nsukka

Properties	Growth media			
Physical	M1	M2	M3	M4
Silt (%)	6	6	8	8
Clay (%)	15	15	13	13
Coarse sand (%)	43	37	40	40
Textural class	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Chemical				
Organic carbon (%)	2.239	7.242	4.828	1.88
Organic matter (%)	3.86	12.485	8.323	3.254
Total nitrogen (%)	0.266	0.490	0.336	0.182
Phosphorus (ppm)	11.26	22.45	23.38	14.06
Sodium (meq/100g)	0.07	0.241	0.161	0.06
Potassium (meq/100g)	0.11	0.301	0.221	0.13
Calcium (meq/100g)	4.4	4.6	6	4.2
Magnesium (meq/100g)	1.2	2.8	2.2	3.8
C E C (%)	16	45.2	38	29.6
pH (H2O)	6.9	7.2	7.4	7.4
pH (KCl)	6.2	6.4	6.6	6.6
Exchangeable acidity in me/ 100 g soil				
Aluminium (Al3+)	0.2	0.2		
Hydrogen (H+)	2.4	2.8	1.4	1.6

Source: The laboratory of Soil Science Department, Faculty of Agriculture, University of Nigeria, Nsukka. M1-TS + PM + RS (2:1:1), M2-TS + PM + RH (2:1:1), M3- TS + PM + SD (2:1:1) and M4- TS + PM + RS + RH + SD (2:1:1:1:1). TS-Topsoil, PM-Poultry manure, RS-River sand, RH-Rice husk and SD-Saw dust.

Table 2: Effect of growth media on plant height, number of leaves, stem diameter and leaf length of onion at harvest

Media	Plant height	Number of leaves	Stem diameter	Leaf length
M1	41.6	10.2	4.42	24.1
M2	51.6	13.0	5.38	28.0
M3	41.6	10.4	4.52	26.1
M4	36.2	8.8	3.66	15.9
LSD (0.05)	10.43	NS	NS	8.32

M1-TS + PM + RS (2:1:1), M2- TS + PM + RH (2:1:1), M3- TS + PM + SD (2:1:1) and M4- TS + PM + RS + RH + SD (2:1:1:1:1). TS-Topsoil, PM-Poultry manure, RS-River sand, RH-Rice husk and SD-Saw dust. NS- non-significant.

Yield

It is worthy of note that bulb diameter, bulb height, bulb circumference, shoot weight and yield of onion bulb increased in plants grown in M2. In support of this is the report of Yeng *et al.* (2012) that rice hull-based substrate enhanced the yield of oyster mushroom. Edemadu *et al.* (2020) stated that growth media that comprised topsoil, poultry manure and rice hull increased yield of sweet potato in Nsukka, Enugu State. Utobo *et al.* (2016) reported that potting media with rice hull gave better results in terms of root circumference and yield of carrot. The result obtained here could be linked to better physicochemical qualities of M2 in comparison to the other three media which probably enhanced bulb development. Rice hull has the benefit of being easily incorporated into media to improve drainage and aeration (Wilkerson, 1994).

Nutritional qualities

Vitamin B_{12} and A ranged from 0.027 - 0.015 and 0.041 - 0.020 mg/100g, respectively. Pareek *et al.* (2018) recorded higher value (2 IU per 100 g) for vitamin A in onion. Higher vitamin C (6.60 mg/100g), lower vitamin B_2 (0.02 mg/100g) and vitamin B_6 0.13 mg/100g was reported by Ogbonna *et al.* (2016) in *Allium cepa* bulb. Presence of vitamin C in onion bulb may explain its use in treating itching, skin infections, eczema and psoriasis. According to previous studies (Okwu and Ekeke, 2003; Okwu and Okwu, 2004), it can be used in the treatment of prostate cancer and common cold and possesses antioxidant properties (Hunt *et al.,* 1980; Ogbonna *et al.,* 2016). The differences observed in vitamin contents could be attributed to the variation in the media used. The variations in the vitamin contents of oyster mushroom was reported to likely due to the differences in substrate composition (Vimla and Sundeh, 2005).

The analysis of mineral composition of onion bulb revealed the presence of calcium, iron, potassium, sodium and phosphorus. Growth media differed with iron and phosphorus. Iron and phosphorus contents varied from 0.367 - 0.028 and 57.050 - 47.940 mg/100g, respectively. The iron value obtained in this work is comparable with 0.31

mg/100g reported by Ogbonna *et al.* (2016) in onion bulb extract but value for phosphorus (35.00 mg/100g) was lower than the result obtained in this work. Cota *et al.* (2013) also reported higher value of iron (1.145 mg/100g) in onion bulb grown in Bosnia and Herzegovina compared to the value reported in this work. Calcium value obtained ranged from 30.50 - 21.20 mg/100g, the value was quite small when compared to 375.15 mg/100g reported by Edet *et al.* (2015) in onion bulb. The presence of calcium in onion bulb implies that onion can enhance structural function, provide energy, osmotic regulation and catalytic functions (Hanounes, 2001; Hermanson *et al.,* 2002). Potassium varied from 7.710 to 6.790 mg/100g, which is lower when compared with potassium content (159.00 mg/100g) reported by Ogbonna *et al.* (2016) in onion bulb. Potassium is the principal cation in the intracellular fluid; it functions by influencing acid-base balance, osmotic pressure including water retention, contraction of smooth, skeletal and cardiac muscles (Greeves and Holmes, 1999). The sodium value ranged from 0.073 - 0.030 mg/100g. The sodium content of onion bulbs was very low when compared to 5.00 mg/100 g in *Tribus terrestris* leaves (Hassan *et al.,* 2005) and 3.29mg/100g in *M. flagellipes* (Ihedioha and Okoye, 2011). Sodium and potassium are important in diets due to their role in blood pressure regulation (Yoshimura *et al.,* 1991). Moisture content ranged from 38.50 - 23.40% which was lower than 88.65% obtained by Sami *et al.* (2021) in onion bulbs from Taif, Saudi Arabia. Armand *et al.* (2018) also reported higher moisture content in onion varieties cultivated in Cameroon. Elhakem *et al.* (2021) reported that rotting and sprouting are initiated by high moisture content. Genetic and environmental effect might have caused the differences in mineral compositions of onion bulb assayed. Ndubuaku *et al.* (2015) reported differences in nutrient contents of Moringa, which was attributed to the locational and environmental variations.

Table 3: Effect of growth media on bulb diameter (cm), bulb height (cm), bulb circumference (cm), shoot weight (g) and bulb weight (g) of onion grown in pot

Media	Bulb diameter	Bulb height	Bulb circumference	Shoot weight	Bulb weight
M1	10.56	4.96	11.20	11.00	20.60
M2	13.86	6.32	14.04	44.60	47.80
M3	11.20	4.40	11.46	21.40	31.50
M4	8.24	3.70	9.00	11.20	26.80
LSD (0.05)	3.89	1.49	NS	24.27	NS

M1-TS + PM + RS (2:1:1), M2- TS + PM + RH (2:1:1), M3- TS + PM + SD (2:1:1) and M4- TS + PM + RS + RH + SD (2:1:1:1:1). TS-Topsoil, PM-Poultry manure, RS-River sand, RH-Rice husk and SD-Saw dust. NS- non-significant.

Table 4: Effect of growth media on vitamin contents (mg/100g) and moisture content of onion grown in pot

Media	Vitamin B_{12}	Vitamin B_2	Vitamin B_6	Vitamin A	Vitamin C
M1	0.023	0.075	2.770	0.040	1.060
M2	0.020	0.102	3.470	0.025	1.320
M3	0.015	0.158	2.320	0.041	2.370
M4	0.027	0.110	3.160	0.020	1.100
LSD (0.05)	0.007	NS	NS	0.011	NS

M1-TS + PM + RS (2:1:1), M2- TS + PM + RH (2:1:1), M3- TS + PM + SD (2:1:1) and M4- TS + PM + RS + RH + SD (2:1:1:1:1). TS-Topsoil, PM-Poultry manure, RS-River sand, RH-Rice husk and SD-Sawdust. NS- non-significant.

Table 5: Effect of growth media on mineral composition (mg/100g) and moisture content (%) of onion grown in pot

Media	Calcium	Iron	Potassium	Sodium	Phosphorus	Moisture content
M1	26.00	0.028	7.710	0.030	47.940	38.500
M2	22.80	0.300	7.410	0.060	54.960	30.400
M3	30.50	0.145	7.040	0.073	57.050	31.300
M4	21.20	0.367	6.790	0.060	48.260	23.400
LSD (0.05)	NS	0.091	NS	NS	6.6730	NS

M1-TS + PM + RS (2:1:1), M2- TS + PM + RH (2:1:1), M3- TS + PM + SD (2:1:1) and M4- TS + PM + RS + RH + SD (2:1:1:1:1). TS-Topsoil, PM-Poultry manure, RS-River sand, RH-Rice husk and SD-Saw dust. NS- non-significant.

CONCLUSION

It was evident that M2 (TS + PM + RH (2:1:1)) exhibited superiority in terms of growth and yield of onion and it should be used in onion production especially in homes to provide nutrient for the teeming population. The results of this study established that onion bulb contain mineral and vitamin contents in varying quantity. The variation in mineral and vitamin composition of onion as affected by growth media could guide the utility of the crop.

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