INFLUENCE OF POTTING MEDIA ON THE GROWTH AND BULB YIELD OF ONION (*Allium cepa* L.)

Supported by tetfund TERTIARY EDUCATION TRUST FUND

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Received: April 27, 2017 **Accepted:** August 20, 2017

Abstract: A trial was conducted in the screen house at the Department of Crop Science, Faculty of Agriculture, University of Benin, Benin City, Nigeria to investigate the effect of different potting media on the growth and yield of *Allium cepa* L. Five sources of growing media: burnt rice husk (BRH), oil palm refuse bunch (OPRB), cattle dung (CD), poultry manure (PM) and river sand (RS) were used. River Sand and the other four sources were combined in ratios of 1:1, 1:2 and 2:1 to make 12 treatment [RS + PM (1:1); RS +PM (1:2); RS +PM (2:1); RS + OPRB (1:1); RS + OPRB (1:2); RS + OPRB (2:1); RS + BRH (1:1); RS + BRH (1:2); RS + BRH (2:1) RS + CD (1:1); RS + CD (1:2); and RS + CD (2:1)]. Together with the five main media sources, made up a total of seventeen (17) treatments. These treatments were laid out in polybags in a completely randomized design with three replications. Data were collected on leaf length, number of leaves, number of bulbs, weight of fresh bulb, bulb girth and bulb yield. Results obtained indicated that potting media influenced growth and yield of onion significantly. The best yield was obtained from OPRB potting media with 30.00 g fresh bulb per plant, bulb girth (11.83 cm) and bulb yield (19.80 t ha^{-1}). In the urban and sub-urban areas constrained with polluted and inadequate land space, potting medium with OPRB could be an innovative approach to good quality, enhanced and sustained onion production.

Keywords: Bulb yield, growth, onion, potting media

Introduction

Onion (*Alliumcepa*) is one of the most important commercial vegetable crops cultivated extensively in northern part of Nigeria. It ranks among the top five vegetables in Nigeria (NIHORT, 1986). Onion bulb is a rich source of minerals such as phosphorus, calcium and carbohydrates, protein and vitamin C (Gambo, *et al*., 2008). According to Hussain*et al*. (2000) onions can be eaten raw, in salad, fried, boiled or roasted, in flavouring soup, canned food products and other dishes.

Onions production in Nigeria is limited to the northern part of the country and the production is mostly carried out during dry season under irrigation (Nwokwu and Ekwu, 2015). The consumption and demand for onions presently is very high and the quantity produced in the northern Nigeria may no longer be sufficient. Nwokwu and Ekwu (2015) has identified limited land resources, poor soil fertility coupled with some production techniques deployed by the farmers as factors responsible for the lower production of onions. Extending the production of onions to the urban areas particularly in the southern Nigeria will help to bridge the production gap, in addition, it will also aid in resolving the unemployment in the urban area and thus stimulate economic activity of the urban centers. To achieve the cultivation of this crop in the urban areas will require the development of environmental friendly techniques with sustainable use of resources that will increase yield per hectare and overcome the problem of low native soil fertility status. This will entail setting up of temporary gardens using potting medium in the urban centers.

A potting medium is a composition of organic material formulated to achieve desirable chemical and physical needs required by the crop to attain its potential growth and development. A good potting medium management is essential for the production of quality crops since vigorous growth is needed to face the seasonal hazard encountered in the field (khan *et al*., 2006). The dominant factors to consider when choosing organic material for potting medium are optimum water holding capacity, electrical conductivity, pH, adequate aeration and organic matter content (khan *et al*., 2006). This innovation on developing and encouraging onions gardening and production in sub-urban and urban areas will also ensure adequate use and recycling of organic wastes generated from various sources (e.g. poultry farms, cattle markets, palm oil processing mills etc.) in such environments. This trial was set up to evaluate the effect of different potting media on the growth and bulb yield of onion.

Materials and Methods

The experiment was conducted in the screen house at the Department of Crop Science, Faculty of Agriculture University of Benin, Benin-City, Nigeria (Latitude 6^0 14′ and 7^0 34′ S and longitude 5^0 40′ and 6^0 43′ E). The trial was laid out in a Completely Randomized design (CRD) involving 17 potting media (T1: Burnt rice husk (600g), T2: Cow dung (600g), T3: Oil palm refuse bunch (600g); T4: Poultry manure (600g); T5: River sand (600g); T6: River sand + Poultry manure 1:1 (300 +300g), T7: River sand + Poultry manure 2:1 (400 +200g); T8: River sand + Poultry manure 1:2 (200 +400g); T9: River sand + Oil palm refuse bunch 1:1 (300 +300g); T10; River sand + Oil palm refuse bunch 2:1 (400 +200g); T11: River sand + Oil palm refuse bunch 1:2 (200 + 400g); T12: River sand + Burnt rice husk 1:1 (300 +300g); T13: River sand + Burnt rice husk 2:1 (400 +200g); T14: River sand + Burnt rice husk 1:2 (200 +400g); T15: River sand + Cattle dung 1:1 (300+300g); T16: River sand + Cattle dung 2:1 (400 +200g) and T17: River sand + Cattle dung 1:2 (200 +400g) and replicated three times. Each replicate had 85 polybags with five bags per treatment. Each poly bags had a dimension of 15 x 15 x 30 cm and were arranged at a spacing of 10 x 15 cm. Potting media were analysed for physical and chemical properties according to methods in Mylavarapus and Kennelley (2002).

Nursery operations were carried out in same screen house, onion seeds were sown in a wooden seed tray filled with soil mixture of top soil and organic manure in a ratio of 3:2. The seeds germinated after 4 – 7 days and remained in the wooden tray for eight weeks. While in the nursery the seedlings were watered daily in early hours of the day. They were transplanted into the potting media at 8 weeks after sowing (WAS). After transplanting, watering was done on daily basis in early hours of the day. Weeding and other cultural operations were performed as at when due. Onion bulbs were harvested at maturity, when the stem and leaves had withered

and dried off. Harvesting was by pulling out, and the bulb removed.

Growth parameters (leaf length and numbers of leaves) were collected on all the plants in each treatment unit at two weeks interval. After harvesting, data were collected on number of bulbs, fresh weight of bulb, bulb diameter, root length and bulb yield. Fresh weight of bulb was used to estimate yield per hectare as thus;

$$\frac{Fresh\ weight\ of\ bulb}{Area\ occupied\ by\ plant}\ x\ 10{,}000\ m2 \quad (g\ ha^{-1})$$

$$\frac{Fresh\ weight\ of\ bulb}{Area\ occupied\ by\ plant}\ x\ \frac{10{,}000\ m2}{1000} \quad (kg\ ha^{-1})$$

$$\frac{Fresh\ weight\ of\ bulb}{Area\ occupied\ by\ plant}\ x\ \frac{10{,}000\ m2}{1000\ x\ 1000} \quad (t\ ha^{-1})$$

Data collected were subjected to analysis of variance and significant differences among treatment means were separated using the least significant difference (LSD) at 5 % level of probability.

Results and Discussion

Physical and chemical properties of the potting sources

The physical and chemical properties of the potting sources are shown in Table 1. The potting source ranged from moderately acidic, topsoil (5.11), slightly acidic, poultry manure (6.11), OPRB (6.20), BRH (6.30) and cattle dung (6.90) to alkaline, river sand (8.20). The bulk density was highest in river sand (1.70 g/cm^3) and lowest in poultry manure (1.10 g/cm^3 and OPRB (1.00 g/cm^3). Organic C ranged from 0.06 % for river sand to 7.78 % for OPRB. The highest total N was obtained in poultry manure (5.00 %) and the least were in river sand (0.05 %) BRH (0.11 %) and OPRB (0.16 %). Phosphorus, Calcium and Magnesium were more abundant in poultry manure and least in river sand. Potassium was most abundant in OPRB (8.90 %) and the least in river sand (0.01 %). C: N ratio was lowest in poultry manure (0.84) and highest in river sand (47.33).

Table 1: Some physical and chemical analysis of different potting sources

Potting source	pH	Bulk density (gcm^{-3})	Org C (%)	TN (%)	Avail P (%)	K (%)	Ca (%)	Mg (%)	C:N
Top soil	5.11	1.33	2.64	1.20	1.25	0.11	2.30	0.20	2.24
Poultry manure	6.11	1.10	4.21	5.00	2.48	1.34	2.10	2.90	0.84
Cattle dung	6.90	1.20	3.18	0.34	0.82	0.62	2.04	0.56	9.35
River sand	8.00	1.70	0.06	0.05	0.03	0.01	0.05	0.10	47.33
OPRB	6.20	1.00	7.78	0.16	0.11	8.90	2.25	0.80	16.80
BRH	6.30	1.20	1.84	0.11	0.08	0.39	2.67	0.65	16.80
$LSD_{(0.05)}$	0.449	0.185	0.050	0.183	0.047	0.094	0.123	0.135	5.790

Table 2: Effect of different potting media on the leaf length of onion

Potting media	Weeks after transplanting							
	2	4	6	8	10	12	14	16
BRH	28.30	32.53	37.07	39.33	44.73	48.37	56.83	60.00
CD	31.37	33.77	41.53	49.47	55.53	57.73	59.27	62.73
OPRB	32.90	40.67	45.63	51.23	53.40	57.23	59.47	62.37
PM	18.53	20.20	22.73	24.33	37.47	45.40	57.03	60.30
RS	31.33	32.73	34.60	36.40	47.03	49.30	52.73	55.80
RS +PM (1:1)	23.47	28.30	33.27	40.60	53.77	56.80	60.07	62.33
RS +PM (1:2)	23.93	21.77	28.10	35.43	46.03	51.40	59.00	62.40
RS +PM (2:1)	28.00	30.43	36.50	46.83	57.80	63.20	66.27	70.03
RS + OPRB (1:1)	33.50	40.77	43.43	46.77	50.17	54.57	57.03	57.87
RS + OPRB (1:2)	26.23	41.23	44.73	48.13	49.07	52.83	54.00	60.33
RS + OPRB (2:1)	35.30	40.10	44.40	46.50	47.70	51.17	54.10	59.07
RS + BRH (1:1)	28.17	32.10	37.97	44.07	49.90	55.03	58.47	60.63
RS + BRH (1:2)	27.00	30.90	37.17	43.40	53.97	59.90	64.03	67.43
RS + BRH (2:1)	29.53	33.97	37.43	44.47	50.03	55.47	59.50	57.97
RS + CD (1:1)	30.63	31.40	37.00	47.63	50.03	51.97	52.10	58.30
RS + CD (1:2)	30.57	32.13	39.97	47.33	52.33	53.30	56.33	56.70
RS + CD (2:1)	32.80	35.77	39.60	47.23	50.00	53.67	56.70	57.23
Mean	29.50	32.87	37.71	43.50	49.94	53.96	57.81	60.68
LSD $_{(0.05)}$	8.693	7.412	7.938	7.053	7.964	7.617	6.557	8.002

Growth of onion

There were significant differences in the leaf length of onions among the treatments throughout the sampling periods (Table 2). At 2 weeks after transplanting (WAT), the longest leaves were observed in RS + OPRB (2.1) potting medium (35.30cm) and was only significantly different from RS + PM (1.2) 23.93 cm, RS +PM (1:1) 23.47 cm and PM potting media 18.53 cm. Onion leaves in other potting media were statistically comparable with RS + OPRB (2:1). At 4 WAT, potting media RS + OPRB (1.2) (41:23cm), RS + OPRB (1:1) (40.77cm), OPRB (40:67cm) and RS + CD (2.1) (35.77 cm) recorded significantly longer leaves. At 6 WAT, onion leaf length ranged from 22.73 cm for PM to 45.63 cm for OPRB. However, PM was statistically comparable to RS +PM (1:2) potting medium while, OPRB was statistically similar to CD, RS + OPRB (1.1), RS + OPRB (1.2), RS + OPRB (2.1), RS + CD (2:1) and RS + CD (2:1). This distribution trend in onion leaf length continued at 8-16WAT.

The number of leaves varied significantly at all the periods of sampling (Table 3) with the only exception at 2 WAT. At 4 WAT, the number of leaves ranged from 3.00 for PM and 5.00 for RS + OPRB (1:2) and RS + OPRB (2:1). Onion plants in RS + OPRB (1:2) and (2:1) potting media had significantly more leaves than PM, RS + PM (1:1); (2:1), RS + BRH (1:2) and RS + CD (1:2). At 6 WAT, the highest number of leaves was observed in OPRB potting media. The

least value in number of leaves was observed in PM (3:53). At 8 WAT, most foliated plants were observed in CD, OPRB, RS + OPRB (1:1), (2:2), (2:1), RS + BRH (1:1), RS + BRA (1:2), RS + CD (1:1)-(2:1) while the least foliated plant was observed in PM. This distribution pattern was similar at 10WAT. At 12 WAT, the highest number of leaves were observed in plants grown in RS + BRA (1:2), (2:1), RS + PM (2:1), (1:2) and CD potting media while the least were observed in BRH, PM, RS + OPRB (1:1) RS + OPRB (1:2), (2:1) and RS + CD (1:1) potting media. This distribution pattern was also repeated at 14 and 16 WAT.

Bulb yield and its components

Potting media had no significant effect on number of bulb as all potting media produced statistical similar values (Table 4). Fresh weight of bulb were significantly heavier in onion plants grown in sole BRH, CD, OPRB, PM, RS, RS + CD (1:2) and (2:1), RS + OPRB (1:1), -(1:2), RS + BRH (1:1), RS + CD (1:2) and (2:1) potting media. The bulb girth significantly varied among potting media and ranged from 7.13 - 11.83 cm for RS + PM (1:1) and OPRB respectively. Thicker bulbs were produced in all potting media except RS + PM (1:1), RS + BRH (1:2) and (2:1), which had the thinner bulbs. The longest roots were observed in PM potting medium (19.70 cm), while, the shortest roots were observed at RS + CD (2:1) (4.90 cm). However, it was only significantly lower than RS + PM (1:2), RS + OPRB (1.1), (2.1), RS + BRH (1.2), (2:1) and RS + CD (1:2).

There were also significant differences in bulb yield per hectare among the potting media evaluated. OPRB potting medium produced the highest yield (19.80 t ha^{-1}) which was significantly higher than RS + PM (1:2) (7.04 t ha), RS + BRH (1:2) (7.70 t ha^{-1}) and (2:1) (7:26 t ha^{-1}) which had lower bulb yields per hectare. However, bulb yield from OPRB was about 34 % higher than that of PM (14.74 t ha^{-1}) which was the next to it.

Table 3: Effect of different potting media on number of leaves of onion

Potting medium	Weeks after transplanting							
	2	4	6	8	10	12	14	16
BRH	3.33	4.00	4.67	5.33	5.33	6.00	7.00	8.33
CD	3.67	4.33	5.00	6.33	7.33	7.67	8.33	8.67
OPRB	3.67	4.67	6.67	6.33	6.33	7.00	8.00	8.33
PM	2.33	3.00	3.33	4.00	5.33	6.33	7.67	8.67
RS	4.00	4.00	4.33	5.33	6.33	6.33	7.00	7.67
RS +PM (1:1)	3.00	3.67	4.33	5.33	7.00	7.00	8.33	9.00
RS +PM (1:2)	3.00	3.00	3.67	5.00	6.00	6.00	7.67	9.00
RS +PM (2:1)	3.00	3.67	4.67	6.00	7.33	7.67	8.67	10.00
RS + OPRB (1:1)	4.00	4.67	5.67	6.00	7.33	7.00	8.00	8.67
RS + OPRB (1:2)	4.33	5.00	5.00	6.00	5.67	6.67	8.00	8.67
RS + OPRB (2:1)	4.00	5.00	5.33	6.33	6.00	6.33	7.67	8.67
RS + BRH (1:1)	3.33	4.00	5.00	6.00	7.00	7.00	8.00	8.67
RS + BRH (1:2)	3.00	3.33	4.33	5.67	7.00	8.00	9.33	10.00
RS + BRH (2:1)	3.00	4.00	5.00	6.67	6.33	7.33	8.33	8.67
RS + CD (1:1)	3.67	3.33	5.00	6.00	7.00	6.67	7.00	8.33
RS + CD (1:2)	3.67	4.00	5.33	6.67	7.00	7.00	7.67	9.00
RS + CD (2:1)	4.00	4.33	4.67	6.33	7.00	7.00	7.67	8.67
Mean	3.47	4.00	4.77	5.78	6.55	6.88	7.90	8.77
LSD $_{(0.05)}$	ns	1.185	0.900	0.929	0.800	0.958	1.162	1.138

ns - Not significant at 5% level or probability

Table 4: Effects of potting media on bulb yield and yield components of onion

Potting media	No. of bulb per plant	Weight Fresh of bulb (g/plant)	Bulb girth (cm)	Root length (cm)	Bulb yield (t/ha)
BRH	1.00	17.30	10.40	5.70	11.44
CD	1.00	20.30	10.57	5.30	13.42
OPRB	1.00	30.00	11.83	6.20	19.80
PM	1.00	22.30	11.17	19.70	14.74
RS	1.00	20.00	11.20	5.20	13.20
RS +PM (1:1)	1.00	20.30	7.13	5.70	13.42
RS +PM (1:2)	1.00	10.70	7.97	8.30	7.04
RS +PM (2:1)	1.00	21.70	10.80	5.10	14.30
RS + OPRD (1:1)	1.00	21.00	11.03	10.00	13.86
RS + OPRD (1:2)	1.00	20.30	10.83	10.50	13.42
RS + OPRD (2:1)	1.00	16.00	10.03	8.20	10.56
RS + BRH (1:1)	1.00	20.30	11.60	5.00	13.57
RS + BRH (1:2)	1.00	11.70	8.47	10.60	7.70
RS + BRH (2:1)	1.00	11.00	8.63	9.20	7.26
RS + CD (1:1)	1.00	12.70	9.33	6.90	8.36
RS + CD (1:2)	1.00	18.70	10.60	8.30	12.32
RS + CD (2:1)	1.00	21.70	10.67	4.90	14.30
Mean	1.00	18.60	10.13	7.90	12.28
LSD $_{(0.05)}$	ns	15.35	4.015	11.980	10.14

The various potting media used in this study demonstrated that they can act as soilless media for onion propagation in the sub-urban areas. The media were cheap to acquire, environmentally friendly as they had no adverse effect on the environment and the onion plants cropped on them survived and were very productive. However, there was variation in the growth and yield of onion among the growth media. The differences could be due to differences in physical and chemical properties among the potting media. This implies that level of fertility varied among the potting media and the potting medium with higher fertility status would have been associated with enhanced availability of more N.P.K and other plant nutrients for plant growth and development, especially onion.

Oil palm refuse bunch (OPRB) had the highest bulb yield which was higher than global (18.3 t ha^{-1}) and Nigeria's (15 t ha^{-1}) averages (FAOSTAT, 2004). Onion yield in OPRB was about 34.30 % higher than the bulb yield of poultry manure (PM) which was the next to it. The relative excellent performance of OPRB compared to other potting media was probably due to its more suitable physical and chemical properties which enhanced the crop to fully manifest its full potential. This implied that OPRB was associated with high porosity, providing adequate aeration. This potting medium had the highest organic carbon which was an indication of high plant nutrient reserve and also optimized water holding capacity. It also had a suitable pH between 5.5 and 6.5 (Fitz Patrick, 1988). The lower bulk density implied high porosity, which was an indication of compaction and increased aeration (Osaigbovo and Law Ogbomo, 2012). This is in line with Dewayne *et al* (2003) who reported aeration and water holding capacity of any potting medium as the most crucial and important soil physical factor. The low bulk density and high percentage organic carbon in the OPRB may have modified the physical status of this medium resulting in better aeration, water retention capacity and better nutrient utilization.

The high relative K content of OPRB is very important in the plant growth and development. K nutrient had pronounced effect on carbohydrate partitioning by affecting either phloem export of assimilates from leaves to bulb (Cakmak*et al*., 1994). The highest yield of OPRB could have been partially due to increased bulb weight resulting from increase in assimilate accumulation, occasioned by enhanced K uptake (Singh and Verma, 2001).

PM had the highest P content that resulted in the longest roots among the potting media. The N content has implication on C: N ratio and good C: N ratio has enhancing effect on the root development for better nutrient utilization. The relatively poorer performance of RS + BRH (1:2), RS + BRH (2:1) and RS+ CD (1:1) could probably be due to the almost inert and lack of all nutrients making it very unsuitable to support plant growth resulting in low bulb yield.

Conclusion and Recommendation

This study has substantially demonstrated that growth and yield performance of onions grown in the potting media were affected by the type and composition of the potting media. All potting media evaluated supported adequate growth and yield of onion either as sole or in combination with river sand, with very few exceptions. However, onion grown in the medium containing OPRB exhibited the best growth indices observed and produced the highest bulb yield. The medium provided the most suitable and optimum nutrients requirements and promoted nutrient uptake by the plants which ultimately enhanced onion bulb yield. Based on the results of this study, it is recommended that for an innovative and novel onion production in sub-urban and urban centers particularly in southern Nigeria and other similar settings, onion could be planted using these tested media depending on availability and in particular, OPRB as growth medium. Bulb yield was most enhanced in this potting medium as it provided the plants with the most optimal physical and chemical growth requirements.

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