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The effect of organic manure on the growth and yield of carrot (*Daucus carota*.) grown in Jos, and Makurdi Benue State, Nigeria

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ABSTRACT

The experiment aimed to evaluate the effect of organic manure on the growth and yield of carrots (*Daucus carota* L.) grown in Jos and Makurdi Benue State, Nigeria. The treatments used were organic manure sources (Poultry dropping (20t/ha), Cow dung (20t/ha), Goat manure (20t/ha), dung site (20t/ha) and control (zero application and) the spacing used between plants and rows were 15 and 75cm, respectively. The experiment was laid in a randomized complete block design with three replications. During the investigation, some physiological variables, such as plant height and the number of leaves were measured. Other characteristics like aerial weight, root weight, root length, rot diameter, harvest index and over-all yield were also recorded. The results of the investigation revealed that carrot responded to nutrient sources with poultry dropping and Jos producing better in both growth and yield parameters. All the parameters studied significantly ($P \leq 0.05$) responded to nutrient source with poultry dropping been superior in both growth and yield-related characters such as plant height at 8WAT (32.20), the number of leaves 8WAT(122.20), aerial weight (10.27g), root weight (18.02g), root length(12.81cm), root diameter (4.00mm), harvest index (0.71) and over-all yield (5.10t/ha). Carrot grown in Jos outgrows those cultivated in Makurdi in both growth and yield-related character. Based on the results obtained it could be suggested that the use of poultry dropping which is better in both growth and yield characteristics will lead to optimum yield in carrot cultivation in the study areas.

Keywords: Carrot Manure, growth, Organic nutrient and yield
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INTRODUCTION

Carrot (*Daucus carota* L.) is one of the most popular root vegetables grown throughout the world China, USA, Uzbekistan and Poland are highest producing countries (Peng, 2019). This vegetable is an important source of bioactive compounds with a beneficial effect on consumer health (Santos et al., 2004). They are consumed in different ways; they can be eaten raw or cooked. It is recognized as an important source of natural antioxidants besides, the anticancer activity of β-carotene is a precursor of vitamin A. They also contain vitamin C, thiamin B1 and riboflavin, Moisture content of carrots varies from 86 to 89%. Carrots are a good source of carbohydrates and minerals like Ca, P, Fe, Na, Cu, Zn and Mg (Krinsky and Johnson, 2005). Nigerian soils are inherently low in fertility status and thus affecting crop yield. To maximize yield in carrot production, the application of nutrient is unavoidable in either inorganic or organic form, the former has a high cost, imposed danger to human health and also affect soil structure over long usage while the latter is cheap, improves soil microbial activities, soil structure, colour and water holding capacity (Madina et al., 2000). Apart from the use of green manure, inorganic fertilizer, crop residuals and bio-fertilizers, organic manure remains one of the most effective tools in improving the fertility status and soil productivity. Organic manure outweighs inorganic fertilizer in terms of having a wide range of essential nutrients and organic matter needed by plants, since nutrients are held in organic form, it is, therefore, important to supply nutrients most especially organic nutrients to the soil to boost plant growth and yield (Akanbi et al.,2015). Consumers tend to use organic

products continuously, and this has become a global trend. In response to consumer demand, organic food products are quickly growing (Peng, 2019). All countries around the world report a trend of continual growth in the organic food and beverage market (Golijan and Dimitrijević, 2018). The demand for organic products has been reported to be increasing in both local and international markets (Declaro-Ruedas, 2019), and is expected to continue growing, especially in developed countries, while the supply of organic products is limited and still cannot produce enough organic products to meet the market demand. Although some proportion of carrot is still produced in the southwest part of Nigeria, there has been a dramatic shift of the dry grain production to the savannah, especially the middle belt of the country which is regarded as the fruit belt. Despite the increase in carrot production, yield is still low and some of the major causes of yield can be linked to soil fertility, location, temperature, relative humidity and appropriate plant population. Recently the Russian-Ukraine war has limited the production and supply of fertilizer to Nigeria leading to high price which necessitated the need for an alternative source of nutrient supply to plants. The study was set to investigate the response of growth, yield and quality of carrots to different organic fertilizer sources applied at two different locations (Jos and Makurdi).

MATERIAL AND METHOD

The experiment was carried out at The University of Agriculture, Makurdi (6° 11'-7° 41'N Latitude and7° 21' - 8° 37'E Longitude) and Jos at (9° 31'- 9º 50`N Latitude and 10° 41'N-11º 09`E Longitude. The experiment aimed to evaluate the effect of organic manure on the growth, yield, and yield component of carrot (*Daucus carota* L.) grown in both Makurdi and Jos, Plateau State, Nigeria, during the 2021 rainy season. Organic source (Poultry dropping, goat manure, Cow dung, dung site and control) was used. Poultry dropping was applied at the rate of 20 tones/ha (100% Dry Matter, Organic Material 55%, Total Nitrogen 6.2%, Total Phosphorus 2.01% and Total Potassium 2.12%), Goat manure was applied at the rate of 20 tones/ha (Dry matter 52%, Organic Material 31%, Total Nitrogen 4.5%, Total Phosphorus 1.0% and Total Potassium 1.3%), Cow dung applied at the rate of 20 tones/ha (Dry matter 22%, Organic Material 21%, Total Nitrogen 11.0%, Total Phosphorus 0.8% and Total Potassium 0.9%), and dung site applied at the rate of 20 tones/ha (Dry matter 32%, Organic Material 20%, Total Nitrogen 18.0%, Total Phosphorus 0.9% and Total Potassium 1.2%). All the organic manure are kept under intensive care and was allowed to undergo partial decomposition for three months following the recommendation of Bello (2015) before it was used for the experiment. The seeds were raised in a nursery before transplanting to the field, the size of the nursery bed was 2m x 2m. The soil of the nursery was prepared well at a 3:2 ratio of soil and organic manure then it was treated for pathogen by covering it with polythene tightly and kept for 10 days, irrigated twice a day (morning and evening) to ensure good germination and establishment, the seeds germinated between five and eight days after sowing (DAS). The seedlings were transplanted in the main field after 30-33 days after sowing (DAS). Nursery establishment was important because direct sowing of seeds may not germinate well. The experiment was laid out in a randomized complete block design (RCBD) with three replicates, a $4m^2$ plot was laid out with 1m between plots and 1m between blocks. There were 4 plots in each block which gave the total number of 12 plots for the study and the spacing used between plants and rows were 15 and 75cm, respectively. Agronomic practice such as weeding was done manually at 2 and 6 weeks after planting to ensure weed-free plots. All the data were collected within the net plot of $4m^2$ where a total of 5 plants were tagged for data collection within each net plot (Berry, 2012). During the investigation, physiological variables, such as growth in the increase in mass and size of the plant which involve the multiplication of cells plant height (measured from the base of the plant to the tip), and the number of leaves ("Definition"). Other characters like root length ("is a part of a vascular plant underground"), and aerial weight ("is the mass/weight of fibre per unit area) root weight ("dry mass of the root of a plant divided by the total dry mass of the entire plant"), root diameter ("the line connecting the root of the teeth of a cylinder gear is the root circle divided by two"), harvest index and (total final output of harvest) were also recorded. All data collected were subjected to a two-way analysis of variance (ANOVA), when treatments were found significantly different, the least significant difference (LSD) at a 5% level of probability was used in separating the means.

RESULTS AND DISCUSSIONS

Table 1 showed the main effect of organic manure and location on plant height of carrots (*Scientific name*) grown in Jos and Makurdi and were found significantly different ($P<0.05$) in both organic sources and growing locations, with poultry droppings having the tallest plants (cm) in all the weeks under consideration, followed by dung site, this could be linked to the fact that plant requires nutrient to grow vegetatively in the needed and available form, this finding conforms with the report from the analysis in the material and method of poultry dropping (100% Dry Matter, Organic Material 55%, Total Nitrogen 6.2%, Total Phosphorus 2.01% and Total Potassium 2.12%) which proved that poultry droppings have high chemical elements when compared to other organic forms of nutrients which are capable of bringing increased in plant height. Sharma et al. (2012) reported that variation in plant height is directly connected to the

Table 1: Main effect of organic source of plant nutrient and location on plant height of carrot grown and recorded in different weeks after transplanting.

Organic Nutrient source	2	4	6	8
Control	3.23c	6.18e	12.50d	22.10d
CD	4.28bc	8.12d	18.00b	26.55c
PD	6.67a	11.02a	20.75a	32.20a
GM	4.00bc	10.91b	16.88c	30.58b
DS	5.01b	9.21c	15.75c	29.98b
SE±	0.43	0.13	1.91	1.19
LSD (0.05)	1.20	1.32	1.62	1.72
Location (L)				
Makurdi	4.32b	9.86a	19.19a	28.94a
Jos	5.98a	10.87a	20.23a	30.02a
SE±	0.21	0.12	0.10	0.10
LSD (0.05)	1.22	1.32 (ns)	1.11 (ns)	1.78 (ns)

CD= cow dung, PD=poultry dropping, GM=goat manure, DS=dung site, NS= not significant. SE= standard error 2=_Weeks after transplanting 4= Weeks after transplanting 6= Weeks after transplanting 8= Weeks after transplanting.
Note: Treatments in a column connected by the same letter were not significant at p<0

Table 2: Main effect of organic source of plant nutrient and location on number of leaves of carrot grown and recorded in different weeks after transplanting.

Organic Nutrient source (N)	2	4	6	8
Control	10.13c	36.18c	69.51d	80.90d
CD	13.68b	38.12b	78.05a	101.25c
PD	17.97a	41.02a	70.71c	122.10 a
GM	14.30b	30.91c	73.84b	110.78b
DS	15.21b	29.21d	65.95d	99.38c
SE ±	0.49	0.23	1.51	1.13
LSD (0.05)	1.03	1.12	2.62	3.02
Location (L)				
Makurdi	16.72a	39.16b	73.39b	99.99b
Jos	17.52a	42.37a	82.23a	111.22a
SE ±	0.30	0.31	0.99	1.01
LSD (0.05)	1.02 (ns)	3.12	3.31	4.18

CD= cow dung, PD=poultry dropping, GM=goat manure, DS=dung site, NS= not significant. SE= standard error 2=_Weeks after transplanting 4= Weeks after transplanting 6= Weeks after transplanting 8= Weeks after transplanting.
Note: Treatments in a column connected by the same letter were not significant at p<0

availability of nutrients and nutrient composition. The study suggested that different sources of organic nutrient affect plant growth due to their nutrient content and composition.

On location, growing carrots in Jos location out performed carrots grown in Makurdi location in plant height, this could be attributed to better climatic factors such as rainfall, temperature, relative humidity and can also be linked to cultural practice. This result is in agreement with the finding of Madina et al. (2020), who reported that rainfall, temperature and cultural practice play an important role in affecting plant height and overall vegetative growth. The interaction effect of organic manure and location turned insignificant for plant height at $p < 0.05$.

Table 2 reports the main effect of organic manure and location on the number of leaves of carrots grown in Jos and Makurdi with significant different ($P<0.05$) was recorded in both organic matter source and growing locations, with poultry droppings having the number of leaves in all the weeks in consideration followed by dung site with control having the least in all the weeks under consideration, this is linked to the fact that poultry dropping can release its nutrients moderately through-out the growing season leading to leave initiation. This work collaborated with the study of Habimana et al. (2014) who stated that poultry droppings, dung site release their nutrient fast and throughout the growing season which could have influences on leaves formation, photosynthetic activities, and metabolic processes in plants. Zamil et al. (2004) reported that poultry manure has more nitrogen in form of uric acids mostly found in birds' droppings since they don't urinate, this content in poultry dropping influences leave and initiate photosynthetic activities thought out the plant growth period.

Table 3: Main effect of organic source of plant nutrient and location on yield and yield related characters of carrot.

Organic nutrient source (N)	Weight of aerial part(g)	Root weight(g)	Root length (cm)	Root diameter (mm)	Harvest index	yield (t/ha)
Control	4.43d	10.18 d	7.91d	2.00d	0.52d	2.30c
CD	8.66b	13.12c	9.65c	2.82c	0.60b	3.05bc
PD	10.27a	18.02a	12.81a	4.00a	0.71a	5.10a
GM	6.20c	14.91c	9.24c	3.01c	0.57c	3.88b
DS	7.11c	16.21b	10.35b	3.98b	0.59c	4.01b
SE ±	1.09	1.13	0.51	1.32	0.34	0.23
LSD (0.05)	1.01	1.02	1.02	0.02	0.02	1.02
Location (L)						
Makurdi	9.32b	39.16b	9.39a	3.23a	0.63b	4.99a
Jos	10.12a	42.37a	10.23a	4.21a	0.71a	5.22a
SE ±	1.02	0.91	0.32	0.41	0.21	0.11
LSD (0.05)	1.02	3.12	1.21(ns)	1.00 (ns)	0.03	1.08 (ns)

CD= cow dung, PD=poultry dropping, GM=goat manure, DS=dung site, NS= not significant.

The interaction effect of organic manure and location turned insignificant for plant height at $p < 0.05$.

The growing of carrots in Jos location superseded that of Makurdi location in the number of leaves, this could be a result of soil nutritional status, weather and cultural practice. This result agrees with the work of Pulgar et al. (2000) who stated that climate, soil nutrient affect leave formation of leaves in plants. Akhilesh et al (2003) also reported that aside from the above-mentioned factors, adaptability and acclimatization of the crop to the growing environment affect leave initiation and plant growth thereby affecting the overall yield. Other factors that might have led to a higher number of leaves could be cultural practice as reported by Thamburaj and Sing (2005).

Table 3 report the effect of organic manure on yield and yield-related characteristics of carrots grown in Jos and Makurdi and significant difference ($P<0.05$) was recorded in both organic source of plant nutrient and growing locations, with poultry droppings having the heavier aerial part, root weight, root length, root diameter, harvest index and overall yield followed by dung site with control having the least in all the weeks under consideration during the study, this could be linked to the successful and early plant vegetative establishment gotten from poultry nutrients. This finding agrees with the work of Leis and Lepik (2001) who reported that early plant establishment affects plant yield and yield-related characteristics, knowing fully well that yield is a product of yield-related attributes such as heavier aerial part, root weight, root length, and root diameter among others. On the contrary Madina et al. (2021) reported that dung site nutrients recorded the highest in both growths, yield and yield-related characteristics attributing to the fast release of nutrients to plants throughout the growing season, he added that phosphorus affects carrots yield positively which could be needed in appreciable quantity at the growing stage. The finding in this study is a par with the report of Rubatzky et al. (1999) which reported that foliage size and biomass are not always an indication of storage root development and more leaves are not always an indication of large roots.

Table 4 showed the interaction effect of organic source of plant nutrients and location on root weight of carrots grown in Jos and Makurdi, significant difference ($P<0.05$) was recorded where a perfect interaction was observed between poultry dropping in Jos, which implies that growing carrots in Jos location with poultry manure was better when compared with other organic source used and also better when compared to cultivating carrot in Makurdi. This can be attributed to the fact that weather condition might have contributed to decomposition/mineralization and fast release of the nutrient coupled with the ability of the plant to utilize the available nutrient resulting in weightier roots in carrot production, this finding collaborates with the work of

On location, the yield and yield parameters of carrot (heavier aerial part, root weight, root length, root diameter, harvest index and overall yield) in Jos was better than what was observed in Makurdi. This is not far from the fact that adaptation and climatic condition plays an important role in plant growth and yield and yield-related characteristics (Arscot and Tanumihardo, 2010). Ahmed et al. (2014) who reported that weather condition of a place not only affects plant growth but also affect the ability of the plant to utilize the readily available nutrient.

Table 4 showed the interaction between nutrient source and location on root length of carrots grown in Jos and Makurdi, a significant difference ($P<0.05$) was recorded where an interaction was recorded between poultry dropping and Jos location, this could be attributed to the uptake and utilization of the available nutrients gotten from the poultry dropping couple with weather condition of the Jos location enabling such activities to take place. This study conforms with the report of Moniruzzaman et al. (2013) who reported that root length is a product of utilized soil nutrients and such roots are safer when such

Table 4: Interaction effect of nutrient source organic source of plant nutrient and location on Root weight (g), Root length (cm) and Yield (t/ha) of carrot grown in Jos and Makurdi, Nigeria.

Location	Organic Nutrient source	Root weight of carrot(g)	Root length(cm)	yield of carrot(t/ha)
	Control	9.23d	6.13d	3.83d
	CD	10.27d	7.17d	4.00c
	PD	18.02a	10.08a	6.73a
Jos	GM	12.81c	8.61c	4.41c
	DS	16.00b	9.20b	5.60b
	Control	8.34d	5.44d	2.31d
	CD	9.20c	6.22c	3.61c
	PD	14.91a	8.41a	5.12a
	GM	9.24c	7.24b	3.14c
Makurdi	DS	12.01b	8.51a	4.31b
SE ±		0.91	0.05	0.06
LSD (0.05)		2.81	1.21	1.00

Note: Treatments in a column connected by the same letter were not significant at p<0

nutrients are gotten from organic sources.

Table 4 shows the interaction between nutrient source and location on yield of carrots grown in Jos and Makurdi, a significant difference (P<0.05) was recorded where a perfect interaction was observed between poultry dropping and Jos location followed by the same location and dung site, this indicate that higher yield is gotten from all the organic nutrient source used on Jos location when compared with Makurdi location. This result is similar to Santos et al., (1994) who reported that organic sources particularly poultry droppings and climatic condition not only improve soil structure, soil colour, moisture conservation but also improves microbial activities and crop yield, in terms of quality and quantity (Rodriguez-Amaya et al., 2008).

CONCLUSION

From the result obtained in this work, it is clear that the cultivation of carrots under organic nutrient sources particularly from poultry dropping significantly surpassed other organic nutrient sources and on location, the cultivation of carrots in Jos is better than in Makurdi. It can therefore be recommended that the cultivation of carrots under poultry manure and dung site by farmers in the study area.

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