

*Full Length Research Paper*

# Effects of tillage methods and poultry manure rates on the production of Carrot (*Daucus carota* L) in Nsukka, Southeast Nigeria

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Carrot (*Daucus carota* L.) has historically been classified as a northern crop because it predominantly grows in the northern regions of Nigeria. Transportation of harvested roots to the south has consequently resulted to decay, shrinkage, loss of roots due to high temperature and long distant travels, high cost of produce etc. The objective was to find out the variety and tillage method that will enhance the production of carrots in Southeast Nigeria and the appropriate poultry manure rates for production. Two Carrot varieties (Touchon mega and Kurado) were evaluated under field experiment and were grown under three poultry manure (PM) rates (0,5,10 t ha<sup>-1</sup>) and two tillage methods (Ridge and Bed) to assess their effects on the growth and yield of carrot roots. Roots were harvested at the 90th day after planting and data were collected on seedling emergence, root weight, leaf weight, whole plant biomass, percentage marketable yield, and total marketable yield. The result showed that poultry manure significantly ( $p < 0.05$ ) enhanced higher yields. The ridge tillage method gave a higher marketable yield than the Bed type. Kurado variety had the highest percent marketable yield though there were no significant ( $p > 0.05$ ) differences between the two varieties. The tillage method and poultry manure influenced the growth and yield of carrot roots suggesting that the appropriate tillage method and poultry manure rate will enhance production in the environment. From the results of the experiment, it could be concluded that for the production of carrots in the environment Kurado variety is recommended due to its high yielding capacity while Ridge tillage method is recommended for farmers in the area due to its efficient use and ability to support root penetration; 10 t ha<sup>-1</sup> manure rate was found to be most economical manure rate.

**Key words:** Tillage methods, poultry manure and carrot variety.

## INTRODUCTION

The edible portion of the carrot plant is the fleshy root, which is the enlarged base of the root system and contains the hypocotyls (Delahaut and Newenhouse,

2000). Carrots can be eaten raw, cooked, as a salad ingredient or juiced.

Carrots are delicious, crisp, and highly nourishing. In

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instance, the nutrients beta carotene, fiber, potassium, vitamin K1, and antioxidants are all abundant in carrots (Sikora et al., 2020). Alpha and beta carotenes, which are precursors to vitamin A, a crucial vitamin and antioxidant needed in human nutrition, are particularly abundant in carrots (Kanall, 2014).

They also offer numerous health advantages. They have been connected to enhanced eye health and lower cholesterol levels, making them a food that supports weight loss (Sikora et al., 2020). Furthermore, a lower risk of cancer has been associated with their carotene antioxidant, Carotenoids-rich diets may aid in the prevention of many cancers (Kassymov et al., 2020). A lesser risk of developing breast cancer may also be associated with women who have high amounts of circulating carotenoids (Adda, 2019). Anywhere in the world, with the exception of very cold regions, carrots can be produced all year round. The ideal temperature range for them is between 15°C and 20°C (Mahmood-ur-Rehman, 2020). Adequate soil moisture and daylight are essential for carrot growth. pH values of 6.5 to 7.5 are ideal for sandy-loamy soils that are deeply loose, well-drained, are suitable for growing carrots (Levizou, et al. 2020).

It has been classified as a northern crop in Nigeria since it grows best in the country's north. Over the years, it has been grown in the northern states of Kaduna, Kano, Plateau, etc (Orakpo, 2010). It is usually shipped from the northern states down south and this has consequently resulted to losses through; damaged roots, decaying roots due to long distance travel and high cost of sale to consumers in the Southern Nigeria especially South-Eastern Nigeria. Therefore there is need to assess the adaptability of carrot production in South-Eastern Nigeria. The purpose of this study was to assess the best and possible way to grow carrot in the South Eastern Nigeria by analyzing the impact of tillage techniques and the use of poultry manure on the development and productivity of carrot (*Daucus carota* L) types in Nsukka, Southeast Nigeria.

## METHODOLOGY

The field experiment was carried out in the Department of Crop Science's Teaching and Research Farm in Nsukka, University of Nigeria. The two carrot cultivars, Touchon mega and Kurado were obtained from a seed seller in Jos, Plateau State, Nigeria. The two types were tested using the Bed and Ridge tillage technique and three different manure rates (0, 5, 10 t ha<sup>-1</sup>). The study was a 2 \* 2 \* 3 factorial, replicated three times, and set up as a split-split plot in a randomized complete block design (RCBD). Prior to planting, poultry manure was applied, the three manure levels served as the subplots to the tillage system, which served as the main plot. The sub-sub plots were carrots varieties.

Using a plot with 15 holes spaced 18 cm apart, a pinch of seed was inserted into each hole, and it was later thinned to produce two stands per hole. 90 days after planting, roots were harvested.

Data were collected on seedling emergence (for roughly 13 days after planting), root weight, leaf weight, whole plant biomass,

percentage of marketable yield, and total marketable yield per plot. At the 90th day after planting, six (6) sample plants from each plot were harvested, measured instantly following harvest, and forwarded to the lab for additional research. For each of the plots, the weights of the whole plant biomass, leaves, and roots were recorded using a weighing scale. The number of total fresh carrot roots that can be marketed from the sample plant roots (six) that were taken from each plot constitutes the % marketable yield. The data were generated by calculation using the formula:

$$PMY = \frac{\text{No of marketable roots} \times 100\%}{\text{Total Harvested Roots}}$$

Where PMY = percentage marketable roots

## Data analysis

All of the collected data were subjected to Analysis of Variance (ANOVA) in accordance with the split-split plot design in the Randomized Complete Block Design (RCBD), and Fisher's Least Significant Difference (F-LSD) at the 5% probability level was used to identify differences between treatments (Obi, 2002).

## The design of experiment

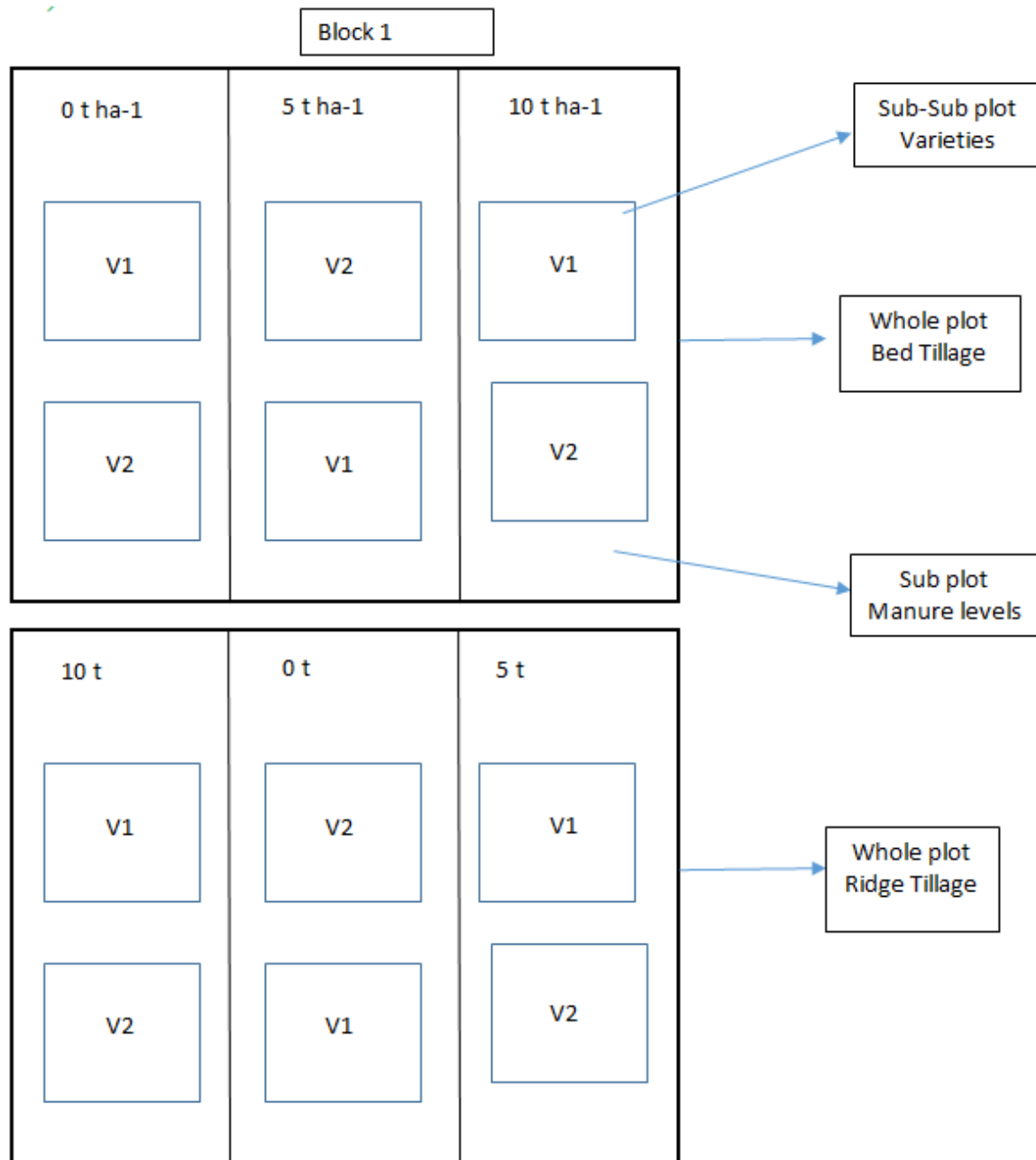
The experiment was a 2 \* 2 \* 3 factorial laid out as a split-split plot in Randomized Complete Block Design replicated three times. (Two carrot varieties: Two tillage systems: Three manure levels). (Figure 1).

## RESULTS

Table 1 shows the soil physiochemical properties of the soil sample collected from the experimental site before planting. The results revealed that the soil is acidic with a pH of 4.7 in water. The total nitrogen was 0.140% which is very low, the total Phosphorus was 20.25mg/100g of soil. The other elements were high; the soil was predominantly sandy clay loam in texture. The Poultry manure used was also subjected to the same analysis and the result showed that the manure had high organic matter (31.64%) while the pH in water was 8.7 and total nitrogen 1.121%.

The experiment's findings, presented in Table 2, revealed that the two varieties had various emergence percentages. From Day 7 to Day 13, there was an increase that came on steadily. In every day that was recorded, the Touchon Mega variety had a higher percentage of emergences. From the seventh to the ninth day, the treatment of varied quantities of poultry manure had a significant impact on emergence; 10 t ha<sup>-1</sup> had a greater percentage of emergences on the 13 day of 74.6%. The two tillage techniques did not differ significantly from one another, although on the 13th day, greater number of plants emerged in the bed technique (74%).

On the yield performance of the two carrot types, Table 3 summarizes the main effects of tillage, manure, and variety. The table shows that there were no significant



**Figure 1.** The field layout of the design of experiment of block 1. Author's analysis and field experiment.

differences between bed and ridge tillage, however bed tillage had higher root weight, leave weight, and whole plant biomass, whereas ridge tillage had higher total marketable roots and higher percent marketable yield. Whole plant biomass (WPB) and root weight (RW), significantly varied across the 3 levels of manure. The table indicates that the growth performance of carrots was modified by poultry manure since 10 t ha<sup>-1</sup> had higher values for the percent marketable yield (85.8%), root weight (0.65 t ha<sup>-1</sup>), and total marketable

root yield (5.2 t ha<sup>-1</sup>). Table 3 further indicates that there were no significant variations between the varieties.

With the exception of the total marketable root yield (4.9 t ha<sup>-1</sup>) and the leaf weight, the Kurado variety recorded the highest values across all yield variables (0.34 t ha<sup>-1</sup>). The interactions between tillage and variety, variety and manure, and tillage and manure are shown in Table 4 as effects on the yield response of carrots. Table 4 shows that the interaction between the tillage system and carrot

**Table 1.** Soil physio-chemical properties and chemical composition of organic manures.

Parameter	Soil	Poultry manure
pH (in H <sub>2</sub> O)	4.7	6.4
pH (in KCl)	3.8	6.1
Total carbon (%)	1.106	18.35
Total organic matter (%)	1.907	31.64
Total Nitrogen (%)	0.140	1.121
<b>Exchangeable cations</b>		
Sodium (100g)	0.04	0.34
Potassium (100g)	0.06	0.56
Calcium (100g)	1.4	8.40
Magnesium (100g)	0.6	7.20
Available phosphorus	20.25	0.239
<b>Particle size (%)</b>		
Textural class	sandy clay loam	nd
Clay	27	nd
Silt	9	nd
Fine sand	25	nd
Coarse Sand	39	nd

Author's analysis and field experiment.

variety resulted in a statistical changes in the whole plant biomass. Although there were no significant changes in the other variables, the Touchon mega planted on the ridge system had a greater percent marketable yield (85.9%).

The Kurado variety, which received 5 t ha<sup>-1</sup> manure, had the better value in the percent marketable yield (87.8%), even though there were no statistically significant variations in the interactions between variety and manure.

The whole plant biomass of the tillage/manure interaction revealed a significant difference. In the table, ridge systems that received 5 t ha<sup>-1</sup> of manure also had a higher value in the percentage marketable yield (89.4%), whereas ridge systems that received 10 t ha<sup>-1</sup> came in second with 88.9%.

## DISCUSSION

The genetic makeup of the Touchon mega and Kurado varieties may be the cause of the variation in days to % emergence among them. Despite the fact that Touchon mega emerged faster than the Kurado variety, their timing came in the period suggested by literature of 7 to 15 days following planting (Carrotmesuem, 2014). This can be evidence that they have genetic similarities. However, both varieties experienced good emergence, which shows that they both have local adaptations.

There were no statistical variations between the two

tillage systems on the yield parameters of the carrot varieties, though it was observed that the ridge tillage system had better and longer roots, better marketable roots and higher values in whole plant biomass yield. Pulling out the roots from the soil was much difficult in the bed than the ridge.

Varieties of carrot planted on the ridge are believed to have utilized more efficiently the poultry manure when compared with those planted on the bed system. This agrees with the study by Sosina (2019) in her study, they compared the effect of planting on Ridge, Flat, and Bed methods were used in two cities (Akure and Ado-Ekiti), and it was found that for white trifoliolate yam and yellow trifoliolate yam in Ado Ekiti, respectively, the Ridge and the heap enhanced tuber output by 25, 42, and 31%. Similar to this, Heap boosted tuber output in Akure by 7, 15, and 11% for yellow trifoliolate yam and by 12, 19, and 18% for white trifoliolate yam.

The highest manure rate plots, first showed 50% emerging on day 7, which was the minimal day for seedling emergence (according to literature) when compared to the plots that got no manure. Poultry manure significantly influenced seedling emergence. The effect of fertilizer nutrients on seed vigor is indirectly related to their impact on seed development and seed chemical composition, according to a previous research by Navazio et al. (2010). As a result, it was likely that the fertilization, which may have favored a chemical entity that generally promotes emergence, had an effect on the

**Table 2.** Effects of variety, manure and tillage on the percent (%) seedling emergence of carrot.

Variety	Day7 (%)	Day9 (%)	Day11 (%)	Day13 (%)
KURADO	36.9	55.3	63.7	66.4
TOUCHON MEGA	42.2	58.5	69.9	72.1
F-LSD <sub>(0.05)</sub>	4.9	NS	5.5	4.6
<b>MANURE(t ha<sup>-1</sup>)</b>				
0	26.7	43.3	59.8	64.4
5	40.4	58.2	67	68.7
10	51.7	69.3	73.5	74.6
F-LSD <sub>(0.05)</sub>	17.4	16.8	NS	NS
<b>Tillage</b>				
BED	36.4	54.4	70.3	74
RIDGE	42.8	59.4	63.3	64.6
F-LSD <sub>(0.05)</sub>	NS	NS	NS	NS

WPB= whole plant biomass, RW= root weight, LW = leaf weight, TMRY = total marketable root yield, MY = marketable yield, FLSD = Fishers least significant difference.

Author's analysis and field experiment.

**Table 3.** Effects of variety, manure, and variety on the yield response of the two carrots.

TILLAGE	WPB(t ha <sup>-1</sup> )	RW(t ha <sup>-1</sup> )	LW (t ha <sup>-1</sup> )	TMRY(n)	PMY (%)
BED	0.97	0.59	0.38	4.7	77.9
RIDGE	0.88	0.56	0.31	5.1	85.7
F-LSD <sub>(0.05)</sub>	NS	NS	NS	NS	NS
<b>MANURE (t ha<sup>-1</sup>)</b>					
0	0.75	0.46	0.31	4.6	76.3
5	1	0.61	0.36	5	83.3
10	1.01	0.65	0.36	5.2	85.8
F-LSD <sub>(0.05)</sub>	0.15	0.12	NS	NS	NS
<b>Variety</b>					
KURADO	0.93	0.58	0.34	4.9	82.5
TOUCHON MEGA	0.92	0.57	0.35	4.9	81.1
F-LSD <sub>(0.05)</sub>	NS	NS	NS	NS	NS

WPB= whole plant biomass, RW= root weight, LW = leaf weight, TMRY = total marketable root yield, PMY = percentage marketable yield, FLSD = Fishers least significant difference.

Author's analysis and field experiment.

chemical makeup of the seed. Carrots could respond favorably to manure application, as seen by the higher values in the growth and yield attributes achieved with poultry manure application. The fact that the root yield increased as the rate of poultry manure increased suggested that the roots were able to absorb nutrients from the manure's nutrients effectively. In a similar study on tomatoes, it was reported that poultry manure

application had positive effects on fruit quality and yield (Turhan and Ozmen, 2021). When compared to unmanured plots in the experiment, the application of poultry manure considerably increased the weight of the roots, leaves, and entire plants. This supports a few research on yellow passion fruit in Nigeria (Fagbayide and Adekunle, 2002; Ani and Baiyeri, 2008). Additionally, it suggested that crops responded

**Table 4.** Yield response of carrot as influenced by the interactions of tillage \* variety, variety \* manure and tillage \* manure.

Tillage	Variety	WPB(t ha <sup>-1</sup> )	RW (t ha <sup>-1</sup> )	LW (t ha <sup>-1</sup> )	TMRY (n)	PMY (%)
BED	KUADO	0.92	0.58	0.36	4.8	79.7
BED	TOUCHON MEGA	1.01	0.6	0.4	4.6	76.1
RIDGE	KURADO	0.93	0.59	0.32	5.1	85.4
RIDGE	TOUCHON MEGA	0.82	0.53	0.31	5.1	85.9
F-LSD <sub>(0.05)</sub>		0.9	NS	NS	NS	NS
<b>Variety</b>	<b>MANURE (t ha<sup>-1</sup>)</b>					
KURADO	0	0.77	0.47	0.31	4.5	75.5
KURADO	5	1	0.62	0.37	5.3	87.8
KURADO	10	1.01	0.66	0.35	5.1	84.3
TMEGA	0	0.73	0.46	0.32	4.6	77.1
TMEGA	5	1	0.6	0.36	4.7	78.9
TMEGA	10	1.02	0.64	0.37	5.2	87.2
F-LSD <sub>(0.05)</sub>		NS	NS	NS	NS	NS
<b>TILLAGE</b>	<b>MANURE (t ha<sup>-1</sup>)</b>					
BED	0	0.92	0.55	0.38	4.4	73.8
BED	5	1	0.61	0.38	4.6	77.2
BED	10	0.98	0.61	0.37	4.9	82.6
RIDGE	0	0.59	0.37	0.25	4.7	78.7
RIDGE	5	1	0.62	0.34	5.4	89.4
RIDGE	10	1.04	0.69	0.35	5.3	88.9
F-LSD <sub>(0.05)</sub>		0.9	NS	NS	NS	NS

WPB= whole plant biomass, RW= root weight, LW = leaf weight, TMRY = total marketable root yield, MY = marketable yield, FLSD = Fishers least significant difference.

Author's analysis and field experiment

favorably to the application of manure. The release of proper nutrients by the poultry manure and their absorption by the roots must that the two combinations can influence growth and yield have resulted in the increase of root weight, leaf weight, and whole plant biomass. The statistical differences observed in the whole plant biomass yield in the combination of tillage and variety interactions indicated of carrots and this also corroborates the study of John et.al (2014) in their study, they combined tillage system and variety on amount of N fixation in soybean, they concluded that the interactions fixed more nitrogen at LM3 than at other agro-ecological zones examined. Interactions of variety and poultry manure showed increases in yield in the plots which received 10 t ha<sup>-1</sup> and 5 t ha<sup>-1</sup> manure rates and this could be attributed to their ability to release nutrients to plants and mineralisation which were well utilized by the plants.

This is similar to the findings of Hasan and Solaiman (2012); they reported that higher rates of manure application led to higher cob weights of maize, presumably as a result of the soil's enhanced availability of nutrients. Higher yield was observed in the interactions

of tillage and manure. The effect of tillage and manure significantly influenced the whole plant biomass yield. The ridge was observed to have recorded higher yields when compared with the bed tillage and this is similar to the results reported by Sonsina (2019), she reported that in comparing heap tillage with an soil amendment to other treatment combinations, the interaction of tillage techniques and amendments revealed higher soil pH, nutrient utilization effectiveness, growth, and yield values. She concluded that the most efficient way to manage soils sustainably and increase the agronomic productivity in trifoliate yams was to combine the heap method and soil amendment at a rate of 20 t ha<sup>-1</sup>.

## Conclusion

Root vegetables like carrots require adequate tillage, the right amount of manure, and variety. Carrots can grow in the environment and can be planted in ridge and bed tillage, according to the results of the experiment. However, ridge tillage produced higher yields. The two carrot types (Touchon mega and Kurado) were found to

have similar adaptations to the Nsukka environment, although the Kurado variety is recommended for commercial carrot cultivation in the area.

Within the limits of this study, it can be said that carrot plants can thrive with varying manure rates. 10 t ha<sup>-1</sup> manure rates is the most economic manure for the cultivation of carrots.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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