

Growth and Yield of Carrot (*Daucus Carota* L) as Affected by Planting Methods in a Derived Savannah Zone of Nigeria.

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ABSTRACT

An experiment on growth and yield of carrot as affected by planting methods in a derived savannah zone of Nigeria was conducted at the research farm of the Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Awka, Nigeria. Two planting methods were used (direct sowing, and transplanting) as treatments for the experiment, which was laid out in a Randomized Complete Block Design (RCBD) and replicated four times. Data was collected on the growth, yield, and root marketability parameters. All data collected were statistically analyzed using all outlined procedures. The results of the study showed no significant variation between the planting methods on the stem girth and leaf number at 4, 6, 8, 10, and 12 WAP and plant height at 12 WAP, while transplanting significantly varied ($P < 0.05$) from direct sowing at 4, 6, 8 and 10 WAP. Planting methods did not influence the plant biomass, root length, number of roots harvested, fresh weight of leaves, fresh weight of roots, but were statistically similar. Transplanting influenced significantly the root diameter, while direct sowing also significantly influenced the harvest index and the root marketability parameters; root uniformity, marketable yield, and total marketable root yield (%). From the results presented in the investigation, direct sowing had significant effect on root marketability, which is paramount in commercial carrot production. It is thereby recommended that for optimum carrot production and marketability, carrots should be directly sown.

Keywords: Carrot, transplanting, direct sowing, growth and yield parameters

INTRODUCTION

Carrots are believed to have originated in Europe or the Western Mediterranean, with origins in Persia which are now known as Iran and Afghanistan, where it was originally cultivated for its leaves and seeds. In Nigeria, carrot is largely cultivated in the Northern parts like Zaria, Sokoto, Kano and Jos. It has a range of colours like purple, black, red, white, yellow and orange which is the most common and popular colour, this is as a result of a variety of pigment contents that are responsible for the pigmentation. The high levels of carotene, pro-vitamin A, fibers, appreciable quantities of thiamine, riboflavin, taste and digestibility are among the reasons why carrot is valuable. (Kharsan et al., 2019). In addition, carrot is a vegetable rich in antioxidants both lipophilic (carotenoids) and hydrophilic (phenolics) compounds that vary considerably among carrot cultivars and varieties (El-Sayed, 2021). Carrot therefore has been used as a potent antioxidant to combat certain types of cancer (Singh et al., 2018). Carrot is used as salad, cooked as vegetables preferably with potatoes, peas and other vegetables; its juice and extracted oils are also becoming quite popular (Patel et al., 2019).

It is conical and its length varies from 5 to 25 cm. (Kharsan et al., 2019). The flavored sweet taste of carrots referred to sugar contents such as glucose, fructose, and starch which are the main types of carbohydrates (Que et al., 2019). In addition, carrot is a vegetable rich in antioxidants both lipophilic (carotenoids) and hydrophilic (phenolics) compounds that vary considerably among carrot cultivars and varieties (El-Sayed, 2021). Carrot, therefore, has been used as a potent antioxidant to combat certain types of cancer (Singh et al., 2018). Carrot is used as salad, cooked as vegetables preferably with potatoes, peas, and other vegetables; their juice and extracted oils are also becoming quite popular (Patel et al., 2019).

Carrot is among the profitable vegetable product to promote due to its high nutritional value. However, its productivity is reduced slowly due to poor application of fertilizers, poor agronomic practices, diseases and insect attack (Ige et al., 2017). Apart from temperature and nutrient composition of the soil, carrots are very sensitive to weeds and plant spacing (El-Sayed, 2021). Agronomic practices like transplanting, plant spacing, mulching, weeding, cropping system, fertilizer application etc, generally aid in optimum vegetable crop production. In Nigeria the increased carrot production has become feasible by the application of sufficient plant nutrients to depleted soils to improve soil fertility (Ige et al., 2017). However other factors like, wasting seeds and seedlings due to the small size of carrot seeds for the former and thinning seedlings to reduce competition for the later, water and weed management still pose a problem in carrot production. In vegetable production, nursery raised seedlings are known to be healthy, strong and have maximum germination rate.

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Thinning of carrot seedlings to reduce competition leads to wastage of viable carrot seedlings and increases the cost of carrot production. Carrot seeds are also lost during sowing due to their small size and since seeders that ease seed sowing and improves precise seed sowing rate are not common amongst rural farmers. This study aims to determine if transplanted carrot will have positive characteristics in comparison with directly sown seeds, which can therefore reduce the cost and improve ease in carrot production.

The objectives of this study are thus to:

determine how two planting methods affect growth of carrot.

assess the extent to which the planting methods improve the yield of carrot.

compare the effect of transplanting and direct sowing on both growth and yield carrot.

MATERIALS AND METHODS

Experimental Site

The study was conducted at Nnamdi Azikiwe University, Awka, Nigeria using the research farm of the Department of Crop Science and Horticulture. This area has a mean rainfall range above 1100mm and lies between latitude 06°15N, longitude 07°08E, with a minimum and maximum average temperature of 27°C - 30°C (Ndukwe et al., 2020).

Experimental Design

The experiment was laid out in a complete Randomized Complete Block Design (RCBD) replicated four times and conducted in a field with a total area of 17m x 23m. The Carrot Seeds used in the experiment was the Carrote Touchon variety which was obtained from market garden Enugu. Two treatments which were replicated 4 times were applied. They included; T1 - Transplanted Carrot and T2 - Directly Sown Carrot

Treatment Application

The chosen site was manually cleared of its existing vegetation before beds of 1m by 2m and furrow spacing of 0.5m were raised with hoes. The beds were then incorporated with poultry manure at equal rates. Part of the

chosen site was also tilled and incorporated with poultry manure as the nursery. For treatment the directly sown treatment, the carrot seeds were sown at the rate of 4 per hole at 2cm depth and with the plant spacing of 30cm by 50cm. While the seeds for the transplanting was evenly broadcasted in the nursery. Before broadcasting the nursery was tilled and mixed with poultry manure. The carrot seedlings in the nursery were transplanted three weeks after germination into raised beds of 1m by 2m, the seedlings were spaced 30cm × 50cm. Thinning was done within 14 to 21 days after sowing, once the carrot seedlings were large enough to be pulled out. The directly sown seedlings were thinned down to one seedling per stand to reduce competition to the barest minimum.

Data Collection and Analysis

Soil samples from 0-15cm depth of the experimental site was taken by simple random sampling method to analyze the physicochemical properties of the soil at the start of the experiment. Ten sub-samples were randomly taken and mixed thoroughly to get a composite sample. The soil sample was then pretreated by air drying and passed through a 2mm sieve before taken to the Lab for analysis. Data for the growth parameters was collected at intervals of two weeks from the 28th day after planting. Plant height of sampled plants was measured from the ground level to the tip of the longest leaf was measured from the 2nd week after transplanting and at 2 weeks intervals with a meter rule in centimeters. The number of leaves (per rosette) was counted at 2 weeks interval. The stem girth of the sample plants (randomly selected plants) was traced round with a thread and then measured with a tape, in centimeters.

Yield parameters collected were immediately after harvest. The average diameter of the root was measured at the thickest portion of the root at harvest with the slide caliper. Fresh weight of leaves per plant was measured by detaching the leaves with a sharp knife after harvesting were weighed on a weighing balance, immediately after harvest. Fresh weight of root per plant was collected with a weighing balance. The harvested root of each sample plant was weighed alone without the vegetative parts, immediately after harvest. The vegetative parts were to be detached with a sharp knife. The number of roots that were harvested from sampled plants from each bed, were counted and recorded. Plant biomass was measured Immediately after harvest. A weighing balance was used to measure the weight of both the harvested roots and vegetative parts of sampled plants. Data on harvest index on fresh weight basis was calculated by dividing root weight by the whole biomass multiplied by 100.

$$HI (\%) = \frac{\text{Root weight}}{\text{Whole plant biomass}} \times \frac{100}{1}$$

The number of roots harvested from sampled plants from each bed, were counted and recorded. The harvested roots of the sampled plants were measured with a meter rule from point of leaf attachment (proximal end) to the last point of the root. For the marketable yield, the total amount of carrot roots that had value and could be sold after harvest were sorted, graded and counted. The amount of carrot roots that had marketable value were sorted and graded then the percentage was calculated thus- Number of valuable carrots/ Total number of harvested carrots x 100/1. And finally data was collected on root uniformity by visual examination of the roots using a uniformity index score created as shown below

Index	Description
1	Not Uniform <30% of the roots are similar in size and shape
2	Fairly Uniform >30%<50% of the roots are similar in size and shape
3	Uniform >50%< 70% of the roots are similar in size and shape
4	Very Uniform >70%<90% of the roots are similar in size and shape
5	Highly Uniform >90% of the roots are similar in size and shape

All data collected were statistically analyzed using all outlined protocol for T- statistic (T-test) with IBM SPSS Statistics for Windows Evaluation, Version 22, Release 22.0.0.0. IBM SPSS Inc. (2013)

RESULTS AND DISCUSSION

Physicochemical properties of the soil samples utilized in the study

The result of analysis carried out with soil samples collected from the experimental site as presented in Table 3.1., shows the physical and chemical soil properties. Based on the physical soil properties, there was high percentage of sand (71.2%), clay was the least (8.4 %) while the textural class of the soil is sandy-loam. The chemical soil properties showed the percentage base saturation to be 80.23 %, organic matter 1.98%, and Total N0.97%, other parameters were also determined.

Table 1: Physical and Chemical properties of the soil samples taken at 0 - 15cm depth of the experimental site before planting

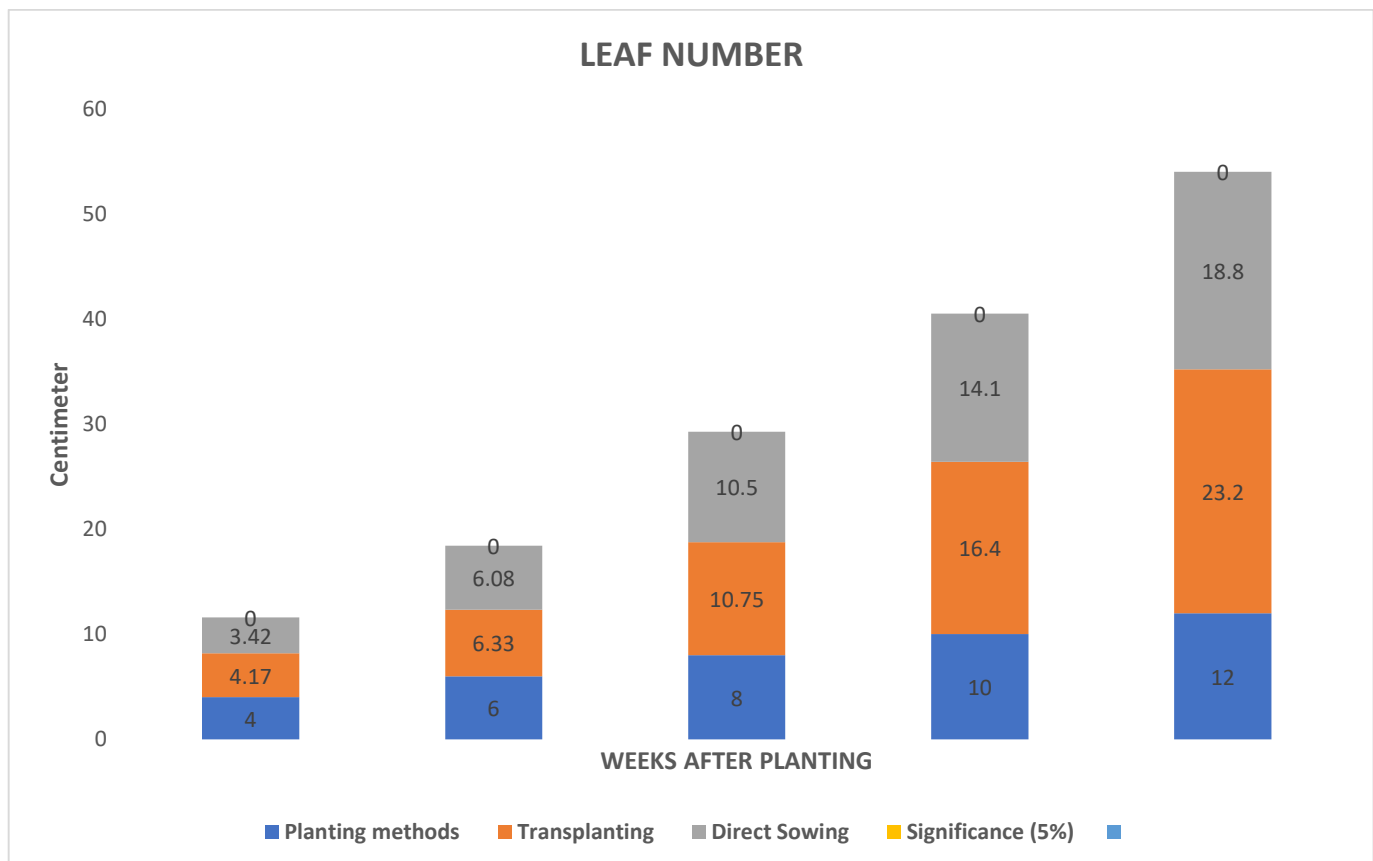
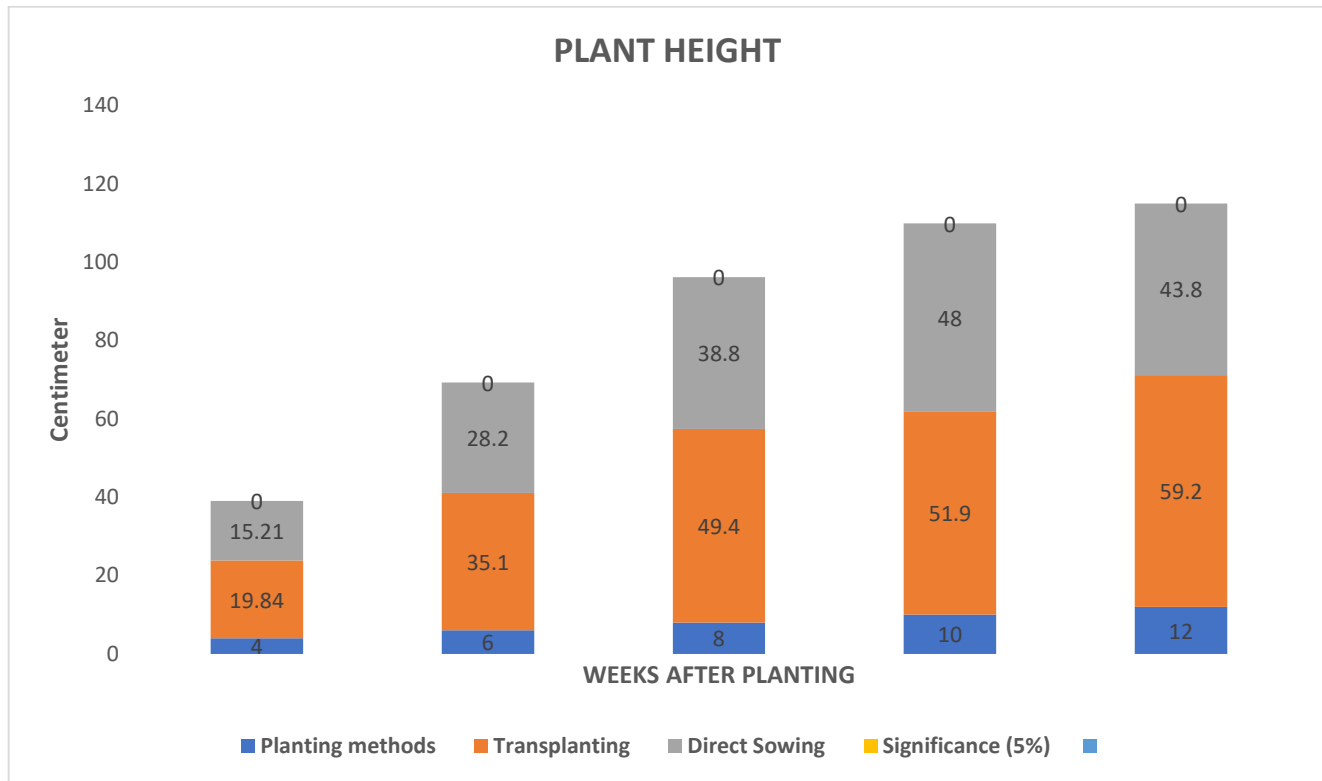
Soil Properties	
Physical	
Sand (%)	69.6
Silt (%)	22.0
Clay (%)	8.4
Textural Class	Sandy-Loam (SL)
Chemical	
pH (H2O)	5.14
Total N%	0.97
Organic Carbon%	1.14
Organic Matter%	1.98
Ca (Cmolkg ⁻¹)	2.27
Mg (Cmolkg ⁻¹)	1.33
K (Cmolkg ⁻¹)	0.25
Na (Cmolkg ⁻¹)	0.12
EA (Cmolkg ⁻¹)	1.63
ECEC (Cmolkg ⁻¹)	4.97
BS (%)	80.23
Available P (mgkg ⁻¹)	5 53

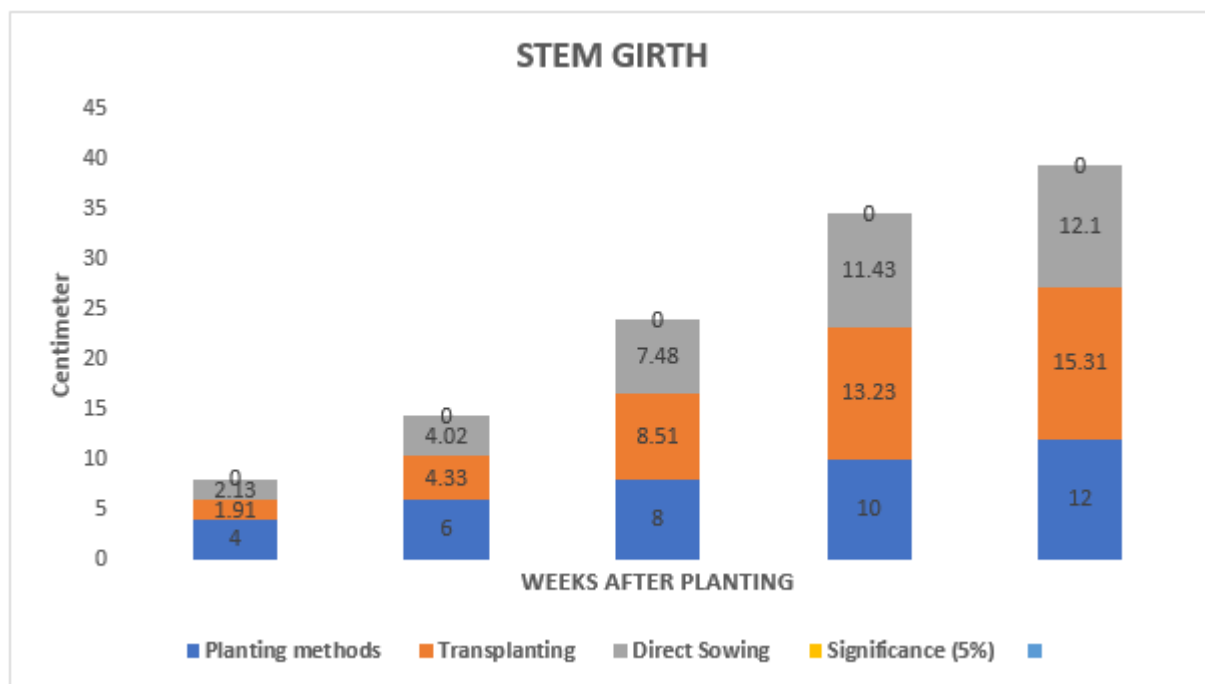
Effect of Planting Methods on the Growth of Carrot

The significant difference between the plant height of the planting methods at 4, 6, 8 and 10 WAP resonates with Leskovar and Othman's (2021) report that more uniform growth is higher in transplants compared to direct seeding. It can also be attributed to climatic conditions and more importantly a reduction in the mean values of the directly sown plants after 10 WAP as opposed to the continuous improvement in the plant height of the transplants. This finding agrees with Afrin et al (2019) work on directly sown carrots, which indicated that, plant height was an important growth contributing character during the experiment, in which the growth rate of the plants at earlier stage were higher, then became slower at the later stage of development, as noticed with the directly sown carrots.

Transplanting did not significantly influence plant height at 12 WAP, the leaf number at 4, 6, 8, 10 and 12 WAP and stem girth at 4, 6, 8 and 10 WAP. This is in line with Leskovar and Othman, (2021) who reported on globe artichoke, that direct seeding and transplanting were statistically similar in both periods of experimenting.

Graph 1: Effect of planting methods on the plant height, number of leaves and stem girth of carrot.





Effect of Planting Methods on the Yield of Carrot

In this study, the root diameter was significantly influenced by planting methods, with the transplanted seedlings having higher value when compared to the directly sown seeds, which is in agreement with the aforementioned reports of Gavric and Omerbegovic (2021) on sweet corn, Bahlgerdi et al (2014) on Cucurbita pepo (Medicinal Pumpkin), and Khozaei et al (2020) report that transplanting significantly influenced the yield, water productivity and quality of sugar beet.

The significant similarity between planting methods in the root length corresponds to Mbatha et al (2014) findings, where carrot root length was not significantly influenced by any of the treatments applied. It also concedes with Leskovar and Othman's (2021) report that length values for direct seeded plants never exceeded those of transplants across months and over the study period in globe artichoke.

On number of harvested plants, Adesina et al (2014) reported that fruit yield in maize was not significantly influenced by planting methods (Transplanting and Direct seeding), instead it was influenced by planting density. The Harvest Index resulted in significant variance between transplants and the directly sown plants where directly sown plants had significant higher values, this corresponds with Kakar et al., (2015) report which revealed that planting methods had significantly affected the harvest index of wheat.

Table 2: Effect of planting methods on plant biomass, fresh weight of roots, fresh weight of leaves, harvest Index% of carrot, number of roots harvested per plot, root length and root diameter of carrot (yield)

Planting Methods	Plant Biomass	Fresh Weight of Roots	Fresh Weight of Leaves	Harvest Index %	No Harvested per plot	Root Length	Root Diameter
Transplanting	330	145	186	43.3	6.25	17.2	5.58
Direct Sowing	213	120	95	56.8	5.75	17.2	3.93
Significance (5%)	Ns	Ns	Ns	*	Ns	Ns	*

Effect of Planting Methods on the Root Marketability of Carrots

The Marketability Parameters followed the same trend, root uniformity, marketable yield and marketable yield percent (%) all differed significantly, with the direct sown carrots significantly influencing all marketable parameters. Significant difference between planting methods in root uniformity can be attributed to the dissimilarity in size and shape of the harvested carrot roots. The forked, irregular and ill-shapen roots harvested from the transplants which is as a result of transplanting, greatly reduced uniformity. According to Fritz, (2012) transplanting of long-rooted vegetables leads to forked roots. This finding is consonant with the study of Wu et al (2020), who reported that direct seeding in carrot production is more suitable and transplanting would lead to the occurrence of fork root and loss of commercial value. It was observed that later most nursery raised seedlings resulted in forked roots. Costa et al (2020) on another crop reported that direct sowing presented the highest numbers of total and commercial ears per hectare and that transplanting in general, caused loss of commercial fruit quality in baby corn production.

Table 3: Effect of Planting Methods on the root uniformity, marketable yield and marketable yield% of carrots.

Treatment	Root Uniformity	Marketable Yield	Marketable Yield%
Transplanting	2.00	2.5	26.0
Direct Sowing	4.25	5.75	100.00
Significance (5%)	*	*	*

CONCLUSION

In consideration of the aforementioned results, it can be concluded that since transplanting had no significant effect on most of the observed parameters and direct sowing had significant effect on root marketability which consists of root uniformity, marketable yield and marketable yield%, which is paramount in commercial carrot production, directly sown carrots remain the best for optimum carrot production, until further experiments on other planting methods are completed.

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