EFFECTS OF ORGANIC AND INORGANIC FERTILIZERS ON VEGETATIVE GROWTH AND TUBER YIELD OF CARROT (*DAUCUS CAROTA* L.)

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ABSTRACT
Pot experiments were conducted to observe the effects of organic and inorganic fertilizers on vegetative growth and tuber yield of Carrot in the Botanical Garden of the University of Ilorin, Ilorin, Kwara State, Nigeria, between April and August, 2018. The experiments were arranged in a complete randomized design (CRD) with six treatments (T0, T_1, T_2, T_3, T_4 andT_5) of three replicates each.Data on number of leaf, leaf height, leaf petiole girth, root tuber girth and root tuber length were taken and analyzed with Analysis of Variance (ANOVA) using SPSS package and means were separated by Duncan Multiple Range Test (DMRT). The results revealed that all growth and yield parameters were significantly improved by organic and inorganic fertilizers. The highest values for number of leaf (16.67), leaf height (18.33cm) and leaf petiole girth (0.30cm) were obtained in organic fertilizer from poultry dung. These values were much higher than those obtained in inorganic fertilizer. Inorganic fertilizer (NPK) showed the highest value (5.17cm) for root tuber girth, followed by control (4.93cm) and least (3.93cm) in organic fertilizer respectively. Highest root tuber length (7.33cm) was obtained in inorganic fertilizer treated carrot plants, followed by control experiment (6.97 cm) and least in organic fertilizer (6.27cm).This study concluded that the application of organic and inorganic fertilizers enhanced increase in all growth and yield parameters like leaf rachis girth, leaf height, number of leaf and root tuber.

Key words: NPK fertilizer, Poultry dung, Root Girth, Root tuber, Leaf petiole girth

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INTRODUCTION

Daucus carota is a biennial plant in the Umbellifer family Apiaceae. Fast- growing cultivars mature within three months (90 days) of sowing the seed, while late maturing cultivars are harvested four months later (120 days).After germination, carrot seedlings show a distinct demarcation between taproot and leaf. Carrot plant is an erect, biennial plant. Leaves have long petiole compound and pinnate (Kochhar, 2011).The first true leaf appears about 10- 15 days after germination. European settlers introduced the carrot to colonial America in the 17th century. There are many claims that Dutch growers created orange carrots in the 17thcentury to honor the Dutch flag at the time. Other authorities argue these claims lack convincing evidence (Greene, 2012). Greeks and Romans initially used carrot for medicinal purpose but has now become widespread human food and is cultivated all over the world as vegetable (Kochhar, 2011).

Carrots grow best in full sun but tolerate some shade (Elzer, 2014) with the optimum temperature of 16 to 21 °C (61 to 70 °F). The ideal soil is deep, loose and well-drained, sandy or loamy, with a pH of 6.3. They require low levels of nitrogen, moderate phosphate and high potash.

Carrot cultivars are majorly of two groups, eastern carrots and western carrots (Grubben, 2016). Eastern carrots that survive to the present day are commonly purple or yellow, and often have branched roots. The purple colour common in these carrots comes from anthocyanin pigments (Tiwari *et al.;* 2012). The orange colour in Western carrot results from abundant carotenes in these cultivars. Western carrot cultivars are commonly classified by their root shape (Greene, 2012).

Organic manure was reported to increase water holding capacity of the soil making the soil to be loose and friable thereby providing favourable growth condition for carrots (Mehedi *et al*.; 2012). Also a mixture of inorganic and organic fertilizers has the ability to produce thick carrot root tubers. Early vegetative growth was greatly enhanced by higher doses of Nitrogen fertilizer (Hailu *et al*.; 2008).

Carrot is an important vegetable which has gained prominence for its medicinal, culinary and nutritional values. It is a readily available root vegetable which can create source of livelihood to the growers as well as source of cheap food item to consumers. It is therefore, the objective of this study to investigate the cultivation of carrot using both organic and inorganic fertilizers to boost its production.

MATERIALS AND METHODS

Study site is the experimental plot of Department of Plant Biology, University of Ilorin, Kwara State, Nigeria. Ilorin is located on latitude $8^{o}29.8^{'}$N and longitude $4^{O}32.53^{'}$E (World site Atlas, 2018). The seeds of carrot (*Daucus carota* L.) used for this study was procured from an Agro-chemical store: Premier Seed Depot, Opposite Baruten Hasada Motor park, Agric Zango road, Ilorin, Kwara State, Nigeria. The soil was collected from the botanical garden of the University of Ilorin filled into 33 polythene bags. The inorganic manure was N.P.K (15:15:15) was procured from an Agro-chemical store located at Murtala road Ilorin, Kwara State, Nigeria while the organic manure was collected from a poultry farm in Ilorin.

The experimental design was a Complete Randomized Design (CRD), the pots were filled with top soil and were arranged side by side in an open space near the screen house for proper aeration and illumination. The planting of already filled pots with top soil were divided into two groups of fifteen pots each for organic and inorganic fertilizers respectively and another set of 3 pots served as control experiment. Each of the 33 planting pots were labelled T_0= Control (No manure application); T_1=10 g; T_2=15 g; T_3=20 g;T_4=25 g and T_5=30 g for organic and inorganic manures respectively.

Soils collected for planting were sieved to remove stones and pebbles which can impede the free development and movement of the root of carrot seedlings. Dry decomposed organic manure (poultry waste) of different treatments (0, 10, 15, 20, 25 and 30g to represent T_0, T_1, T_2, T_3, T_4 and T_5 respectively) which were previously mixed thoroughly with the soil before planting was done. Seeds were planted at a depth of 0.5 cm and watered. Inorganic (N.P.K) fertilizer was applied in two equal installments. The first was done at 4 weeks after planting and the second 8 weeks after planting. Watering was done everyday so as to keep the soil moist.

Data collection and analysis

Germination started taking place 5 daysafter planting. Thinning out was carried out to reduce the number of plants and possible competition.

Number of leaf: Number of leaf was determined by manual counting and recorded for all the treatments at 4, 6 and 8 WAP (Weeks after planting).

Leaf height: Leaf height was measured from the ground level to the top of the shoot during the course of growth and development with the help of a meter rule and recorded appropriately in (cm) at 4, 6 and 8 WAP.

Leaf petiole girth: Leaf petiole girth was taken using thread and meter rule, and recorded in (cm) at 4, 6 and 8 WAP.

Root tuber girth: Root tuber girth was taken using thread and meter rule, and recorded in (cm) at harvest.

Root tuber length: Root tuber length was taken by using meter rule, and recorded in (cm) at harvest.

Data were taken and analyzed with Analysis of Variance (ANOVA) using SPSS package and means were separated by Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSIONS

Number of Leaf: Number of leaves increased with age of carrot and highest (16.67) at 8

WAP in T_1 followed by (16.00) in T_4 and least (4.33) in T_0 (Table 1). At 4, 6, 8 WAP number of leaf of Carrot were significantly affected due to different levels of inorganic manure and the highest number of leaf at 4WAP was obtained in T_2 (13.00) followed by T_3 (12.67) and least (12.00) in each of T_0 and T_3 (Table 2). These values decreased at both 6 and 8 WAP due to foliar contact injuries sustained during the application of NPK fertilizer (Table 2).At 4 WAP, higher number of leaf (13.00) was enhanced by inorganic manure. This result was similar to the earlier observations by Ganesh (2016) and Uddain *et al.*; (2010) that both inorganic and organic manures increased the number of leaf in carrots. At 8WAP number of leaf was greatly enhanced by organic manure (16.67) which was significantly different from other treatment, followed by inorganic manure (10.33) and followed by control (4.33).

Leaf Height: Leaf height increased steadily with age in all the treatments in organic fertilizer and highest at 8WAP in T_3 (18.33 cm) followed by T_1 (18.00 cm) and least (14.33 cm) in T_4 (Table 3). Leaf height increase in inorganic fertilizer followed the same trend in organic fertilizer and was highest at 8WAP in T_5 (18.00 cm) followed by T_0 (15.67 cm) and least (11.00 cm) in T_4 (Table 4).At 4 WAP, leaf height was enhanced by organic manure (9.33cm) this observation reported by Uddain *et al.;* (2010) followed by inorganic manure (8.60cm) and followed by control (7.33cm). At 6 and 8 WAP, it was significantly enhanced by organic manure (13.27 and 18.33cm) this may be as result of water holding capacity of the soil, kept soil loose and friable which are desirable for carrot (Mehedi *et al.;* 2012). Values of leaf heights of inorganic manure treated seeds at 8WAp (10.33 and 18.00cm) and followed by control (10.17 and 15.67cm).

Leaf Petiole Girth: Leaf petiole girth in organic fertilizer treatments increased with and highest at 8WAP in T_3 (0.30 cm) followed by T_1 (0.28 cm) and least (0.06 cm) in T_0 (Table 5). Leaf petiole girth in inorganic treatments followed the same trend with organic treatments and highest (0.27 cm) in T_1, T_2 and T_4 and least (0.06 cm) in T_0 (Table 6).

At 4WAP, it was enhanced by organic manure (0.08cm) followed by the control (T_0) (0.06 cm) and the inorganic manure treatment (0.05cm). At 6 and 8 WAP, it was enhanced by organic manure (0.10 and 0.30cm).This agrees with the earlier observation of Mehedi *et al.;* (2012). Followed by inorganic manure (0.08 and 0.27cm) and followed by control (0.06 and 0.06cm).

TABLE 1: Effects of organic manure on number of leaf in carrot

Treatment	4 WAP	6 WAP	8 WAP
T_0	12.00^a	7.00^b	4.33^b
T_1	12.00^a	11.33^a	16.67^a
T_2	11.67^a	10.00^a	13.67^a
T_3	12.00^a	11.33^a	14.67^a
T_4	12.67^a	12.00^a	16.00^a
T_5	11.67^a	10.67^a	15.33^a

Values carrying the same letter(s) within the column are not significantly different at $P < 0.05$

TABLE 2: Effects of inorganic manure on number of leaf in carrot

Treatment	4 WAP	6 WAP	8 WAP
T_0	12.00^a	7.00^a	4.33^c
T_1	12.33^a	5.67^{ab}	10.33^a
T_2	13.00^a	2.67^b	5.00^{bc}
T_3	12.67^a	3.00^b	5.67^{bc}
T_4	12.33^a	3.67^{ab}	5.67^{bc}
T_5	12.00^a	6.00^{ab}	7.33^b

Values carrying the same letter(s) within the column are not significantly different at $P < 0.05$

TABLE 3: Effects of organic manure on leaf height of carrot

Treatment	4 WAP	6 WAP	8 WAP
T_0	7.33^{a}	10.17^{b}	15.67^{a}
T_1	8.67^{a}	12.43^{ab}	18.00^{a}
T_2	9.33^{a}	13.07^{ab}	17.67^{a}
T_3	8.17^{a}	13.57^{a}	18.33^{a}
T_4	6.67^{a}	11.83^{ab}	14.33^{a}
T_5	7.83^{a}	13.27^{ab}	16.00^{a}

Values carrying the same letter(s) within the column are not significantly different at $P < 0.05$

TABLE 4: Effects of inorganic manure on leaf height in carrot (cm)

Treatment	4 WAP	6 WAP	8WAP
T_0	7.33^{ab}	10.17^{a}	15.67^{a}
T_1	8.60^{a}	8.83^{ab}	14.67^{a}
T_2	7.90^{ab}	10.33^{a}	12.33^{a}
T_3	7.07^{ab}	8.17^{ab}	12.00^{a}
T_4	7.80^{ab}	6.67^{b}	11.00^{a}
T_5	6.40^{b}	9.30^{ab}	18.00^{a}

Values carrying the same letter(s) within the column are not significantly different at $P < 0.05$

TABLE 5: Effects of organic manure on leaf petiole girth in carrot (cm)

Treatment	4 WAP	6 WAP	8 WAP
T_0	0.06^{a}	0.06^{b}	0.06^{c}
T_1	0.08^{a}	0.10^{a}	0.28^{ab}
T_2	0.07^{a}	0.09^{a}	0.20^{b}
T_3	0.08^{a}	0.10^{a}	0.27^{ab}
T_4	0.07^{a}	0.10^{a}	0.27^{ab}
T_5	0.08^{a}	0.09^{a}	0.30^{a}

Values carrying the same letter(s) within the column are not significantly different at $P < 0.05$

TABLE 6: Effects of inorganic manure on leaf petiole girth in carrot

Treatment	4 WAP	6 WAP	8 WAP
T_0	0.06^{a}	0.06^{b}	0.06^{b}
T_1	0.05^{ab}	0.08^{a}	0.27^{a}
T_2	0.03^{c}	0.07^{a}	0.27^{a}
T_3	0.04^{c}	0.06^{b}	0.23^{a}
T_4	0.03^{c}	0.07^{a}	0.27^{a}
T_5	0.04^{bc}	0.07^{a}	0.23^{a}

Values carrying the same letter(s) within the column are not significantly different at $P < 0.05$

Root Tuber Girth: At harvest, control (T_0) had the highest root tuber girth (4.93cm) when compared to those treated with organic manure followed by (3.93cm) at rate of both 15 and 30g (T_2 and T_5) followed by (3.83cm) at the rate of 10g (T_1) followed by (3.30cm) at rate of 20g (T_3) and followed by (3.23cm) at the rate of 25g (T_4) organic manure (Figure 1). At harvest, the highest root tuber girth (5.17cm) was obtained when inorganic manure was applied at the rate of 15g (T_2) followed by (5.00cm) at both 10 and 30g (T_1 and T_5) followed by (T_0) control (4.93cm) followed by (4.70cm) at the rate of 20g (T_3) followed by

(4.60cm) at the rate of (T_4) 25g (Figure 2). This observation agrees with the report of Hailu *et al.;* (2008).

Root Tuber Length: At harvest, control (T_0) had the highest root tuber length (6.97cm) when compared to those treated with organic manure followed by (6.27cm) at the rate of 10g followed by (6.00cm) at the rate of both 15 and 30g (T_5) followed by (5.17cm) at (T_3) the rate of 20g followed by (4.93cm) at the rate of 25g (T_4) organic manure (Figure 3). At harvest, the highest root tuber length (7.33cm) was obtained when inorganic manure was applied at the rate of 10g followed by (7.27cm) at rate of 30g followed by (7.17cm) at the rate of 20g (T_3) followed by control (6.97cm) followed by (6.57cm) at the rate of 25g (T_2) followed by (6.50 cm) at (T_2) rate of 15g (Figure 4).At harvest, values of root tuber length in plants treated with both organic and inorganic manures were enhanced. These results agree with the findings of Hailu *et al.;* (2008), Mehedi *et al.*, (2012) and Kiran *et al.;* (2016) who reported remarkable increase in root tuber length of carrot due to application of increased inorganic manure.

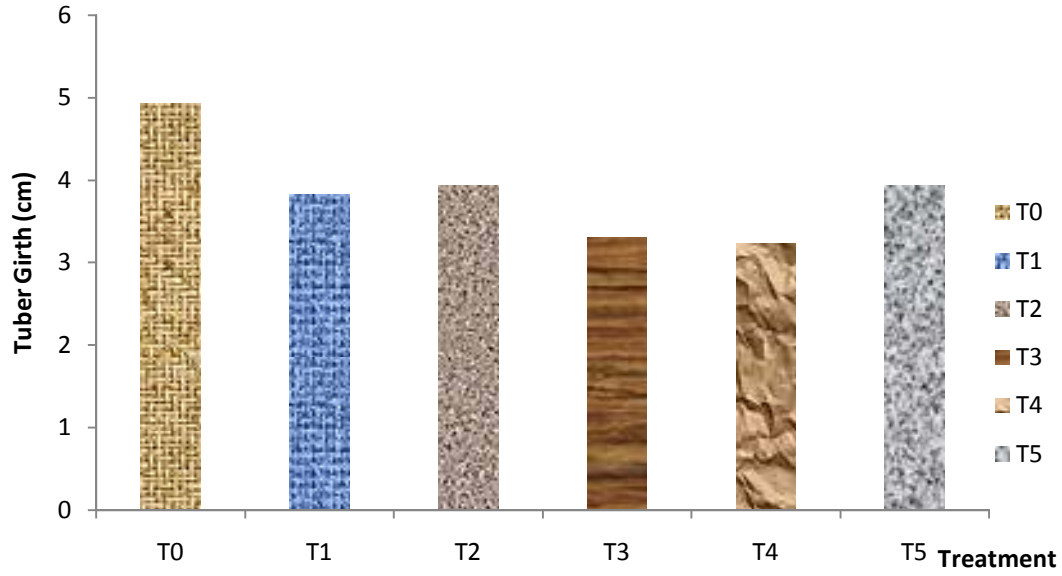

Figure 1: Effects of organic fertilizer on the root tuber girth of carrot

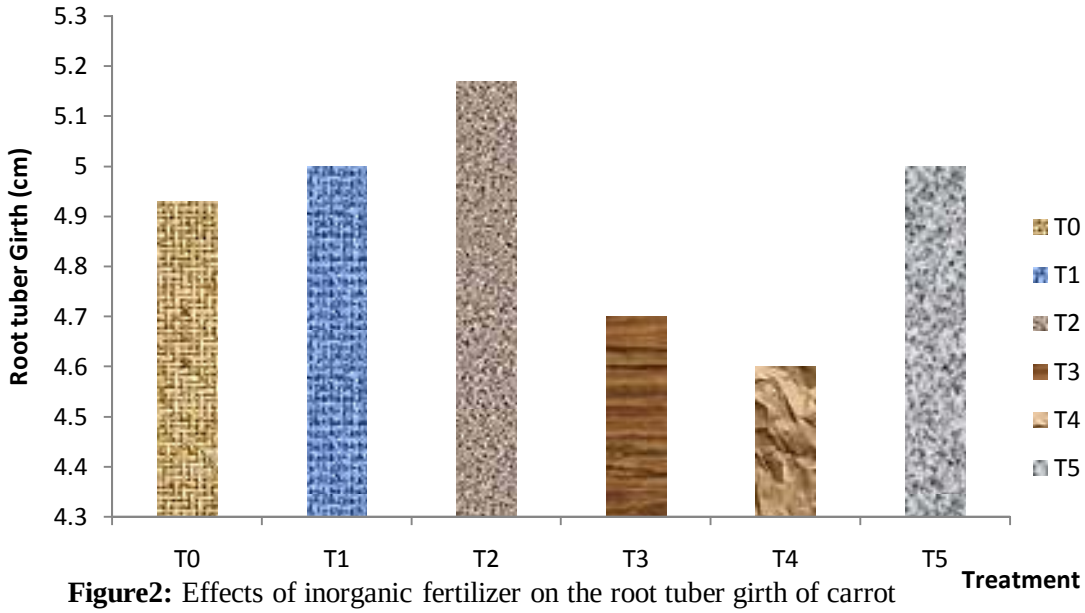

Figure2: Effects of inorganic fertilizer on the root tuber girth of carrot

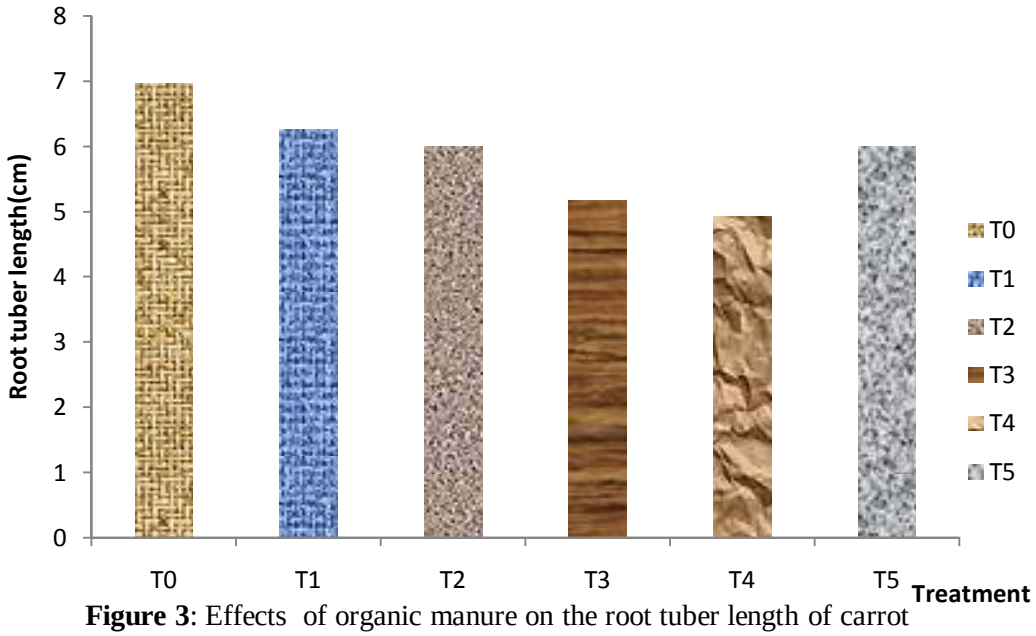

Figure 3: Effects of organic manure on the root tuber length of carrot

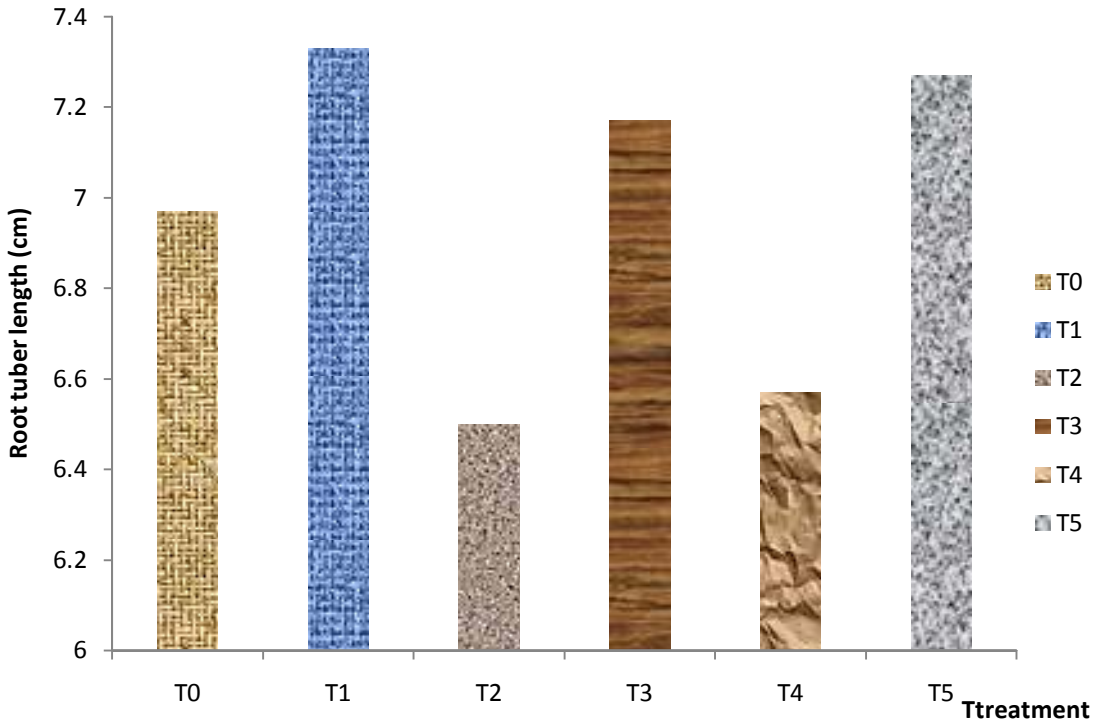

Figure4: Effects of inorganic manure on the root tuber length of carrot

CONCLUSION

This study has revealed the effectiveness of both organic and inorganic manures in the growth and yield of carrot. These manures enhanced both vegetative growth and yield parameters like leaf petiole girth, leaf height and number of leaf, root tuber girth and root tuber length. The highest values for number of leaf, leaf height and leaf petiole girth were recorded for organic manure followed by inorganic manure. The highest yields for root tuber girth and length occurred in inorganic manure. Inorganic manure appeared to be better than organic manure.

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