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Effect of Poultry Manure and Nitrogen, Phosphorus, and Potassium (15:15:15) Soil Amendment on Growth and Yield of Carrot *(Daucus carota)*

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***Abstract*—**This present experiment was carried out during the 2012 cropping season, at the Farming for the Future Experimental Field of the University for Development Studies, Nyankpala Campus in the Northern Region of Ghana. The objective of the experiment was to determine the carrot growth and yield responses to poultry manure and N.P.K (15:15:15). Six treatments (Control (no amendment), 20 t/ha poultry manure (PM), 40 t/ha PM, 70 t/ha PM, 35 t/ha PM + 0.11t/ha N.P.K and 0.23 t/ha N.P.K) with three replications for each were laid in a Randomized Complete Block Design (RCBD). Data were collected on plant height, number of leaves per plant, canopy spread, root diameter, root weight, and root length. Microsoft Excel and Genstat Statistical Package (9th edition) were used for the data analysis. The treatment means were compared by using Least Significant Difference at 10%. Generally, the results showed that there were no significant differences (P>0.1) among the treatments with respect to number of leaves per plant, root diameter, root weight, and root length. However, significant differences occurred among plant heights and canopy spreads. Plant height treated with 40 t/ha PM at the fourth week after planting and canopy spread at eight weeks after planting and ten weeks after planting by 70 t/ha PM and 20 t/ha PM respectively showed significant difference (P<0.1). The study recommended that any of the amended treatments can be applied at their recommended rates to plots for carrot production, since there were no significant differences among the treatments.

***Keywords*—**Poultry manure, N.P.K., soil amendment, growth, yield, carrot.

I. Introduction

DAUCUS *carota*, commonly known as carrot, is a popular exotic vegetable grown throughout the world [11]. According to [15], carrots belong to the family Umbelliferae and it is grown for its fresh roots, which can be eaten either fresh or cooked.

It has been reported in [17] that the carrot with the purple root was domesticated in Afghanistan and spread to Eastern Mediterranean area under Arab influence in the 10th to 12th centuries and to Western Europe in the 14th century.

The early known carrot type was the yellow type. The red, purple, green, black, and the orange coloured types that we see mostly on the market today, are mutated from the yellow carrot type due to accumulation of carotene in the cell being abundant [11]. According to [19], commonly cultivated varieties include Adelaide, Amsterdam forcing, Autumn king 2, Carrot Tendersmax, Carson, Flyaway, Flyfree, Healthmaster, Infinity, Ingot, Jeanette, Jumbo, Juwarot, Kingston, Langerote stumfe, Little finger, Mokum, Nanduri, Nantes, Nigel, Parmex, Resista fly, New Red Intermediate, St Valery, Chantenay, and Yellowstone.

Counted among the most important root vegetables, carrot is high in nutritional value and can be eaten either raw or cooked as mentioned earlier on. It is known to be the most important anti-aging vegetable because of its high carotenoid content making it a good source of carotene. Carotene is a precursor of vitamin A [3]. Vegetables are vital components of healthy diet and life, and particularly green leafy vegetables and yellows (example carrot) provides essential minerals and vitamin A, E, and C [9].

Despite the numerous benefits that carrot gives to the wellbeing of human health, there are also some factors that affect the effective production of this noble crop in discussion. These factors are low soil fertility, drought, pest and diseases, weeds and climatic factors.

Soil fertility is the most important natural resource for increasing agricultural crop production as it is one of the key determinants of good growth and high yield of crops [16]. One of the techniques employed by farm operators to maintain or improve the resource base of the land for crop production is the use of organic manure.

Inorganic fertilizers are defined as compounds derived from mineral salts; these are most commonly used in agriculture today because of many associated benefits [1]. Some examples of the inorganic fertilizers are N.P.K. and sulphate of ammonia. Organic fertilizers are not at all man-made, but are completely natural by the process of bacterial metabolism; examples are poultry manure, cow dung, and green manure.

Poultry manure which is common in most localities has been found to reduce soil parasitic nematodes and to increase soil nutrients [2], [7].

Poultry manure supplies other essential plants nutrients and serves as soil amendments by adding organic matter that improves soil moisture and nutrients retention [8].

Poultry manure has frequently been found to increase the yields of pastures and crops including vegetables [4], and [5] stated that organic manure and soil organic matter play a key role in sustaining the desirable soil physical conditions for the growth of crops and the enhancement of farm income. The objective of this present study is therefore to determine the

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effect of poultry manure and NPK (15:15:15) at different levels on the growth and yield of carrot.

II. Materials and Methods

A. Site Description

The experiment was carried out during the 2012 cropping season on the farming for the future experimental field of the Faculty of Agriculture (FOA) of the University for Development Studies, Nyankpala in the Northern Region of Ghana, about 16 km south-west of Tamale.

The area lies within the Guinea savanna ecological zone of Ghana. The soil is moderately drained sandy loam free from concretion developed from Voltaian Sandstone and classified as Nyankpala series. The area lies between latitude 9º25' N and Longitude 10º00' W and at an altitude of 183 m above sea level [10].

The area experiences a unimodal rainfall of about 1000 to 1200 mm distributed unevenly between the months of April and November, a uniform mean monthly temperature of 22 ºC during the rainy season and a maximum temperature of 34 ºC during the dry season, and mean monthly relative humidity of 80% during the raining season and 53% during the dry season [13]

B. Experimental Design

The field experiment was laid out in a randomized complete block design (RCBD) with six treatments and three blocks. Each block contains six plots with each plot size of 1.2 m x 0.8 m.

A distance of 1 m was left between blocks and 0.5 m within blocks/replications. The total land area used was 42.68 m^2.

Total amount of Poultry Manure (PM) used = 47.52 kg, Total amount of NPK used = 0.0966 kg, Bed area = 0.96 m^2.

TABLE I
THE VARIOUS TREATMENTS AND RATES OF APPLICATION IN TONNES/HECTARE AND KILOGRAM/BED

Treatments (T)	Rate (Tonne/Hectare)	Rate (Kilogram/Bed)
T1= Control (No amendment)	0	0
T2 = Poultry Manure (PM)	20.00	1.92
T3 = Poultry Manure (PM)	40.00	3.84
T4 = Poultry Manure (PM)	70.00	6.72
T5 = PM + NPK (15:15:15)	35.00 + 0.11	3.36 + 0.011
T6 = NPK (15:15:15)	0.225	0.022

C. Agronomic Practices

1. Field Preparation

The field was ploughed, and beds of size 1.2 m x 0.8 m raise for each plot. The beds were raised across the slope to check soil erosion taking soil fertility gradient into consideration. The soil in the beds was tilled properly to remove any stones, sticks, or any material in the soil which can impede the free development and movement of the rooting system of the carrot plant.

2. Poultry Manure Application

Dry decomposed poultry manure was applied to the beds by thoroughly mixing it with the soil and was allowed for a period of two weeks before planting was done.

3. Planting Material and Planting

The carrot seed was obtained from Agrimart, Madina a suburb of Accra, Ghana. The seeds were planted on the beds at least two weeks after the application of the poultry manure in drills of three rows and at a planting depth of 0.5 cm and planting distance of 30 cm x 4 cm.

4. Soil Tillage

The soil on each bed was tilled every two weeks starting from the fourth week after planting (WAP) to make the soil very loose for easy development of the rooting system of the carrot, since carrot does not tolerate heavy and compacted soils for effective development. Hand fork was used for this operation.

5. Weeding and Fertilization

Weeding was done using hoe and hand picking. N.P.K fertilizer was applied to the crops in treatment 5 and 6 at the fifth WAP.

6. Mulching, Watering and Thinning Out

The planted seeds as well as growing carrot plants were mulched with dry grass. The planting was done in the rainy season and the crops were mostly rain fed. Thinning out was performed to help reduce the number of plants to the recommended number of one plant per stand by hand from 10 days after emergence (DAE).

D. Data Collection

The parameters measured in the data collection process were; height of plant, canopy spread, number of leaves per plant, root diameter, weight of root, length of root. Five plants were randomly selected from each bed and tagged for data collection.

E. Height of Plant

The height of the tagged plant was measured from the base of the carrot plant at ground level to the apex of the plant using a meter rule at 4, 6, 8, 10, and 12 WAP.

F. Canopy Spread

Canopy spread was determined by measuring the spread of the canopy from east to west and from north to south of the plant with tape measure. The average of the two lengths is considered as of the canopy spread of the tagged plant at 4, 6, 8, 10, and 12 WAP.

G. Number of Leaves per Plant

The leaves of the tagged plants on each bed were counted, and the average was determined for each bed at 4, 6, 8, 10, and 12 WAP.

H. Root Weight and Diameter

The largest part of the root was measured with a veneer caliper after harvesting from the tagged plants, and the average was determined for each bed. The individual weights of the roots of the five tagged plants were weighed after removing the leaves after harvesting. Electric balance was used for the weighing.

I. Length of Root

The length from the shoulder to the tip of the carrot root was measured for the tagged plants on each bed. A tape measure or meter rule was used to take the length after harvesting.

J. Data Analysis

The data which was collected was analysed by using Microsoft Excel and GenStat statistical package (9th edition) for the analysis of variance (ANOVA). Treatments were compared by using Least Significant Difference (LSD) at 10%.

III. Results

A. Canopy Spread

There was no significant difference between the treatments at 4 WAP and 6 WAP for all variables measured. At 8 WAP, there was significant difference in the treatments ($P < 0.10$) with 70 t/ha PM recording the highest canopy spread. At 10 WAP, there was significant difference ($P < 0.10$) in the treatments with 20 t/ha PM recording the highest canopy spread at the end of the experiment.

The control plot performed poorly as compared to the other treatments in terms of canopy spread throughout the weeks after planting (WAP).

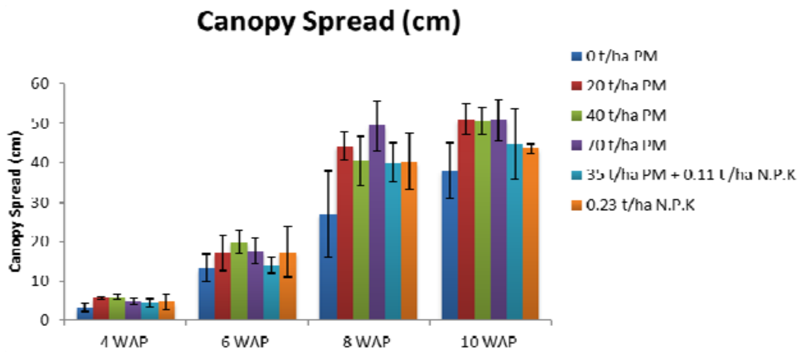

Fig. 1 Effect of poultry manure and N.P.K on the canopy spread, Bars represent ± Standard Deviation

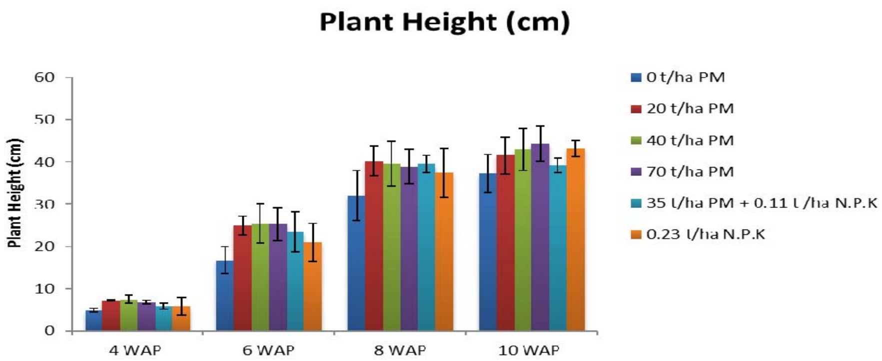

Fig. 2 Effect of poultry manure and N.P.K on the plant height, Bars represent ± Standard Deviation

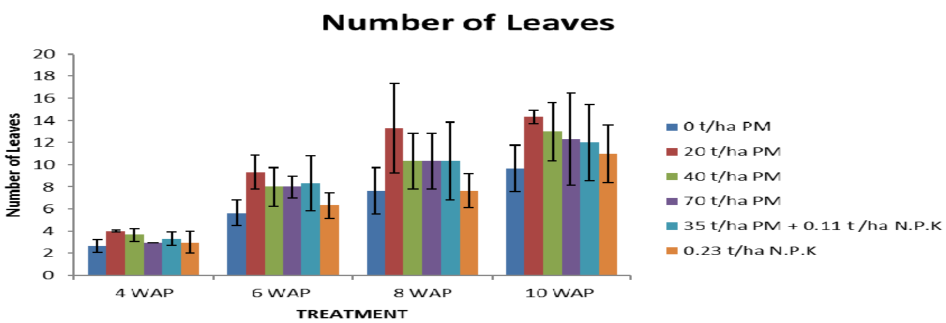

Fig. 3 Effect of poultry manure and N.P.K on the number of leaves, Bars represent ± Standard Deviation

B. Plant Height

From the fourth WAP, plant height showed significant difference (P <0.10) with 40 t/ha PM producing the highest plant. Although there was no significant difference (P>0.10) among the treatments from 6 to 12 WAP, at 8WAP, 20 t/ha PM overtook the 40 t/ha PM to give the highest plant height. At 10 WAP, 70 t/ha PM recorded the highest plant height plant height.

Throughout the experiment, the control (no amendment) plot recorded the lowest plant height in all the weeks after planting.

C. Number of Leaves

In the experiment, there was no significant difference (P >0.10) in the treatments throughout the growth of the carrot plant. But, 40 t/ha PM recorded the highest number of leave count, and the control (no amendment) recorded the least number of leave count. 40 t/ha PM plot which recorded the highest leave throughout the experiment gave 14.33 leaves/ plant at the end of the experiment. Control (no amendment) plot gave 9.67 leaves /plant at the end of the experiment.

D. Root Length

There was no significant difference (P>0.10) between the treatment on the root length. The results however showed that plots treated with 0.23 t/ha N.P.K gave the longest root length (18.5 cm).

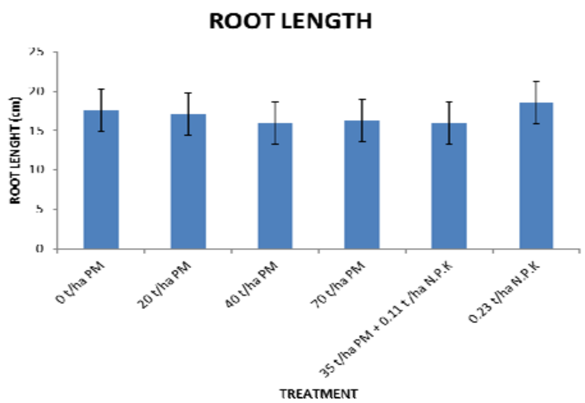

Fig. 4 Effect of poultry manure and N.P.K on root length, Bars represent ± Standard Deviation

E. Root Diameter

The various treatments did not show any significant difference (P >0.10) when applied throughout the experiment.

However, plots treated with 40 t/ha PM gave carrots with highest root diameter of 4.30 cm. The other four treatments with the exception of the control (no amendment) almost equally performed well as that of the 40 t/ha PM.

The control performed poorly in terms of the root diameter of the carrots produced from it by giving a root diameter of 3.02 cm.

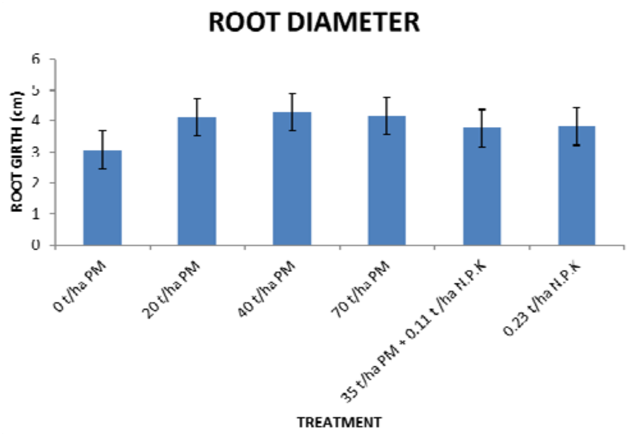

Fig. 5 Effect of poultry manure and N.P.K on the root diameter, Bars represent ± Standard Deviation

F. Root Weight

The treatments applied did not show significant difference (P>0.10) on the root weight of carrot. However, plots treated with 40t/ha PM produced carrot with the highest root weight. Among all the six treatments, the treatment which had the least performance was the control (no amendment) plot. The other four treatments apart from the control and the 40 t/ha PM performed equally well as compared to that of the 40 t/ha PM.

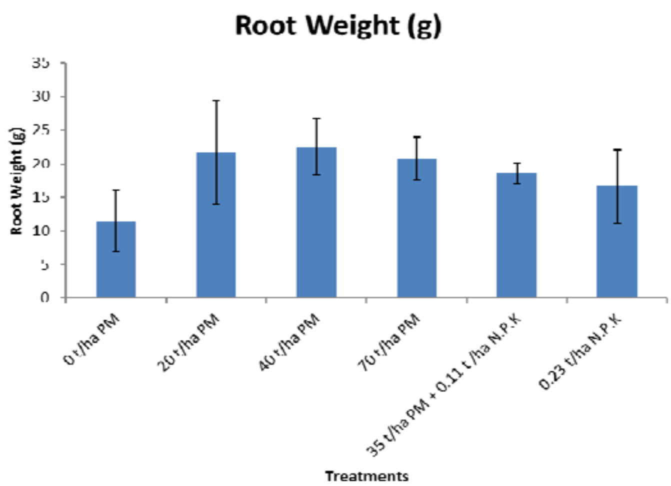

Fig. 6 Effect of poultry manure and N.P.K on the root weight of carrot, Bars represent ± Standard Deviation

IV. Discussion

A. Canopy Spread

The 70 t/ha PM produced a significantly greater canopy spread than the rest of the treatment at 8 WAP. At 10 WAP, the 20 t/ha PM produced a greater effect in respect of canopy spread than all the other treatments. This could be a result of the ability of the poultry manure to readily supply nutrients for the growth of carrot. According to [6] animal manure supplies most of the chemical compounds necessary for plant growth.

The effects of the treatments on the canopy becoming clear after 6 WAP could be attributed to the slow release of nutrients by the poultry manure, which is confirmed by [1] that organic fertilizers release nutrients very slowly. However, 35 t/ha PM + 0.11 t/ha N.P.K. (15:15:15) and 0.23 t/ha N.P.K (15:15:15) could not perform better than that of the 20 t/ha, 40 t/ha, and 70 t/ha PM treatments after 6 WAP. This attests to an assertion by Norman [11] that chemical fertilizer may not be necessary with heavy application of animal manure. The poor performance of the control treatment throughout the experiment in terms of the canopy spread could possibly be as a result of the low nutrient status which ended up affecting the growth and performance of the carrot.

B. Plant Height

The plant height was only significantly influenced (P<0.10) by the treatments at 4 WAP. The 20 t/ha, 40 t/ha and the 70 t/ha PM treated plots gave the best performing plant heights with the 40 t/ha PM taking the lead.

According to [12], carrots have an erect main stem, 30 to 120 cm high arising from a thick, fleshy taproot. After six weeks, the plants seem to be reaching the maximum plant height with even the control (no amendment) treatment which recorded the least plant height in all the weeks after planting, giving plant height which was close to the 35 t/ha PM + 0.11 t/ha N.P.K. treatment. This can be an indication that carrot can reach its maximum plant height regardless of soil fertility amendments. This disagrees with [14], who reported that application of N.P.K fertilizer increases plant height in carrots.

C. Number of Leaves

As nitrogen is mostly known to promote vegetative growth, the result indicated that, in terms of the leaves number in relation to carrot, carrot does not need heavy supply of nitrogen.

The 20 t/ha PM treatment giving the highest number of leaves per plant throughout the experiment was a clear indication of this. The 20 t/ha PM at the end of the experiment produced 14.33 leaves per plant. This confirms [15] who claimed that carrots need little supply of nitrogen for optimal growth and development.

The control (no amendment) treatment gave 9.67 leaves per plant, this poor performance may be a result of the very low nitrogen content in the soil compared to that amended treatments.

D. Root Length

The results however showed that plots treated with 0.23 t/ha N.P.K gave the longest root length (18.5cm). This disagrees with [18] who reported that organic manure improves the soil structure and maintains uniform soil moisture and nutrient level which allows carrots to extend their root length to deeper soil layer. Surprisingly, the control plot (no amendment) gave the second highest root length (17.5 cm) after the 0.23 t/ha N.P.K. The plots treated with the various high levels of poultry manure could not give the expected root length compared to that of the control plot and the 0.23 t/ha N.P.K plots. This confirms [15] which stated that excessive nitrogen will cause luxuriant growth at the expense of root development.

E. Root Diameter

The various treatments did not show any significant difference (P >0.10) when applied throughout the experiment. However, plots treated with 40 t/ha PM gave carrots with highest root diameter of 4.30 cm. The inability of 70 t/ha PM to produce carrots with bigger root diameter than all the other treatments may also be a confirmation by the statement made by [15] that excessive nitrogen will cause luxuriant growth at the expense of root development.

The relatively close performance showed by all the treatments may also be an indication that carrot does not need much nutrients to give a meaningful root diameter. This is to the fact that the least performed treatment being the control (no amendment) gave a diameter of 3.02 cm and the best performed treatment being the 40 t/ha PM gave 4.30 cm. The other treatments performed within the 3.02 cm and 4.30 cm limits.

F. Root Weight

Although the treatments applied did not show significant difference (P>0.10) on the root weight, it was observed that the plots treated only with the poultry manure gave the best root weight. The 40 t/ha PM gave the highest root weight of 22.5 g/plant (4.69 t/ha). The treatments, 35 t/ha PM + 0.11 t/ha N.P.K. and 0.23 t/ha N.P.K gave root weights of 18.6 g/plant (3.88 t/ha) and 16.6 g/plant (3.46 t/ha), respectively, which were not as good as that of the 40 t/ha PM treatment.

This attest to an assertion by [20] that vegetables grown with higher doses of organic manure grew better and resulted in a final higher yield than those grown with synthetic manure.

V. Conclusion

The experiment was aiming at achieving the earlier stated objective. The results obtained from the experiment indicated that there was no significant effect at P= 0.10 of the various treatments applied to the plots. The control plot showed the least performance in all growth parameters throughout the experiment. As carrot is grown mostly for its root yield, the study recommends that any of the treatments with the exception of the control can be applied for optimum growth and yield.

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