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Impact of different levels of nitrogen and FYM on soil properties, yield attributes and nutrient uptake by carrot (*Daucus carota* L.) Cv. Deep red.

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Abstract
A field experiment was conducted during rabi season of 2017-18 at the research farm of Soil Science, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad to study the impact of different levels of Nitrogen and FYM on soil properties, yield attributes and nutrient uptake by carrot (*Daucus carota* L.) Cv. Deep red. The experiment was laid out in Randomized Block Design with three replications and nine treatments. The crop was applied with recommended dose of fertilizer *i.e*., N and Farm Yard Manure at three different factors- N (@ 0, 20, 40 kg ha-1), and FYM (@ 0, 5, 10 t ha-1). Each plot size was of 4m². Based on the above research work, it is concluded that application of nitrogen @ 40 kg/ ha (100%) and FYM@ 10 t/ha (100%) *i.e*., the treatment T_8 (100%N_{40} + @10 t ha-1 FYM) followed by nitrogen @ 40 kg/ ha(100%) and FYM @ 5 t/ha (100%) *i.e* T_7 (100%N_{40} + 5 t ha^{-1} FYM) was found more beneficial and significantly improved growth parameters and root yield of Carrot grown under Allahabad Agro-climatic conditions. These findings are based on one year research trial to sustains more work to be needed for the same.

Keywords: *Daucuscarota*, Nitrogen, FYM, yield attributes, soil properties

Introduction
Carrot (*Daucuscarrota L*.) is a winter crop and is one of the important root vegetable crops cultivated throughout the world. Its fleshy edible roots are used as human foods and animal feed.Carrots belong to Umbelliferae family and is one of the major root vegetable use as salad and cooked vegetables, which is the rich source of beta-carotene, having chromosome number 2n=18, a precursor of vitamin A which prevents infection, some forms of cancer and improve vision. They also contain vitamin C, thiamin B and riboflavin B2.

Green carrot leaves are highly nutritive, rich in protein, minerals and vitamins. Consumers choice to eat carrots is often based on perceptions of carrots quality that include organoleptic, sensory and nutritional factors (Rubatzky *et al*. 1999) [17]. In carrot roots, the total sugar content ranges from 3.5 to 10.7% in fresh carrots. Sucrose was the major sugar (representing 56.9% of total sugars), followed by glucose 24.6% and fructose 18.5% (Alasalvar *et al*. 2001).

The edible portion of carrot is an enlarged, modified fleshy tap root of 5-30cm length. As biennial crop, carrot plants complete their growth in first season and produce flowers in second season. Its tap roots attains potential length in 12-24 days after emergence. The root consist of two parts- the outer phloem (cortex) with a thin layer of periderm and the inner layer (core). The quality of carrot roots depends on the ratio of these two parts. The colour intensities is found more in the phloem than the xylem tissues. The ratio of alpha and beta-carotene in carrots root is about 1:2. The principle carotenoids, are responsible for yellow and orange colours, respectively. The carotene increases with the increase in age of the roots and accumulates rapidly at the temperature range of 18-210^{0}C.The tender roots are commonly used for making pickles, soups, stew, pies and preserves. Carrot is also cultivated for sugar production and for making alcohol. The enzyme present in carrot leads to detoxification of chemicals. It is very useful in reducing the risk of lungs, cervix, oesophagus and stomach.

The requirement of additional nitrogen fertilizer varies between 0-110 kg/. Nitrogen application above 110 kg/ha decreases the yield (Bishop, 1973). Large nitrate concentration in soil tends to improve shoot: root ratio.

Above 85-90% of nitrogen is absorbed by carrot during the growth stage of plant; while in the first and last quarter of its growth only 10-15% of nitrogen is absorbed. Split applications of fertilizers, especially nitrogen, improve carrot yield. Increasing nitrogen would increase nitrogen content in carrot roots.

FYM improves soil structures, stimulates soil biological activities and enhance the solubility of phosphorus applied as fertilizer in the soil (Stephenson and Ardakani, 1972) [18]. FYM imparts dark colour of the soil and thereby helps to maintain the temperature of the soil. The composition of FYM is 1.13% N, 1.25%P, 1.30%K, and 2.26% Zn. FYM is a decomposed mixture of cattle dung and urine with straw and litter used as bedding material and residues from the fodder fed to the cattle. FYM helps to improve and conserve the fertility of the soil (Kaack *et al*., 2002; Ashraf *et al*., 2004) [9, 1].

Materials and Methods

The research work comprise of field experiment which was laid out at research farm, Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Science, Allahabad 211007 (U.P) India during the Rabi season November 2017 to Jan 2018, which is situated six km away from Allahabad city on the right bank of Yamuna river, the experimental site is located in the sub–tropical region with 250 57' N latitude, 810 57' E longitude and 98 meter above the mean sea level.

Laboratory experiment was conducted to examine the physical and chemical properties of soil.The climate in this part of the country has been classified as semi-arid with both the extent of temperature during winter and summer. The experiment was laid out in Randomised Block Design (RBD) with three replicates for each treatments. Each plot size was of 4m². The crop was applied with recommended dose of fertilizer i.e., Nitrogen and application of organic manure i.e., Farm Yard Manure has significantly Influenced the growth and yield of carrot. The treatment combinations of inorganic fertilizers are given in Table 1

Table 1: Treatment combination

Treatment	Combinations
T_0	**Control**
T_1	@0% (N_0) + @5 t ha^{-1} FYM
T_2	@ 0% (N_0) + @10 t ha^{-1} FYM
T_3	@ 50% (N_{20}) + @0 t ha^{-1} FYM
T_4	@50% (N_{20}) + @5 t ha^{-1} FYM
T_5	@50% (N_{20}) + @10t ha^{-1} FYM
T_6	@100% (N_{40}) + @0 t ha^{-1} FYM
T_7	@100% (N_{40}) + @5 t ha^{-1} FYM
T_8	@100% (N_{40}) + @10 t ha^{-1} FYM

Table 2: Physical and chemical analysis of soil (pre-sowing)

Particulars	Method	Results
Sand (%)	Bouyoucous Hydrometer (1927)	71.58%
Silt (%)	Bouyoucous Hydrometer (1927)	16.19%
Clay (%)	Bouyoucous Hydrometer (1927)	12.23%
Textural class	Bouyoucous Hydrometer (1927)	Sandy loam
Bulk density(Mg m^{-3})	Muthuval *et al*. (1992)	2.65 Mg m^{-3}
Particle density (Mg m^{-3})	Muthuval *et al*. (1992)	1.14 Mg m^{-3}
Pore space (%)	Muthuval *et al*. (1992)	60 %
pH (1:2)	Digital pH meter (Jackson, 1958)	7.8
EC (dSm^{-1})	EC meter (Wilcox, 1950)	0.42 dSm^{-1}
Organic carbon (%)	Rapid titration method (Walkley and Black's marthod,1947)	0.6%
Available Nitrogen (Kg ha^{-1})	Alkaline potassium permanganate method (Subbiah and Asija, 1956)	212.4 kg ha^{-1}
Available phosphorous (Kg ha^{-1})	Calorimetric method (Olsen *et al*, 1954)	24 kg ha^{-1}
Available potassium (Kg ha^{-1})	Flame photometric method (Toth and Prince, 1949)	214 kg ha^{-1}

Results and Discussion

Response of Nitrogen and FYM on plant growth and yield attributes of carrot

The result in the given Table 3 indicates some of the important growth and yield parameters on carrot crop. At 30 Days after Sowing (DAS), treatment T_8 recorded maximum plant height (14.23cm) followed by treatment T_7 (13.86 cm) whereas, the minimum recorded was 9.83 cm with treatment T_0 (Control).The maximum plant height at 60 DAS recorded in treatment $T_8$was (44.13 cm) followed by $T_5$with (42.13 cm) whereas, the minimum plant height obtained with T_0 (control) was (33.43 cm). At 90 DAS, maximum plant height recorded with treatment $T_8$was (72.32 cm) which was closely followed by (70.32 cm) with treatment T_5whereas, the minimum plant height obtained with T_0 (control) was 61.62 cm. The similar findings are also reported by Malik (1973) [12] and Hipps *et al.* (1978) [8]. At 30 DAS, the maximum number of leaves have been recorded with the treatment$T_8$was 5.44 followed by treatment $T_7$with 4.78 and the minimum recorded was 3.44 with the treatment T_0 (control). At 60 DAS, the maximum number of leaves have been recorded with the treatment $T_8$was 13.11 followed by treatment $T_7$with 11.58 and the minimum recorded was 7.58 with the treatment T_0 (control). At 90 DAS, the maximum no. of leaves have been recorded with the treatment $T_8$was 15.74 followed by treatment $T_7$with 14.28 and the minimum recorded was 9.54 with the treatment T_0 (control). The results are in conformity with the findings of Lingaiah *et al*. (1992) [7]. The maximum root length was (26.36 cm) recorded with treatment T_8 followed by treatment T_7 with (24.98 cm) whereas the minimum recorded was (21.40 cm) with the treatment T_0 (Control). The maximum root diameter recorded was (4.66 mm) in treatment T_8followed by (4.09 mm) in treatment T_7 whereas, the minimum recorded was 2.88 mm with the treatment T_0(Control). The maximum root weight recorded was (86.86 g) in treatment T_4 followed by treatment $T_3$with (83.73 g) and the minimum reported was (65.44 g) in treatment T_0 (Control).The maximum plant dry weight was (36.38 g) obtained with treatment T_8 followed by (32.48 g) with treatment T_7) whereas the minimum was (28.94 g) recorded with treatment T_0 (Control).The maximum plant fresh weight recorded was (268.62 g) in treatment T_8 followed by treatment T_7 with (245.35 g) and the minimum reported was (195.72 g) in treatment T_0 (Control). The maximum root yield

per plot was (11.93 kg) obtained with treatment T_8 followed by (10.60 kg) with treatment T_7whereas the minimum was (4.77 kg) recorded with treatment T_0 (Control).These results are in consonance with the findings of many workers (Pujari *et al*., 1977; Rajgopal *et al*., 1979; Lingaiah *et al*., 1992 and Parthasarathy, 1998) [10, 7].

Response of Nitrogen and FYM on soil physio-chemical properties of carrot

The result in the given Table 4 indicates some of the important physical and chemical parameters of soil. The pH (7.80) was found in T_8 which was followed by (7.60) in T_7 and minimum pH (7.40) was recorded in T_0 (control)which was found significant and Similar findings were also reported by Chaudhary *et al.* (2010) Abdel-Nasser and Hussein (2001)**.**The E.C. (0.70 dSm^{-1}) was found in T_8 which was followed by (0.69dSm^{-1}) in T_7 and minimum E.C. (0.62 dSm^{-1}) was recorded in T_0 (Control) which was found significant and Similar findings were also reported by Chaudhary *et al.* (2010) Abdel-Nasser and Hussein (2001)**.** The maximum Bulk Density (1.26 g cm^{-3}) was found in treatment T_8 which was followed by (1.25 g cm^{-3}) in treatment T_7 and the minimum Bulk Density (1.13 g cm^{-3}) was recorded in T_0 (Control). The maximum Particle Density (2.52 g cm^{-3}) was found in treatment T_8 which was followed by (2.45 g cm^{-3}) in treatment T_7 and the minimum Particle Density (2.22 g cm^{-3}) was recorded in T_0 (Control). Similar findings were also reported by Chaudhary *et al.* (2010). The maximum% Pore Space (55.55%) was recorded in treatment T_8 and minimum % Pore Space (52.93%) was found inT_0 (Control). It may be due to the presence of FYM in optimum amounts improves the bulk density and % water holding capacity of soil. The maximum available % Organic Carbon (0.53%) was recorded to be increased by the application increased levels of FYM in treatment T_8 followed by treatment T_7 with (0.52%) and the minimum (0.42%) was reported in treatment T_0 (Control). The maximum available nitrogen (106.50 kg ha^{-1}) was recorded to be increased by the application of increased levels of nitrogen and FYM in treatment T_8 followed by treatment T_7 (105.50 kg ha^{-1}) and the minimum (100.50 kg ha^{-1}) was reported in treatment T_0 (control). The mean available P kg ha^{-1} of post-harvest soil recorded was found to be T_8 (21.65kg ha^{-1}), T_5 (21.46kg ha^{-1}) and T_0 (13.89 kg ha^{-1}) in 2018. The mean available P kg ha^{-1} of post-harvest were recorded in the order of $T_0<T_5<T_8$ during the experimental trial. The available P kg ha^{-1} of post-harvest soil in T_8 treatment tend to be significantly greater than the remaining treatments. The mean available % Organic carbon of post-harvest soil recorded was found to be T_8 (0.53%), T_7 (0.52%) and T_0 (0.42%) in 2018. The mean available % Organic carbon of post-harvest were recorded in the order of $T_0<T_7<T_8$ during the experimental trial. The available % Organic carbon of post-harvest soil in T_8 treatment tend to be significantly greater than the remaining treatments.

Table 3: Effect of different levels of Nitrogen and FYM on plant growth and yield of Carrot. (90 DAS)

Treatment combination	Plant height (cm)	Number of leaves^{-1}	Root length (cm)	Root diameter (mm)	Root weight (g)	Plant dry weight (g)	Plant fresh weight (g)	Yield kg ha^{-1}	Cost benefit ratio
T_0	61.62	9.54	21.40	3.60	65.54	28.94	195.72	4.77	3.18
T_1	67.72	10.68	22.98	3.22	78.13	29.18	206.79	5.70	3.56
T_2	70.32	11.28	22.71	3.39	79.94	30.11	212.45	7.23	4.25
T_3	69.82	11.74	23.40	3.11	83.73	30.34	218.79	7.87	5.19
T_4	67.86	12.74	23.93	2.88	86.86	30.98	226.22	9.37	5.80
T_5	70.32	13.28	24.24	3.79	75.40	31.58	239.45	9.47	5.52
T_6	68.96	13.48	24.72	3.94	75.46	32.08	231.55	9.10	5.95
T_7	68.96	14.28	24.98	4.09	75.72	32.48	245.35	10.60	6.51
T_8	72.32	15.74	26.36	4.66	88.23	36.38	268.62	11.93	6.90
F-test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	
S.Ed (±)	1.606	0.618	0.257	0.063	1.414	0.778	1.410	0.96	
C.D at 5%	3.316	1.275	0.530	0.130	2.918	1.606	2.911	2.04	

Table 4: Effect of different levels of Nitrogen and FYM on soil physico-chemical properties of Carrot

Treatment Combination	pH	EC (dSm^{-1})	Bulk Density (g cm^{-3})	Particle (g cm^{-3})	Pore space (%)	Organic Carbon (%)	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})
T_0	7.40	0.62	1.13	2.22	52.93	0.42	100.50	13.89	269.30
T_1	7.50	0.65	1.15	2.31	53.00	0.44	102.75	17.40	270.28
T_2	7.40	0.63	1.18	2.31	53.50	0.45	104.25	18.11	271.40
T_3	7.50	0.68	1.20	2.41	52.82	0.47	105.75	19.16	276.01
T_4	7.50	0.65	1.20	2.41	53.55	0.47	102.75	20.20	278.12
T_5	7.40	0.65	1.22	2.43	54.50	0.49	104.25	21.46	290.50
T_6	7.50	0.67	1.22	2.44	50.00	0.50	104.25	19.52	280.50
T_7	7.60	0.69	1.25	2.45	52.94	0.52	105.50	21.33	281.00
T_8	7.80	0.70	1.26	2.52	55.55	0.53	106.50	21.65	308.66
F-test	S	S	S	NS	S	S	S	S	S
S.Ed (±)	0.06	0.006	0.049	0.218	0.561	0.01	1.401	0.622	1.074
C.D. at 5%	0.14	0.013	0.100	0.450	1.157	0.02	2.892	1.283	2.216

Conclusion

It is concluded that application of Nitrogen @ 40 kg/ ha (100%) + FYM @ 10 t/ha (100%) *i.e*., the treatment T_8 (100%N_{40} + @10 t ha-1 FYM) was found more beneficial and significantly improved in growth parameters and root yield of Carrot grown under Allahabad Agro-climatic conditions. The of Bulk density, % pore space, pH and EC at 25° C (d Sm^{-1}), % Organic Carbon, available Nitrogen, Phosphorus and Potassium of soil was found significant whereas Particle density was non- significant at different levels of Nitrogen and FYM. This treatment also showed maximum gross return, net return and benefit: cost ratio *i.e.* (Rs.6.9061) respectively.

These findings are based on one year research trial, to sustain more work to be needed for the same.

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