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Effect of Different Level of Inorganic Fertilizer, FYM, and Neem Cake on Soil Properties and Yield Attributes by Carrot (*Daucus carota* L.)

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A B S T R A C T

An experiment was conducted on "Effect of Different Level of Inorganic Fertilizer, FYM, and Neem Cake on Soil Properties and Yield attributes by Carrot (*Daucus carota* L.)" during Rabi season 2019-20 at the Research farm Department of Soil Science and Agricultural Chemistry, Naini Agriculture Institute, SHUATS, Prayagraj. The design applied was 3x3 randomized block design having three factors with three levels of N P K @ 0, 50, and 100 % ha^{-1}, two levels of FYM @ 50 and 100 % $ha^{-1}$and two levels of neem cake @ 50 and 100 % ha^{-1}respectively. The result obtained with treatment T_9 - 100%(NPK)+5t ha^{-1} FYM+5t ha^{-1} NC that showed the best resulted in a slight increase in soil pH 6.76, Electrical conductivity 0.19dS m^{-1}. In post-harvest soil of N P K fertilizers observations were resulted in significant increase in Organic carbon 0.57 %, Particle density 2.50 Mg m^{-3}, Bulk density 1.23 Mg m^{-3}, Pore space 55.46 %, water holding capacity % 56.62 and available N 321.35 kg ha^{-1}, P 29.45 kg ha^{-1}, K 265.18 kg ha^{-1}, significant increase in case of Nitrogen (kg ha^{-1}), Phosphorus (kg ha^{-1}), Potassium (kg ha^{-1}) was found to be significant among other treatments in carrot cultivation and soil quality improvement. It was also revealed that the application of N P K with FYM and neem cake was excellent source for fertilization than fertilizers.

Introduction

Carrot (*Daucus carota* L.) from Family Apiaceae having chromosome no- 2n=18 is a well-known cool season root crop grown all over India. They are used for human consumption as well as for the forage and particularly for feeding horses (Shweta *et al.*, 2017). 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).

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. India is the second largest producer of vegetables in the world, after China. In India, vegetables are grown in 7.2 m ha with a production of 113.5 MT with productivity 15.9 tha^{-1}.

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).

Carrot is an important vegetable root crops and is ranked third among the succulent vegetables in the world production (Yamaguchi, 1983). It is mainly a temperate crop grown during spring through autumn in temperate countries and during winter in tropical and subtropical countries of the world (Bose and Som, 1990). Carrot grows successfully in Bangladesh during rabi season when temperature ranges from 11.17 to 28.9 0C (Alim, 1974) and mid-November to early December is the best time for its cultivation to get satisfactory yield (Rashid, 1993). In the year 2009-2010, the area under carrot cultivation was 1215 ha and total production of 14000 metric tons in Bangladesh (BBS, 2010). Rashid (1999) mentioned an average yield of 25 tha-1 of carrot. This production is relatively low compared to other carrot producing countries like Israel, Australia, Sweden and Switzerland where the yield are reported to be 58.66, 56.37, 50.56 and 57.60 tha^{-1}, respectively (FAO, 2004). The popularity of organic carrot is increasing day by day in Bangladesh especially among the urban people because of its high nutritive value and possible diversified use in making different palatable foods. Vermicompost which is produced by earthworms is a rich source of macro and micro nutrients, vitamins, growth hormones, and enzymes (Bhavalkar, 1991). Among the neem oil cakes, neem and castor cakes are quick acting though insoluble in water and they provide slow and steady nourishment and protection from nematodes and improve yield and quality of produce (Gaur *et al.*, 1992). Insects controlled by neem products include migratory locust, army worms, whitefly and even head lice. The pathogen controls include Meloidogyne rootknot nematode, rhizoctonia root-rot fungus and rice stunt virus (Anonymous, 1992; Anjorin *et al.*, 2004). Neem products improve soil structure as well as increases water holding capacity

Nitrogen imparts dark green colour required for an accelerated photosynthetic behaviour of plants. It increases growth and development of all living tissues area improves succulence of leaf vegetables. A deficiency of nitrogen cause poor plant yield symptoms appears first in older parts of the plant. The whole plant will start yellowing (chlorosis). If the growth is poor, plant spindly and prone to wilting. Nitrogen imparts dark green colour required for an accelerated of all living tissues and improves succulence of leafy vegetables. It increases utilisation of phosphorus and potash to an appreciable extend. Nitrogen is the key to successful organic matter management. To predict total amount of N needed by a crop, estimates of crop demand, potential indigenous nutrient supply and recovery from applied inorganic and organic sources should be studied. 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).

Materials and Methods

The experiment entitled "Effect of different level of inorganic fertilizer, FYM and Neem cake on soil properties and yield attributes by Carrot (*Doucuscarota* L.)" was conducted during Rabi season of the year 2019-2020 on Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology, Prayagraj. The area is situated on the south of Prayagraj on the right bank of the river Yamuna at Rewa Road at a distance of about 6 Km from Allahabad city. It is positioned at 25.7^0N latitude and 81.5^0E latitude and about 90 m from above sea level.

Prayagraj has subtropical climate, which prevails in the South East part of U.P., with the both extremes of temperature i.e. the winters and the summers. In fairly cold winters (during Oct-Feb), the temperature falls to 4-5^0C. During summer (March-June) the temperature rises up to 45^0C, sometimes 47-48^0C with low relative humidity (20%) and dust laden winds. During monsoon (June-Sept) 85% of average rainfall of 1100mm with fall in temperature 40-45^0C on rainy days. The meteorological data (Dec-2010 to April-2011) with respective to total rainfall, maximum and minimum temperature, relative humidity is presented.

Fertilizers were applied according to recommended doses for carrot, i.e. N_2: P_2O_5: K_2O @ 120: 60: 60 kg ha^{-1}, FYM @ 5 t ha^{-1} and Neem cake @ 5 t ha^{-1}. Nitrogen (N_2) was applied in three equal splits. One third dose of nitrogen, total phosphorus and potash were applied as basal dressing before planting. Remaining dose of N_2 was applied in two splits each at 30 DAS and 60 DAS as top dressing.

The experiment was laid out in Randomized Block Design (Fisher, 1925).comprising of 9 treatments each replicated three times. Treatments were randomly arranged in each replication, divided into nine plots (Table 1).

Results and Discussion

Bulk Density (Mg m^{-3})

The mean value of bulk density (Mg m^{-3}) of soil was found significant of different levels of Inorganic fertilizer, FYM and Neem cake. The result of the data depicted that the maximum bulk density (Mg m^{-3}) of soil at crop harvest of carrot was found in T_1 (Control) was 1.46 followed by T_3 00% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1} NC, T_2 00% (NPK) + 2.5t ha^{-1} FYM + 2.5t ha^{-1} NC,and minimum values of the bulk density (Mg m^{-3}) result was found in $T_9$100% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1} NC was (1.23) (Fig. 1 and 2)

Particle density (Mg m^{-3})

The mean value of particle density (Mg m^{-3})of soil was found significant of different levels of Inorganic fertilizer, FYM and Neem cake. The result of the data depicted that the maximum particle density (Mg m^{-3}) of soil at crop harvest of carrot was found in T_1 (Control) was 2.67 followed by T_2 00% (NPK) + 2.5t ha^{-1} FYM+2.5t ha^{-1} NC,T_6 50% (NPK) + 5t ha^{-1} FYM+5t ha^{-1} NC,and minimum values of the particle density (Mg m^{-3}) result was found in T_9 100% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1} NC was (1.50) (Table 2).

Table.1 Treatment details

Treatments No.	Treatments Symbols
T_1	Control
T_2	00%(NPK)+2.5t ha^{-1} FYM+2.5t ha^{-1} NC
T_3	00%(NPK)+5t ha^{-1} FYM+5t ha^{-1} NC
T_4	50%(NPK)+00t ha^{-1}FYM+00 t ha^{-1} NC
T_5	50%(NPK)+2.5 t ha^{-1} FYM+2.5 t ha^{-1} NC
T_6	50% (NPK)+5t ha^{-1} FYM+5t ha^{-1} NC
T_7	100% (NPK)+00t ha^{-1} FYM+00t ha^{-1} NC
T_8	100(NPK)+2.5t ha^{-1} FYM+2.5t ha^{-1} NC
T_9	100%(NPK)+5t ha^{-1} FYM+5t ha^{-1} NC

Table.2 Physical analysis of pre harvesting soil

Particulars	Method employed	Results
Bulk density (Mg m^{-3})	Muthuval*et al.*, 1992	1.23
Particle density(Mg m^{-3})	Muthuval*et al.*, 1992	2.32
Pore Space (%)	Muthuval*et al.*, 1992	46.98
Water holding capacity (%)	Muthuval*et al.*, 1992	43.50

Table.3 Chemical analysis of soil

Particulars	Method employed	Results
Soil pH (1:2)	Glass electrode, pH meter (Jackson, 1958)	7.18
Soil EC (dS m^{-1})	EC meter (Digital Conductivity Meter) (Wilcox, 1950)	0.32
Organic Carbon (%)	(Walkley and Black method 1947)	0.60
Available Nitrogen (kg ha^{-1})	Alkaline potassium permanganate method (Subbaih and Asija (1956)	245.26
Available Phosphorus (kg ha^{-1})	Colorimetric method (Olsen *et al.*, 1954)	22.05
Available Potassium (kg ha^{-1})	Flame photometric method (Toth and Prince, 1949)	140.62

Table.4 Effect of different level of inorganic fertilizer, FYM, and Neem Cake on physical properties after crop of soil by carrot (*Daucus carota* L.)

Treatments No.	Bulk density (Mg m^{-3})	Particle density (Mg m^{-3})	Pore Space (%)	Water holding capacity (%)
T_1	1.46	2.67	46.13	52.18
T_2	1.36	2.61	48.18	53.31
T_3	1.37	2.57	49.28	54.24
T_4	1.36	2.58	50.48	55.42
T_5	1.24	2.57	50.68	55.49
T_6	1.29	2.61	51.15	56.20
T_7	1.32	2.54	52.22	56.52
T_8	1.27	2.51	54.15	56.48
T_9	1.23	2.50	55.46	56.62
F-Test	S	S	S	S
C.D. at 0.5%	0.081	0.102	0.340	0.340
S.Ed. (±)	0.038	0.048	0.160	0.160

Table.5 Effect of different level of inorganic fertilizer, FYM, and neem cake on physical properties after crop of soil by carrot (*Daucus carota* L.)

Treatments No.	pH	EC	Organic carbon (%)	Available nitrogen (kg ha^{-1})	Available phosphorus (kg ha^{-1})	Available potassium (kg ha^{-1})
T_1	7.53	0.28	0.45	203.51	20.92	193.49
T_2	7.40	0.26	0.46	264.26	21.65	231.97
T_3	7.16	0.25	0.46	248.88	22.91	257.41
T_4	7.25	0.24	0.48	247.98	23.96	218.52
T_5	7.20	0.23	0.50	268.87	24.71	229.64
T_6	7.25	0.23	0.51	308.87	24.31	232.22
T_7	7.05	0.22	0.53	315.62	25.44	244.19
T_8	6.82	0.22	0.55	318.21	27.15	247.22
T_9	6.76	0.19	0.57	321.35	29.45	265.18
F-Test	S	S	S	S	S	S
C.D. at0.5%	0.212	0.113	0.03	9.392	1.42	4.065
S.Ed. (±)	0.100	0.053	0.01	4.430	0.66	1.917

Fig.1 Effect of different level of inorganic fertilizer, FYM, and neem cake on physical properties after crop of soil by carrot (*Daucus carota* L.)

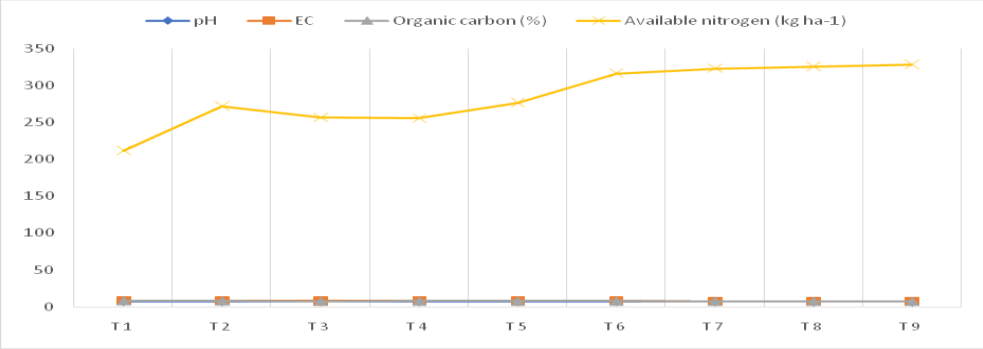
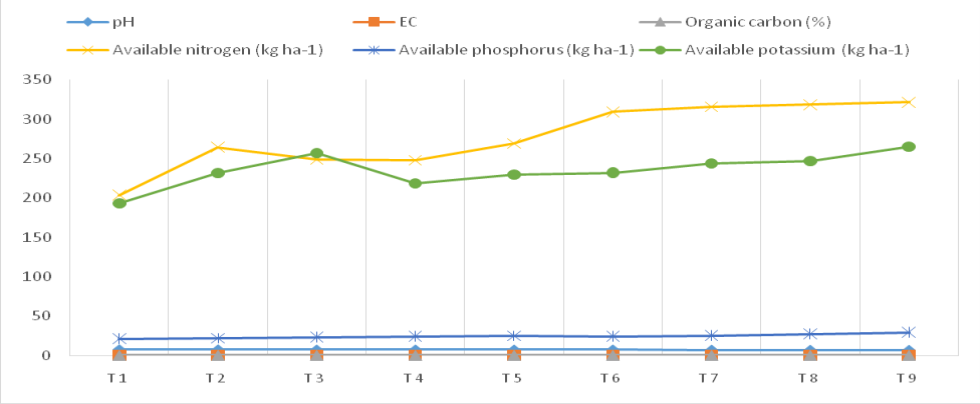


Fig.2 Effect of different level of inorganic fertilizer, FYM, and neem cake on physical properties after crop of soil by carrot (*Daucus carota* L.)



Pore space (%)

The mean value of pore space (%) of soil was found significant of different levels of Inorganic fertilizer, FYM and Neem cake. The result of the data depicted that the maximum pore space (%) of soil at crop harvest of carrot was found in $T_9$100% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1} NC was 55.46 followed by T_8 100 (NPK) + 2.5t ha^{-1} FYM + 2.5t ha^{-1} NC,T_7 100% (NPK) + 00t ha^{-1} FYM + 00t ha^{-1} NC and T_6 50% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1} NC and minimum values of the pore space (%) result was found in T_1(Control) was (46.13).

Water holding capacity (%)

The mean value of water holding capacity (%) of soil was found significant of different levels of Inorganic fertilizer, FYM and Neem cake. The result of the data depicted that the maximum water holding capacity (%) of soil at crop harvest of carrot was found in $T_9$100% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1} NC was 56.62 followed by T_8 100 (NPK) + 2.5t ha^{-1} FYM + 2.5t ha^{-1} NC,T_6 50% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1} NC and T_7 100% (NPK) + 00t ha^{-1} FYM + 00t ha^{-1} NC and minimum values of the water holding capacity (%) result was found in T_1 (Control) was (52.18).

Soil pH

The mean value of pH of soil was found significant of different levels of Inorganic fertilizer, FYM and Neem cake. The result of the data depicted that the maximum pH of soil at crop harvest of carrot was found in T_1(Control) was 7.53 followed by T_2:00% (NPK) + 2.5t ha^{-1} FYM + 2.5t ha^{-1} NC, T_4:50% (NPK) + 00t ha^{-1}FYM + 00 t ha^{-1} NC, and T_5: 50% (NPK) + 2.5 t ha^{-1} FYM+2.5 t ha^{-1} NC and minimum values of the pH result was found in T_9 100% (NPK) + 5t ha^{-1} FYM+5t ha^{-1} NC was (6.76). May be due to increase in levels of inorganic fertilizer and FYM fertilizer, similar observation was found by (Everaarts and Booi, 2000) (Table 3).

Soil EC (dS m^{-1})

The mean value of EC of soil was found significant of different levels of Inorganic fertilizer, FYM and Neem cake. The result of the data depicted that the maximum EC (dS m^{-1})of soil at crop harvest of carrot was found in T_1 (Control) was 0.28 followed by T_2 00% (NPK) + 2.5t ha^{-1} FYM + 2.5t ha^{-1} NC,T_3 00% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1} NC and T_4 50% (NPK) + 00t ha^{-1} FYM + 00 t ha^{-1} NC and minimum values of the EC result was found in $T_9$100% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1} NC was (0.19).The treatments as regarded both for pH and EC of the soil were found significant statistically for both the years of experimentation results were same reported by (Tadesse *et al.,* 2013) and (Hemalata *et al.,* 2013).

Organic carbon (%)

The mean value of (%) Organic carbon of soil was found significant of different levels of Inorganic fertilizer, FYM and Neem cake. The result of the data depicted that the maximum Organic carbon(%) of soil at crop harvest of carrot was found in $T_9$100% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1} NC was (0.57) followed by T_5 50% (NPK) + 2.5 t ha^{-1} FYM + 2.5 t ha^{-1} NC, T_7 100% (NPK) + 00t ha^{-1} FYM + 00t ha^{-1} NC and $T_8$100 (NPK) + 2.5t ha^{-1} FYM + 2.5t ha^{-1} NC and minimum values of the Organic carbon(%)result was found inT_1Control was (0.45) (Table 4 and 5).

Available nitrogen (kg ha^{-1})

The mean value of Available nitrogen (kg ha^{-1}) of soil was found significant of different levels of Inorganic fertilizer, FYM and Neem cake. The result of the data

depicted that the maximum Available nitrogen (kg ha^{-1}) of soil at crop harvest of carrot was found in T_9 100% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1} NC was (321.35 kg ha^{-1}) followed byT_8 100(NPK) + 2.5t ha^{-1} FYM + 2.5t ha^{-1} NC,T_7 100% (NPK) + 00t ha^{-1} FYM + 00t ha^{-1} NC, and T_3 00% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1} NC and minimum values of the Available nitrogen (kg ha^{-1}) result was found inT_1Control was (203.51 kg ha^{-1}). (Tadesse *et al.,* 2013) and (Hemalata *et al.,* 2013) also reported the similar findings.

Available Phosphorus (kg ha^{-1})

The mean value of Available potassium (kg ha^{-1}) of soil was found significant of different levels of Inorganic fertilizer, FYM and Neem cake. The result of the data depicted that the maximum Available potassium (kg ha^{-1}) of soil at crop harvest of carrot was found in$T_9$100% (NPK) +5t ha^{-1} FYM + 5t ha^{-1} NC was (29.45 kg ha^{-1}) followed by T_8 100 (NPK) + 2.5t ha^{-1} FYM + 2.5t ha^{-1} NC, T_7 100% (NPK) + 00t ha^{-1} FYM + 00t ha^{-1} NC and T_6 50% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1} NC,and minimum values of the Available potassium (kg ha^{-1}) result was found inT_1Control was (20.96 kg ha^{-1}). Corroborative findings also were reported by (Tadesse *et al.,* 2013) and (Hemalata *et al.,* 2013).

Available Potassium (kg ha^{-1})

The mean value of Available potassium (kg ha^{-1}) of soil was found significant of different levels of Inorganic fertilizer, FYM and Neem cake. The result of the data depicted that the maximum Available potassium (kg ha^{-1}) of soil at crop harvest of carrot was found in T_9 100% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1} NC was (193.49 kg ha^{-1}) followed byT_8 100 (NPK) + 2.5t ha^{-1} FYM + 2.5t ha^{-1} NC, T_7 100% (NPK) + 00t ha^{-1} FYM + 00t ha^{-1} NC, and T_3 00% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1} NC and minimum values of the Available potassium (kg ha^{-1}) result was found in T_1 Control was (265.18kg ha^{-1}). (Singh 2007) and (Hemalata *et al.,* 2013) have been reported the similar results.

In conclusion the treatment combination T_9 100% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1} was appropriate for Carrot on Prayagraj. Physical-chemical properties of soil were also improved significantly in same treatment combination of T_9 100% (NPK) + 5t ha^{-1} FYM + 5t ha^{-1}.

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