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Response of Different Combination Levels of NPK and FYM on Physicochemical Properties of Inceptisol Soil at Prayagraj District, Uttar Pradesh, India under Cultivation of Carrot (*Daucus carota*)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

An experiment was conducted to investigate the Response of different combination level of NPK and FYM on physicochemical properties of Inceptisol soil at Prayagraj district, Uttar Pradesh, India under cultivation of carrot (*Daucus carota*). during the Rabi season of 2022-2023 at the Research

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Farm of the Department of Soil Science and Agricultural Chemistry, NAI, SHUATS, Prayagraj. The experimental having two factors with three levels of NPK at 0%, 50% and 100% ha^{-1}, and three levels of FYM at 0%, 50% and 100% ha^{-1} which was layout in randomized block design (RBD). The results showed that the physicochemical properties of soil were significantly affected with the application of FYM in conjunction with NPK fertilizers. This was evident through a significant increase in organic carbon percentage, per cent pore space, and higher levels of available nitrogen, phosphorus, and potassium in the soil. Additionally, the combination of NPK and FYM led to a decrease in bulk density, particle density, and pH of soil. In conclusion, the experiment demonstrated that the combination of NPK and FYM positively influenced the soil health under carrot cultivation.

Keywords: FYM; NPK; carrot; soil properties; soil health.

1. INTRODUCTION

Soil is a dynamic non-renewable natural resource that is vital to life. There are connections between soil and land use, water flow, water quality, and vegetation productivity have an important relation with soil. The ability of the soil to supply all of the necessary plant nutrients in readily available forms and in an appropriate balance is referred to as soil fertility, whereas soil productivity is the outcome of a number of factors. The nutrients and physical characteristics can have a direct impact on yields in cultivated fields Bindu et al. [1].

Soil plays an important role in carrot production by providing nutrients, water and physical support for growth. To grow healthy and straight carrots, it is important to provide the right soil conditions. Loose soil helps the roots to grow straight down without obstruction, while clumps or hard clayey chunks can cause deformities [2,3]. Carrots require soil that is rich in Nitrogen potassium and phosphorus to encourage healthy root growth. Soil fertility management *via.* organic and inorganic fertilizers can improve fertility and increase Carrot yield. The ideal pH level for carrots is between 6 to 6.8. However, carrots can grow well in pH level anywhere between 5.5 to 7.5 Srinivas and Swaroop [4].

Carrot *(Daucus carota)*, is a member of the family Apiaceae and important root vegetable crops of the world. It is grown in spring, summer and autumn in temperate countries and during winter in tropical and subtropical countries [5,6]. It is mainly a cold requiring crop but it can also be grown at a relatively higher temperature without much difficulty. In India it is grown during winter when the temperature ranges from 11.17 to 28.9°C. Risk of growing carrot is also much less due to fewer problems of diseases and insects' pests Appiah et al. [7].

Fertilizer plays a crucial role in carrot cultivation as it affects growth and yield attributes. Nitrogen increases vegetative growth and promotes carbohydrate synthesis, while phosphorus stimulates root diameter and increases growth rate. Potassium is important for root development and the manufacture of sugar and starch [8-11]. Improper doses of N, P, and K can negatively impact growth and yield, and excessive nitrogen can cause root splitting and reduce marketable yield. Proper application of manure and fertilizers, especially NPK, can increase crop yield Verma et al. [12].

The use of organic manures such as FYM, vermicompost, and poultry manure has gained prominence in recent years as they can improve crop productivity and maintain soil fertility. FYM is a valuable organic amendment for soil improvement in agriculture. When applied to soil, FYM enriches it with organic matter, enhancing soil structure, water holding capacity, and nutrient retention. The slow release of nutrients from FYM supplies plants with essential elements over time, while also improving nutrient availability in the soil. FYM acts as a pH buffer, regulating soil pH and creating optimal conditions for plant growth. Additionally, it enhances water retention, drainage, and infiltration, making it beneficial in water-scarce and waterlogged conditions. FYM promotes the growth of beneficial microorganisms, contributing to nutrient cycling, organic matter decomposition, maintaining the ideal C:N ratio and disease suppression. Its positive impacts on soil quality and plant productivity have been widely recognized, leading to increased soil fertility, higher crop yields, and reduced reliance on synthetic inputs Bhattarai et al. [13].

Considering the importance of soil fertility and the role of NPK and FYM in carrot cultivation, this experiment was conducted to investigate the effects of different levels of NPK and FYM on the physicochemical properties of soil under carrot crop cultivation. The study aimed to evaluate the changes in organic carbon percentage, pore space, pH, bulk density, particle density, and the availability of nitrogen, phosphorus, and potassium in the soil. The results would provide valuable insights into the combined influence of NPK and FYM on soil health and optimize the management practices for carrot cultivation.

2. MATERIALS AND METHODS

The field experiment was conducted at Research Farm of Soil Science and Agricultural Chemistry at Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj which is situated at $25^0 24' 23''$ N latitude, $81^0 50' 38''$ Longitude and at the altitude of 98 meter above the sea level.

The fieldwork was done in the Prayagraj district, which is part of the subtropical belt and has semi-arid climatic conditions with both winter and summer temperature extremes. “The maximum temperature of the location reaches up to 46˚-48˚C and seldom falls as 4˚-5˚C. The relative humidity ranges between 20% to 94%. The average annual rainfall in Prayagraj is around 900-1100 mm annually. The minimum temperature during the crop season was to be 6.9˚C and the maximum is to be 28.57˚C. The maximum humidity was to be 89% and minimum was to be 93.28%”. The present research investigation was setup in randomized block design (RBD) with nine treatment combinations, which are replicated three times and randomly allocated in each replication, dividing the research site into twenty- seven plots. In this study, NPK and FYM was applied in three different doses. Sowing of the Carrot crop was carried out on the 19th Nov, 2022, by hand. The seed variety Nantes was sown at a rate of 4 kg ha^{-1} and at a row-to-row spacing of 25 cm and plant-to-plant spacing of 5 cm. The recommended doses of NPK were applied @60:80:70 kg ha^{-1}. The graded level of NPK were applied through Urea, Single super phosphate and Murate of potash. Half dose of nitrogen and full dose of phosphorus and potassium were applied basally at the time of sowing. In addition to these applications, FYM was used as a basal dose at 0, 10, and 20 t ha^{-1} for the treatment.

The soils from each plot were separately collected, air-dried, ground, and passed through a 2-mm-size sieve for laboratory analysis. Soil samples were analyzed for bulk density, particle density, Percentage pore space, and water holding capacity, pH, EC, Percentage Organic Carbon, Available Nitrogen, Available Phosphorus and Available Potassium before sowing and after harvesting of the crop. Findings of the Soil analysis before sowing of the crops at depth of 0-15 and 15-30 cm are bulk density (1.32 and 1.35 Mg m^{-3}), particle density (2.52 and 2.53 Mg m^{-3}), pore space (43.79 and 41.54%), water holding capacity (40.19 and 39.27 %), pH (7.24 ad 7.26) EC (0.29 and 0.27 dS m^{-1}), organic carbon (0.35 and 0.34 %), available nitrogen (224.84 and 221.25 kg ha^{-1}), available Phosphorus (21.51 and 18.41kg ha^{-1}) and available potassium (188.39 and 185.82kg ha^{-1}).

Table 1. Treatment Combinations

Treatment	Treatment combination	Symbol
T_1	(Absolute control)	$NPK_0\ FYM_0$
T_2	NPK @ 0 % + FYM @ 50 %	$NPK_0\ FYM_{50}$
T_3	NPK @ 0 % + FYM @ 100 %	$NPK_0\ FYM_{100}$
T_4	NPK @ 50 % + FYM @ 0 %	$NPK_{50}\ FYM_0$
T_5	NPK @ 50 % + FYM @ 50 %	$NPK_{50}\ FYM_{50}$
T_6	NPK @ 50 % + FYM @ 100 %	$NPK_{50}\ FYM_{100}$
T_7	NPK @ 100 % + FYM @ 0 %	$NPK_{100}\ FYM_0$
T_8	NPK @ 100 % + FYM @ 50 %	$NPK_{100}\ FYM_{50}$
T_9	NPK @ 100 % + FYM @ 100 %	$NPK_{100}\ FYM_{100}$

3. RESULTS AND DISCUSSION

Table 2. Response of different combination levels of NPK and FYM on bulk density (BD), particle density PD, pore space (PS), and water holding capacity (WHC) of soil

Treatments	BD (Mg m^{-3})		PD (Mg m^{-3})		PS (%)		WHC (%)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
NPK_0 FYM_0	**1.32**	**1.35**	2.52	2.53	43.79	41.54	40.19	39.27
NPK_0 FYM_{50}	1.29	1.31	2.47	2.52	45.29	43.92	42.10	40.7
NPK_0 FYM_{100}	1.26	1.28	2.44	2.48	46.45	44.93	43.09	41.87
NPK_{50} FYM_0	1.31	1.33	2.51	2.54	44.43	42.84	41.28	40.02
NPK_{50} FYM_{50}	1.28	1.30	2.46	2.50	45.56	44.55	42.27	41.03
NPK_{50} FYM_{100}	1.26	1.28	2.43	2.46	47.16	45.76	44.01	42.74
NPK_{100} FYM_0	1.30	1.32	2.50	2.52	44.80	43.41	41.77	40.54
NPK_{100} FYM_{50}	1.27	1.29	2.45	2.50	46.12	44.52	42.76	41.49
NPK_{100} FYM_{100}	1.25	1.27	**2.42**	**2.44**	**47.70**	**46.52**	**44.49**	**43.08**
F- Test	S	S	S	S	S	S	S	S
S. Em (±)	0.004	0.005	0.004	0.006	0.094	0.27	0.195	0.235
CD at (5%)	0.011	0.014	0.013	0.018	0.285	0.816	0.59	0.711

Table 3. Response of different combination levels of NPK and FYM on pH, electrical conductivity (EC) and organic carbon (OC) of soil

Treatments	pH		EC (dSm^{-1})		OC (%)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
NPK_0 FYM_0	7.24	7.26	0.29	0.27	0.35	0.34
NPK_0 FYM_{50}	7.19	7.25	0.32	0.30	0.44	0.42
NPK_0 FYM_{100}	7.03	7.08	0.34	0.32	0.52	0.50
NPK_{50} FYM_0	7.22	7.25	0.31	0.28	0.38	0.37
NPK_{50} FYM_{50}	7.17	7.18	0.32	0.31	0.46	0.44
NPK_{50} FYM_{100}	6.98	7.01	0.35	0.32	0.52	0.51
NPK_{100} FYM_0	7.2	7.23	0.30	0.30	0.41	0.40
NPK_{100} FYM_{50}	7.13	7.15	0.33	0.30	0.48	0.46
NPK_{100} FYM_{100}	6.95	6.98	**0.36**	**0.33**	**0.54**	**0.52**
F- Test	S	S	S	S	S	S
S. Em (±)	0.01	0.016	0.004	0.004	0.005	0.006
CD at (5%)	0.031	0.049	0.011	0.013	0.014	0.017

Table 4. Response of different combination levels of NPK and FYM on Available Nitrogen (N), Phosphorus (P) and Potassium (K) of soil

Treatments	N (kg ha^{-1})		P (kg ha^{-1})		K (kg ha^{-1})	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
NPK_0 FYM_0	224.84	221.25	21.51	18.41	188.39	185.82
NPK_0 FYM_{50}	228.54	225.35	22.68	19.62	192.28	188.46
NPK_0 FYM_{100}	234.42	229.20	23.56	20.23	194.52	192.09
NPK_{50} FYM_0	239.35	235.78	24.47	21.85	197.25	195.32
NPK_{50} FYM_{50}	243.62	240.85	24.93	23.03	200.66	198.24
NPK_{50} FYM_{100}	246.81	243.21	25.48	23.67	203.59	201.95
NPK_{100} FYM_0	252.12	249.35	26.01	24.50	206.54	204.12
NPK_{100} FYM_{50}	256.93	252.97	26.64	25.18	209.32	206.35
NPK_{100} FYM_{100}	**258.46**	**257.58**	**27.18**	**25.40**	**211.39**	**208.94**
F- Test	S	S	S	S	S	S
S. Em (±)	0.531	0.419	0.163	0.186	0.577	0.513
CD at (5%)	1.605	1.268	0.494	0.562	1.744	1.55

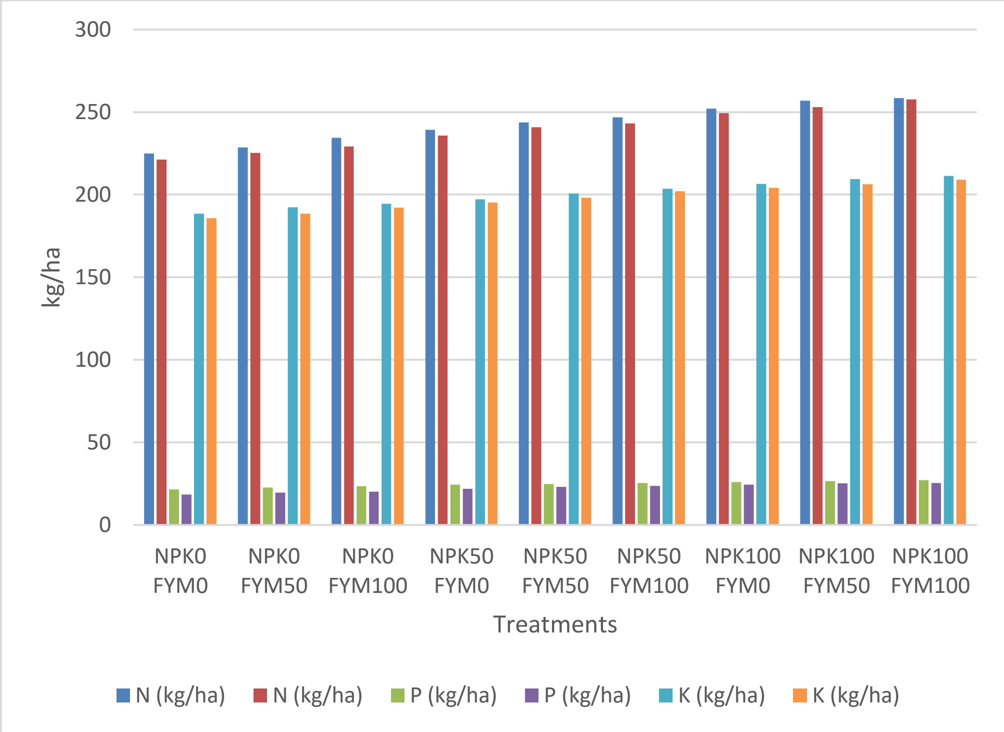

Fig. 1. Response of different combination levels of NPK and FYM on Available Nitrogen (kg ha^{-1}), Phosphorus (kg ha^{-1}), and Potassium (kg ha^{-1}) of soil

3.1 Physical and Chemical Analysis of Soil

The findings revealed that treatment T_9 (NPK_{100} FYM_{100}) exhibited the highest values for various physiochemical properties, including pore space (%), water holding capacity (%), EC (dS m^{-1}), organic carbon (%), available nitrogen (kg ha^{-1}), available Phosphorus (kg ha^{-1}) and available potassium (kg ha^{-1}). Conversely, bulk density (Mg m^{-3}), particle density (Mg m^{-3}) and pH demonstrated their highest readings in T_1 (NPK_0 FYM_0).

4. CONCLUSION

The results of experiment concluded as the application of NPK and FYM was found to improve soil health references to carrot. Treatment T_9 ($NPK_{100}FYM_{100}$) was found optimal for improving soil properties like Pore space, Water holding capacity, organic carbon, pH, Electrical conductivity and Available Nitrogen, Phosphorus, Potassium of soil

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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