



Soil Parameters of Carrot (*Daucus carota* L.) under Treatment with Inorganic Fertilizers and Vermicompost

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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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ABSTRACT

The objective of study to show the effect of inorganic fertilizers sources with vermicompost on soil parameters of carrot. For this experiment, a randomized block design was implemented, featuring three levels for both NPK (0%, 50% and 100%) and Vermicompost (0%, 50%, and 100%). The treatments were replicated three times and allocated random of each replication. The result shows that significant in pore space (%), water holding capacity, organic carbon and available NPK in depth wise findings. Treatment T9 [NPK @ 100% + Vermicompost @ 100%] has shown best in all parameters of soil compared to T1 [(control) NPK @ 0% + Vermicompost @ 0%]. Application of NPK and Vermicompost increased growth, yield of carrot and improved also physical and chemical properties of soil.

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1. INTRODUCTION

“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 t ha⁻¹. Carrot is most popular amongst the root crops, because it is a rich and the cheapest source of carotene, a precursor of vitamin A (28129 I.U.). It is also rich in iron, thiamine, riboflavin, ascorbic acid and niacin. The carrot roots contain sucrose several times higher than glucose or fructose. South western Asia, especially Afghanistan, is considered the primary Centre of carrot origin since the greatest morphological diversity is found here in this region” [1]. “Carrot (*Daucus carota* L.) contains carotene, thiamine, and riboflavin in addition to energetic value and some therapeutic functions [2] as it enhances resistance against blood, eye [2] and other human diseases” [3]. “Carrot production can be a beneficial enterprise for small-scale, resource-poor farmers because it is a short duration crop and higher yields can be obtained per unit area” [4]. “Being rich in alpha and Beta-carotene, it has special values as food. The carrot roots are rich in sucrose, having at least 10 times higher than glucose and fructose. The highest score for sweet taste is obtained in carrots grown at the lowest temperature, while bitter taste, terpenes and sugar how increasing values with increasing growth temperature” [5].

1.1 Role of NPK and Vermicompost

“Fertilizer and organic manure play an important role in increasing production, improving quality of vegetable and sustaining soil fertility. Organic manure contains all nutrients which are required for healthy growth of crop and help to improve

physical, chemical and biological properties of soil” [6]. “Nitrogen, Phosphorus and Potassium are among the common major nutrients, which are essential for the growth and development part of plant parts such as chlorophyll, amino acid, proteins and pigments. Nitrogen, Phosphorus and Potash influence vegetative and reproductive phase of crops” [7].

“Use of vermicompost has been advocated in integrated nutrient management (INM) system in vegetable crops. Vermicompost helps in reducing ratio, increased humic acid content, cation exchange capacity and water-soluble carbohydrate. It also contains biological active substance such as plant growth regulators. Vermicompost is a source of micro and macro nutrients and acts as a chelating agent. Vermicompost is greatly humified through the fragmentation of parent organic materials by earthworms and colonization by microorganisms” [8].

2. METHODOLOGY

A field experiment conducted at the central research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, during the Rabi season 2022 growing carrot *Var. Pusa Vasuda* applied 3 levels of NPK and Vermicompost respectively 0%, 50% and 100% including RDF for carrot = 100:60:50 kg ha⁻¹ experiment is lead to observe the physical and chemical parameters. Physical characteristics such as bulk density, particle density, pore space, and water holding capacity were measured using the method and procedure developed by Muthuvel et al. in [9] using a 100 ml graduated measuring cylinder.

Table 1. Detailed treatment combination of inorganic fertilizers with organic fertilizers

Treatment	Treatments Combinations
T1	N: P: K @ 0 % + Vermicompost @ 0%
T2	N: P: K @ 0 % + Vermicompost @ 50%
T3	N: P: K @ 0 % + Vermicompost @ 100%
T4	N: P: K @ 50 % + Vermicompost @ 0%
T5	N: P: K @ 50 % + Vermicompost @ 50%
T6	N: P: K @ 50 % + Vermicompost @ 100%
T7	N: P: K @ 100 % + Vermicompost @ 0%
T8	N: P: K @ 100 % + Vermicompost @ 50%
T9	N: P: K @ 100 % + Vermicompost @ 100%

By using a digital pH metre, Jackson, M. L. [10]'s method for measuring soil pH, Wilcox, 1950's method for measuring soil EC (dSm^{-1}), and other methods for measuring chemical parameters, [11] provided a wet oxidation method for determining organic carbon (%). Nitrogen available (kg ha^{-1}) [12] Kjeldhal Method Phosphorus available (kg ha^{-1})- The colorimetric approach described by Olsen et al. [13] utilising a Jasper single beam ultraviolet spectrophotometer at a wavelength of 660 nm; Kg ha^{-1} of available potassium- The Flame Photometer technique described by Toth and Prince [14].

3. RESULTS AND DISCUSSION

3.1 Physical Properties of Soil

3.1.1 Bulk density (Mg m^{-3})

The data presented in Table 2 variation in bulk density (Mg m^{-3}) of soil after crop harvest as influenced by NPK and Vermicompost. The response in bulk density of soil was found non-significant due to levels of NPK and Vermicompost. The maximum bulk density of soil 1.23 Mg m^{-3} and 1.27 Mg m^{-3} at 0-15 cm and 15-30 cm was recorded in treatment T_1 (NPK @ 0% + Vermicompost @ 0%) and minimum 1.12 Mg m^{-3} and 1.15 Mg m^{-3} at 0-15 cm and 15-30 cm was recorded in treatment T_9 (NPK @ 100% + Vermicompost @ 100 %) respectively. Similar result has been recorded by Singh et al. [15]; Kunj et al. [16]; Ali et al. [17] and Kumar et al. [18].

3.1.2 Particle density (Mg m^{-3})

The data presented in Table 2 variation in particle density Mg m^{-3} of soil after crop harvest as influenced by NPK and Vermicompost. The response in particle density of soil was found non-significant due to levels of NPK and Vermicompost. The maximum particle density of soil 2.54 Mg m^{-3} and 2.56 Mg m^{-3} at 0-15 cm and 15-30 cm was recorded in treatment T_9 (NPK @ 100% + Vermicompost @ 100%) and minimum 2.36 Mg m^{-3} and 2.40 Mg m^{-3} at 0-15 cm and 15-30 cm was recorded in treatment T_1 (NPK @ 0% + Vermicompost @ 0%) respectively. Similar result has been recorded by Singh et al. [15]; Kunj et al. [16]; Kumar et al. [18] and Ali et al. [17].

3.2 Percent Pore Space

The data presented in Table 2 variation in percent pore space of soil after crop harvest as

influenced by NPK and Vermicompost. The response in percent pore space of soil was found to be significant due to levels of NPK and Vermicompost. The maximum pore space of soil 48.74% and 45.38% at 0-15 cm and 15-30 cm was recorded in treatment T_9 (NPK @ 100% + Vermicompost @ 100%) and minimum 42.26% and 40.45% at 0-15 cm and 15-30 cm was recorded in treatment T_1 (NPK @ 0% + Vermicompost @ 0%) respectively. Similar result has been recorded by Kumar et al. [19]; Hailu et al. [20]; Sarma et al. [21] and Mehedi et al. [22].

3.3 Water Holding Capacity (%)

The data presented in Table 2 variation in water holding capacity % of soil after crop harvest as influenced by NPK and Vermicompost. The response in water holding capacity % of soil was found to be significant due to levels of NPK and Vermicompost. The maximum water holding capacity of soil 46.70% and 42.85% at 0-15 cm and 15-30 cm was recorded in treatment T_9 (NPK @ 100% + Vermicompost @ 100%) and minimum 34.53% and 31.40% at 0-15 cm and 15-30 cm was recorded in treatment T_1 (NPK @ 0% + Vermicompost @ 0%) respectively. Similar result has been recorded by Kumar et al. [19]; Hailu et al. [20]; Sarma et al. [21] and Mehedi et al. [22].

3.4 Chemical Properties of Soil

3.4.1 Soil pH (1:2.5) w/v

The data presented in Table 3 variation in pH of soil after crop harvest as influenced by NPK and Vermicompost. The response pH of soil was found non-significant due to levels of NPK and Vermicompost. The maximum pH of soil 7.20 and 7.25 at 0-15 cm and 15-30 cm was recorded in treatment T_1 (NPK @ 0% + Vermicompost @ 0%) and minimum 6.75 and 6.82 at 0-15 cm and 15-30 cm was recorded in treatment T_9 (NPK @ 100% + Vermicompost @ 100%) respectively. Similar result has been recorded by Kumar et al. [19] and Mehedi et al. [22].

3.5 Soil Electrical Conductivity

The data presented in Table 3 variation in electrical conductivity (dSm^{-1}) of soil after crop harvest as influenced by NPK and Vermicompost. The response EC of soil was found non-significant due to levels of NPK and Vermicompost. The maximum EC of soil 0.48 dSm^{-1} and 0.55 dSm^{-1} at 0-15 cm and 15-30 cm

Table 2. Variation in Bulk density (Mg m^{-3}), Particle density (Mg m^{-3}), Pore space (%) and Water holding capacity (%) of soil after crop harvest as influenced by Inorganic Fertilizers with Vermicompost

Treatment	Bulk density (Mg m^{-3})		Particle density (Mg m^{-3})		Pore space (%)		Water holding capacity (%)	
	0 – 15 cm	15 – 30 cm	0 – 15 cm	15 – 30 cm	0 – 15 cm	15 – 30 cm	0 – 15 cm	15 – 30 cm
T₁ NPK @ 0 % + Vermicompost @ 0 %	1.23	1.27	2.36	2.40	42.26	40.45	34.53	31.40
T₂ NPK @ 0 % + Vermicompost @ 50 %	1.22	1.25	2.38	2.44	42.85	40.80	35.92	32.82
T₃ NPK @ 0 % + Vermicompost @ 100 %	1.20	1.24	2.40	2.46	43.62	41.13	37.08	33.10
T₄ NPK @ 50 % + Vermicompost @ 0 %	1.21	1.22	2.39	2.42	44.37	41.60	37.45	34.62
T₅ NPK @ 50 % + Vermicompost @ 50 %	1.19	1.21	2.43	2.45	45.20	42.76	38.27	35.82
T₆ NPK @ 50 % + Vermicompost @ 100 %	1.17	1.19	2.47	2.49	46.41	43.52	40.74	37.58
T₇ NPK @ 100 % + Vermicompost @ 0 %	1.18	1.22	2.44	2.47	46.60	43.92	41.26	38.42
T₈ NPK @ 100 % + Vermicompost @ 50 %	1.15	1.18	2.50	2.53	47.28	44.32	43.82	40.23
T₉ NPK @ 100 % + Vermicompost @ 100 %	1.12	1.15	2.54	2.56	48.74	45.38	46.70	42.85
F-Test	NS	NS	NS	NS	S	S	S	S
S.Ed. (\pm)	-	-	-	-	0.78	0.56	0.55	0.46
C.D. at 0.5%	-	-	-	-	1.60	1.15	1.12	0.94

Table 3. Variation in pH (w/v), electrical conductivity (dS m⁻¹), organic carbon (%), available nitrogen (kg ha⁻¹), available phosphorus (kg ha⁻¹) and available potassium (kg ha⁻¹) of soil after crop harvest as influenced by NPK and Vermicompost

Treatment	Soil pH (1:2.5) w/v		Electrical Conductivity (dSm ⁻¹)		Organic Carbon (%)		Available Nitrogen (kg ha ⁻¹)		Available Phosphorus (kg ha ⁻¹)		Available Potassium (kg ha ⁻¹)	
	0 – 15 cm	15 – 30 cm	0 – 15 cm	15 – 30 cm	0 – 15 cm	15 – 30 cm	0 – 15 cm	15 – 30 cm	0 – 15 cm	15 – 30 cm	0 – 15 cm	15 – 30 cm
T ₁ NPK @ 0 % + Vermicompost @ 0 %	7.20	7.25	0.35	0.38	0.37	0.30	292.35	285.23	17.40	14.36	178.32	174.25
T ₂ NPK @ 0 % + Vermicompost @ 50 %	7.17	7.22	0.37	0.41	0.38	0.33	293.58	285.89	18.63	14.85	179.14	176.42
T ₃ NPK @ 0 % + Vermicompost @ 100 %	7.12	7.18	0.40	0.44	0.40	0.35	293.82	287.15	20.07	16.05	181.85	177.46
T ₄ NPK @ 50 % + Vermicompost @ 0 %	7.15	7.20	0.38	0.42	0.38	0.32	295.27	290.58	21.48	17.62	180.18	179.02
T ₅ NPK @ 50 % + Vermicompost @ 50 %	7.10	7.15	0.41	0.45	0.39	0.36	297.86	294.70	22.74	19.27	184.65	182.80
T ₆ NPK @ 50 % + Vermicompost @ 100 %	6.98	7.07	0.44	0.49	0.41	0.38	300.04	296.37	24.86	22.58	187.82	185.56
T ₇ NPK @ 100 % + Vermicompost @ 0 %	6.90	7.02	0.43	0.46	0.40	0.37	306.26	299.64	25.05	23.22	190.21	188.25
T ₈ NPK @ 100 % + Vermicompost @ 50 %	6.84	6.95	0.45	0.50	0.42	0.40	311.15	305.82	28.70	26.55	195.05	191.74
T ₉ NPK @ 100 % + Vermicompost @ 100 %	6.75	6.82	0.48	0.55	0.45	0.41	318.42	310.06	30.02	27.78	198.24	195.62
F-Test	NS	NS	NS	NS	NS	NS	S	S	S	S	S	S
S.Ed. (±)	-	-	-	-	-	-	2.21	1.80	0.80	0.65	1.25	1.05
C.D. at 0.5%	-	-	-	-	-	-	4.45	3.62	1.65	1.34	2.55	2.14

was recorded in treatment T₉ (NPK @ 100% + Vermicompost @ 100%) and minimum 0.35 dSm⁻¹ and 0.38 dSm⁻¹ at 0-15 cm and 15-30 cm was recorded in treatment T₁ (NPK @ 0% + Vermicompost @ 0%) respectively. Similar result has been recorded by Kumar et al. [19]; Hailu et al. [20] and Sarma et al. [21].

3.6 Organic Carbon (%)

The data presented in Table 3 variation in organic carbon (%) of soil after crop harvest as influenced by NPK and Vermicompost. The response of OC of soil was found non-significant due to levels of NPK and Vermicompost. The maximum OC of soil 0.45% and 0.41% at 0-15 cm and 15-30 cm was recorded in treatment T₉ (NPK @ 100% + Vermicompost @ 100%) and minimum 0.37% and 0.30% at 0-15 cm and 15-30 cm was recorded in treatment T₁ (NPK @ 0% + Vermicompost @ 0%) respectively. Similar result has been recorded by Hailu et al. [20] and Sarma et al. [21].

3.7 Available Nitrogen (kg ha⁻¹)

The data presented in Table 3 variation in available nitrogen (kg ha⁻¹) of soil after crop harvest as influenced by NPK and Vermicompost. The response of available nitrogen of soil was found significant due to levels of NPK and Vermicompost. The maximum available nitrogen of soil 318.42 kg ha⁻¹ and 310.06 kg ha⁻¹ at 0-15 cm and 15-30 cm was recorded in treatment T₉ (NPK @ 100% + Vermicompost @ 100%) and minimum 292.35 kg ha⁻¹ and 285.23 kg ha⁻¹ at 0-15 cm and 15-30 cm was recorded in treatment T₁ (NPK @ 0% + Vermicompost @ 0%) respectively. Similar result has been recorded by Anjaiah et al. [23]; Devendra et al. [24]; Kumar et al. [25] and Zakir et al. [26].

3.8 Available Phosphorus (kg ha⁻¹)

The data presented in Table 3 variation in available phosphorus (kg ha⁻¹) of soil after crop harvest as influenced by NPK and Vermicompost. The response of available phosphorus of soil was found significant due to levels of NPK and Vermicompost. The maximum available phosphorus of soil 30.02 kg ha⁻¹ and 27.78 kg ha⁻¹ at 0-15 cm and 15-30 cm was recorded in treatment T₉ (NPK @ 100% + Vermicompost @ 100%) and minimum 17.40 kg ha⁻¹ and 14.36 kg ha⁻¹ at 0-15 cm and 15-30 cm was recorded in treatment T₁ (NPK @ 0% +

Vermicompost @ 0%) respectively. Similar result has been recorded by Anjaiah et al. [23]; Devendra et al. [24]; Kumar et al. [25] and Zakir et al. [26].

3.9 Available Potassium (kg ha⁻¹)

The data presented in Table 3 variation in available potassium (kg ha⁻¹) of soil after crop harvest as influenced by NPK and Vermicompost. The response of available potassium of soil was found significant due to levels of NPK and Vermicompost. The maximum available potassium of soil 198.24 kg ha⁻¹ and 195.62 kg ha⁻¹ at 0-15 cm and 15-30 cm was recorded in treatment T₉ (NPK @ 100% + Vermicompost @ 100%) and minimum 178.32 kg ha⁻¹ and 174.25 kg ha⁻¹ at 0-15 cm and 15-30 cm was recorded in treatment T₁ (NPK @ 0% + Vermicompost @ 0%) respectively. Similar result has been recorded by Anjaiah et al. [23]; Devendra et al. [24]; Kumar et al. [25] and Zakir et al. [26,27-30].

4. CONCLUSION

The experiment's results showed that the different concentrations of inorganic fertilisers from NPK sources produced the best results in treatment T₉ (NPK @ 100% + Vermicompost @ 100%), which was followed by treatment T₈. In treatment T₉, the soil health parameters kept the appropriate soil attributes. Therefore, for increased farm revenue and sustainable agriculture, it might be advised that farmers receive the finest combination Treatment (T₉).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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