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

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 1OO%) and Vermicompost (0 %, 50 %, and ,1OO %). 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 toT1 [(control) NPK @ 0% + Vermicompost @ 0 %]. Application of NPK and Vermicompost increased growth, yield of carrot and improved also physical and chemical properties of soil.

Key words: *Carrot, Physico-chemical Properties, NPK and Vermicompost*

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" (Nihad and Jessy, 2010). "Carrot (*Daucus carota* L.) contains carotene, thiamine, and riboflavinin addition to energetic value and some therapeutic functions (Pant and Manandhar, 2007) as it enhances resistance against blood, eye (Pant and Manandhar, 2007) and other human diseases" (Appiah *et al.*, 2015). "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" (Ahmad *et al.*, 2005). "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”. (Kurrey *et al*., 2018).

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”. (Ola *et al*., 2018). “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”. (Adeleye *et al*., 2010).

“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”. (Singh *et al*., 2013).

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 1992 using a 100 ml graduated measuring cylinder.

By using a digital pH metre, Jackson, M. L. 1958's method for measuring soil pH, Wilcox, 1950's method for measuring soil EC (dSm-1), and other methods for measuring chemical parameters, (Walkley and Black, 1947) provided a wet oxidation method for determining organic carbon (%). Nitrogen available (kg ha^{-1}) (Subbiah and Asija, 1956) Kjeldhal Method Phosphorus available (kg ha-1)- The colorimetric approach described by Olsen et al. (1954) 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 (1949).

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 %

Result and Discussion

Physical Properties of Soil

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.*, 2020; Kunj *et al.*, 2018; Ali *et al.*, 2016 and Kumar *et al.*, 2014.

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*., 2020; Kunj *et al.,* 2018; Kumar *et al*., 2014 and Ali *et al.,* 2016.

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*., 2017; Hailu *et al*., 2016; Sarma *et al*., 2015 and Mehedi *et al*., 2012.

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*., 2017; Hailu *et al.,* 2016; Sarma *et al.,* 2015 and Mehedi *et al*., 2012.

Chemical Properties of Soil

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.*, 2017 and Mehedi *et al*., 2012.

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 was recorded in treatment T_9 (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 T_1 (NPK @ 0% + Vermicompost @ 0 %) respectively. Similar result has been recorded by Kumar *et al.*, 2017; Hailu *et al.*, 2016 and Sarma *et al.*, 2015.

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 T_9 (NPK @ 100% + Vermicompost @ 100 %) and minimum 0.37 % and 0.30 % 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 Hailu *et al.*, 2016 and Sarma *et al.*, 2015.

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 T_9 (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 T_1 (NPK @ 0% + Vermicompost @ 0 %) respectively. Similar result has been recorded by Anjaiah *et al.*, 2019; Devendra *et al.*, 2018; Kumar *et al.*, 2012 and Zakir *et al.*, 2012.

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 T_9 (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 T_1 (NPK @ 0% + Vermicompost @ 0 %) respectively. Similar result has been recorded by Anjaiah *et al.*, 2019; Devendra *et al.*, 2018; Kumar *et al.*, 2012 and Zakir *et al.*, 2012.

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 T_9 (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 T_1 (NPK @ 0% + Vermicompost @ 0 %) respectively. Similar result has been recorded by Anjaiah *et al.*, 2019; Devendra *et al.*, 2018; Kumar *et al.*, 2012 and Zakir *et al.*, 2012.

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
T_1	NPK @ 0 % + Vermicompost @ 0 %	1.23	1.27	2.36	2.40	42.26	40.45	34.53	31.40
T_2	NPK @ 0 % + Vermicompost @ 50 %	1.22	1.25	2.38	2.44	42.85	40.80	35.92	32.82
T_3	NPK @ 0 % + Vermicompost @ 100 %	1.20	1.24	2.40	2.46	43.62	41.13	37.08	33.10
T_4	NPK @ 50 % + Vermicompost @ 0 %	1.21	1.22	2.39	2.42	44.37	41.60	37.45	34.62
T_5	NPK @ 50 % + Vermicompost @ 50 %	1.19	1.21	2.43	2.45	45.20	42.76	38.27	35.82
T_6	NPK @ 50 % + Vermicompost @ 100 %	1.17	1.19	2.47	2.49	46.41	43.52	40.74	37.58
T_7	NPK @ 100 % + Vermicompost @ 0 %	1.18	1.22	2.44	2.47	46.60	43.92	41.26	38.42
T_8	NPK @ 100 % + Vermicompost @ 50 %	1.15	1.18	2.50	2.53	47.28	44.32	43.82	40.23
T_9	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. (±)	-	-	-	-	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

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).

Reference

Adeleye, K., Habyarimana, J. and Gatsinzi, A. (2010) Nutritional quality of carrot (*Daucus carota* L.) as influenced by farm yard manure. *African Journal of Agricultural Economics and Rural Development* 4:322-27.

Ahmed, A., Sambo, B.E., Arunah, U.L. and Odion, E.C. (2005) Response of frmyard mnure and Inorganic Fertilizers for Sustainable Growth of Carrot (*Daucus carota* L.) in Northern Nigeria. *Journal of Agriculture and Veterinary Science*, 18-25.

Ali, Abu S. M. Y., Solaiman, Abul H. M., Saha, Krisna C., (2016) Influence of Organic Nutrient Sources and Neem (Azadirachta) Products on Growth and Yield of Carrot. *International Journal of Crop Science and Technology*, 2(1): 19-25.

Anjaiah, T., Padmaja, G. and Raju, A.S. (2019) Influence of levels of K and FYM on yield and K-uptake by carrot (*Daucus carota* L.) grown on an alfisols. *Journal of Research Sciences*, 33(3): 82-86.

Appiah, K., Kwakye, P.K., Osei, B.A. and Frimpong, K.A. (2015) The effect of organic soil amendment on root-knot nematodes, soil nutrients and growth of carrot. *Journal of Agronomy*, 5(4): 642-646.

Bouyoucos, G.L, (1927) The hydrometer as a new method for the mechanical analysis of soils.*Soil Sci*. 23: 343-353.

Devendra, D.P., Sanjay, K., Sutanu, M. and Kumar, P.V. (2018) Studies on integrated nutrient management on growth, yield and quality of carrot (*Daucus carota* L.). *International Journal of Agriculture Sciences* 8:2187-88.

Fisher, R. A. and Yates (1960) *Statistical method for research worker Oliver and Boyd Ltd*. Edin. burgh and London.10.

Hailu, S., Seyoum, T. and Dechassa, N. (2016) Effect of combined application of organic- P and inorganic-N fertilizers on yield of carrot. *African Journal of Biotechnology*, 7(1): 27-34.

Jackson, M. L. (1958) Soil chemical analysis Prentice Hall of India Ltd. New Delhi. 219-221.

Kumar, G.S., Tiwari, R. and Venkatasubbaiah, Y.P. (2017) Root Yield and Nutrient Uptake of Carrot (*Daucus carota* L.) as Influenced by the Application of Different Organic Manures. *Int. J. Pure App. Biosci*., 5(5): 131-138.

Kumar, P., Meghwal, P. R. and Painuli, D. K. (2014) Effect of organic and inorganic nutrient sources on soil health and quality of carrot. *Indian J. Hort*., 71(2): 222-226.

Kumar, S., Sutanu, M., Kumar, S. and Singh, H. D. (2012) Efficacy of organic manures on growth and yield of carrot. *International Journal of Plant Sciences*. 9: 57-60.

Kunj, B. M., Alam, M. S., Singh, H., Bhat, M. A., Singh, A. K., Mishra, A. K. and Thomas, T. (2018) Influence of farmyard manure and fertilizers on soil properties and yield and nutrient uptake of wheat. *International Journal of Chemical Studies*; 6(3): 386-39.

Kurrey, D. K., Sharma, R., Lahre, M. K. and Kurrey, R. L. (2018) Effect of Azotobacter on physio-chemical characteristics of soil in Carrot. *The Pharma Innovation Journal*; 7(2): 108-113.

Mehedi, T. A., Siddique, M. A. and Sonia, B. S. (2012) Effects of Urea and Cow dung on growth and yield of Carrot. *Bangladesh Agricultural Research Institute*, 10(1): 9- 13.

Munsell, A. H. (1971) Munsell's description of his colour system, from a lecture to the American Psychological Association. *American Journal of Psychology* 23(2): 236-244.

Muthuvel, P., Udayasoorian, C., Natesan, R. and Ramaswamy, P. P. (1992) Introduction to Soil Analysis, *Tamil Nadu Agricultural University Coimbatore*-641002.

Nihad, K. and Jessykutty, P. C. (2010) Long term effect of organic manures and microbial inoculants on nutrient uptake and yield. *Journal of Medicinal and Aromatic Plant Sciences.* 32(3): 257-261.

Ola, R., David, A.A., Singh, P. and Baloda, S.S. (2018) Response of different levels of NPK and FYM on growth and yield of carrot. *International Journal of Chemical*

Studies; **6**(5): 1098-1101.

Olsen, S. R., Cole, C. V., Watanabe, F. S. and Dean, L. A. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate (NaHCO3), *U.S.D.A. Circular*. 939: 1-19.

Pant, B. and Manandhar, S. (2007) In vitro propagation of carrot (*Daucus carota* L.*)*. *Scientific World*, 5 (5).

Sarma, A., Sharma, R.P., Sonia, S. and Sharma, J.J., (2015) Influence of integrated use of nitrogen, phosphorus, potassium and FYM on the yield attributing traits and marketable yield of carrot (*Daucus carota* L.) under the high hill's dry temperate conditions of North- Western Himalayas. *Indian Journal of Agricultural Sciences*, 73(9): 500-503.

Singh, S., Mishra, A. and Greene, A. (2020) Assessment of Growth, Yield and Quality of Carrot (*Daucus carota* L.) var. Pusa Kesar under Integrated Nutrient Management. *Int. J. Curr. Microbiol. App. Sci., 9*(7): 1086-1093.

Singh, S.N., Rai, J.P., Singh, S.R., Goyal, S.K. and Singh, S.P. (2013) Effect of integrated use of organic manures and fertilizers on yield, nutrient uptake and soil fertility in onion on red soils of Vindhyan region. *Vegetable Science* 41:150-54.

Subbiah, B. V. and Asiija, E. C. (1956) A rapid procedure for estimation of available nitrogen in soil. *Current Science* 25(8): 259-260.

Toth, S. J. and Prince, A. L. (1949) Estimation of cation exchange capacity and exchangeable Ca, K and Na content of soil by flame photometer technique. *Soil Sci.*, 67: 439-445.

Walkley, A. and Black, I. A., (1947) Estimation of soil organic carbon by the chromic acid titration method. *Soil Science*. 47: 29-38.

Wilcox, L.V. (1950) Electrical conductivity. Am. Water Works Assoc. *J*. 42: 775-776.

Zakir H. M., Sultana M. N. and Saha K. C. (2012) Influence of cmmercially Available oganic vs inorganic fertilizers on Growth Yield and Quality of Carrot. *J. Environ. Sci. & Natural Resources*, 5(1): 39 – 45.