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Effect of Different Level of Organic and Inorganic Fertilizer on Nutritional Status of Inceptisol and Growth Attributes of Radish

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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

An experiment was conducted during *Rabi* season (December 2021 – March 2022) on central research farm of Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The experiment was laid out in randomized block design with three levels of NPK 0% 50% and 100% and three levels of vermicompost 0% 50% and 100%. The result shows that application of different levels combination of NPK and vermicompost increased growth, yield of radish and improved soil physical and chemical properties. It was recorded from the application of NPK and Vermicompost in treatment T_9 [NPK @ 100% + Vermicompost @ 100%] shows maximum bulk

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density 1.232 Mg m^{-3} and 1.240 Mg m^{-3}, particle density 2.401 Mg m^{-3} and 2.406 Mg m^{-3}, percent pore space 47.64% and 42.47%, water holding capacity 50.24% and 45.76%, pH 7.25 and 7.32, EC 0.56 dS m^{-1} and 0.68 dS m^{-1}, organic carbon 0.48% and 0.45%, available nitrogen 318.42 kg ha^{-1} and 310.06 kg ha^{-1}, available phosphorus 28.02 kg ha^{-1} and 25.78 kg ha^{-1}, available potassium 197.24 kg ha^{-1} and 193.62 kg ha^{-1} at 0-15 cm and 15-30 cm respectively in all treatments.

Keywords: Radish; NPK; vermicompost; physico-chemical properties of soil etc.

1. INTRODUCTION

Radish (*Raphanus sativus* L.) is an important winter season -short duration (70-80) vegetable used as root vegetable. It is a member of the Brassicaceae family native place Southeast Asia. It is a popular root crop grown all over the world, in India, in some places it can be grown throughout the year. It is grown for its young fleshy tuberous roots consumed mainly as salted vegetable, eaten as a grated salad. It is annual and beneficial crop. It is cool season crop which is popular in both tropical and temperate region. The fleshy edible portion of the roots develops from primary roots. The best quality roots are produced at temperature between 10 to 15.5^{0}C [1].

Nitrogen is an important nutrient for all crops. It increases yield nutrition also increases protein content [27-29]. Deficient plants may have stunted growth and develop yellow- green colour. It accelerates photosynthetic behaviour of green plants as well as growth and development of living tissues specially tiller count in cereals [13-16].

The supply of phosphorus and potassium to radish crops is necessary especially at the flowering and pod setting stages [24-26]. Large quantities of Phosphorus are found in seed and fruit and it is considered essential for seed formation. It enhances activity of rhizobia and increased the formation of root nodules. Thus, it helps in fixing more of atmosphere nitrogen in root nodules [2,17-21].

Potassium is one of the seventeen elements which are essential for growth and development of plants. Potassium is required for improving the yield and quality of different crops because of its effect on photosynthesis, water use efficiency and plant tolerance to diseases, drought and cold as well for making the balance between protein and carbohydrates [22,23]

2. MATERIALS AND METHODS

A field experiment conducted at the Soil Science Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, during the *Rabi* season of (December 2021 – March 2022) growing field radish *var Pusa Rashmi* applied 3 levels of NPK and Biochar respectively NPK and Biochar (0%, 50% and 100%) experiment is lead to observe the physical and chemical parameters. In physical parameters like that bulk density, particle density, pore space and water holding capacity through method by 100 ml graduated measuringcylinder and process by Muthuvel et al. [3].

In chemical parameters through method by-

a) Soil pH – method given by (Jackson, M. L. 1958) through using digital pH meter.
b) Soil EC (dSm^{-1}) - method given by (Wilcox, 1950) through using digital EC meter.
c) Organic Carbon (%) - Wet oxidation method given by (Walkley and Black, 1947)
d) Available Nitrogen (kg ha^{-1}) - Kjeldhal Method (Subbiah and Asija, 1956)
e) Available Phosphorus (kg ha^{-1}) - Colorimetric method by using Jasper single beam U.V. Spectrophotometer at 660 nm wavelength given by Olsen et al. [4]
f) Available Potassium (kg ha^{-1}) - Flame photometric method by using Metzer Flame Photometer given by Toth and Prince [5]

3. RESULTS AND DISCUSSION

3.1 Physical Properties of Soil

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

The response bulk density of soil was found to be non-significant in levels of organic and inorganic fertilizer. The maximum bulk density of soil 1.232 Mg m^{-3} and 1.240 Mg m^{-3} at 0-15 cm and 15-30 cm was recorded in treatment T_1 (NPK @ 0% + Vermicompost @ 0%) and minimum 1.202 Mg m-3 and 1.207 Mg m^{-3} at 0-15 cm and 15-30 cm was recorded in treatment

T9 (NPK @ 100% + Vermicompost @ 100%) respectively. Similar result has been recorded by Bajshya *et al.,* 2013; Jilani et al. [6] and Gangwar et al. 2009.

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

The maximum particle density of soil 2.401 Mg m^{-3} and 2.406 Mg m^{-3} at 0-15 cm and 15-30 cm was recorded in treatment T_1 (NPK @ 0% + Vermicompost @ 0%) and minimum 2.362 Mg m^{-3} and 2.367 Mg m^{-3} at 0-15 cm and 15-30 cm was recorded in treatment T9 (NPK @ 100% + Vermicompost @ 100%) respectively. Similar result has been recorded by Bajshya *et al.,* 2013; Jilani et al., [6] and Gangwar et al. 2009.

3.1.3 Pore space (%)

The response pore space of soil was found to be significant in levels of NPK and biochar. The maximum pore space of soil 47.64% and 42.47% at 0-15 cm and 15-30 cm was recorded in treatment T9 (NPK @ 100% + Vermicompost @ 100%) and minimum 40.52% and 38.27% at 0-15 cm and 15-30 cm was recorded in treatment T1 NPK @ 0% + Vermicompost @ 0%) respectively. Similar result has been recorded by Khatri et al. [7], Lakra et al. 2017, Jadhav et al. 2014 and Islam et al. 2010.

3.1.4 Water holding capacity (%)

The response water holding capacity of soil was found to be significant in levels of organic and inorganic fertilizers. The maximum water holding capacity of soil 50.24% and 45.76% at 0-15 cm and 15-30 cm was recorded in treatment T9 (NPK @ 100% + Vermicompost @ 100%) and minimum 37.56% and 34.45% at 0-15 cm and 15-30 cm was recorded in treatment T1(NPK @ 0% + Vermicompost @ 0%) respectively. Similar result has been recorded by Khatri et al. [7], Lakra et al. 2017; Jadhav et al. 2014 and Islam et al. 2010.

3.2 Chemical Properties of Soil Soil pH (1:2.5) w/v

The response pH of soil was found to be non-significant in levels of organic and inorganic fertilizer.The maximum pH of soil 7.25 and 7.32 at 0-15 cm and 15-30 cm was recorded in treatment T_1 (NPK @ 0% + Vermicompost @ 0%) and minimum 6.92 and 7.02 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 Mani et al. [8]; Yumnam et al. 2017 and Kumar et al. 2013.

3.2.1 Soil EC (dS m^{-1})

The response EC of soil was found to be non-significant in levels of organic and inorganic fertilizer. The maximum EC of soil 0.56 dSm^{-1} and 0.68 dSm^{-1} at 0-15 cm and 15-30 cm was recorded in treatment T_9 (NPK @ 100% + Vermicompost @ 100%) and minimum 0.38dSm^{-1} and 0.42 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 Mani et al., [8] Yumnam et al., 2017 and Kumar et al. 2013.

3.2.2 Organic carbon (%)

The response organic carbon of soil was found to be non-significant in levels of organic and inorganic fertilizer. The maximum OC of soil 0.48% and 0.45% at 0-15 cm and 15-30 cm was recorded in treatment T_9 (NPK @ 100% + Vermicompost @ 100%) and minimum 0.36% and 0.33% at 0-15 cm and 15-30 cm was recorded in treatment T_1 (NPK @ 0% + Vermicompost @ 0%) . Similar result has been recorded by Mani et al., [8] Yumnam et al. 2017 and Kumar et al. 2013.

3.2.3 Available nitrogen (kg ha^{-1})

The response available nitrogen of soil was found to be significant in levels of organic and inorganic fertilizer. 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%) andminimum 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 Yadav *et al.,* 2018; Kumari *et al.,* 2017 and Sentiyangla et al. [8].

3.2.4 Available phosphorus (kg ha^{-1})

The response available phosphorus of soil was found to be significant in levels of organic and inorganic fertilizer. The maximum available phosphorus of soil 28.02 kg ha^{-1} and 25.78 kg ha^{-1} at 0-15 cm and 15-30 cm was recorded in treatment T9 (NPK @ 100% + Vermicompost @ 100%) Minimum 16.40 kg ha^{-1} and 13.36 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 Yadav et al., 2018; Kumari et al., 2017 and Sentiyangla et al. [9].

3.2.5 Available potassium (kg ha^{-1})

The response available potassium of soil was found to be significant in levels of organic and inorganic fertilizer The maximum available potassium of soil 197.24 kg ha^{-1} and 193.62 kg ha^{-1} at 0-15 cmand 15-30 cm was recorded in treatment T9 (NPK @ 100% + Vermicompost @ 100%)and minimum 180.32 kg ha^{-1} and 172.25 kg ha^{-1} at 0-15 cm and 15-30 cm was recordedin treatment T1 (NPK @ 0% + Vermicompost @ 0%) respectively.Similar result has been recorded by Warade et al., 2004; El-Desuki et al., [10], Parwaiz et al. [11] and Jaisankar, P. [12].

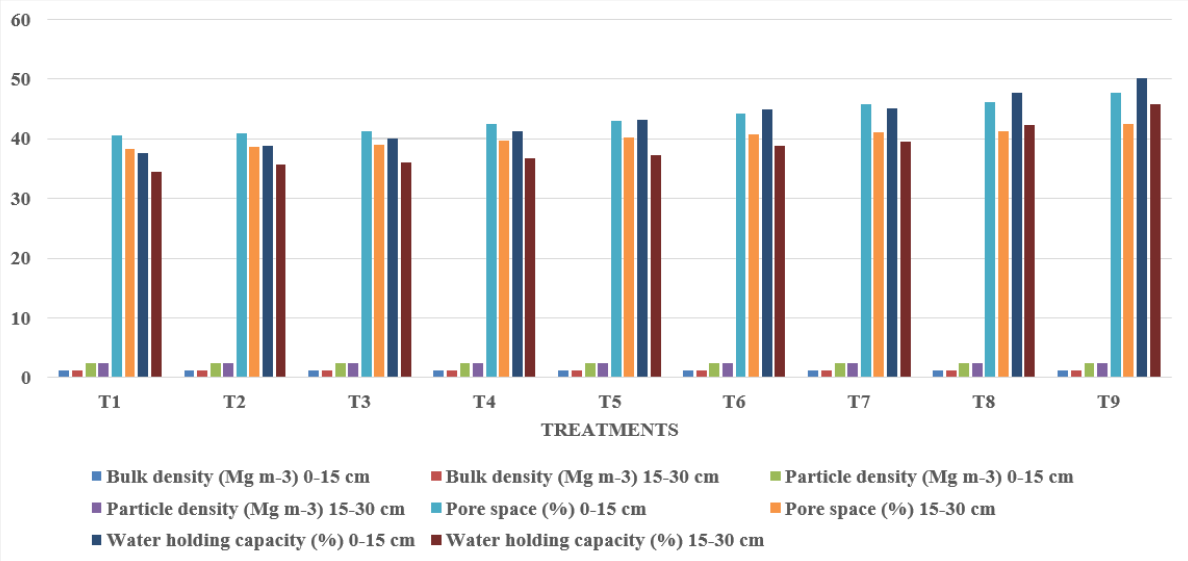

Fig. 1. Effect of different levels of NPK and Vermicompost on bulk density (Mg m^{-3}), particle density (Mg m^{-3}), pore space (%) and water holding capacity (%) of soil after crop harvest

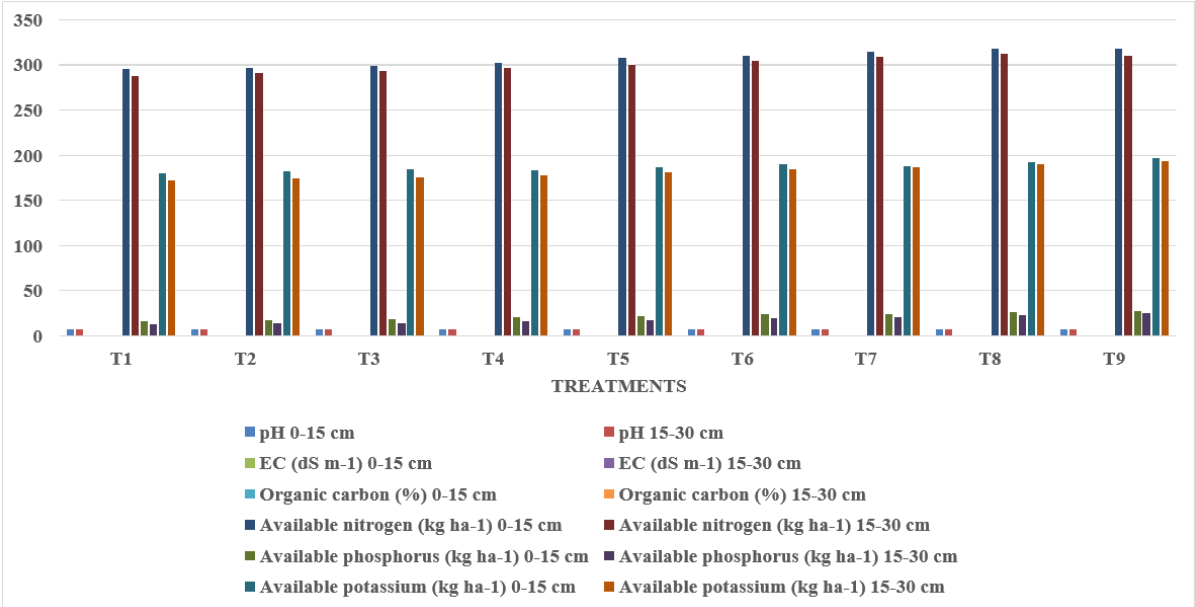

Fig. 2. Effect of different levels of NPK and Vermicompost on pH (1:2.5) w/v, EC (dSm^{-1}), organic carbon (%), available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}) and available potassium (kg ha^{-1}) of soil after crop harvest

Table 1. Effect of different levels of NPK and Vermicompost on bulk density (Mg m-3), particle density (Mg m-3), pore space (%) and water holding capacity (%) of soil after crop harvest

Treatments		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 %	1.232	1.240	2.362	2.367	40.52	38.27	37.56	34.45
T2	NPK @ 0% + Vermicompost @ 50%	1.229	1.237	2.368	2.371	40.95	38.62	38.90	35.76
T3	NPK @ 0% + Vermicompost @ 100%	1.225	1.232	2.372	2.376	41.28	39.03	40.06	36.12
T4	NPK @ 50% + Vermicompost @ 0%	1.220	1.229	2.375	2.379	42.45	39.66	41.35	36.69
T5	NPK @ 50% + Vermicompost @ 50%	1.216	1.226	2.380	2.384	43.03	40.14	43.28	37.32
T6	NPK @ 50% + Vermicompost @ 100%	1.211	1.220	2.386	2.388	44.32	40.72	44.85	38.78
T7	NPK @ 100% + Vermicompost @ 0%	1.208	1.215	2.389	2.393	45.80	41.05	45.19	39.55
T8	NPK @ 100% + Vermicompost @ 50%	1.205	1.211	2.394	2.398	46.15	41.22	47.72	42.34
T9	NPK @ 100% + Vermicompost @ 100%	1.202	1.207	2.401	2.406	47.64	42.47	50.24	45.76
	F-Test	NS	NS	NS	NS	S	S	S	S
	S.Ed. (±)	-	-	-	-	0.72	0.51	0.48	0.42
	C.D. at 0.5%	-	-	-	-	1.46	1.02	0.98	0.86

Table 2. Effect of different levels of NPK and Vermicompost on pH (1:2.5) w/v, EC (dSm^{-1}), organic carbon (%), available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}) and available potassium (kg ha^{-1}) of soil after crop harvest

Treatments		Soil pH (1:2.5) w/v		EC (dS m^{-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
T1	NPK @ 0% + Vermicompost @ 0%	7.25	7.32	0.38	0.42	0.36	0.33	295.35	288.23	16.40	13.36	180.32	172.25
T2	NPK @ 0% + Vermicompost @ 50%	7.22	7.30	0.40	0.46	0.37	0.35	297.58	290.89	17.63	13.85	182.14	174.42
T3	NPK @ 0% + Vermicompost @ 100%	7.20	7.27	0.41	0.49	0.39	0.37	299.82	293.15	19.07	14.05	184.85	175.46
T4	NPK @ 50% + Vermicompost @ 0%	7.16	7.23	0.44	0.52	0.38	0.34	302.27	296.58	20.48	16.62	183.18	178.02
T5	NPK @ 50% + Vermicompost @ 50%	7.13	7.19	0.45	0.55	0.42	0.38	307.86	300.70	21.74	17.27	186.65	181.80
T6	NPK @ 50% + Vermicompost @ 100%	7.09	7.15	0.48	0.58	0.45	0.40	310.04	304.37	23.86	19.58	189.82	184.56
T7	NPK @ 100% + Vermicompost @ 0%	7.04	7.11	0.50	0.62	0.42	0.39	314.26	309.64	24.05	20.22	188.21	187.25
T8	NPK @ 100% + Vermicompost @ 50%	6.98	7.07	0.53	0.65	0.44	0.41	318.15	312.82	26.70	22.55	193.05	190.74
T9	NPK @ 100% + Vermicompost @ 100%	6.92	7.02	0.56	0.68	0.48	0.45	318.42	310.06	28.02	25.78	197.24	193.62
	F-Test	NS	NS	NS	NS	NS	NS	S	S	S	S	S	S
	S.Ed. (±)	-	-	-	-	-	-	2.28	1.85	0.76	0.60	1.20	1.03
	C.D. at 0.5%	-	-	-	-	-	-	4.60	3.74	1.55	1.24	2.42	2.08

4. CONCLUSION

According to the results revealed the various level of NPK and Vermicompost used from different sources fertilizers [*i.e.,* Urea (46% N), + SSP (16% P2O5) + MOP (60% K2O) in the experiment gave the best result in the treatment T_9 (NPK @ 100% + Vermicompost @ 100%) followed by treatment T_8, in T_9 the soil health parameters retained the suitable soil properties, yield attributes and yield of carrot. Therefore, it can be suggested for farmers to obtain best combination Treatment (T_9) for higher farm income and sustainable agriculture.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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