Original Research Article

Influence of Different Levels of NPK and Biochar on Physico-Chemical Properties of Soil in Field pea

Abstract

An experiment was conducted during in *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 and Biochar (0 %, 50 % and 100 %). The result shows that application of different levels combination of inorganic fertilizers increased growth, yield of field pea and improved soil chemical properties. It was recorded from the application of NPK and Biochar fertilizers in treatment T_9 [NPK @ 100% + Biochar @ 100 %] maximum bulk density 1.274 Mg m^{-3} at and 1.279 Mg m^{-3}, particle density 2.518 Mg m^{-3} and 1.523 Mg m^{-3}, % pore space 47.71 % and 44.68 %, water holding capacity 39.75 % and 36.82 %, pH 7.05 at and 7.15 at, EC 0.473 dSm^{-1} and 0.479 dSm^{-1}, organic carbon 0.497 % and 0.495 %, available nitrogen 314.56 kg ha^{-1} and 311.55 kg ha^{-1}, available phosphorus 38.70 kg ha^{-1} and 36.28 kg ha^{-1}, available potassium 220.42 kg ha^{-1} and 217.67 kg ha^{-1} all parameters at 0-15 cm and 15-30 cm best from T_1 [NPK @ 0% + Biochar @ 0 %].

Key word: Field pea, Biochar, NPK, Physico-Chemical Properties of Soil, etc.

Introduction

Field Pea (*Pisum sativum* L.) is an important Rabi leguminous crop grown in Indian subcontinent. It is one of the main sources of dietary protein for most Indians. The productivity (1356 kg ha^{-1}). Moreover, its high yield potential (3.5 tonnes ha^{-1}) through balanced fertilization envisages ample scope to increase its yields further (Anonymous, 2009). Pea is one of the important vegetables in the world and ranks among the top 10 vegetable crops. Pea is commonly used in human diet throughout the world and it is rich in protein (21-25 %), carbohydrates, vitamin A and C, Ca, phosphorous and has high levels of amino acids lysin and tryptophan (Bhat *et al*., 2013). Pea is one of the foremost important versatile legume crops which is highly nutritious due to its important bio-chemical attributes viz protein content, protein quality (having good amount of essential amino acids such as lysine, methionine, leucine etc. which are not synthesized by the human body), minerals, oil, and sugar content. Peas are highly nutritive and contain a high percentage of digestible 22.5% proteins, 58.5% carbohydrates, 1.0% fats, 4.4% fibbers and 3% minerals vitamins, particularly of the B group (Verma *et al*., 2018). Pea is also widely used as pulse in daily diet, it contains a high percentage of digestible proteins (7.2 100 g^{-1} of edible protein), good content of vitamins i.e., Vit B1 (.025 mg 100 g^{-1}), Vit C (9 mg 100 g^{-1}), and minerals like Phosphorus (139 mg 100 g^{-1}), Magnesium (34 mg 100 g^{-1}) and Iron (1.5 mg 100 g^{-1}) (Singh *et al*., 2005).

The nitrogen (N) is a vital nutrient for the activity of plant organs. It is a fraction of many components, so plant growth can be affected by the amount of nitrogen. The present study was under taken to verify the effect of different fertilizer forms on the performance of pea varieties (AL-Bayati *et al.,* 2019).

Phosphorus is known to play an important role in growth and development of the crop and have direct relation with root proliferations, straw strength, grain formation, crop maturation (Bhat *et al*., 2013). Enhancing P availability to crop through phosphate-solubilizing bacteria (PSB) holds promise in the present scenario of escalating prices of phosphatic fertilizers and a general deficiency of Phosphorus in Indian soils (Joshi *et al*., 2020).

Potassium is associated with the movement of water, nutrients, and carbohydrates in plant tissue, it’s involved with enzyme activation within the plant, which affects protein, starch and adenosine triphosphate (ATP) production. The production of ATP can regulate the rate of photosynthesis (Kumari *et al*., 2012). Biochar is a carbon rich product that is produced by pyrolysis (heating in incomplete or partial absence of oxygen) of biomass at relatively low temperature (<700°C) (Demirbas, A., 2002; Mayhead, G. J., 2010).

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 pea *Var*. Rachna 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 measuring cylinder and process by Muthuvel *et al*., 1992.

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.,* 1954)
f) Available Potassium (kg ha^{-1}) - Flame photometric method by using Metzer Flame Photometer given by (Toth and Prince, 1949)

Result and Discussion

1. **Physical Properties of Soil**

Bulk density (Mg m^{-3})

The response bulk density of soil was found to be non-significant in levels of NPK and biochar. The maximum bulk density of soil was recorded 1.274 and 1.279 Mg m^{-3} in treatment T_9 (NPK @ 100% + Biochar @ 100 %) and minimum bulk density of soil was recorded 1.242 and 1.246 Mg m^{-3} at 0-15 cm and 15-30 cm in treatment T_1 (NPK @ 0% + Biochar @ 0 %) respectively. **(Das *et al*., 2020 and Panday *et al*., 2017).**

Particle density (Mg m^{-3})

The maximum particle density of soil was recorded 2.518 and 2.523 Mg m^{-3} in treatment T_9 (NPK @ 100% + Biochar @ 100 %) and minimum particle density of soil was recorded 2.485 and 2.488 Mg m^{-3} at 0-15 cm and 15-30 cm in treatment T_1 (NPK @ 0% + Biochar @ 0 %) respectively. **(Chanu *et al*., 2020 and Sharma, N. and Thakur, K. S., 2016).**

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 was recorded 58.71 and 57.68 % in treatment T_9 (NPK @ 100% + Biochar @ 100 %) and minimum pore space of soil was recorded 46.25 and 44.50 % at 0-15 cm and 15-30 cm in treatment T_1 (NPK @ 0% + Biochar @ 0 %) respectively. **(Chanu *et al*., 2020 and Sharma, N. and Thakur, K. S., 2016).**

Water holding capacity (%)

The response water holding capacity of soil was found to be significant in levels of NPK and biochar. The maximum water holding capacity of soil was recorded 47.75 and 44.82 % in treatment T_9 (NPK @ 100% + Biochar @ 100 %) and minimum water holding capacity of soil was recorded 33.56 and 30.45 % at 0-15 cm and 15-30 cm in treatment T_1 (NPK @ 0% + Biochar @ 0 %) respectively. **(Rani *et al.*, 2017 and Yadav *et al.*, 2018).**

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 NPK and biochar. The maximum pH of soil was recorded 7.05 and 7.15 in treatment T_9 (NPK @ 100% + Biochar @ 100 %) and minimum pH of soil was recorded 6.62 and 6.66 at 0-15 cm and 15-30 cm in treatment T_1 (NPK @ 0% + Biochar @ 0 %) respectively. **(Rani *et al.*, 2017 and Yadav *et al.*, 2018).**

Soil EC (dSm^{-1})

The response EC of soil was found to be non-significant in levels of NPK and biochar. The maximum EC of soil was recorded 0.473 and 0.479 dSm^{-1} in treatment T_9 (NPK @ 100% + Biochar @ 100 %) and minimum EC of soil was recorded 0.442 and 0.445 dSm^{-1} 0-15 cm and 15-30 cm in treatment T_1 (NPK @ 0% + Biochar @ 0 %) respectively **(Das *et al.*, 2020 and Panday *et al.*, 2017).**

Organic carbon (%)

The response organic carbon of soil was found to be non-significant in levels of NPK and biochar. The maximum organic carbon of soil was recorded 0.497 and 0.495 % in treatment T_9 (NPK @ 100% + Biochar @ 100 %) and minimum organic carbon of soil was recorded 0.472 and 0.470 % at 0-15 cm and 15-30 cm in treatment T_1 (NPK @ 0% + Biochar @ 0 %) respectively **(Chethan *et al.*, 2018, Gabr e*t al.*, 2007 and Rani *et al.*, 2017).**

Available nitrogen (kg ha^{-1})

The response available nitrogen of soil was found to be significant in levels of NPK and biochar. The maximum available nitrogen of soil was recorded 314.56 and 311.55 kg ha^{-1} in treatment T_9 (NPK @ 100% + Biochar @ 100 %) and minimum available nitrogen of soil was recorded 292.75 and 288.32 kg ha^{-1} at 0-15 cm and 15-30 cm in treatment T_1 (NPK @ 0% + Biochar @ 0 %) respectively **(Toppo *et al.*, 2017 and Singh *et al.*, 2015).**

Available phosphorus (kg ha^{-1})

The response available phosphorus of soil was found to be significant in levels of NPK and biochar. The maximum available phosphorus of soil was recorded 38.70 and 36.28 kg ha^{-1} in treatment T_9 (NPK @ 100% + Biochar @ 100 %) and minimum available phosphorus of soil was recorded 21.45 and 19.34 kg ha^{-1} at 0-15 cm and 15-30 cm in treatment T_1 (NPK @ 0% + Biochar @ 0 %) respectively **(Bunker *et al*., 2018, Rajput, R. L. and Kushwah, S. S., 2005 and Bhat *et al*., 2013).**

Available potassium (kg ha^{-1})

The response available potassium of soil was found to be significant in levels of NPK and biochar. The maximum available potassium of soil was recorded 220.42 and 217.67 kg ha^{-1} in treatment T_9 (NPK @ 100% + Biochar @ 100 %) and minimum available potassium of soil was recorded 192.23 and 190.55 kg ha^{-1} at 0-15 cm and 15-30 cm in treatment T_1 (NPK @ 0% + Biochar @ 0 %) respectively **(Bunker *et al*., 2018, Rajput, R. L. and Kushwah, S. S., 2005 and Bhat *et al*., 2013).**

Table 1: Effect of different levels of NPK and biochar on bulk density (Mg m^{-3}), particle density (Mg m^{-3}), pore space (%) and water holding capacity (%) of soil.

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**
T_1	Absolute control	1.242	1.246	2.485	2.488	46.25	44.50	33.56	30.45
T_2	NPK @ 0 % + Biochar @ 50 %	1.243	1.247	2.489	2.491	48.87	45.85	34.97	31.85
T_3	NPK @ 0 % + Biochar @ 100 %	1.245	1.250	2.492	2.496	49.65	47.10	36.09	33.08
T_4	NPK @ 50 % + Biochar @ 0 %	1.249	1.254	2.495	2.501	50.34	48.65	37.41	34.67
T_5	NPK @ 50 % + Biochar @ 50 %	1.252	1.256	2.499	2.506	52.21	50.72	39.23	36.90
T_6	NPK @ 50 % + Biochar @ 100 %	1.257	1.261	2.505	2.510	53.45	51.54	41.78	39.56
T_7	NPK @ 100 % + Biochar @ 0 %	1.262	1.267	2.508	2.514	55.67	53.90	42.21	40.40
T_8	NPK @ 100 % + Biochar @ 50 %	1.268	1.273	2.513	2.519	57.32	55.28	45.87	43.26
T_9	NPK @ 100 % + Biochar @ 100 %	1.274	1.279	2.518	2.523	58.71	57.68	47.75	44.82
	F-Test	NS	NS	NS	NS	S	S	S	S
	S.Ed. (±)	-	-	-	-	0.80	0.68	0.52	0.47
	C.D. at 0.5%	-	-	-	-	1.56	1.32	1.02	0.91

Table 2: Effect of different levels of NPK and biochar 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.

Treatments		Soil pH (1:2.5) w/v		EC (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	Absolute control	6.62	6.66	0.442	0.445	0.472	0.470	292.75	288.32	21.45	19.34	192.23	190.55
T_2	NPK @ 0 % + Biochar @ 50 %	6.65	6.70	0.446	0.448	0.474	0.471	294.54	290.65	22.62	20.78	196.41	194.82
T_3	NPK @ 0 % + Biochar @ 100 %	6.68	6.76	0.449	0.451	0.477	0.473	296.32	292.90	24.78	22.90	201.58	198.56
T_4	NPK @ 50 % + Biochar @ 0 %	6.72	6.82	0.453	0.455	0.478	0.475	299.70	295.65	25.05	23.06	202.08	199.72
T_5	NPK @ 50 % + Biochar @ 50 %	6.78	6.88	0.458	0.460	0.483	0.480	301.62	298.72	27.42	26.82	204.56	201.80
T_6	NPK @ 50 % + Biochar @ 100 %	6.84	6.95	0.462	0.465	0.489	0.485	304.80	302.35	30.61	29.45	207.78	205.45
T_7	NPK @ 100 % + Biochar @ 0 %	6.91	7.01	0.467	0.471	0.490	0.488	307.08	305.62	32.54	31.72	211.81	208.72
T_8	NPK @ 100 % + Biochar @ 50 %	6.98	7.08	0.470	0.474	0.493	0.491	310.25	308.38	35.17	34.20	215.95	212.65
T_9	NPK @ 100 % + Biochar @ 100 %	7.05	7.15	0.473	0.479	0.497	0.495	314.56	311.55	38.70	36.28	220.42	217.67
	F-Test	NS	NS	NS	NS	NS	NS	S	S	S	S	S	S
	S.Ed. (±)	-	-	-	-	-	-	1.87	1.59	2.05	1.70	1.70	1.52
	C.D. at 0.5%	-	-	-	-	-	-	3.78	3.14	4.15	2.43	3.46	3.08

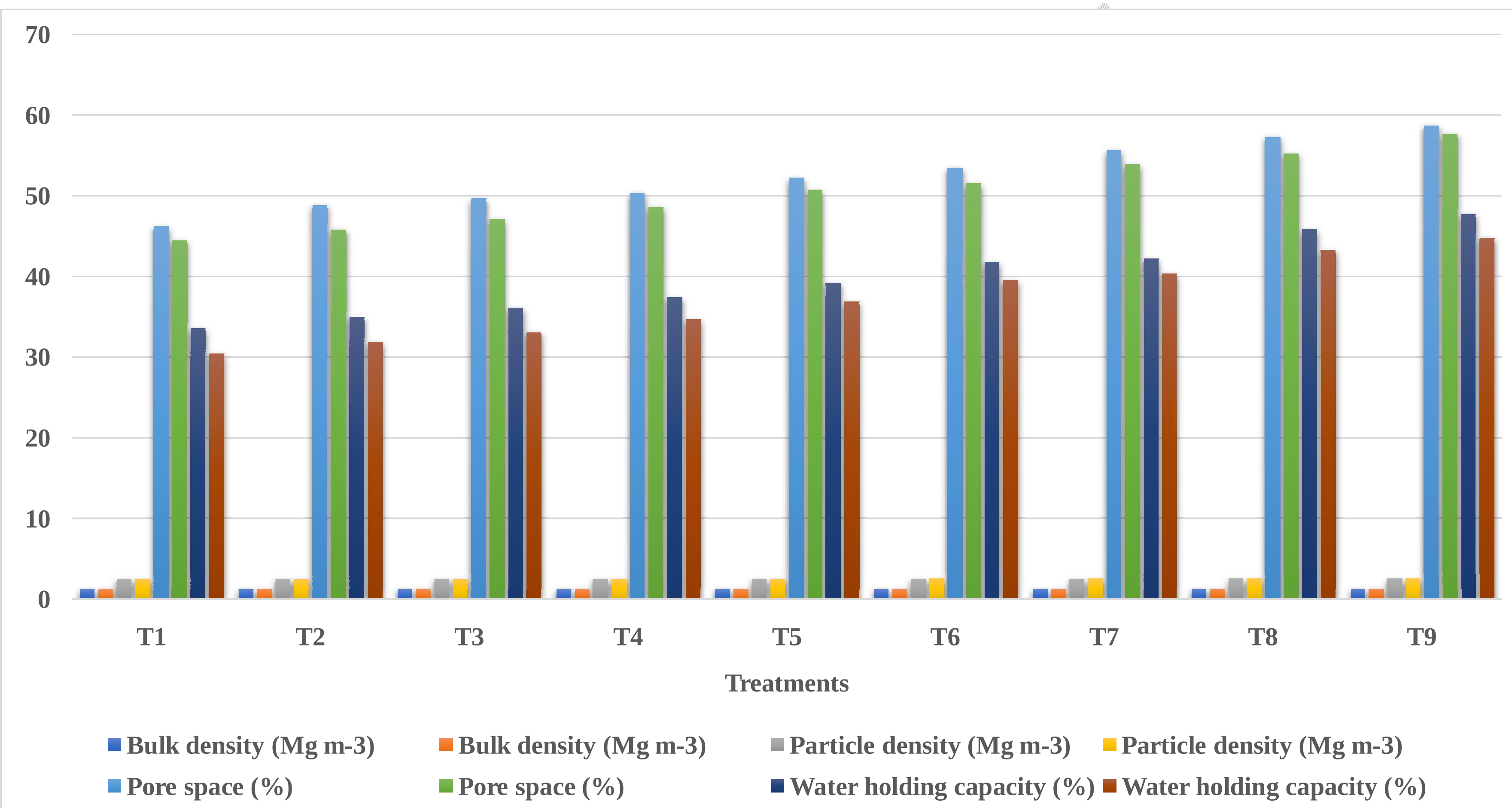

Fig. 1: Effect of different levels of NPK and biochar on bulk density (Mg m^{-3}), particle density (Mg m^{-3}), pore space (%) and water holding capacity (%) of soil.

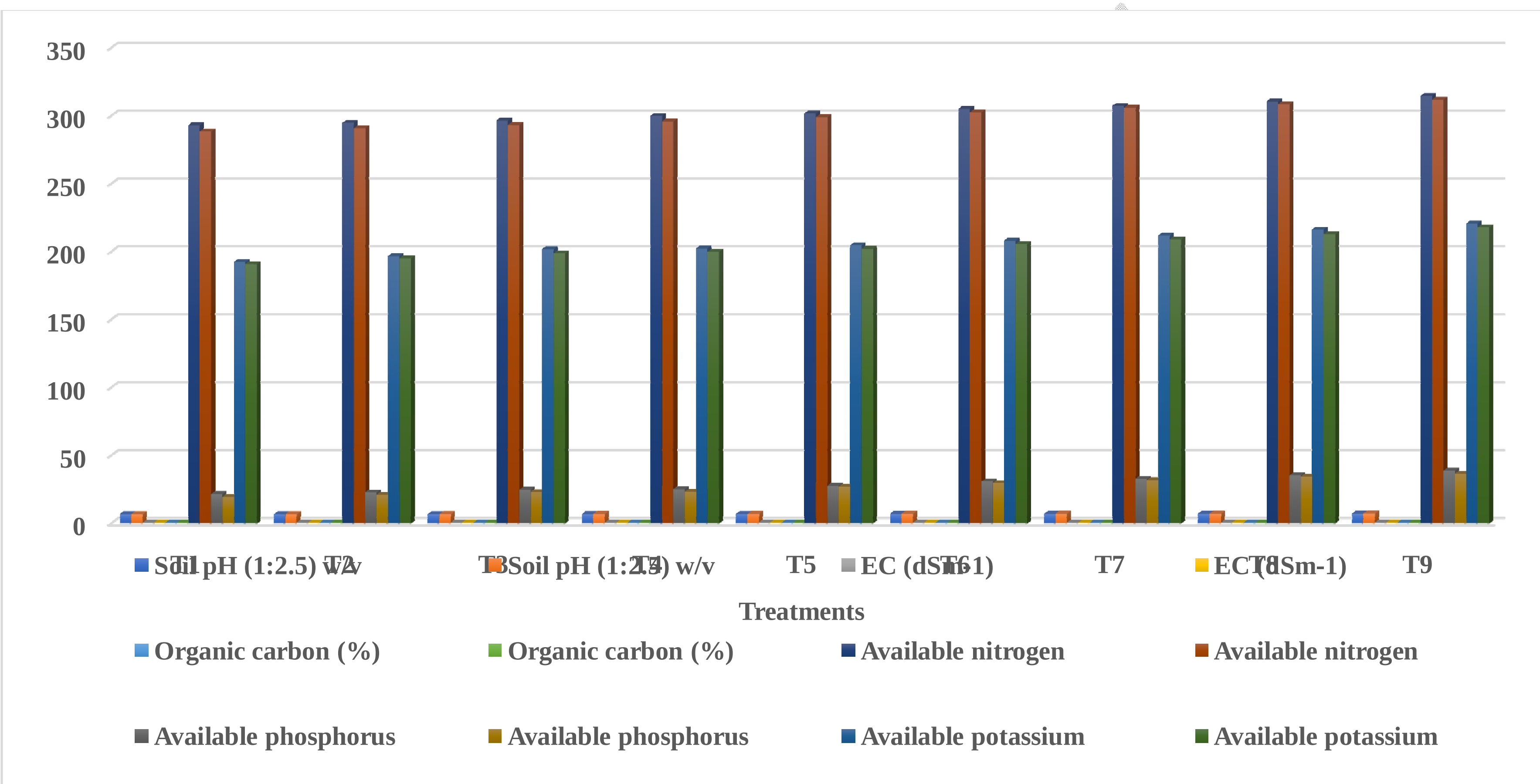

Fig. 2: Effect of different levels of NPK and biochar on pH (1:2.5) w/v, EC (dSm^{-1}), organic carbon (%), available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}) and available potassium (kg ha^{-1}) of soil.

Conclusion

According to the results revealed the various level of inorganic fertilizer and organic manures used from different sources fertilizers [*i.e.* Urea (N 46%), + SSP (16 P_2O_5) + MOP 60% K_2O)] in the experiment gave the best result in the treatment T_9 (NPK @ 100% + Biochar @ 100 %) followed by treatment T_8, in T_9 the soil health parameters retained the suitable soil properties. Therefore, it can be recommended for farmers to obtain best combination Treatment (T_9) for higher farm income and sustainable agriculture.

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