

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 T₉ [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 dS m⁻¹ and 0.479 dS m⁻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 T₁ [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% fibers 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 following different method

- a) Soil pH – method given by (Jackson, 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)

Statistical analysis:

The data recorded during the investigation was subjected to statistical analysis by RBD, as per the method “Analysis of Variance (ANOVA) technique” as given by R. A. Fischer (1955). Experiment was laid out in RBD and the treatment will be replicated three times. The significant and non-significant effect was judged with the help of “F” (variance ratio) table. The significant difference between the means will be tested against the critical difference of 5% level. For testing the hypothesis, ANOVA table will be used.

Results 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 T₉ (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 T₁ (NPK @ 0% + Biochar @ 0 %) respectively. Similar result has been recorded by (**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 T₉ (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 T₁ (NPK @ 0% + Biochar @ 0 %) respectively. Similar result has been recorded by (**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 T₉ (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 T₁ (NPK @ 0% + Biochar @ 0 %) respectively. Similar result has been recorded by (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 T₉ (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 T₁ (NPK @ 0% + Biochar @ 0 %) respectively. Similar result has been recorded by (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 T₉ (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 T₁ (NPK @ 0% + Biochar @ 0 %), respectively. Similar result has been recorded by (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 T₉ (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 T₁ (NPK @ 0% + Biochar @ 0 %), respectively. Similar result has been recorded by (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 T₉ (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 T₁ (NPK @ 0% + Biochar @ 0 %), respectively. Similar result has been recorded by (Chethan *et al.*, 2018, Gabr *et 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 T₉ (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 T₁ (NPK @ 0% + Biochar @ 0 %), respectively. Similar result has been recorded by **(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 T₉ (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 T₁ (NPK @ 0% + Biochar @ 0 %), respectively. Similar result has been recorded by **(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 T₉ (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 T₁ (NPK @ 0% + Biochar @ 0 %), respectively. Similar result has been recorded by **(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
T₁	Absolute control	1.242	1.246	2.485	2.488	46.25	44.50	33.56	30.45
T₂	NPK @ 0 % + Biochar @ 50 %	1.243	1.247	2.489	2.491	48.87	45.85	34.97	31.85
T₃	NPK @ 0 % + Biochar @ 100 %	1.245	1.250	2.492	2.496	49.65	47.10	36.09	33.08
T₄	NPK @ 50 % + Biochar @ 0 %	1.249	1.254	2.495	2.501	50.34	48.65	37.41	34.67
T₅	NPK @ 50 % + Biochar @ 50 %	1.252	1.256	2.499	2.506	52.21	50.72	39.23	36.90
T₆	NPK @ 50 % + Biochar @ 100 %	1.257	1.261	2.505	2.510	53.45	51.54	41.78	39.56
T₇	NPK @ 100 % + Biochar @ 0 %	1.262	1.267	2.508	2.514	55.67	53.90	42.21	40.40
T₈	NPK @ 100 % + Biochar @ 50 %	1.268	1.273	2.513	2.519	57.32	55.28	45.87	43.26
T₉	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. (\pm)	-	-	-	-	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, EC (dS m⁻¹), organic carbon (%), available nitrogen (kg ha⁻¹), available phosphorus (kg ha⁻¹) and available potassium (kg ha⁻¹) of soil.

Treatments		pH		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
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

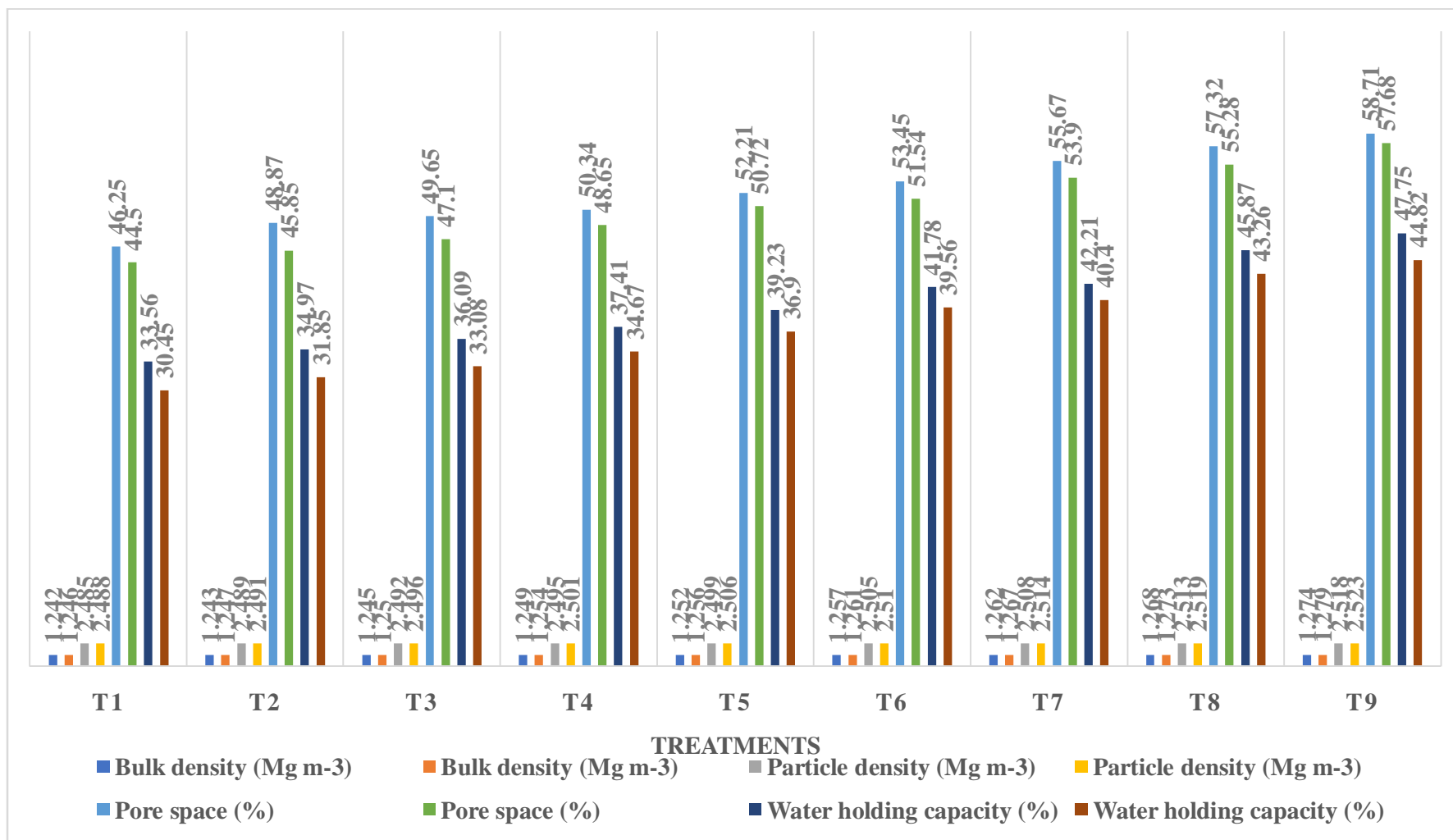


Fig. 1: Effect of different levels of NPK and biochar on bulk density (Mg m⁻³), particle density (Mg m⁻³), pore space (%) and water holding capacity (%) of soil.

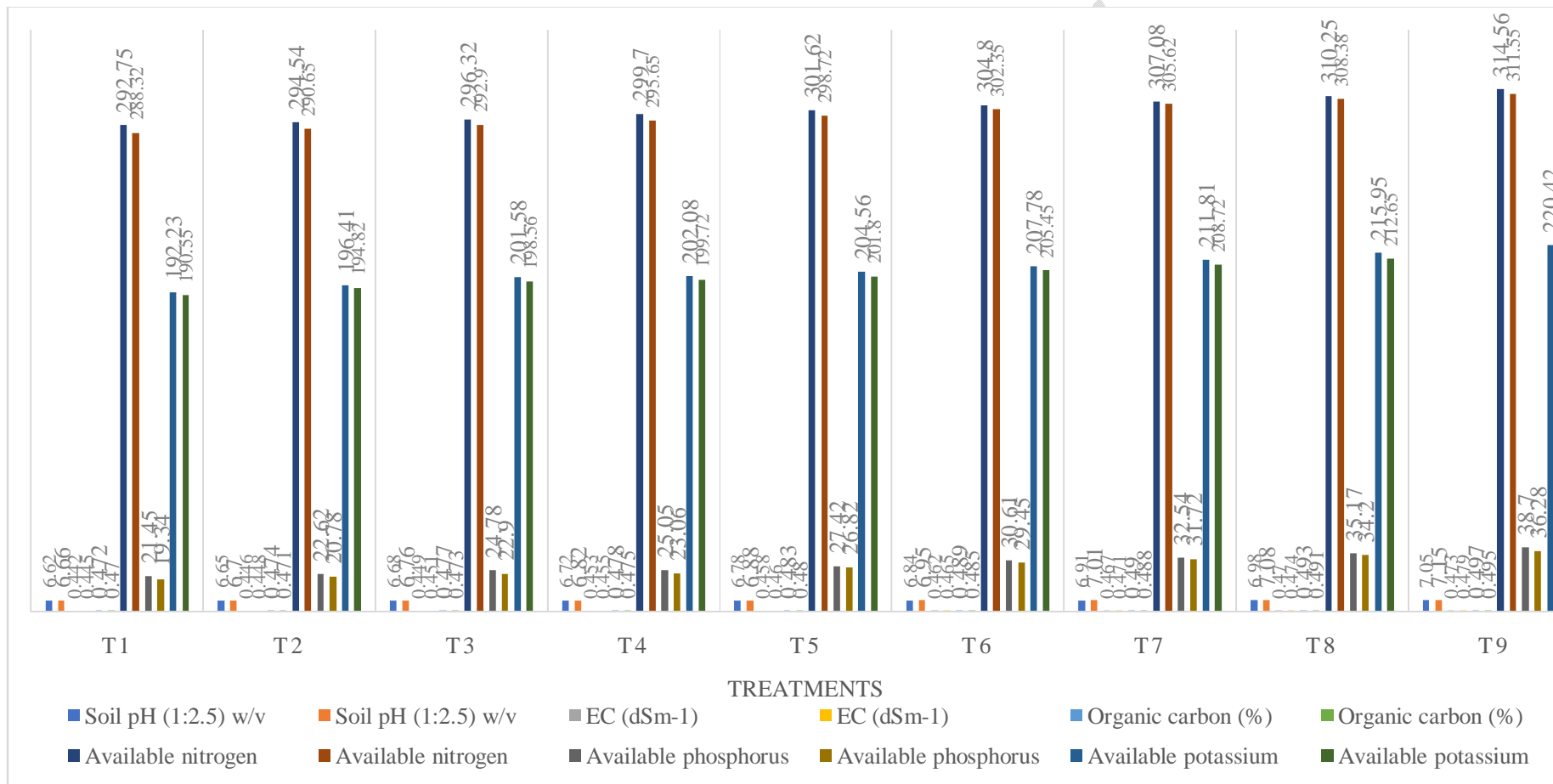


Fig. 2: Effect of different levels of NPK and biochar on pH (1:2.5) w/v, EC (dS m⁻¹), organic carbon (%), available nitrogen (kg ha⁻¹), available phosphorus (kg ha⁻¹) and available potassium (kg ha⁻¹) of soil.

Conclusions

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 P₂O₅) + MOP 60% K₂O)] in the experiment gave the best result in the treatment T₉ (NPK @ 100% + Biochar @ 100 %) followed by treatment T₈ (NPK @ 100% + Biochar @ 50 %), in the treatment T₉ (NPK @ 100% + Biochar @ 100 %) the soil health parameters retained the suitable soil properties. Therefore, it can be recommended for farmers to obtain best combination Treatment (T₉) for higher farm income and sustainable agriculture.

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