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Effect of organic and inorganic source of nutrients on physio-chemical properties of soil in black gram (*Vigna mungo* L.) Var. Sekhar-2

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Abstract
An experiment was conducted during in *Zaid* season (March 2021-June 2021) in an Inceptisols of Prayagraj, (U.P.) India*"* to study the entitled "Effect of Organic and Inorganic Source of Nutrients on Physio-Chemical Properties of Soil in Black Gram (*Vigna Mungo* L.) The experiment was laid out in randomized block design with three levels of NPK (0% NPK, 50% NPK and 100% NPK) and three levels of FYM (0% FYM, 50% FYM, 100% FYM). The result shows that application of different levels combination of inorganic fertilizers increased growth, yield of black gram and improved soil chemical properties. It was recorded from the application of NPK and FYM fertilizers in treatment T_9 (NPK @ 100% + FYM @ 100%) maximum bulk density 1.228 Mg m^{-3} at 0-15 cm and 1.232 Mg m^{-3} at 15-30 cm, particle density 2.485 Mg m^{-3} at 0-15 cm and 2.489 Mg m^{-3} at 15-30 cm, pore space 52.26% at 0-15 cm and 49.81% at 15-30 cm, water holding capacity 43.62% at 0-15 cm and 38.52% at 15-30 cm, pH 7.32 at 0-15 cm and 7.02 at 15-30 cm, electrical conductivity 0.49 dSm^{-1} at 0-15 cm and 0.60 dSm^{-1} at 15-30 cm, organic carbon 0.58% at 0-15 cm and 0.56% at 15-30 cm, available nitrogen 329.23 kg ha^{-1} at 0-15 cm and 326.70 kg ha^{-1} at 15-30 cm, available phosphorus 34.86 kg ha^{-1} at 0-15 cm and 32.76 kg ha^{-1} at 15-30 cm, available potassium 214.54 kg ha^{-1} at 0-15 cm and 207.63 kg ha^{-1} at 15-30 cm. Plant parameters also increase dose of NPK and FYM with cost benefit ratio is 1: 3.54 best from T_1 [(control) NPK @ 0% + FYM @ 0%] respectively.

Keywords: Black gram, FYM, NPK and physico-chemical, etc.

Introduction
Pulses "The wizard of the health", symbolic to its nomenclature pulse (P = People U = Umbrella L = Livestock S= Soil E= Energy) are a super energy food. It is Umbrella for people as dietary, proteins for livestock as green nutrition fodder and feed and for soil as mini nitrogen plant and green manure.

Among these, Black gram [*Vigna mungo* (L.)] also known as urad, mash bean or black gram, belongs to family *Fabaceae* (*Leguminaceae*) is an important pulse crop grown throughout India in an area of about 1.33 million tons annually from an area of 3.17% million hectare (Anonymous, Annual Report, IIPR Kanpur, 2016) [2]. Black gram contributes 13% in total pulses area and 10% in total pulses production of India. India is largest producer of pulse in the world with 25% shares in the global production.

Black gram has been distributed mainly in tropical to subtropical countries. It is grown in Kharif, Rabi and summer season in India, Pakistan, Sri Lanka, Burma, and some countries of East Asia. In India black gram is very popularly grown in Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, Uttar Pradesh, West Bengal, Punjab, Haryana, Tamil Nadu and Karnataka. In India, it is grown on an area of about 31 lakh ha^{-1} with the total production of 14 lakh tonnes with an average productivity of 452 kg ha^{-1}. In Uttar Pradesh, it is grown on an area of 3.91 lakh ha^{-1} with the production and productivity of 1.72 lakh tonnes and 440 kg ha^{-1}, respectively (Anonymous, 2016) [3].

The per capita availability in pulses is dwindling fast from 70 gm in 1959 to 31.6 g in 2011 as against the minimum requirement of 84 gm/capita/day prescribed by ICMR. To alleviate protein-energy malnutrition, a minimum of 50 gm pulses/capita should be available in addition to other sources of proteins such as cereals, milk, meat and eggs. It is rich source of protein (24%), fat (1.4%), carbohydrate (59.6%), calcium (154 mg), phosphorus (385 mg), iron (9.1 mg), beta carotene (38 mg), thiamine (0.4 mg), riboflavin (0.37 mg) and niacin (2 mg) per 100 g seeds (Aggarwal *et al*., 2019) [1].

Nutrient balance is the key component to increase crop yields. Excess and imbalanced use of nutrients has caused nutrient mining from the soil, deteriorated crop productivity and ultimately soil health. Replenishment of these nutrients through organic and combination with organic and inorganic has a direct impact on soil health and crop productivity (Datt *et al*., 2003) [6].

Phosphorus is an important nutrient next to nitrogen, Indian soils are poor to medium in available phosphorus. Only about 30 percent of the applied phosphorus is available for crops and remaining part converted into insoluble phosphorus. Its deficiency is most important single factor, which is responsible for poor yield of black gram on all types of soil. It is an indispensable, constituent of nucleic acid, ADP and ATP. It has beneficial effects on nodule stimulation, root development, growth and hastens maturity as well as improves quality of crop produces. Phosphorus stimulates the symbiotic nitrogen fixation because in presence of phosphorus bacterial cell becomes mobile which is prerequisite for migration of bacterial cell to root hair for nodulation (Charel, 2006) [4].

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. (Singh *et al*., 2012) [20]. Potassium enhances the ability of plants to resist diseases, insect-pest attack, cold, drought and other adversities. Potassium is known to play a vital role in photosynthesis, translocation of photosynthates, regulation of plant pores, activation of plant catalysts and many other processes.

Application of organic nutrients sources or adopting soil health management practices will enable the maize plants to have quick growth and better yield along with enhancement in residual fertility in next crop. Organic nutrients sources applied to the preceding crops exhibit residual effects on succeeding crops due to slow decomposition process particularly in temperate zone like Sikkim. Hence organic manure must apply in soil keeping the whole cropping sequence in view rather than individual crop. Biomass which are locally available, not economically important and cause considerable crop yield loss can be used as raw material for biochar preparation in any production system (Das *et al*., 2014) [5].

Materials and Methods

The present study entitled "Effect of Organic and Inorganic Source of Nutrients on Physio-Chemical Properties of Soil in Black gram (*Vigna mungo* L.) Var. Sekhar-2" comprise of a field experiment which was carried out at the Soil Science & Agricultural Chemistry Research Farm, Sam Higginbottom University of Agriculture Technology and Sciences Prayagraj during *Kharif* season 2021, which is located at 25⁰24˙30˝ N latitude, 81⁰51˙10˝ E longitude and 98 m above the mean sea level. The detail of the experimental site, soil and climate is described in this chapter together with the experimental design, layout plan, cultural practice and techniques employed for the parameters. The area of Prayagraj district comes under subtropical belt in the South East Uttar Pradesh, which experience extremely hot summer and fairly winter. The maximum temperature of the location reaches up to 46 ºC-48 ºC and seldom falls as 4 ºC-5 ºC. The relative humidity ranged between 20 to 94 percent. The average rainfall in this area is around 1100 mm annually. It comes under subtropical climate receiving the mean annual rainfall of about 1100 mm, major rainfall from July to end of September. However, occasional precipitation was also not uncommon during winter. The winter months were cold while summer months were very hot and dry. The minimum temperature during the crop season was to be 27.1 ºC and the maximum is to be 39.94 ºC. The minimum humidity was 57.70% and maximum was to be 75.37%.

Experiment was laid out in randomized block design with three levels of NPK and Three level of FYM. Plot size was 2 x 2 m^2 for crop seed rate is 15-20 kg ha^{-1} black gram (*Vigna mungo* L.) Var. Sekhar-2. Basal dose of fertilizer was applied in respective plots according to treatment allocation uniform furrows opened by about 5 cm. All the agronomic practices were carried out uniformly to raise the crop. The crop was harvested in February.

Table 1: Treatment combination for Garden pea crop

Treatment	Treatment Combination
T_1	Control (NPK @ 0% + FYM @ 0%)
T_2	NPK @ 0% + FYM @ 50%
T_3	NPK @ 0% + FYM @ 100%
T_4	NPK @ 50% + FYM @ 0%
T_5	NPK @ 50% + FYM @ 50%
T_6	NPK @ 50% + FYM @ 100%
T_7	NPK @ 100% + FYM @ 0%
T_8	NPK @ 100% + FYM @ 50%
T_9	NPK @ 100% + FYM @ 100%

Results and Discussion

Bulk density (Mg m^{-3})

The data presented in table 2 and depicted in fig. 1 clearly shows the bulk density (Mg m^{-3}) of soil as influenced by organic and inorganic source of nutrients. The response bulk density of soil was found to be non-significant in levels of NPK and FYM. The maximum bulk density of soil was recorded 1.228 Mg m^{-3} at 0-15 cm and 1.232 Mg m^{-3} at 15-30 cm in treatment T_9 (NPK @ 100% + FYM @ 100%) followed by 1.221 Mg m^{-3} at 0-15 cm and 1.225 Mg m^{-3} at 15-30 cm in treatment T_8 (NPK @ 100% + FYM @ 50%) and minimum bulk density of soil was recorded 1.190 Mg m^{-3} at 0-15 cm and 1.194 Mg m^{-3} at 15-30 cm in treatment T_1 [control (NPK @ 0% + FYM @ 0%)] respectively. Similar result has been recorded by Divyavani *et al*., 2020, Markam *et al*., 2017 and Khatana *et al*., 2021 [10, 17, 14].

Particle density (Mg m^{-3})

The data presented in table 2 and depicted in fig. 1 clearly shows the particle density (Mg m^{-3}) of soil as influenced by organic and inorganic source of nutrients. The response particle density of soil was found to be significant in levels of NPK and FYM. The maximum particle density of soil was recorded 2.485 Mg m^{-3} at 0-15 cm and 2.489 Mg m^{-3} at 15-30 cm in treatment T_9 (NPK @ 100% + FYM @ 100%) followed by 2.479 Mg m^{-3} at 0-15 cm and 2.483 Mg m^{-3} at 15-30 cm in treatment T_8 (NPK @ 100% + FYM @ 50%) and minimum particle density of soil was recorded 2.447 Mg m^{-3} at 0-15 cm and 2.452 Mg m^{-3} at 15-30 cm in treatment T_1 [control (NPK @ 0% + FYM @ 0%)] respectively. Similar result has been recorded by Divyavani *et al*., 2020, Markam *et al*., 2017, Khatana *et al*., 2021 and Kumar *et al.*, 2008 [10, 17, 14, 15].

% Pore space

The data presented in table 2 and depicted in fig. 1 clearly shows the % pore space of soil as influenced by organic and inorganic source of nutrients. The response pore space of soil was found to be significant in levels of NPK and FYM. The maximum pore space of soil was recorded 52.26% at 0-15 cm and 49.81% at 15-30 cm in treatment T_9 (NPK @ 100% + FYM @ 100%) followed by 49.75% at 0-15 cm and 47.32% at 15-30 cm in treatment T_8 (NPK @ 100% + FYM @ 50%) and minimum pore space of soil was recorded 39.20% at 0-15 cm and 36.45% at 15-30 cm in treatment T_1 [control (NPK @ 0% + FYM @ 0%)] respectively. Similar result has been recorded by Divyavani *et al*., 2020, Markam *et al*., 2017, Khatana *et al*., 2021 and Kumar *et al.*, 2008 [10, 17, 14, 15].

Water holding capacity (%)

The data presented in table 2 and depicted in fig. 1 clearly shows the water holding capacity (%) of soil as influenced by organic and inorganic source of nutrients. The response water holding capacity of soil was found to be significant in levels of NPK and FYM. The maximum water holding capacity of soil was recorded 43.62% at 0-15 cm and 38.52% at 15-30 cm in treatment T_9 (NPK @ 100% + FYM @ 100%) followed by 41.72% at 0-15 cm and 37.35% at 15-30 cm in treatment T_8 (NPK @ 100% + FYM @ 50%) and minimum water holding capacity of soil was recorded 31.57% at 0-15 cm and 28.65% at 15-30 cm in treatment T_1 [control (NPK @ 0% + FYM @ 0%)] respectively. Similar result has been recorded by Divyavani *et al*., 2020, Markam *et al*., 2017, Khatana *et al*., 2021 and Kumar *et al.*, (2008) [10, 17, 14, 15].

Soil pH (1:2.5) w/v

The data presented in table 2 and depicted in fig. 1 clearly shows the pH of soil as influenced by organic and inorganic source of nutrients. The response pH of soil was found to be non-significant in levels of NPK and FYM. The maximum pH of soil was recorded 6.93 at 0-15 cm and 7.02 at 15-30 cm in treatment T_9 (NPK @ 100% + FYM @ 100%) followed by 6.86 at 0-15 cm and 6.94 at 15-30 cm in treatment T_8 (NPK @ 100% + FYM @ 50%) and minimum pH of soil was recorded 6.52 at 0-15 cm and 6.56 at 15-30 cm in treatment T_1 [control (NPK @ 0% + FYM @ 0%)] respectively. Similar result has been recorded by Kumar *et al*., 2020, Singh *et al*., 2016, Hussain *et al.*, (2011) and Takase *et al.*, (2011) [15, 21, 11, 22].

Electrical conductivity (dSm^{-1})

The data presented in table 2 and depicted in fig.1 clearly shows the electrical conductivity (dSm^{-1}) of soil as influenced by organic and inorganic source of nutrients. The response electrical conductivity of soil was found to be non-significant in levels of NPK and FYM. The maximum electrical conductivity of soil was recorded 0.49 dSm^{-1} at 0-15 cm and 0.60 dSm^{-1} at 15-30 cm in treatment T_9 (NPK @ 100% + FYM @ 100%) followed by 0.46 dSm^{-1} at 0-15 cm and 0.55 dSm^{-1} at 15-30 cm in treatment T_8 (NPK @ 100% + FYM @ 50%) and minimum electrical conductivity of soil was recorded 0.28 dSm^{-1} at 0-15 cm and 0.34 dSm^{-1} at 15-30 cm in treatment T_1 [control (NPK @ 0% + FYM @ 0%)] respectively. Similar result has been recorded by Kumar *et al*., 2020, Singh *et al*., 2016, Hussain *et al.*, (2011) and Takase *et al.*, (2011) [15, 21, 11, 22].

Organic carbon (%)

The data presented in table 2 and depicted in fig. 1 clearly shows the organic carbon (%) of soil as influenced by organic and inorganic source of nutrients. The response the organic carbon of soil was found to be significant in levels of NPK and FYM. The maximum the organic carbon of soil was recorded 0.58% at 0-15 cm and 0.56% at 15-30 cm in treatment T_9 (NPK @ 100% + FYM @ 100%) followed by 0.55% at 0-15 cm and 0.53% at 15-30 cm in treatment T_8 (NPK @ 100% + FYM @ 50%) and minimum the organic carbon of soil was recorded 0.42% at 0-15 cm and 0.38% at 15-30 cm in treatment T_1 [control (NPK @ 0% + FYM @ 0%)] respectively. Similar result has been recorded by Kumar *et al*., 2020, Dhyani *et al*., (2011), Nawlakhe and Mankar, (2009) [15, 9, 18].

Available nitrogen (kg ha^{-1})

The data presented in table 2 and depicted in fig. 1 clearly shows the available nitrogen (kg ha^{-1}) of soil as influenced by organic and inorganic source of nutrients. The response the available nitrogen of soil was found to be significant in levels of NPK and FYM. The maximum the available nitrogen of soil was recorded 329.23 kg ha^{-1} at 0-15 cm and 326.70 kg ha^{-1} at 15-30 cm in treatment T_9 (NPK @ 100% + FYM @ 100%) followed by 325.93 kg ha^{-1} at 0-15 cm and 322.37 kg ha^{-1} at 15-30 cm in treatment T_8 (NPK @ 100% + FYM @ 50%) and minimum the available nitrogen of soil was recorded 295.56 kg ha^{-1} at 0-15 cm and 290.65 kg ha^{-1} at 15-30 cm in treatment T_1 [control (NPK @ 0% + FYM @ 0%)] respectively. Similar result has been recorded by Javaid, A. (2009), Dhivya, R.S. and Lala, I.P.R. (2020) and Parthasarathi *et al*., (2008) [12, 8, 19].

Available phosphorus (kg ha^{-1})

The data presented in table 2 and depicted in fig. 1 clearly shows the available phosphorus (kg ha^{-1}) of soil as influenced by organic and inorganic source of nutrients. The response the available phosphorus of soil was found to be significant in levels of NPK and FYM. The maximum the available phosphorus of soil was recorded 34.86 kg ha^{-1} at 0-15 cm and 32.76 kg ha^{-1} at 15-30 cm in treatment T_9 (NPK @ 100% + FYM @ 100%) followed by 33.54 kg ha^{-1} at 0-15 cm and 30.62 kg ha^{-1} at 15-30 cm in treatment T_8 (NPK @ 100% + FYM @ 50%) and minimum the available phosphorus of soil was recorded 24.50 kg ha^{-1} at 0-15 cm and 20.06 kg ha^{-1} at 15-30 cm in treatment T_1 [control (NPK @ 0% + FYM @ 0%)] respectively. Similar result has been recorded by Javaid, A. (2009), Dhivya, R.S. and Lala, I.P.R. (2020) and Datt *et al.*, (2013) [12, 8, 7].

Available potassium (kg ha^{-1})

The data presented in table 2 and depicted in fig. 1 clearly shows the available potassium (kg ha^{-1}) of soil as influenced by organic and inorganic source of nutrients. The response the available potassium of soil was found to be significant in levels of NPK and FYM. The maximum the available potassium of soil was recorded 214.54 kg ha^{-1} at 0-15 cm and 207.63 kg ha^{-1} at 15-30 cm in treatment T_9 (NPK @ 100% + FYM @ 100%) followed by 210.27 kg ha^{-1} at 0-15 cm and

204.84 kg ha^{-1} at 15-30 cm in treatment T_8 (NPK @ 100% + FYM @ 50%) and minimum the available potassium of soil was recorded 182.90 kg ha^{-1} at 0-15 cm and 176.14 kg ha^{-1} at 15-30 cm in treatment T_1 [control (NPK @ 0% + FYM @ 0%)] respectively. Similar result has been recorded by Javaid, A. (2009), Khanday *et al*., (2012), Dhivya, R. S. and Lala, I. P. R. (2020) and Datt *et al*., (2013) [12, 13, 8, 7].

Table 2: Effect of different levels of organic and inorganic source of nutrients on bulk density (Mg m^{-3}), Particle density (Mg m^{-3}), Pore space (%), Wate holding capacity (%), pH, EC (dSm^{-1}), Organic carbon (%), Available nitrogen (kg ha^{-1}), Available phosphorus (kg ha^{-1}) and Available potassium (kg ha^{-1}) of soil

Treatments	Bulk density (Mg m^{-3})		Particle density (Mg m^{-3})		Pore space (%)		Water holding capacity (%)		pH		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	0-15 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	1.190	1.194	2.447	2.452	39.20	36.45	31.57	28.65	6.52	6.56	0.28	0.34	0.42	0.38	295.56	290.65	24.50	20.06	182.90	176.14
T_2	1.196	1.199	2.451	2.455	40.42	38.56	32.18	29.70	6.61	6.62	0.30	0.37	0.43	0.39	301.83	296.38	26.58	22.36	185.18	180.32
T_3	1.201	1.205	2.456	2.461	42.37	39.76	34.42	31.21	6.65	6.68	0.31	0.39	0.45	0.42	303.88	299.61	27.19	24.05	190.43	184.56
T_4	1.205	1.208	2.459	2.467	43.78	41.68	35.89	32.54	6.70	6.74	0.34	0.42	0.46	0.44	310.22	306.54	28.68	25.84	194.27	189.71
T_5	1.209	1.214	2.463	2.471	44.43	42.90	36.72	34.65	6.78	6.78	0.36	0.44	0.48	0.47	314.31	309.14	29.38	26.72	197.40	192.09
T_6	1.213	1.218	2.468	2.474	45.40	43.62	38.29	35.78	6.86	6.82	0.38	0.47	0.52	0.50	317.60	313.08	30.68	28.51	201.84	195.42
T_7	1.216	1.220	2.473	2.478	47.59	45.17	39.82	36.45	6.92	6.88	0.43	0.51	0.53	0.51	321.65	319.53	31.58	29.40	206.90	199.67
T_8	1.221	1.225	2.479	2.483	49.75	47.32	41.72	37.35	7.20	6.94	0.46	0.55	0.55	0.53	325.93	322.37	33.54	30.62	210.27	204.84
T_9	1.228	1.232	2.485	2.489	52.26	49.81	43.62	38.52	7.32	7.02	0.49	0.60	0.58	0.56	329.23	326.70	34.86	32.76	214.54	207.63
F-Test	NS	NS	S	S	S	S	S	S	NS	NS	NS	NS	S	NS	S	S	S	S	S	S
S.Ed. (±)	0.05	0.09	1.07	1.48	1.38	1.14	1.74	1.42	0.44	0.81	0.28	0.36	0.01	0.10	3.24	1.84	0.56	0.45	7.78	2.06
C.D. at 0.5%	0.11	0.17	2.20	2.98	2.94	2.30	3.26	2.80	1.06	1.60	0.06	0.74	0.03	0.22	6.87	3.70	1.18	0.92	16.49	4.13

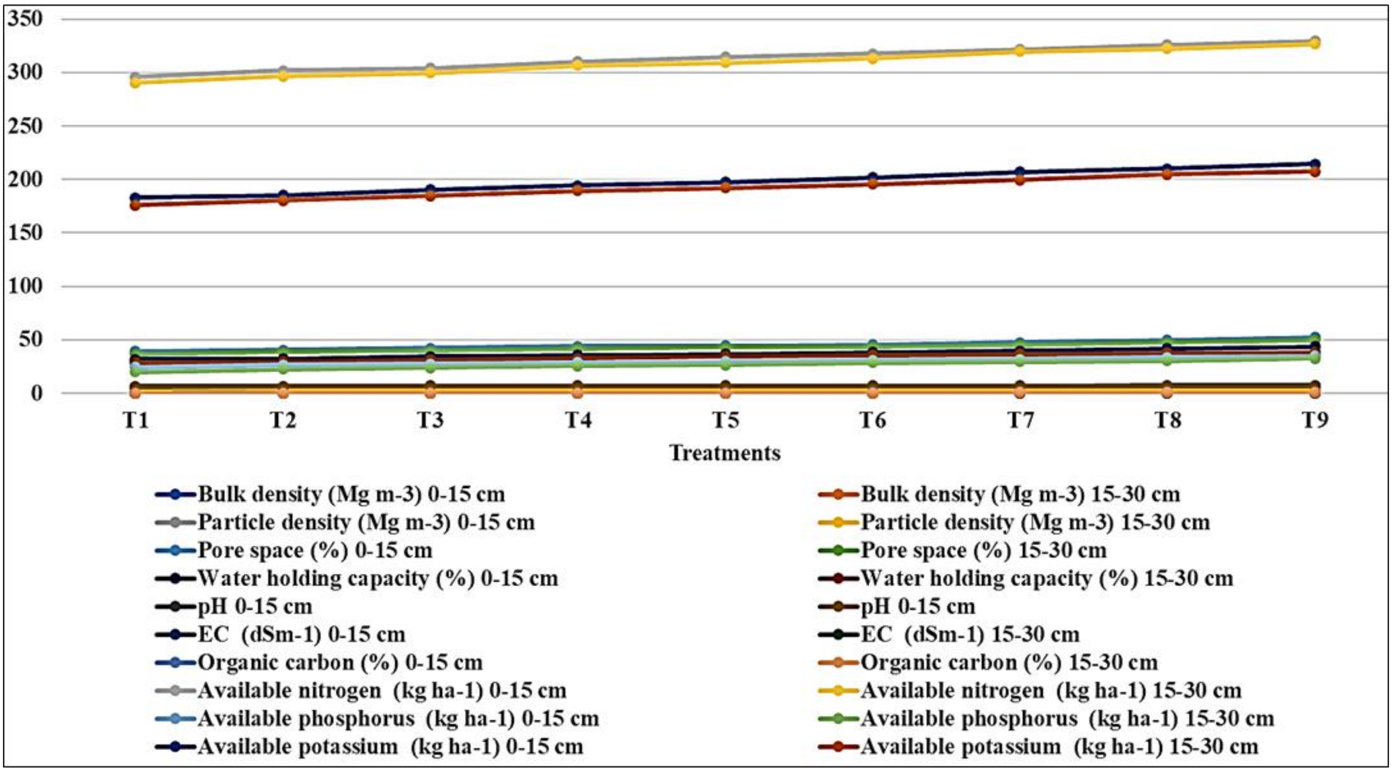

Fig 2: Effect of different levels of organic and inorganic source of nutrients on bulk density (Mg m^{-3}), Particle density (Mg m^{-3}), Pore space (%), Water holding capacity (%), pH, EC (dSm^{-1}), Organic carbon (%), Available nitrogen (kg ha^{-1}), Available phosphorus (kg ha^{-1}) and Available potassium (kg ha^{-1}) of soil

Conclusion

In the present investigation, it was apparent that application of NPK and FYM fertilizer in treatment T_9 (NPK @ 100% + FYM @ 100%) was found on physical and chemical parameters of soil such as bulk density, particle density, % pore space, water holding capacity, EC, pH, organic carbon, available N, P and K than other treatment combinations. Thus it can be concluded that different levels of NPK and FYM fertilizer improved soil available nutrient, increased soil available nitrogen, phosphorus, potassium and electrical conductivity. However, pH of soil increased and also among the treatments T_9 recorded the best treatment which increased the availability of nutrient and influenced on physical and chemical properties of soil as well.

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