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Impact of Integrated Nutrient Management on Physico-chemical properties of soil in Pea (*Pisum sativum* L.) var. GS 10

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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

During the rabi season of 2021-2022, a field experiment was conducted at the soil science research farm of the Sam Higginbottom University of Agriculture, Technology and Sciences in Prayagraj, UttarPradesh, India. Three different parameters viz., three levels of NPK, FYM at 0%, 50%, and 100% ha^{-1}, and three levels of rhizobium inoculation at 0%, 25%, and 50% ha^{-1} were used in the study. The result obtained with treatment T9[I3@100% + F3@ 100% + R3@50%] had a bulk density (1.17 Mg m^{-3}) at 0-15cm and (1.18 Mg m^{-3}) at 15-30 cm, particle density (2.41 Mg m^{-3}) at 0-15cm and (2.42 Mg m^{-3}) at 15-30, pore space (58.26%) at 0-15cm and (58.09%) at 15-30cm, water holding capacity (58.60%) at 0-15cm and (58.13%) at 15-30, pH (7.75) at 0-15cm and (7.75) at 15-30cm, EC (0.47dSm^{-1}) at 0-15cm and (0.48 dSm^{-1}) at 15- 30cm, soil organic Carbon (0.58%) at 0-15cm and (0.49%) at 15-30cm as regards soil available nutrients, available nitrogen (280.86 kg ha^{-1}) at 0-15cm and (286.40) at 15-30cm, available phosphorus (16.56 kg ha^{-1}) at 0-15cm and (17.26 kg ha^{-1}), available potassium (178.13 kg ha^{-1}) at 0-15cm and (172.80 kg ha^{-1}). The use of FYM and *Rhizobium*, as well as its blend with complete NPK, significantly improves the growth and overall production of Pea.

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1. INTRODUCTION

Pea (*Pisum sativum* L.) belongs to Fabaceae family and has a chromosome number 2n=14. Peas are native to Central or Southeast Asia and are grown all around the world. In India, Garden pea is grown as a winter vegetable crop in hilly and plain areas. It is very rich source of protein, carbohydrates, vit. A & C, calcium, phosphorus whose nutritive value of fresh green pea per 100g contain Energy 339KJ, Dietary fiber 5.1g, Protein: 5.42 g, Carbohydrates: 14.45 g, Sugars: 5.67 g, Fat: 0.4 g, Vitamin C: 40 mg, Folic acid: 50.7 mg, Iron: 1.47 mg, Potassium: 217 mg, Magnesium: 33 mg, and Phosphorus: 108 mg. Temperature favorable for grown of pea is 15-25ºC [1]. It can be cultivated in various types of soil condition like loam, sandy loam to clay soil. Pea needs well drained, loose and friable soil condition. Pea does not thrive on acidic condition and very sensitive to saline and alkaline soil. The pH ideal for it is 6.0-7.0 [2].

Chemical fertilizers provide instant nutrient supply and to get good crop yield but it can have harmful effect for environment. To sustain soil fertility and productivity, it's critical to utilize a combination of inorganic, organic, and biofertilizers. Biofertilizers improve soil fertility by symbiotically fixing atmospheric nitrogen with plant roots, solubilizing insoluble soil phosphates, and producing necessary plant development chemicals [3,4]. The organic source of manure like FYM a type bulky organic manure that supplies the entire nutrient to the plant in easily available form in slow mineralization. It has a significant positive impact on soil's physical, chemical, and biological qualities besides, pulverising the soil and improves the structure of the soil. Thus, an integrated strategy to nutrient supply that includes chemical fertilisers, organic manure, and biofertilizer which not only minimises inorganic fertiliser consumption, but also improves soil health and is ecologically friendly. This study aimed to evaluate the effect of integrated application of biofertilizer, organic manure and inorganic fertilizers on pea in terms of physico-chemical properties [5].

2. MATERIALS AND METHODS

The field investigation was carried out with garden pea variety GS-10 during rabi season 2021 in the Department of Soil science and Agricultural Chemistry, SHUATS, Prayagraj, U.P., India located at 25°24'30" North latitude, 81°51'10" East longitude and 98 m above mean sea level. The experimental soil is classified as Inceptisol, and the soil in the experimental plots is alluvial in character. The location's highest temperature ranges from 46 to 48ºC, with lows of 4-5ºC. The relative humidity ranged between 20 to 94 percent.The average rainfall of this area is around 1100mm annually.The soil texture (% of sand, silt, and clay) of the departmental research farm, with soil samples taken at depths of 0-15cm and 15-30cm. The soil had a sandy loam texture, with 55% sand, 30% silt, and 15% clay. The soil color (dry and wet method) sample was taken on depth 0-15cm and the soil color-yellowish brown was found at dry condition and at wet condition the soil color- brown was found and on depth 15-30cm the soil color- light yellowish brown was found at dry condition and at wet condition the soil color- yellowish brown was found. The trial used a randomised block design (RBD) with three replications and nine treatments, using varied levels of FYM (0, 50, and 100 percent) and Rhizobium inoculation (0, 25 and 50 percent). T1 absolute control, T2 NPK @ 0% + FYM @ 50% + Rhizobium @ 25%, T3 NPK @ 0%+ FYM @ 100% + Rhizobium@ 50%, T4 NPK @ 50% + FYM @ 0% + Rhizobium @ 0%, T5 NPK @ 50% + FYM @ 50% + Rhizobium @ 25%, T6 NPK @ 50% + FYM @ 100% + Rhizobium @ 50%, T7 NPK @ 100% +FYM @ 0%+ Rhizobium @ 0%, T8 NPK @ 100%+ FYM @ 50% + Rhizobium @ 25%, T9 NPK @ 100%+ FYM @ 100% + Rhizobium @ 50%. Basal doses of nitrogen, phosphorus and potassium are applied to the field where RDF was 30:50:50 NPK kg ha^{-1}. The sources of NPK were Urea, SSP, MOP. *Rhizobium* inoculation was done at 200g $10kg^{-1}$ of seeds, FYM were applied at their recommended dose 5 t $ha^{-1}$of soil depth 0-15cm and 15-30 cm both were taken for analysis of soil physico-chemical properties.

3. RESULTS AND DISCUSSION

3.1 Effects of Various Treatment Combinations on Soil Physical Properties

During the trail of field experiment, a perusal of data reveals the application of NPK, FYM and *Rhizobium* inoculation was observed that Treatment T9 has shown the effective soil health

parameters, detail pre and post-harvest of soil has shown on Table 2 and Table 4. Bulk density ranged from 1.24 Mg m^{-3} to 1.17 Mg m^{-3} at 0-15cm soil depth and 1.26 Mg m^{-3} to 1.18 Mg m^{-3} at 15-30cm soil depth. In both soil depths, the lowest bulk density was found in T9. Soil particle density ranged from 2.48 Mg m^{-3} to 2.41 Mg m^{-3} in 0-15cm and 2.50 Mg m^{-3} to 2.42 Mg m^{-3} in 15-30cm soil depth. FYM impact on particle density positively means lowest particle density observed in T9. porosity ranged from 51.56% to 58.26% and water holding capacity ranged from 52.73% to 58.60% in 0-15cm soil depth respectively. However, as soil depth increased, porosity and water holding capacity decreased, resulting in a range of 50.66 % to 58.09 % porosity and 51.46 % to 58.13 % water holding capacity at 15-30 cm. Similar results were reported by Kimi *et al.* [6] and Varsha *et al.* [7].

3.2 Effects of Various Treatment Combinations on Soil Chemical Properties

The application of NPK, FYM and *Rhizobium* inoculation significantly, affected the soil parameters. The detail analysis of pre and postharvest of soil analysis show on Table 3 and Table 4. A minimum soil pH was recorded under the treatment T_1 i.e., 7.41 and 7.49 at 0-15cm, 15-30cm respectively. EC (dSm^{-1}) was influenced significantly it is ranged from 0.34 dSm^{-1} to 0.47 dSm^{-1}. A maximum EC was recorded in T9 and minimum in T_1, in both the depths. Soil organic carbon content maximum in

Table 1. Particular of the treatments

S. No.	Treatment	Dosage	Symbol
1.	Levels of N P K	0% N P K	I_0
		50% N P K	I_1
		100% N P K	I_2
2.	Levels of FYM	0% FYM	F^1
		50% FYM	F^2
		100% FYM	F^3
3.	Levels of Rhizobium	0% Rhizobium	**R_1**
		25% Rhizobium	**R_2**
		50% Rhizobium	**R_3**

Table 2. Physical analysis of pre-sowing soil

Particulars	Method employed	Results
Sand (%)		55%
Silt (%)	Bouyoucos Hydrometer [8]	30%
Clay (%)		15%
Textural class		Sandy loam
Soil Colour	Munsell color chart	Yellowish brown
Bulk density (Mg m^{-3})		1.24%
Particle density (Mg m^{-3})	Graduated measuring cylinder method Muthuval *et al.* [1]	2.48
Pore Space (%)		51.56%

Table 3. Chemical analysis of pre-sowing soil

Particulars	Method employed	Results
Soil pH (1:2)	Jackson [9]	7.41
Soil EC (dSm^{-1})	Wilcox [10]	0.34
Organic Carbon (%)	Walkley and Black's [11]	0.51
Available Nitrogen (kg ha^{-1})	Subbiah and Asija [12]	239.96
Available Phosphorus (kg ha^{-1})	Olsen *et al.* [13]	14.06
Available Potassium (kg ha^{-1})	Toth and Prince [14]	158.28

Table 4. Effect of NPK, FYM and Rhizobium on Physico-chemical properties of post-harvest soil of Pea

Soil Parameters →	Bulk density(Mg m^{-3})		Particle density (Mg m^{-3})		Pore space (%)		WHC (%)		pH (1:2)		EC (dSm^{-1})		OC (%)		Nitrogen(Kg ha^{-1})		Phosphorus (Kg ha^{-1})		Potassium (Kg ha^{-1})	
Depths (cm) →	**0-15**	**15-30**	**0-15**	**15-30**	**0-15**	**15-30**	**0-15**	**15-30**	**0-15**	**15-30**	**0-15**	**15-30**	**0-15**	**15-30**	**0-15**	**15-30**	**0-15**	**15-30**	**0-15**	**15-30**
Treatments↓																				
T1	1.24	1.26	2.48	2.50	51.56	50.66	52.73	51.46	7.41	7.49	0.34	0.35	0.51	0.40	239.96	234.26	14.06	13.70	158.2	156.7
T2	1.23	1.25	2.47	2.49	52.65	51.60	53.40	52.96	7.53	7.48	0.35	0.38	0.53	0.43	242.90	237.86	14.66	14.20	164.3	163.2
T3	1.22	1.23	2.47	2.48	53.55	52.66	54.50	53.36	7.57	7.52	0.35	0.38	0.53	0.44	247.56	240.70	15.26	14.63	167.2	164.6
T4	1.22	1.23	2.45	2.46	54.58	53.33	55.43	54.43	7.52	7.52	0.40	0.41	0.54	0.44	250.50	245.36	15.20	15.00	167.6	166.4
T5	1.22	1.22	2.45	2.46	55.54	54.47	55.50	55.40	7.69	7.68	0.40	0.42	0.55	0.45	254.96	262.30	15.43	15.53	168.6	166.6
T6	1.21	1.20	2.45	2.45	56.32	55.61	56.66	55.90	7.70	7.70	0.41	0.42	0.56	0.47	259.16	264.30	15.80	15.86	171.9	167.2
T7	1.20	1.20	2.44	2.44	56.81	56.72	57.03	56.13	7.71	7.71	0.44	0.44	0.56	0.47	261.23	272.76	16.03	16.26	174.9	167.5
T8	1.18	1.19	2.43	2.44	57.14	57.44	57.73	56.70	7.72	7.74	0.44	0.45	0.57	0.48	276.06	281.10	16.36	16.83	175.9	169.5
T9	1.17	1.18	2.41	2.42	58.26	58.09	58.60	58.13	7.75	7.75	0.47	0.48	0.58	0.49	280.86	286.40	16.56	17.26	178.1	172.8
F-Test	NS	NS	NS	NS	S	S	S	S	NS	NS	S	S	S	S	S	S	S	S	S	S
S. Em. (±)	-	-	-	-	0.33	0.25	0.17	0.18	-	-	0.002	0.006	0.007	0.008	2.01	1.28	0.19	0.21	1.18	0.84
C.D.(P=0.05)	-	-	-	-	0.99	0.78	0.52	0.54	-	-	0.007	0.019	0.023	0.025	6.06	3.38	0.57	0.63	2.52	1.80

T_9 with a value of 0.58% and 0.49% in 0-15cm and 15- 30cm soil depth respectively it was followed by T_7. The available nitrogen content in soil ranged from 239.96 kg ha^{-1} to 280.86 kg ha^{-1} at 0-15cm soil depth and 234.26 kg ha^{-1} to 286.40 kg ha^{-1} at 15-30cm soil depth. Maximum T_9 and minimum in T_1, recorded both soil depth. Available phosphorus at 0-15cm soil depths, phosphorus levels ranged from 14.06 kg ha^{-1} to 16.56 kg ha^{-1} while at 15-30cm soil depth it was 13.70 kg ha^{-1} to 17.26 kg ha^{-1} and T_9 had the most accessible phosphorus in both soil depths, owing to increased soil organic carbon, which boosted the activity of phosphorus solubilizing microorganism in the soil. The maximum available potassium in 0-15cm and 15-30cm soil depth i.e., 158.2 kg ha^{-1} and 178.1 kg ha^{-1} and 156.7 kg ha^{-1}, 172.8 kg ha^{-1} respectively (which was at par with T_8 and T_7) followed by T_6 (which was at par with T_5 and T_4) followed by T_3 (which was at par with T_2 and T_1) in both soil depth by *Rhizobium* inoculation, FYM and NPK application. Similar results were also reported by Sharma and Thakur *et al.* [15].

4. CONCLUSION

Treatment I_3@100% +@ 100% F_3 + @50%R_3 was the best in terms of physico-chemical parameters like bulk density, particle density, % pore space, water holding capacity, pH, EC, soil organic carbon and soil available nutrients. Nevertheless, fertilizer requirements in pea are critical for early development and overall yield generation. But Crop productivity can be improved by combining biofertilizer, organic and inorganic fertilizers also enhance nutrient absorption, which accelerates cell division, cell elongation and hence plant metabolic activity.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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