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

Abstract

During the Rabi season 2021-2022, the field experiment was conducted at the soil science research farm of the Sam Higginbottom University of Agriculture, Technology and Sciences in Prayagraj. Three different parameters were used in the study: 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}. The result obtained with treatment T_9[I_3@100% + F_3@ 100% + R_3@50%] showed 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, Organic Carbon (0.58%) at 0-15cm and (0.49%) at 15-30cm, 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}). Under control and full NPK fertilizer application, no significant differences in Pea yield and growth were detected. The use of FYM and *Rhizobium*, as well as its blend with complete NPK, significantly improves the growth and overall production of Pea.

Keywords: Physico-chemical Properties of soil, NPK, FYM, *Rhizobium*, Pea, Yield attributes

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. 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.

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. FYM is a type of bulky organic manure that is widely employed. Since it is derived from plant and animal residues therefore, it 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. It pulverises the soil and improves the structure of the soil. Thus, an integrated strategy to nutrient supply that includes chemical fertilisers, organic manure, and biofertilizer 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.

Materials and Method

The field investigation was carried out with garden pea variety GS-10 during Rabi season 2021 in research area Department of Soil science and Agricultural Chemistry, SHUATS, Prayagraj, at 25°24’30” North latitude, 81°51’10” East longitude and 98 m above mean sea level. The soil in the experimental area is classified as Inceptisol, and the soil in the experimental plots is alluvial in character. The soil texture (% of sand, silt, and clay) of the departmental research farm, with soil samples taken at depths of 0-15cm and 15-30cmThe 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). Basal doses of nitrogen, phosphorus and potassium are applied to the field where RDF was found 30:50:50 NPK kg ha^{-1}. The sources of NPK were Urea, SSP, MOP. 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.

Chart 1: Soil texture property

Particulars	Method employed	Results
Sand (%)		55%
Silt (%)	Bouyoucos Hydrometer (1927)	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.*, (1992)	2.48
Pore Space (%)		51.56%

Chart 2: Study methods

Particulars	Method employed	Results
Soil pH (1:2)	Jackson (1958)	7.41
Soil EC (dSm^{-1})	Wilcox (1950)	0.34
Organic Carbon (%)	Walkley and Black's (1947)	0.51
Available Nitrogen (kg ha^{-1})	Subbiah and Asija (1956)	239.96
Available Phosphorus (kg ha^{-1})	Olsen *et al.* (1950)	14.06
Available Potassium (kg ha^{-1})	Toth and Prince (1949)	158.28

Results and Discussion

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 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 T_9. 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 T_9. 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 also reported by Yadav *et. al.,* (2018), Bhambhu *et al*., (2016).

Effects of various treatment combinations on soil chemical properties

The application of NPK, FYM and Rhizobium inoculation significantly, affect the soil pH at 0-15cm and 15-30cm soil depth. Minimum soil pH was recorded under the treatment T_1 i.e., 100% NPK + % 100FYM + 50% Rhizobium. EC (dSm^{-1}) was influenced significantly it is ranged from 0.34 dSm^{-1} to 0.47 dSm^{-1}. Maximum EC was recorded into T_9 and Minimum in T_1, recorded into both soil depth. % Organic carbon maximum found in T_9 0.58% and 0.49% in 0-15cm and 15-30cm soil depth respectively 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 depth, phosphorus levels ranged from 14.06 kg ha $^{-1}$ to 16.56 kg ha^{-1} at 15-30cm soil depth 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.,* (2016).

Table 1: 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) → / Treatments ↓	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
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	-	-	0.006	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	-	-	0.019	0.019	0.023	0.025	6.06	3.38	0.57	0.63	2.52	1.80

Conclusion

The effect of different levels in the experiment was concluded based on the trail. Treatment T_9 (I_3@100% +@ 100% F_3 + @50%R_3) was shown to be the best in terms of Physico-Chemical parameters of soil such as Bulk density, Particle density, % pore space, Water holding capacity, pH, EC, % Organic carbon, Available Nitrogen, Available Phosphorus, Available Potassium. Fertilizer requirements in pea are critical for early development and overall yield generation. 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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