



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(8): 01-05
Received: 02-05-2026
Accepted: 08-06-2026

Sarika Kumari
Research Scholar, Department of
Soil Science, Faculty of
Agriculture, Prof. Rajendra Singh
(Rajju Bhaiya) University,
Prayagraj, Uttar Pradesh, India

Tarun Kumar
Assistant Professor, Department of
Soil Science, Faculty of
Agriculture, Prof. Rajendra Singh
(Rajju Bhaiya) University,
Prayagraj, Uttar Pradesh, India

Shalini Kumari
Research Scholar, Department of
Soil Science, Faculty of
Agriculture, Prof. Rajendra Singh
(Rajju Bhaiya) University,
Prayagraj, Uttar Pradesh, India

Kashish Kumari
Research Scholar, Department of
Soil Science, Faculty of
Agriculture, Prof. Rajendra Singh
(Rajju Bhaiya) University,
Prayagraj, Uttar Pradesh, India

Corresponding Author:
Tarun Kumar
Assistant Professor, Department of
Soil Science, Faculty of
Agriculture, Prof. Rajendra Singh
(Rajju Bhaiya) University,
Prayagraj, Uttar Pradesh, India

Effect of phosphorous and zinc on physico-chemical properties of soil of garden pea (*Pisum sativum* Var. *hortense* L. CV. Psm-3) under alluvial soil of Prayagraj

Sarika Kumari, Tarun Kumar, Shalini Kumari and Kashish Kumari

DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i8a.6189>

Abstract

The Field Experiment was titled “Effect of Phosphorous and Zinc on Physio-Chemical Properties of Soil of Garden Pea (*Pisum sativum* var. *hortense* L. cv. PSM-3)” was conducted during *Rabi* 2025 -26 at the Crop Research Farm, Department of Soil Science, Prof. Rajendra Singh (Rajju Bhaiya) University, Naini, Prayagraj- 211010 (U.P.) India. The soil of experimental plot was sandy loamy in texture. The experiment was laid out in Randomized Block Design with Nine treatments which are replicated thrice. The result showed that Physico-Chemical Properties of soil was observed maximum bulk density 1.336 Mg m^{-3} at 0 -15 cm and 1.356 Mg m^{-3} at 15- 30 cm, higher particle density 2.610 Mg m^{-3} at 0 -15 cm and 2.657 Mg m^{-3} at 15- 30 cm was recorded in Treatment T_1 (control) and Water Holding Capacity 49.88% at 0 -15 cm and 49.29% at 15- 30 cm, higher Percentage Pore Space 54.20% at 0 -15 cm and 52.2% at 15- 30 cm were recorded in T_9 (Phosphorous @ 60 kg ha^{-1} + Zinc @ 15 kg ha^{-1}). pH of soil 7.30% at 0 -15 cm and 7.37% at 15- 30 cm, maximum EC 0.423 dSm^{-1} at 0 -15 cm and 0.441 dSm^{-1} 15- 30 cm was recorded in T_1 (control). The higher Organic Carbon 0.547% at 0 -15 cm and 0.536% at 15- 30 cm, maximum Phosphorus 22.81 kg ha^{-1} at 0 -15 cm and 19.26 kg ha^{-1} at 15- 30 cm and Zinc 0.419 kg ha^{-1} at 0 -15 cm and 0.411 kg ha^{-1} at 15- 30 cm was observed in T_9 (Phosphorous @ 60 kg ha^{-1} + Zinc @ 15 kg ha^{-1}). The findings indicate that the combined application of phosphorous and zinc serves as an efficient nutrient management strategy to improve soil fertility and maximize garden pea productivity in the alluvial soils of Prayagraj.

Keywords: Garden pea, physio-chemical properties of soil, phosphorous, zinc and economics

1. Introduction

Garden pea (*Pisum sativum* L.) is one of the most important cool-season vegetable crops belonging to the family *Fabaceae*. It is widely cultivated throughout temperate and subtropical regions of the world for its tender green pods and seeds, which are rich in proteins, carbohydrates, vitamins, and minerals. Pea is considered an important dietary component because of its high nutritive value and digestibility. Green peas contain approximately 20–25% protein, appreciable amounts of vitamins A, B, and C, and essential minerals such as phosphorus, calcium, and iron.

Role of Phosphorous (P) and zinc (Zn) are essential macro- and micronutrients, respectively, required for optimum growth, nodulation, flowering, and seed development in garden pea. Phosphorus plays a key role in root growth, energy transfer (ATP), nodulation, and efficient biological nitrogen fixation, whereas zinc is involved in enzyme activation, protein synthesis, auxin metabolism, membrane integrity, and pollen formation. Gupta *et al.* (2017) [3].

Role of Phosphorous (P) and zinc (Zn) are essential macro- and micronutrients, respectively, required for optimum growth, nodulation, flowering, and seed development in garden pea. Phosphorus plays a key role in root growth, energy transfer (ATP), nodulation, and efficient biological nitrogen fixation, whereas zinc is involved in enzyme activation, protein synthesis, auxin metabolism, membrane integrity, and pollen formation. Zinc deficiency adversely affects plant growth by reducing internodal elongation, leaf expansion, and reproductive development. Deficiencies of phosphorus and zinc have been widely reported in the cultivated soils of the North-Eastern Hill region of India, leading to poor crop performance and yield reduction in legumes and vegetable crops. Balanced application of phosphorus and zinc along with major nutrients is therefore essential for improving growth and productivity of garden pea. Several studies have

demonstrated that the combined application of phosphorus and zinc significantly enhances growth parameters, yield attributes, and seed quality in legumes, including garden pea Gupta *et al.* (2017) [3].

2. Materials and Methods

The experiment was conducted during Rabi 2025-26 at the Soil Science Research Farm, Department of Soil Science, PRSU, Naini, Prayagraj-211010 (U.P.). The experiment was laid out in Randomized Block Design (RBD) with four levels of Phosphorus and Zinc. The treatments have been replicated three times. The different treatments were employed randomly in each replication. Treatment consists of nine combinations of T₁ Control, T₂ Phosphorous 55 kg ha⁻¹, T₃ Phosphorous 60 kg ha⁻¹, T₄ Zinc 10 kg ha⁻¹, T₅ Zinc 15 kg ha⁻¹, T₆ Phosphorous 55 kg ha⁻¹ + Zinc 10 kg ha⁻¹, T₇ Phosphorous 55 kg ha⁻¹ + Zinc 15 kg ha⁻¹, T₈ Phosphorous 60 kg ha⁻¹ + Zinc 10 kg ha⁻¹, T₉ Phosphorous 60 kg ha⁻¹ + Zinc 15 kg ha⁻¹.

RDF for Zinc = 20 kg/ha.

Source: Handbook of Agriculture, by ICAR, 2016.

The physical properties of the soil samples, namely bulk density (Mg m⁻³), particle density (Mg m⁻³), pore space (%), and water-holding capacity (%), were determined standard analytical procedures described by Muthuvel *et al.* (1992). The chemical properties of the soil samples were analysed using standard analytical procedures. Soil pH (1:2 soil-water suspension) was determined by the method of Jackson (1973) [6]. Electrical conductivity (dSm⁻¹) was estimated using the method described by Wilcox (1950) [12]. Organic carbon (%) was determined by the Walkley and Black's method (1934). Available nitrogen (kg ha⁻¹) was estimated by the method of Subbiah and Asija (1956), while available phosphorus (kg ha⁻¹) was determined using the Olsen *et al.* (1954) [9], Available potassium (kg ha⁻¹) was estimated by the method of Toth and Prince (1949), Available Zn were determined by Lindsay and Norvell (1978) procedure using DTPA extractant.

3. Results and Discussion

3.1. Effect of Various Treatment Combination on Soil Physical Properties

Bulk density (Mg m⁻³)

Bulk density of soil was increase according to depth which was found to be maximum 1.336 Mg m⁻³ at 0 -15 cm and 1.356 Mg m⁻³ at 15- 30 cm in treatment T₁ which was followed by 1.313 Mg m⁻³ at 0 -15 cm and 1.329 Mg m⁻³ at 15- 30 cm in treatment T₂. Whereas, Minimum 1.159 Mg m⁻³ at 0 -15 cm and 1.245 Mg m⁻³ at 15- 30 cm in T₉. Bulk density is an important physical property of soil that reflects soil compaction, pore space distribution, and root penetration capacity. However, since the observed differences were non-significant, it can be inferred that phosphorus and zinc fertilization had little direct influence on soil physical structure during a single cropping season.

Particle density (Mg m⁻³)

Particle density (Mg m⁻³) of soil was increase according to depth which was found to be maximum 2.610 Mg m⁻³ at 0 -15 cm and 2.657 Mg m⁻³ at 15- 30 cm in treatment T₁ which was followed by 2.540 Mg m⁻³ at 0 -15 cm and 2.620 Mg m⁻³ at 15- 30 cm in treatment T₂. Whereas, Minimum 2.349 Mg m⁻³ at 0 -15 cm and 2.368 Mg m⁻³ at 15- 30 cm in T₉. The results indicate that levels of phosphorus and zinc tended to increase particle density, although the magnitude of change was relatively small. The values obtained in the present investigation fall within the normal

range reported for mineral soils. Similar Findings were reported by Kumar *et al.* (2020) [7].

Water Holding Capacity (%)

Water holding capacity (%) of soil was increases according to depth which was found to be maximum 49.88% at 0 -15 cm and 49.29% at 15- 30 cm in treatment T₉ which was followed by 49.20% at 0 -15 cm and 48.49% at 15- 30 cm in treatment T₈. Whereas, Minimum 43.64% at 0 -15 cm and 42.45% at 15- 30 cm in treatment T₁ respectively. These results are consistent with those of by Vasava *et al.* (2020) [10].

Percentage Pore Space (%)

Percent Pore space (%) of soil was increases according to depth which was found to be maximum 54.20% at 0 -15 cm and 52.22% at 15- 30 cm in treatment T₉ with application of (Phosphorus 60 kg ha⁻¹ + Zinc 15 kg ha⁻¹) which was followed by 52.43 at 0 -15 cm and 51.04% at 15- 30 cm in treatment T₈ with application of (Phosphorous 60 kg ha⁻¹ + Zinc 10 kg ha⁻¹). Whereas, Minimum 45.15% at 0 -15 cm and 43.40% at 15- 30 cm in treatment T₁ respectively. Similar findings were reported by Hussain *et al.*, (2022) [4].

3.2 Effect of Various Treatment Combination on Soil Chemical Properties

pH of soil w/v (1:2.5)

pH of soil was increase according to depth which was found to be maximum 7.30% at 0 -15 cm and 7.37% at 15- 30 cm in treatment T₁ with application of (Control) which was followed by 7.28% at 0 -15 cm and 7.33% at 15- 30 cm in treatment T₂ with application of (Phosphorous 55 kg ha⁻¹). Whereas, Minimum 6.68% at 0 -15 cm and 6.83% at 15- 30 cm in treatment T₉ with application of (Phosphorus 60 kg ha⁻¹ + Zinc 15 kg ha⁻¹) respectively. Zinc application, in combination with phosphorus, may have influenced the exchange reactions in the soil solution, indicating that phosphorus and zinc application had only a limited effect on soil reaction.

Electrical Conductivity EC (dS m⁻¹)

EC of soil was increase according to depth which was found to be maximum 0.423 dSm⁻¹ at 0 -15 cm and 0.441 dSm⁻¹ 15- 30 cm in treatment T₁ which was followed by 0.414 dSm⁻¹ at 0 -15 cm and 0.421 dS m⁻¹ at 15- 30 cm in treatment T₂. Whereas, Minimum 0.330 dSm⁻¹ at 0 -15 cm and 0.343 dSm⁻¹ at 15- 30 cm treatment T₉. Present findings agree with the observation of Hussain *et al.*, (2022) [4].

Organic carbon (%)

Organic carbon (%) of soil was increases according to depth which was found to be maximum 0.547% at 0 -15 cm and 0.536% at 15- 30 cm in treatment T₉ which was followed by 0.529% at 0 -15 cm and 0.513% at 15- 30 cm in treatment T₈. Whereas, Minimum 0.443% at 0 -15 cm and 0.434% at 15- 30 cm in treatment T₁ respectively. Similar results were also reported by Yadav *et al.* (2021) [11].

Nitrogen (kg ha⁻¹)

Available Nitrogen kg ha⁻¹ of soil was found to be maximum 311.53 kg ha⁻¹ at 0 -15 cm and 308.19 kg ha⁻¹ at 15- 30 cm in treatment T₉ which was followed by 309.16 kg ha⁻¹ at 0 -15 cm and 297.49 kg ha⁻¹ at 15- 30 cm in treatment T₈. Whereas, Minimum 263.16 kg ha⁻¹ at 0 -15 cm and 260.49 kg ha⁻¹ at 15- 30 cm treatment T₁. Our results are in line with Hussain *et al.*, (2022) [4].

Phosphorous (kg ha⁻¹)

Available Phosphorous kg ha⁻¹ of soil was increase according to depth which was found to be maximum 22.81 kg ha⁻¹ at 0 -15 cm and 19.26 kg ha⁻¹ at 15- 30 cm in treatment T₉ which was followed by 21.84 kg ha⁻¹ at 0 -15 cm and 18.75 kg ha⁻¹ at 15- 30 cm in treatment T₈. Whereas, Minimum 16.96 kg ha⁻¹ at 0 -15 cm and 15.77 kg ha⁻¹ at 15- 30 cm treatment T₁. A similar trend was also observed by Vasava *et al.*, (2020) ^[10].

Potassium (kg ha⁻¹)

Available potassium of soil was increase according to depth which was found to be maximum 220.42 kg ha⁻¹ at 0 -15 cm and 210.67 kg ha⁻¹ at 15- 30 cm in treatment T₉ which was followed

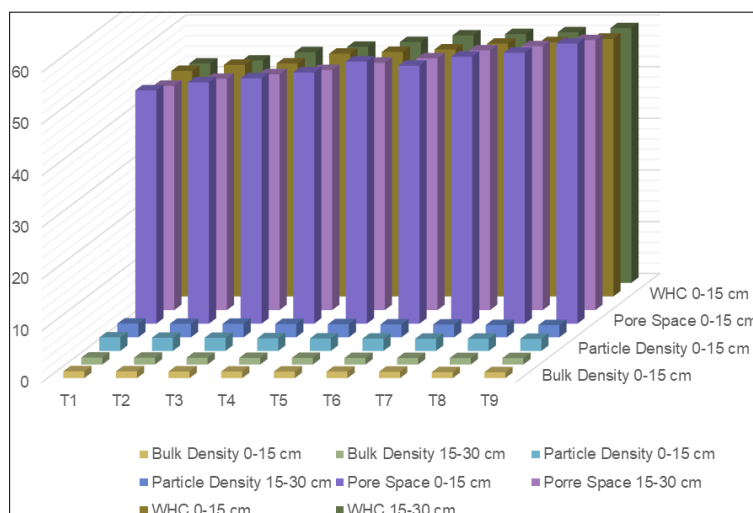
by 216.95 kg ha⁻¹ at 0 -15 cm and 207.65 kg ha⁻¹ at 15- 30 cm in treatment T₈. Whereas, Minimum 191.23 kg ha⁻¹ at 0 -15 cm and 186.55 kg ha⁻¹ at 15- 30 cm treatment T₁. These findings are in accordance with the results reported by Hussain *et al.*, (2022) ^[4].

Zinc (mg kg⁻¹)

Available Zinc (mg kg⁻¹) of soil was found to be maximum 0.419 mg kg⁻¹ at 0 -15 cm and 0.411 mg kg⁻¹ at 15- 30 cm in treatment T₉ which was followed by 0.412 mg kg⁻¹ at 0 -15 cm and 0.406 mg kg⁻¹ at 15- 30 cm in treatment T₈. Whereas, Minimum 0.336 mg kg⁻¹ at 0 -15 cm and 0.287 mg kg⁻¹ at 15- 30 cm in treatment T₁. These findings are in agreement with the observations reported by Yadav *et al.* (2021) ^[11],

Table 1: Effect of Phosphorous and Zinc on Bulk Density, Particle Density, Pore Space Percentage, Water Holding Capacity

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	Control	1.33	1.35	2.61	2.65	45.15	43.40	43.64	42.45
T ₂	Phosphorous 55 kg ha ⁻¹	1.31	1.32	2.54	2.62	46.70	44.74	44.83	43.02
T ₃	Phosphorous 60 kg ha ⁻¹	1.29	1.31	2.53	2.61	47.48	45.63	45.09	44.63
T ₄	Zinc 10 kg ha ⁻¹	1.28	1.29	2.43	2.57	48.61	46.45	46.98	45.67
T ₅	Zinc 15 kg ha ⁻¹	1.27	1.28	2.40	2.53	50.72	47.85	47.32	46.60
T ₆	Phosphorous 55 kg/ha + Zinc 10 kg ha ⁻¹	1.26	1.27	2.38	2.49	49.93	48.71	47.80	47.87
T ₇	Phosphorous 55 kg/ha + Zinc 15 kg ha ⁻¹	1.25	1.26	2.36	2.47	51.66	50.26	48.93	48.14
T ₈	Phosphorous 60 kg/ha + Zinc 10 kg ha ⁻¹	1.17	1.25	2.35	2.37	52.43	51.04	49.20	48.49
T ₉	Phosphorous 60 kg/ha + Zinc 15 kg ha ⁻¹	1.15	1.24	2.34	2.36	54.20	52.22	49.88	49.29
F-Test		NS	NS	NS	NS	S	S	S	S
S.Ed. (±)		-	-	-	-	0.98	1.14	1.33	1.17
C.D. at 0.5%		-	-	-	-	2.09	2.42	2.83	2.50

**Fig 1:** Effect of all treatments on bulk density (Mg m⁻³), Particle density (Mg m⁻³), Pore space (%) and Water holding capacity (%) of soil.**Table 2:** Effect of Phosphorous and Zinc on pH, EC, Organic Carbon

Treatments		pH		EC (dSm ⁻¹)		Organic carbon (%)	
		0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T ₁	Control	7.30	7.37	0.42	0.44	0.443	0.434
T ₂	Phosphorous 55 kg ha ⁻¹	7.28	7.33	0.41	0.42	0.462	0.445
T ₃	Phosphorous 60 kg ha ⁻¹	7.24	7.27	0.39	0.41	0.480	0.459
T ₄	Zinc 10 kg ha ⁻¹	7.23	7.28	0.38	0.40	0.470	0.476
T ₅	Zinc 15 kg ha ⁻¹	7.20	7.25	0.37	0.39	0.530	0.489
T ₆	Phosphorous 55 kg/ha + Zinc 10 kg ha ⁻¹	7.09	7.17	0.36	0.37	0.496	0.493
T ₇	Phosphorous 55 kg/ha + Zinc 15 kg ha ⁻¹	6.96	7.09	0.35	0.36	0.518	0.505
T ₈	Phosphorous 60 kg/ha + Zinc 10 kg ha ⁻¹	6.87	6.96	0.34	0.35	0.529	0.513
T ₉	Phosphorous 60 kg/ha + Zinc 15 kg ha ⁻¹	6.68	6.83	0.33	0.34	0.547	0.536
F-Test		S	S	S	S	S	S
S.Ed. (±)		0.16	0.20	0.01	0.02	0.02	0.01
C.D. at 0.5%		0.34	0.44	0.03	0.04	0.05	0.01

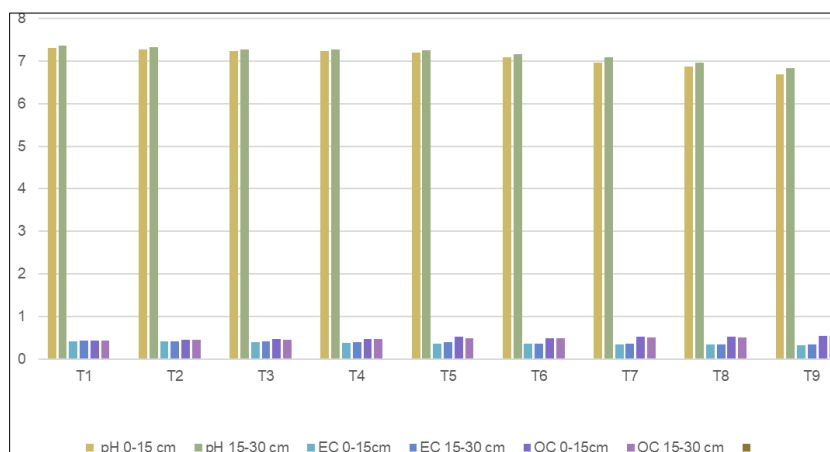


Fig 2: Effect of all treatments on pH, EC (dSm⁻¹), and Organic carbon (%) of soil.

Table 3: Effect of Phosphorous and Zinc on Available NPK, Available Zinc

Treatments		Available Nitrogen (kg ha ⁻¹)		Available phosphorus (kg ha ⁻¹)		Available Potassium (kg ha ⁻¹)		Available Zinc (mg kg ⁻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
T ₁	Control	263.16	260.49	16.96	15.77	191.23	186.55	0.336	0.287
T ₂	Phosphorous 55 kg ha ⁻¹	264.50	262.50	17.88	16.56	192.41	188.82	0.346	0.308
T ₃	Phosphorous 60 kg ha ⁻¹	270.17	267.17	18.24	16.87	195.58	190.56	0.359	0.295
T ₄	Zinc 10 kg ha ⁻¹	284.62	277.95	18.07	17.31	198.08	193.72	0.370	0.328
T ₅	Zinc 15 kg ha ⁻¹	292.76	280.43	19.10	18.29	202.56	196.80	0.380	0.344
T ₆	Phosphorous 55 kg ha ⁻¹ + Zinc 10 kg ha ⁻¹	298.99	283.66	19.46	17.34	208.78	200.45	0.392	0.363
T ₇	Phosphorous 55 kg ha ⁻¹ + Zinc 15 kg ha ⁻¹	304.99	288.66	20.33	18.34	212.81	202.72	0.398	0.377
T ₈	Phosphorous 60 kg ha ⁻¹ + Zinc 10 kg ha ⁻¹	309.16	297.49	21.84	18.75	216.95	207.65	0.412	0.406
T ₉	Phosphorous 60 kg ha ⁻¹ + Zinc 15 kg ha ⁻¹	311.53	308.19	22.81	19.26	220.42	210.67	0.419	0.411
F-Test		S	S	S	S	S	S	S	S
S.Ed. (±)		10.22	11.43	0.74	1.17	1.93	1.72	0.00	0.00
C.D. at 0.5%		30.78	34.41	1.58	2.50	4.06	3.85	0.02	0.01

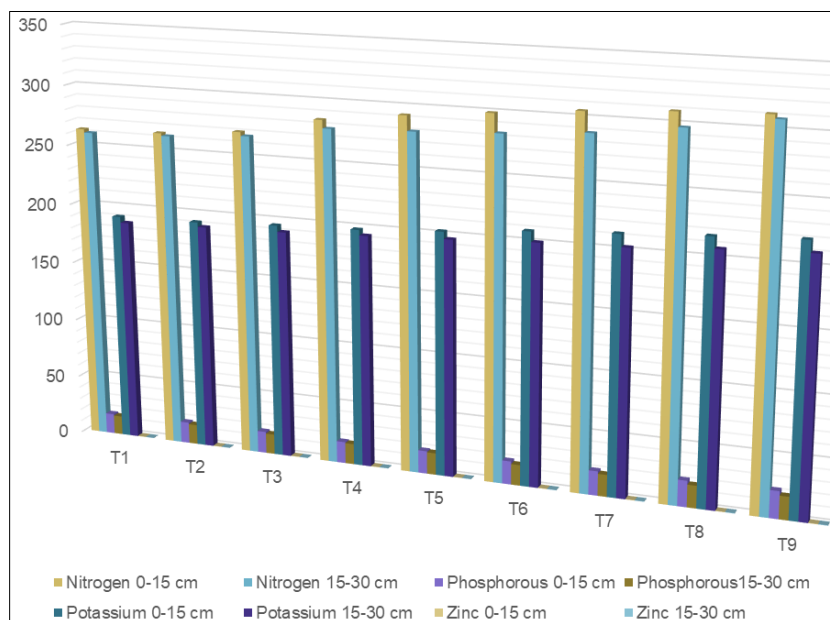


Fig 3: Effect of all treatment on Available nitrogen (kg ha⁻¹), Available phosphorus (kg ha⁻¹), Available potassium (kg ha⁻¹), Available Zinc (mg kg⁻¹) in soil.

4. Conclusion

Treatment – 9 with application of (Phosphorus 60 kg/ha + Zinc 15 kg/ha) was seen to be best for all the physio-chemical, growth, yield and economics parameters. T₉ led to a statistically significant increase in yield components, achieving the highest green pod yield (115.77 q ha⁻¹), number of pods per plant (11.15), and pod length (8.32cm). Economic analysis in confirms that T₉

was the most profitable treatment, delivering the maximum net profit of ₹1,84,549.07 ha⁻¹ and the highest benefit-cost ratio of for optimal growth, maximum green pod yield, and the highest economic returns in garden pea cultivation,

Acknowledgement

The authors express their gratitude to the Hon'ble Vice Chancellor

of PRSU's Department of Soil Science in Naini, Prayagraj, for his enthusiastic interest in and support of the study project. I like his insightful criticism and practical recommendations for improving the caliber of my work.

Competing Interests

The authors declare that there are no conflicts of interest regarding the publication of this paper.

References

1. Bouyoucos GJ. The hydrometer as a new method for the mechanical analysis of soils. *Soil Science*. 1927;23:343–353.
2. Government of India. Agricultural production and productivity statistics handbook 2024–2025. New Delhi: Ministry of Agriculture and Farmers Welfare; 2025.
3. Gupta RK, Kumar T, Singh M. Morphological and physiological evaluation of garden pea cv. PSM-3 under varied fertility tiers. *Journal of Food Legumes*. 2017;29(3):190–195.
4. Hussain M, Ali A, Ahmad S, Iqbal MA. Influence of foliar zinc and boron on yield and quality of chickpea. *The Pharma Innovation Journal*. 2022;11(5):1550–1554.
5. Hossain MA, Jahiruddin M, Islam MR. Effect of boron and zinc on growth and yield of chickpea. *Bangladesh Agronomy Journal*. 2016;19(1):45–53.
6. Jackson ML. Soil chemical analysis. New Delhi: Prentice Hall of India Ltd.; 1958. p. 219–221.
7. Kumar J. Effect of phosphorus and Rhizobium inoculation on growth, nodulation and yield of garden pea 'Mattar Ageta-6'. *Indian Journal of Agronomy*. 2020;54(3):319–323.
8. Kumar V, Singh AK, Singh SK. Effect of organic amendments on phosphorus fractions and availability in alluvial soil. *Annals of Agricultural Research*. 2015;36(2):152–158.
9. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Circular No. 939. Washington (DC): United States Department of Agriculture; 1954.
10. Vasava HB, Aspinall D, Vestergaard RJ. Quantitative assessment of soil physical and chemical attributes using proximally sensed data. *Soil and Tillage Research*. 2020;199:104525.
11. Yadav SK, Alluvial PJ, Central C. Soil organic carbon (SOC) dynamics and continuous production challenges under Ganga-Yamuna plains. *Alluvial Soil Research*. 2023;14(3):114–121.
12. Wilcox LV. Electrical conductivity. *Journal of the American Water Works Association*. 1950;42(8):775–776.