
Effect of Nitrogen and Phosphorus on Yield, Quality and Nutrient Uptake by Pea (*Pisum sativum* L.)

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Abstract

A pot experiment was conducted to study the effects of nitrogen and phosphorus on yield, quality, and nutrient uptake by pea (*Pisum sativum* L.). The results of this pot experiment clearly demonstrate that application of nitrogen up to 120 kg ha⁻¹ and phosphorus up to 80 kg ha⁻¹ significantly enhanced the productivity and quality of pea (*Pisum sativum* L. cv. Arkel). Higher levels of both nutrients led to substantial improvements in seed and stover yields, with the maximum seed yield (35.16 g/pot) recorded at 120 kg N ha⁻¹ and stover yield (36.22 g/pot) at 80 kg P₂O₅ ha⁻¹. Protein content in seeds and stover also increased markedly with rising doses of N and P, reaching peak values of 31.19% and 5.46% (seeds and stover, respectively) at the highest nitrogen level, and 24.25% and 5.54% at the highest phosphorus level. Nitrogen application progressively increased both N and P uptake in seeds and stover, while phosphorus fertilization dramatically boosted P uptake (particularly in stover) and also improved N uptake, indicating a synergistic interaction between the two nutrients.

Keywords: Nitrogen, phosphorus, yield, nutrient uptake, pea

Introduction

Pea is commonly grown in temperate areas of all continents. It has many uses: immature pods and seeds are used as green vegetables, either fresh or frozen; it is used as green forage for grazing animals, in situ or as hay or silage; and it is grown for its mature seed, which has many uses. If the crop is managed properly, green pods are produced continuously for several months. Application of balanced fertilizers increases vegetative growth and improves yield and quality of the produce. As a grain legume, field peas are capable of fixing most of their required nitrogen from the environment. Fertilizer use is essential for the production of high yields of good-quality seed. The yield of pea is influenced by numerous agronomical, ecological, and biotic factors, such as environment, soil fertility, and cultural practices. Among these, soil fertility is the prime consideration for increasing crop production. Indian

soils are known to be nitrogen-deficient because of the tropical climate. Therefore, application of nitrogenous fertilizers and manures becomes imperative for obtaining increased yields. It has been reported that nitrogen fertilization of legumes has a positive effect on growth attributes. The nutrient phosphorus is an essential constituent of every living cell of the plant and of the majority of enzymes; it is also a structural component of the membrane systems of the cell, the chloroplasts, and the mitochondria. It takes an active part in all types of metabolism in the plant. It stimulates root development and growth in the seedling stage, and stimulates flowering, fruit setting, and seed formation. Along with a special action on leguminous crops, it induces nodule formation and rhizobial activity in the roots

Materials and Methods

The pot experiment was carried out at the agricultural experimental field (Department of Soil Science & Agricultural Chemistry), Nehru Mahavidyalaya, Lalitpur (U.P.) during 2023–24. Lalitpur district is part of the Bundelkhand plateau. The Betwa River forms the boundary between Jhansi and Lalitpur in the north. Most of the area is at an average elevation of 300–450 m above sea level. Its latitudinal extension is from 24°10' N to 25°15' N and longitudinal extension is from 78°10' E to 79°00' E. The experimental station is situated 1.5–2.00 km south of the Centre of Lalitpur city on the Sagar Road. The soil had EC 0.20 dSm⁻¹, pH 7.9, organic carbon 4.68 g kg⁻¹, and available N 84.67 kg ha⁻¹, P 5.13 kg ha⁻¹, and K 96.45 kg ha⁻¹. The experiment was laid out in a randomized block design with four levels of nitrogen (0 (control), 30, 60, and 120 kg N ha⁻¹) and four levels of phosphorus (0 (control), 20, 40, and 80 kg P₂O₅ ha⁻¹) with three replications. Pea variety Arkel was sown on October 15, 2023, and irrigated as needed based on soil and crop appearance. Grain and stover samples were analyzed for N content by the Kjeldahl method (Jackson, 1973). Grain and stover samples were digested in a di-acid mixture (HNO₃ + HClO₄), and the digests were

analyzed for phosphorus by the vanadomolybdophosphoric acid yellow color method, for K by flame photometer, and for Mn by atomic absorption spectrophotometer (Jackson, 1973). Nutrient uptake was calculated using yield data in conjunction with their respective concentrations.

Results and Discussion

Yield studies

The data presented in Table 1 reveal that nitrogen application had a marked effect on seed and stover yields of pea, and higher doses of nitrogen were significantly superior to the control. Significantly higher seed and stover yields of pea (35.16 and 37.41 g/pot) were observed with the application of nitrogen @ 120 kg ha⁻¹, followed by @ 60 kg ha⁻¹ (33.41 and 35.72 g/pot) and @ 30 kg ha⁻¹ (31.49 and 33.77 g/pot), compared to the control (28.33 and 31.05 g/pot). Significantly higher seed and stover yields of pea (34.49 and 36.22 g/pot) were observed with the application of phosphorus @ 80 kg ha⁻¹, followed by @ 40 kg ha⁻¹ (33.49 and 35.05 g/pot) and @ 20 kg ha⁻¹ (31.49 and 33.69 g/pot), compared to the control (29.41 and 33.12 g/pot). These findings are similar to those of Munna et al. (2012) and Sahu et al. (2024).

Table 1: Effect of nitrogen and phosphorus on seed and stover yield (g/pot) and protein content (%) of pea crop

Treatments	Seed yield	Stover yield	Protein (%) in seed	Protein (%) in stover
Nitrogen (kg ha ⁻¹)				
N ₀	28.33	31.05	19.37	4.94
N ₁	31.49	33.77	27.73	5.05
N ₂	33.41	35.72	30.29	5.41
N ₃	35.16	37.41	31.19	5.46
SEm±	0.51	0.51	0.81	0.06
CD @ 5%	0.86	0.86	1.65	0.12
Phosphorus (kg ha ⁻¹)				
P ₀	29.41	33.12	20.63	4.88
P ₁	31.49	33.69	20.74	5.04
P ₂	33.49	35.05	21.50	5.39
P ₃	34.49	36.22	24.25	5.54
SEm±	0.51	0.51	0.81	0.06
CD @ 5%	0.86	0.86	1.65	0.12

Protein content

The data in Table 1 reveal that the application of nitrogen increased the protein content in pea seed and stover. Significantly higher protein content in seed and stover (31.19% and 5.46%) was observed with the application of nitrogen @ 120 kg ha⁻¹, followed by @ 60 kg ha⁻¹ (30.29% and 5.41%) and @ 30 kg ha⁻¹ (27.73% and 5.05%), compared to the control (19.37% and 4.94%). Significantly higher protein content in seed and stover (24.25% and 5.54%) was observed with the application of phosphorus @ 80 kg ha⁻¹, followed by @ 40 kg ha⁻¹ (21.50% and 5.39%) and @ 20 kg ha⁻¹ (20.74% and 5.04%), compared to the control (20.63% and 4.88%).

Nutrients uptake studies**Nitrogen uptake**

The data presented in Table 2 clearly indicate that nitrogen application had a significant effect on nitrogen uptake in pea seed and stover. Significantly higher nitrogen uptake in seed and stover (133.95 and 32.85 mg/pot) was observed with the application of nitrogen @ 120 kg ha⁻¹, followed by @ 60 kg ha⁻¹ (121.05 and 27.85 mg/pot) and @ 30 kg ha⁻¹ (106.21 and 27.19 mg/pot), compared to the control

(89.64 and 24.57 mg/pot). Significantly higher nitrogen uptake in seed and stover (125.44 and 32.26 mg/pot) was observed with the application of phosphorus @ 80 kg ha⁻¹, followed by @ 40 kg ha⁻¹ (121.02 and 30.32 mg/pot) and @ 20 kg ha⁻¹ (106.40 and 27.49 mg/pot), compared to the control (73.88 and 26.60 mg/pot). These results are similar to those obtained by Munna et al. (2012, 2016), Kumari et al. (2024), and Sahu et al. (2025).

Phosphorus uptake

The data presented in Table 2 clearly indicate that nitrogen application had a significant effect on phosphorus uptake in pea seed and stover. Significantly higher phosphorus uptake in seed and stover (15.18 and 8.15 mg/pot) was observed with the application of nitrogen @ 120 kg ha⁻¹, followed by @ 60 kg ha⁻¹ (14.05 and 7.45 mg/pot) and @ 30 kg ha⁻¹ (12.78 and 6.85 mg/pot), compared to the control (11.33 and 5.83 mg/pot). Significantly higher phosphorus uptake in seed and stover (14.37 and 20.40 mg/pot) was observed with the application of phosphorus @ 80 kg ha⁻¹, followed by @ 40 kg ha⁻¹ (14.13 and 11.06 mg/pot) and @ 20 kg ha⁻¹ (12.95 and 7.53 mg/pot), compared to the control (11.92 and 2.66 mg/pot). These results are similar

Table 2: Effect of nitrogen and phosphorus on nitrogen and phosphorus uptake (mg/pot) by seed and stover of pea crop

Treatments	N uptake in seed	N uptake in stover	P uptake in seed	P uptake in stover
Nitrogen (kg ha ⁻¹)				
N ₀	89.64	24.57	11.33	5.83
N ₁	106.21	27.19	12.78	6.85
N ₂	121.05	27.85	14.05	7.45
N ₃	133.95	32.85	15.18	8.15
SEm±	7.19	0.69	0.80	0.10
CD @ 5%	14.69	1.41	1.70	0.30
Phosphorus (kg ha ⁻¹)				
P ₀	73.88	26.60	11.92	2.66
P ₁	106.40	27.49	12.95	7.53
P ₂	121.02	30.32	14.13	11.06
P ₃	125.44	32.26	14.37	20.40
SEm±	7.19	0.69	0.80	0.10
CD @ 5%	14.69	1.41	1.70	0.30

to those obtained by Munna et al. (2016), Kumari et al. (2024), and Singh et al. (2024).

Conclusion

In conclusion, for achieving higher yield, better seed quality, and efficient nutrient utilization in pea under similar edaphic conditions, application of 120 kg N ha⁻¹ combined with 80 kg P₂O₅ ha⁻¹ is recommended. However, field-level validation and consideration of Rhizobium inoculation are advised to optimize nitrogen use efficiency and minimize reliance on high fertilizer inputs.

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