International Journal of Plant & Soil Science

Volume 38, Issue 9, Page 458-465, 2026; Article no.IJPSS.165063
ISSN: 2320-7035

Response of Linseed (*Linum usitatissimum* L.) to Phosphorus and Sulphur Levels on Growth and Yield Attributes and Productivity under Rainfed Conditions of Chitrakoot Region

Anisha Jendre [a*], Pawan Sirothia [a++] and U. S. Mishra [a++]

[a] *Department of Natural Resource Management, Agricultural Soil Science, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna, Madhya Pradesh, India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ijpss/2026/v38i96308

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://pr.sdiarticle5.com/review-history/165063

Original Research Article

Received: 03/07/2026
Accepted: 29/08/2026
Published: 07/09/2026

Abstract

A field experiment was conducted during the rabi season of 2019–20 at the Agricultural Research Farm, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna (Madhya Pradesh), to evaluate the influence of phosphorus and sulphur fertilisation on the growth, yield attributes and productivity of linseed (*Linum usitatissimum* L.) under rainfed conditions. The experiment was conducted on sandy loam soil with a slightly alkaline reaction (pH 7.4), low organic carbon (0.338%), available nitrogen (205.4 kg ha^{-1}), available phosphorus (15.38 kg ha^{-1}), available potassium (242.0 kg ha^{-1}) and available sulphur (11.19 kg ha^{-1}). The study comprised three levels of phosphorus (0, 30 and 40 kg ha^{-1}) and three levels of sulphur (0, 30 and 40 kg ha^{-1}), and observations were recorded on plant height, number of branches per plant, number of capsules per plant, number of seeds per capsule, seed yield and straw yield. The results revealed that the application of phosphorus and sulphur significantly improved the growth and productivity of linseed over the control. Among the phosphorus levels, application of 30 kg P ha^{-1} recorded the highest seed yield (418.27 kg ha^{-1}), number of branches per plant (11.65) and capsules per plant (34.53),

[++] *Professor;*
**Corresponding author: E-mail: anishazendre77@gmail.com;*

Cite as: *Jendre, A., Sirothia, P., & Mishra, U. S. (2026). Response of Linseed (Linum usitatissimum L.) to Phosphorus and Sulphur Levels on Growth and Yield Attributes and Productivity under Rainfed Conditions of Chitrakoot Region. International Journal of Plant & Soil Science, 38(9), 458–465. https://doi.org/10.9734/ijpss/2026/v38i96308*

whereas the maximum plant height at harvest (73.91 cm) was observed with 40 kg P ha^{-1}. Similarly, the application of sulphur at 40 kg ha^{-1} produced the tallest plants (73.91 cm), the highest number of branches (12.36 plant^{-1}), capsules (36.00 plant^{-1}), seeds per capsule (7.55), seed yield (406.34 kg ha^{-1}) and straw yield (442.62 kg ha^{-1}). These findings indicate that balanced phosphorus and sulphur nutrition plays a crucial role in enhancing vegetative growth, reproductive development and overall productivity of linseed under the rainfed agro-climatic conditions of Chitrakoot. The study suggests that the application of 30 kg P ha^{-1} is optimal for maximising seed yield, while 40 kg S ha^{-1} is more effective in improving growth, yield attributes and straw production, thereby offering a practical nutrient management strategy for sustainable linseed cultivation in the Bundelkhand region.

Keywords: Linseed; Linum usitatissimum L.; phosphorus; sulphur; growth; yield attributes; seed yield, rainfed conditions, Chitrakoot.

1. Introduction

Linseed (*Linum usitatissimum* L.), a member of the family Linaceae, is one of the oldest cultivated oilseed crops in the world and has been grown for centuries for both its oil and fibre. The crop is valued for its exceptional nutritional and industrial importance due to its high content of α-linolenic acid (ALA), dietary fibre, quality protein and lignans, which are associated with several health-promoting properties. Besides its nutritional value, linseed oil is extensively utilised in the manufacture of paints, varnishes, printing inks, linoleum, soaps and other industrial products, while its fibre is recognised for high strength and durability and is widely used in the textile industry. India is one of the major linseed-producing countries, accounting for a substantial share of the global acreage, and the crop is predominantly cultivated in the states of Madhya Pradesh, Chhattisgarh, Maharashtra, Bihar and Uttar Pradesh under rainfed agro-ecosystems. Owing to its adaptability to diverse climatic conditions and multiple economic uses, linseed occupies an important position among the rabi oilseed crops. Despite its importance, the average productivity of linseed in India remains considerably lower than its potential, primarily due to poor soil fertility, moisture stress under rainfed conditions and imbalanced nutrient application. Among these constraints, nutrient deficiency has emerged as one of the major factors limiting crop growth and productivity. The continuous cultivation of crops without balanced fertilisation has resulted in depletion of essential nutrients from the soil, thereby reducing nutrient use efficiency and crop performance. Therefore, balanced nutrient management has become increasingly important for sustaining soil fertility and enhancing the productivity of linseed crops under rainfed conditions. Phosphorus is an essential macronutrient required for several physiological and biochemical processes in plants. It plays a central role in energy transfer, photosynthesis, respiration, cell division, root development, flowering, seed formation and the synthesis of nucleic acids, phospholipids and adenosine triphosphate (ATP). Adequate phosphorus nutrition promotes vigorous root growth, improves nutrient and water uptake, enhances reproductive development and accelerates crop maturity, thereby contributing to higher seed yield. Sulphur is recognised as the fourth major plant nutrient after nitrogen, phosphorus and potassium and is particularly important for oilseed crops because of their comparatively higher sulphur requirement. It is an indispensable constituent of sulphur-containing amino acids such as cysteine and methionine, vitamins, coenzymes and several biologically active compounds involved in plant metabolism. Sulphur plays a significant role in protein synthesis, chlorophyll formation, enzyme activation, photosynthesis and oil biosynthesis, ultimately improving both crop productivity and quality. In recent years, the widespread use of high-analysis fertilisers containing little or no sulphur has accelerated sulphur deficiency in many agricultural soils, particularly under intensive cropping systems. Numerous studies have demonstrated that the application of phosphorus and sulphur individually or in combination significantly improves plant growth, yield attributes, nutrient uptake and seed yield of linseed. Recent field studies in linseed have also highlighted the value of site-specific fertiliser prescriptions and integrated nutrient sources for improving crop productivity and nutrient management (Sharma *et al.*, 2024; Rajak *et al.*, 2026). Recent evidence further indicates that phosphorus supply can influence dry-matter production, seed yield and phosphorus-use efficiency in oilseed flax, while sulphur supplied with adequate nitrogen can improve linseed growth and yield attributes (He *et al.*, 2024; Pawar *et al.*, 2023). Information regarding the optimum levels of phosphorus and sulphur for linseed cultivation under the rainfed conditions of the Chitrakoot area is still limited. Therefore, the present investigation entitled "Growth, Yield Attributes and Productivity of Linseed (*Linum usitatissimum* L.) as Influenced by Phosphorus and Sulphur Fertilisation under Rainfed Conditions of Chitrakoot" was undertaken to evaluate the effect of different levels of phosphorus and sulphur on the growth, yield attributes and productivity of linseed and to identify an appropriate nutrient management strategy for improving linseed production under the rainfed agro-climatic conditions of Chitrakoot, Madhya Pradesh.

2. Materials and Methods

The present investigation was conducted during the rabi season of 2019–20 at the Agricultural Research Farm, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna, Madhya Pradesh, India, situated in the Bundelkhand agro-climatic region at an altitude of approximately 306 m above mean sea level. The experimental site is characterised by a semi-arid subtropical climate with hot summers, cool winters and an average annual rainfall of 900–1000 mm, most of which is received during the southwest monsoon. During the experimental period, meteorological conditions were generally favourable for the growth and development of the crop.

The experimental soil was sandy loam in texture with a slightly alkaline reaction (pH 7.4) and electrical conductivity of 0.30 dS m^{-1}. The soil was low in organic carbon (0.338%) and available nitrogen (205.4 kg ha^{-1}), medium in available phosphorus (15.38 kg ha^{-1}) and potassium (242.0 kg ha^{-1}), and contained 11.19 kg ha^{-1} available sulphur. Prior to sowing, representative surface soil samples (0–15 cm depth) were collected, air-dried, processed through a 2-mm sieve and analysed using standard laboratory procedures. Soil pH was determined using a glass electrode pH meter, electrical conductivity by the conductivity bridge method, organic carbon by the Walkley and Black wet oxidation method, available nitrogen by the alkaline permanganate method, available phosphorus by Olsen's extraction method, available potassium using a flame photometer, and available sulphur by the turbidimetric method employing 0.15% $CaCl_2$ extractant.

Table 1. Effect of phosphorus and sulphur on growth, yield-attributing characteristics and yield of linseed under Chitrakoot conditions

Treatments	Plant height (cm)				No. of branches/plant			No. of Capsules/plant		No. of seeds/Capsule	Seed yield (kg/ha)	Straw yield (kg/ha)
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	60 DAS	90 DAS			
P levels (kg/ha)												
P_0- 0	13.62	38.37	53.97	69.57	1.76	4.73	8.93	11.42	28.42	6.82	315.75	423.24
P_1-30	16.22	41.31	55.11	68.91	2.48	8.05	11.65	16.91	34.53	7.42	418.27	451.96
P_2.40	14.83	42.62	58.26	73.91	2.15	9.25	9.82	14.51	31.04	7.33	406.92	431.90
S.EMm±	0.56	0.93	1.28	1.91	0.15	0.51	0.69	1.84	3.27	0.19	12.21	5.38
CD (p=0.05)	1.70	2.81	N/A	N/A	0.45	1.56	2.01	N/A	N/A	N/A	36.94	16.28
S levels kg/ha												
S_0- 0	13.81	38.60	54.15	69.71	1.08	5.28	7.88	10.91	23.06	6.97	344.67	433.80
S_1-30	15.63	39.84	54.31	68.77	2.17	7.95	10.15	13.37	34.93	7.04	389.93	430.68
S_2-40	15.23	43.86	58.88	73.91	2.43	9.24	12.36	18.56	36.00	7.55	406.34	442.62
S.EMm±	0.56	0.93	1.28	1.91	0.15	0.51	0.69	1.84	3.72	0.19	12.21	5.38
CD (p=0.05)	N/A	2.81	3.87	N/A	0.45	1.56	2.01	5.56	11.26	N/A	36.94	N/A

The experiment comprised three phosphorus levels (0, 30 and 40 kg P ha^{-1}) and three sulphur levels (0, 30 and 40 kg S ha^{-1}). The treatments were evaluated under field conditions to assess their influence on the growth, yield attributes and productivity of linseed (*Linum usitatissimum* L.). Standard agronomic practices, including land preparation, sowing, weed management and plant protection measures, were uniformly adopted throughout the experimental period to minimise the influence of non-treatment factors.

Observations on growth parameters, including plant height and number of branches per plant, were recorded at different crop growth stages, whereas yield attributes comprising the number of capsules per plant and the number of seeds per capsule were measured at crop maturity. Seed yield and straw yield were recorded after harvest and expressed on a hectare basis. The experimental data were subjected to statistical analysis following the standard analysis of variance (ANOVA) procedure, and treatment means were compared using the Critical Difference (CD) test at the 5% probability level to determine the significance of treatment effects.

3. Results And Discussion

3.1 Effect of Phosphorus Levels on Growth and Yield Attributes of Linseed

The data presented in Table 1 show that phosphorus application influenced the growth, yield attributes and productivity of linseed under rainfed conditions. Plant height increased with phosphorus application during the early growth stages. At 30 DAS, the greatest plant height (16.22 cm) was recorded with 30 kg P ha^{-1} (P_1), followed by 40 kg P ha^{-1} (14.83 cm), whereas the control (P_0) recorded 13.62 cm. At 60 DAS, the maximum plant height (42.62 cm) was recorded with 40 kg P ha^{-1}, followed by 30 kg P ha^{-1} (41.31 cm), both exceeding the control (38.37 cm). At 90 DAS, the differences were statistically non-significant; however, the tallest plants at harvest (73.91 cm) were recorded with 40 kg P ha^{-1}. The improvement in plant height with phosphorus application may be associated with enhanced energy transfer, cell division, root development and nutrient acquisition, which collectively support vegetative growth under rainfed conditions.

Phosphorus application also enhanced the number of branches per plant. At 30 DAS, the highest number of branches (2.48 $plant^{-1}$) was recorded with 30 kg P ha^{-1}, followed by 40 kg P ha^{-1} (2.15 $plant^{-1}$), whereas the control recorded 1.76 $plant^{-1}$. At 60 DAS, 40 kg P ha^{-1} produced the maximum number of branches (9.25 $plant^{-1}$), whereas at 90 DAS, 30 kg P ha^{-1} recorded the highest value (11.65 $plant^{-1}$). The favourable response of branching to phosphorus may be attributed to its role in ATP synthesis, nucleic acid formation, rapid cell division, root growth and assimilate translocation. Similar improvements in vegetative growth and biomass production with phosphorus fertilisation have been reported by Hanumanthappa *et al.* (1998), Xie *et al.* (2016) and Patil *et al.* (2018).

Yield-attributing characters were also improved by phosphorus application. At 60 DAS, the highest number of capsules per plant (16.91) was recorded with 30 kg P ha^{-1}; at 90 DAS, the highest number (34.53) was also recorded with 30 kg P ha^{-1}. The corresponding values with 40 kg P ha^{-1} were 14.51 and 31.04 at 60 and 90 DAS, respectively, whereas the control produced 11.42 and 28.42 capsules $plant^{-1}$ at the corresponding stages. Although the differences among phosphorus levels were statistically non-significant, the numerical improvement suggests that adequate phosphorus favoured reproductive development through enhanced flower initiation, capsule setting and assimilate translocation. Similarly, the highest number of seeds per capsule (7.42) was recorded with 30 kg P ha^{-1}, followed by 40 kg P ha^{-1} (7.33), compared with 6.82 under the control. These responses may be associated with improved carbohydrate metabolism, energy transfer and efficient movement of photosynthates towards developing reproductive organs. Comparable responses have been reported by Xie *et al.* (2016), Patil *et al.* (2018) and Choudhary *et al.* (2016).

Seed and straw yields were significantly influenced by phosphorus fertilisation. The greatest seed yield (418.27 kg ha^{-1}) was obtained with 30 kg P ha^{-1}, which was significantly superior to the control (315.75 kg ha^{-1}), while 40 kg P ha^{-1} produced 406.92 kg ha^{-1}. The highest straw yield (451.96 kg ha^{-1}) was also recorded with 30 kg P ha^{-1}, followed by 40 kg P ha^{-1} (431.90 kg ha^{-1}) and the control (423.24 kg ha^{-1}). The increase in productivity may be attributed to improved root proliferation, nutrient uptake, photosynthetic efficiency, branching, capsule formation and assimilate partitioning towards developing seeds. These findings are in close agreement with Xie *et al.* (2016) and Patil *et al.* (2018), who reported improved productivity of linseed with phosphorus fertilisation.

3.2 Effect of Sulphur Levels on Growth and Yield Attributes of Linseed

The application of sulphur produced a pronounced improvement in linseed growth. At 30 DAS, the greatest plant height (15.63 cm) was recorded with 30 kg S ha^{-1}, whereas at 60 DAS, 90 DAS and at harvest, 40 kg S ha^{-1} recorded the maximum plant heights of 43.86, 58.88 and 73.91 cm, respectively. The control consistently recorded lower values, indicating that inadequate sulphur supply restricted vegetative development. The positive response may be attributed to the essential role of sulphur in protein synthesis, chlorophyll formation, enzyme activation, sulphur-containing amino acid synthesis and photosynthetic efficiency. Similar responses have been reported by Dubey *et al.* (1987), Nandanwar *et al.* (2000), Raj and Kanthaliya (2004), Parmar *et al.* (2020) and Jimo and Singh (2017).

The number of branches per plant also increased with sulphur fertilisation. At 30 DAS, the highest number of branches (2.43 $plant^{-1}$) was recorded with 40 kg S ha^{-1}, followed by 30 kg S ha^{-1} (2.17 $plant^{-1}$), compared with only 1.08 $plant^{-1}$ under the control. At 60 DAS, 90 DAS and at harvest, 40 kg S ha^{-1} produced the greatest branch numbers of 9.24, 12.36 and 18.56 $plant^{-1}$, respectively. The increase in branching may be associated with enhanced synthesis of sulphur-containing amino acids, proteins, vitamins and enzymes, together with improved chlorophyll formation, photosynthesis and nitrogen utilisation. The present findings are consistent with Nandanwar *et al.* (2000), Banerjee *et al.* (2001), Sune *et al.* (2006), Jimo and Singh (2017) and Parmar *et al.* (2020).

Sulphur fertilisation also improved the yield-attributing characters of linseed. The highest number of capsules per plant (36.00) and seeds per capsule (7.55) were recorded with 40 kg S ha^{-1}, followed by 30 kg S ha^{-1} with 34.93 capsules plant^{-1} and 7.04 seeds capsule^{-1}, whereas the control recorded 23.06 capsules plant^{-1} and 6.97 seeds capsule^{-1}. Although the differences for these parameters were statistically non-significant, the numerical increase indicates a favourable reproductive response to adequate sulphur nutrition. The improvement may be attributed to enhanced protein synthesis, chlorophyll formation, enzyme activity and photosynthate availability during flowering and seed development. Similar responses have been reported by Chaubey *et al.* (1992), Chourasia *et al.* (1992), Dubey *et al.* (1997), Nandanwar *et al.* (2000), Sune *et al.* (2006) and Jimo and Singh (2017).

Sulphur application increased seed and straw yields over the control. The maximum seed yield (406.34 kg ha^{-1}) was recorded with 40 kg S ha^{-1}, followed by 30 kg S ha^{-1} (389.93 kg ha^{-1}), whereas the control produced 344.67 kg ha^{-1}. Although the differences in seed yield were statistically non-significant, the numerical increase reflects the beneficial influence of sulphur on crop productivity. The highest straw yield (442.62 kg ha^{-1}) was also recorded with 40 kg S ha^{-1}, compared with 433.80 kg ha^{-1} under the control and 430.68 kg ha^{-1} with 30 kg S ha^{-1}. The yield response may be associated with improved vegetative growth, branching, capsule formation, seed development, chlorophyll synthesis, protein formation and nitrogen utilisation. Similar responses to sulphur fertilisation in linseed have been reported by Dubey *et al.* (1987), Chaubey *et al.* (1992), Raj and Kanthaliya (2004), Parmar *et al.* (2020) and Jimo and Singh (2017).

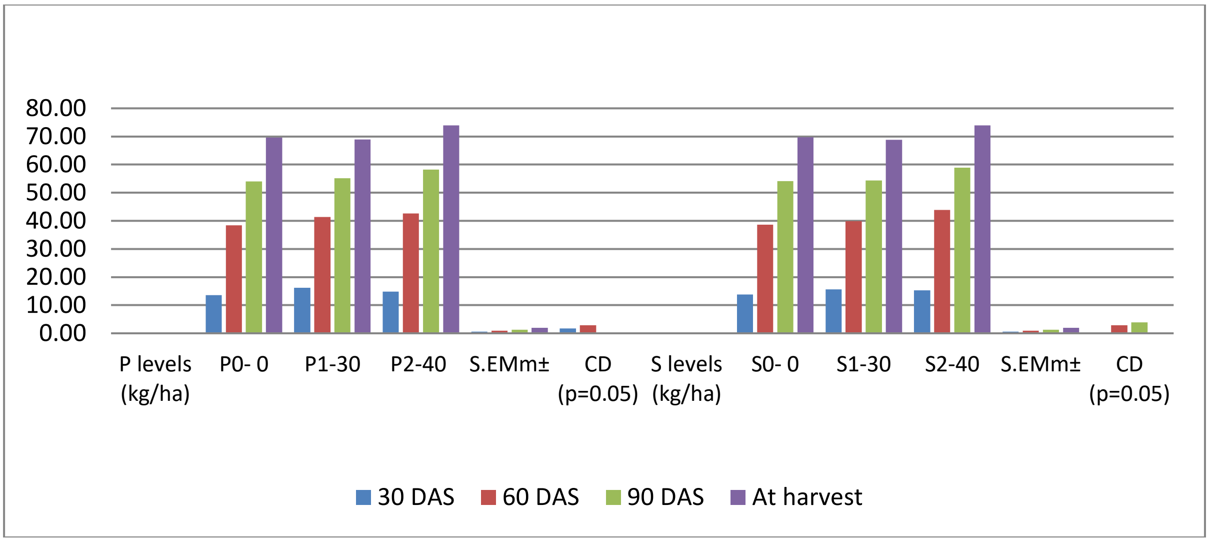

Fig. 1. Plant height as affected by P & S

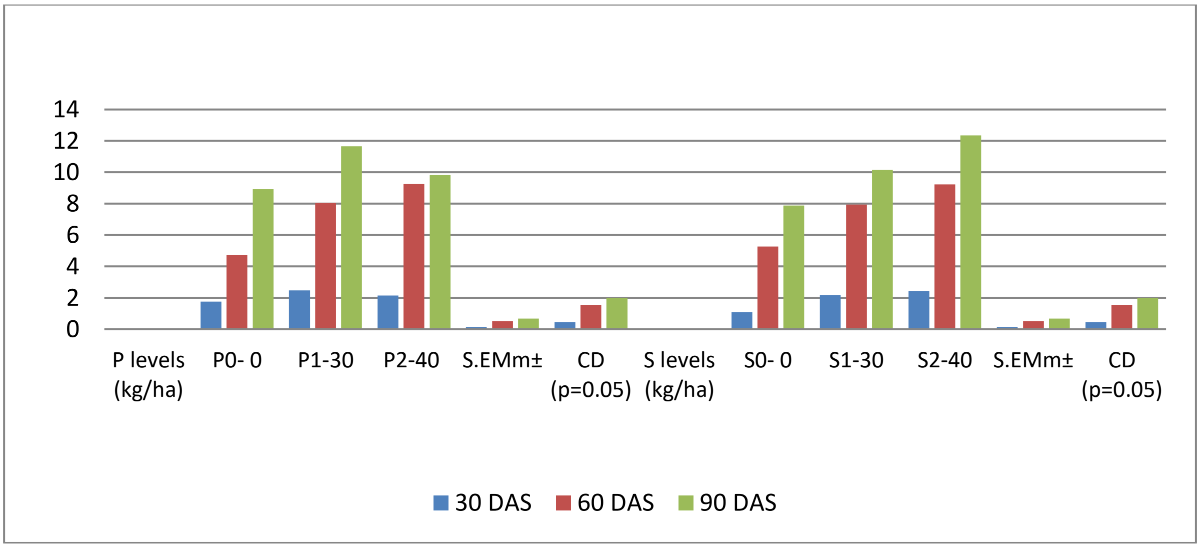

Fig. 2. No. of Branches per plant as affected by P & S

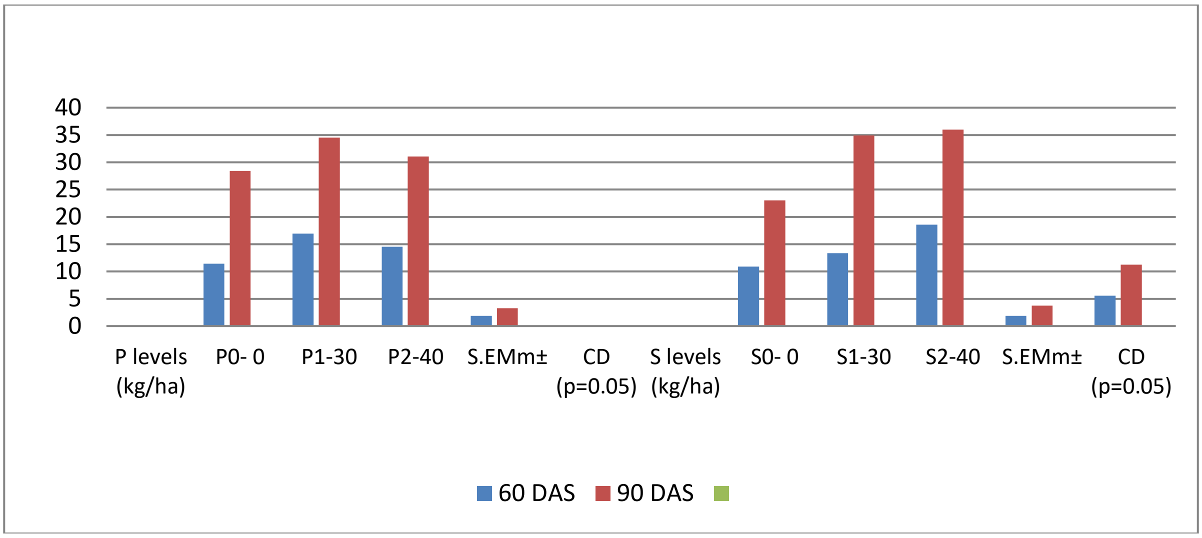

Fig. 3. No. of capsules per plant as affected by P & S

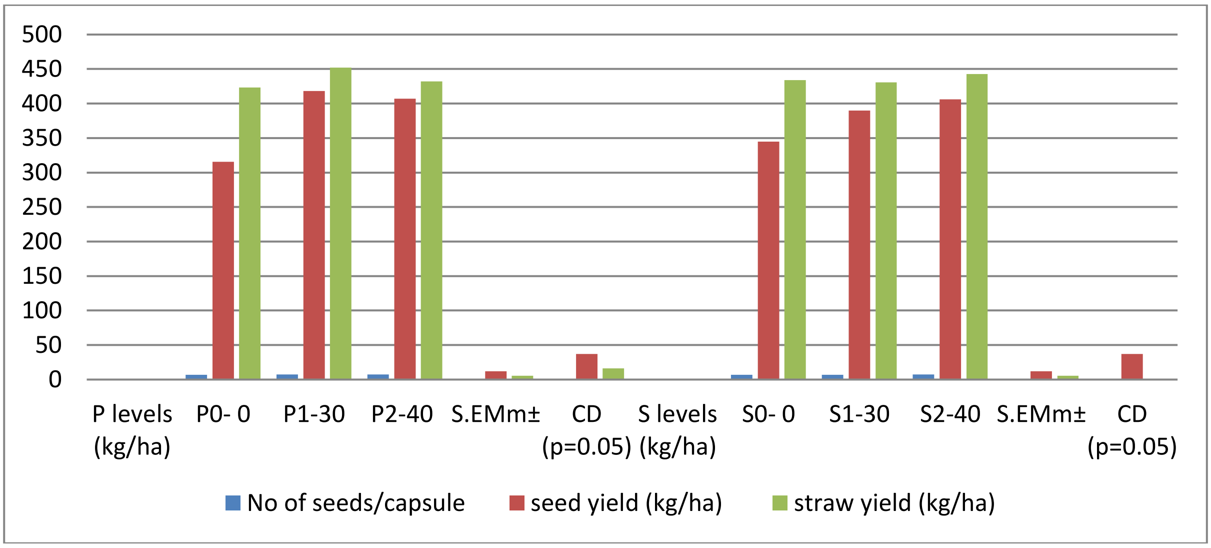

Fig. 4. Effect of P & S on yield attributing characters

4. Discussion

The present investigation showed that the application of phosphorus and sulphur improved the growth, yield attributes and productivity of linseed under rainfed conditions of Chitrakoot. Increases in plant height, number of branches, capsules per plant, seeds per capsule, seed yield and straw yield may be associated with the complementary physiological roles of phosphorus and sulphur in plant metabolism. Phosphorus supports energy transfer, root development, cell division, photosynthesis and assimilate translocation, whereas sulphur contributes to protein synthesis, chlorophyll formation, enzyme activation, nitrogen utilisation and synthesis of sulphur-containing amino acids. Adequate availability of both nutrients therefore supports vegetative growth, reproductive development and efficient partitioning of photosynthates towards developing seeds.

The response pattern further indicated that 30 kg P ha^{-1} was the most effective phosphorus level for maximising seed yield, straw yield, branching and capsule formation, whereas 40 kg P ha^{-1} produced the tallest plants at harvest. In contrast, 40 kg S ha^{-1} consistently produced the highest values for the major growth and yield attributes and resulted in the greatest seed and straw yields among the sulphur treatments. The present findings are consistent with earlier reports demonstrating beneficial responses of linseed to phosphorus and sulphur fertilisation under different agro-climatic conditions (Dubey *et al.*, 1987; Hanumanthappa *et al.*, 1998; Nandanwar *et al.*, 2000; Xie *et al.*, 2016; Patil *et al.*, 2018; Parmar *et al.*, 2020). Overall, balanced phosphorus and sulphur nutrition appears important for improving nutrient use, reproductive development and productivity of linseed under the rainfed conditions of Chitrakoot.

5. Conclusion

The present investigation demonstrated that phosphorus and sulphur fertilisation markedly influenced the growth, yield attributes and productivity of linseed (*Linum usitatissimum* L.) under the rainfed conditions of Chitrakoot. Among the phosphorus levels evaluated, 30 kg P ha^{-1} proved to be the optimal dose for maximising seed yield (418.27 kg ha^{-1}), straw yield (451.96 kg ha^{-1}), number of branches per plant (11.65) and number of capsules per plant (34.53), whereas 40 kg P ha^{-1} produced the maximum plant height at harvest (73.91 cm). Similarly, sulphur fertilisation exerted a positive influence on crop growth and productivity, with 40 kg S ha^{-1} recording the highest plant height (73.91 cm), number of branches per plant (12.36), capsules per plant (36.00), seeds per capsule (7.55), seed yield (406.34 kg ha^{-1}) and straw yield (442.62 kg ha^{-1}).

Based on the experimental findings, it can be concluded that balanced phosphorus and sulphur nutrition is essential for achieving higher productivity of linseed under the rainfed agro-climatic conditions of Chitrakoot. Application of 30 kg P ha^{-1} was found to be the most suitable phosphorus level for maximising seed yield, while 40 kg S ha^{-1} was more effective in improving overall crop growth, yield attributes and biomass production. Therefore, adoption of these nutrient levels can be considered an effective nutrient management strategy for enhancing the productivity and sustainability of linseed cultivation in the Bundelkhand region under rainfed conditions.

The statistical pattern further revealed that several growth and yield attributes were significantly affected by nutrient application, particularly during early growth stages and at harvest. This reinforces the notion that nutrient adequacy during the formative and reproductive phases is pivotal for maximising yield potential in linseed.

6. Limitations

This experiment was conducted during a single rabi season at one location in Chitrakoot on sandy loam soil under rainfed conditions. Therefore, the responses observed for the tested phosphorus and sulphur levels may be specific to the prevailing soil and seasonal conditions. Only 0, 30 and 40 kg ha^{-1} levels of each nutrient were evaluated, so responses outside these rates were not assessed. Multi-season and multi-location validation would be required before extending the findings beyond comparable conditions.

Declaration of AI Use

This manuscript was prepared through the intellectual contributions of the author(s) to the study design, data analysis, interpretation of results, and scholarly content. Grammarly and ChatGPT were used solely to assist with grammatical refinement and reference formatting during manuscript revision. The author(s) accept full responsibility for the accuracy, integrity, and final content of the manuscript.

Competing Interests

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Banerjee, S., Basu, T. K., Bhowmick, N., & Bhattacharya, J. (2001). Effect of potassium and sulphur on growth attributes, yield parameters and seed yield of linseed (*Linum usitatissimum* L.). *Journal of Interacademicia, 5*(3), 318–323.

Chaubey, A. K., Dwivedi, K. N., & Yadav, R. S. (1992). Effect of nitrogen, phosphorus and sulphur on linseed. *Journal of the Indian Society of Soil Science, 40*(4), 758–761.

Choudhary, A. A., Nikam, R. R., & Patil, S. S. (2016). Effect of phosphorus and sulphur on oil, nutrient uptake and yield of linseed. *International Journal of Life Sciences, Special Issue A6*, 33–36. ResearchGate article record

Chourasia, S. K., Namdeo, K. N., & Chaurasia, S. C. (1992). Effect of nitrogen, sulphur and boron on growth, yield and quality of linseed (*Linum usitatissimum*). *Indian Journal of Agronomy, 37*(3), 496–499.

Dubey, S. D., Pathak, R. K., & Rai, M. (1987). Sulphur nutrition in linseed. *Oilseeds Newsletter, 1*, 2.

Dubey, S. D., Shukla, P., & Tiwari, S. P. (1997). Effect of fertilizer on yield of linseed (*Linum usitatissimum*). *The Indian Journal of Agricultural Sciences, 67*(11), 539–540.

Hanumanthappa, M., Sreeramulu, K. R., & Naik, R. G. (1998). Influence of phosphorus levels on dry matter production and yield in soybean varieties. *Journal of Maharashtra Agricultural Universities, 23*, 195–196.

He, N., Huang, F., Luo, D., Liu, Z., Han, M., Zhao, Z., & Sun, X. (2024). Oilseed flax cultivation: Optimizing phosphorus use for enhanced growth and soil health. *Frontiers in Plant Science, 15*, 1432875. https://doi.org/10.3389/fpls.2024.1432875

Jimo, H., & Singh, R. (2017). Effect of sources and doses of sulphur on yield attributes, yield and quality of linseed (*Linum usitatissimum* L.). *Journal of Pharmacognosy and Phytochemistry, 6*(4), 613–615. Official journal article page

Nandanwar, S. B., Chaphale, S. D., Badole, W. P., & Badole, R. B. (2000). Effect of sulphur and zinc on growth and yield of linseed. *Journal of Soils and Crops, 10*(2), 301–302.

Parmar, S. K., Thanki, J. D., Tandel, B. B., & Pankhaniya, R. M. (2020). Effect of nitrogen, phosphorus and sulphur application on yield, quality, uptake and economics of linseed (*Linun usitatissimum* L.). *International Journal of Chemical Studies, 8*(5), 1956–1960. https://doi.org/10.22271/chemi.2020.v8.i5aa.10587

Patil, S. S., Ransing, S. S., Hiwale, S. D., & Rasal, S. J. (2018). Effect of phosphorus and sulphur management on growth and yield attributes of linseed. *International Journal of Current Microbiology and Applied Sciences, Special Issue 6*, 1147–1155.

Pawar, A. V., Misal, A. M., Rathod, M. R., & Thombre, P. R. (2023). Effect of nitrogen and sulphur nutrition on growth, yield and quality parameters in linseed (*Linum usitatissimum*) varieties. *Journal of Oilseeds Research, 40*(Special Issue). https://doi.org/10.56739/c7c6q713

Raj, B., & Kanthaliy, P. C. (2004). Response of linseed to levels and sources of sulphur. *Annals of Plant and Soil Research, 6*(1), 84–85.

Rajak, S., Gangwar, B. J., & Kumar, R. (2026). Effect of different combinations of organic sources on growth, yield and economics of linseed crop (*Linum usitatisimum* L.) in Bundelkhand region. *Journal of Biology and Nature, 18*(1), 183–190. https://doi.org/10.56557/joban/2026/v18i110258

Sharma, S., Singh, Y. V., & Kundu, A. (2024). Soil test crop response based fertilizer prescriptions for achieving target yields of linseed in Varanasi, India. *Journal of Experimental Agriculture International, 46*(7), 792–806. https://doi.org/10.9734/jeai/2024/v46i72632

Sune, S. V., Deshpande, R. M., Khawale, V. S., Baviskar, P. K., & Gurao, B. P. (2006). Effect of phosphorus and sulphur application on growth and yield of linseed. *Journal of Soils and Crops, 16*(1), 217–221.

Xie, Y., Niu, X., & Niu, J. (2016). Effect of phosphorus fertilizer on growth, phosphorus uptake, seed yield, yield components, and phosphorus use efficiency of oilseed flax. *Agronomy Journal, 108*(3), 1257–1266. https://doi.org/10.2134/agronj2015.0537

Peer-review history:
The peer review history for this paper can be accessed here:
https://pr.sdiarticle5.com/review-history/165063