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2 Effect of phosphorus on different varieties

3 on growth and yield of pea

4 **(*Pisum sativum* L.)**

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# ABSTRACT

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A field experiment entitled “Effect of phosphorus on different varieties on growth and yield of field pea (*Pisum sativum* L.)” was carried out during the *rabi* season 2023-24 at Pandit Deen Dayal Upadhyay Institute of Agriculture Science, Utlou, Bishnupur District, Manipur, India. The treatment comprised of three different phosphorus levels (0,40 and 60 kg/ha) and three varieties V1 – Prakash, V2 – Rachna, V3 – Aman with a total of 9 treatment combinations. The experiment was laid out in a factorial randomized block design (FRBD) with three replications. The results reveal that the maximum growth character viz. plant height(cm), number of branches per plant, fresh weight and dry weight per plant(g), number and dry weight of nodules were recorded maximum on Aman (V3) and minimum values were recorded on Prakash (V1).The maximum yield character such as number of pods per plant, number of seed per pod, pod length(cm), stover yield (q/ha), test weight (g), harvest index (%) were recorded under variety Aman (V3) followed by Rachna(V2) and Prakash(V1).Among the phosphorus levels 60 kg P2O5/ha recorded higher growth attribute, yield attribute and yield of pea as compare to other phosphorus which was followed by 40 kg P2O5/ha and 0 kg P2O5/ha. The treatment combination 60 kg P₂O₅/ha + Aman (P3V3) was found best for pea cultivation. From the present record it can be concluded that using 60 kg P₂O₅/ha + Aman (P3V3) proved to be more productive and profitable for the cultivation of pea during rabi season in Manipur climate condition.

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22 *Keywords:* Field pea, phosphorus, varieties, growth, yield

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# 1. INTRODUCTION

1. Field pea (*Pisum sativum* L*.*) is one of the important pulse crops in the world. It is cultivated
2. in a 6.2 million hectares area with a total production of 20.5 million tonnes annually. The
3. important field pea-growing countries are Canada, Russia, the USA, China & India. Canada
4. ranks first in the world in respect of production followed by Russia. In India, field pea
5. occupies an area of 0.64 million ha with an annual production of 0.88 million tonnes (2020 -
6. 21). Uttar Pradesh is the major field pea-growing state. Besides, Uttar Pradesh, Madhya
7. Pradesh and Bihar are the major field pea-producing states. It is highly nutritious and
8. contains a high proportion of digestible protein (22.5%), carbohydrates (62.1%), fats (1.8%),
9. minerals (Ca - 64 mg/100 g, Fe—4.8 mg/100 g), and vitamins (riboflavin - 0.15 mg/100 g,
10. thiamine - 0.72 mg/100 g, and niacin - 2.4 mg/100 g). Peas contribute about 3% of the total
11. pulse area and about 5% of total pulse production in India.
12. The response of phosphorus depends upon many factors like climate, variety of soil type
13. and availability of nutrients during growth period. The application ophosphorusincreased the production of pulse crops. Phosphorus is the vital component of DNA, RNA,
14. ATP and photosynthetic system apart from that it also catalyzes a number of biochemical reactions from the
15. beginning of seedling growth through the formation of grains at maturity. Sharma *et al.*
16. (2004) reported that one of the advantages of feeding plants with phosphorus is to create
17. deeper and more abundant roots. It also raises the efficiency of plants for photosynthesis,
18. enhances the activity of rhizobia and increases the number of branches and pod per plants,
19. consequently producing a higher total yield of pea. Phosphorus is very crucial for root
20. development, energy transfer, and overall plant metabolism Nadeem *et al*. (2003). The
21. genetic diversity within pea varieties is significant,in which each variety displays distinct
22. characteristics and adaptations. This diversity is essential for breeding programs focused on
23. enhancing yield, disease resistance, and adaptability to different environmental conditions.
24. Keeping these points in mind , the present investigation entitled “Effect of phosphorus ion
25. different varieties on growth and yield of field pea (*Pisum sativum* L.)” was conducted during
26. rabi 2023-24 at the farm of Pandit Deen Dayal Upadhyay Institute of Agriculture Science,
27. Utlou, Bishnupur, Manipur.

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# 54 2. MATERIAL AND METHODS

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1. The field experiment was conducted during Rabi seasons 2023-24 at Pandit Deen Dayal
2. Upadhyay Institute of Agriculture Science, Utlou, Bishnupur District, Manipur, India. The
3. experimental site is located at 24°43’22.4” N latitude, 93°51’35.2” E longitude and at an
4. altitude of 790 m above mean sea level. The soil texture and nature of the experimental field was clay
5. with acidic reaction (pH 5.2)high organic carbon (1.9%), low in available nitrogen (188
6. kg/ha), medium available phosphorus (20 kg P/ha) and medium in available potash (216.18
7. kg K/ha). The experiment was laid out in a factorial randomized block design (FRBD) with
8. three replications. The treatments are T₁ P₁V₁ 0 kg P₂O₅/ha + Prakash,T₂ P₁V₂ 0 kg
9. P₂O₅/ha + Rachna, T₃ P₁V₃ 0 kg P₂O₅/ha + Aman, T₄ P₂V₁ 40 kg P₂O₅/ha + Prakash, T₅
10. P₂V₂ 40 kg P₂O₅/ha + Rachna, T₆ P₂V₃ 40 kg P₂O₅/ha + Aman, T₇ P₃V₁ 60 kg P₂O₅/ha +
11. Prakash, T₈ P₃V₂ 60 kg P₂O₅/ha + Rachna, T₉ P₃V₃ 60 kg P₂O₅/ha + Aman.A uniform dose
12. of 20 kg nitrogen (as urea), 60 kg phosphorus (SSP) and 40 kg potash (MOP) was applied to
13. all the treatments. The biometric observations on different characteristics *viz*., plant height,
14. number of branches were recorded at various stages of crop growth. The grain yield (kg/ha)
15. was also recorded from each net plot at the time of harvest. Mean values of data obtained
16. from the experiment are computed for statistical analysis to test significance and
17. interpretation of results.
18. Clear the treatments as:
19. here; P1, P2 and P3 represnets phosphorus concentration
20. and V1, V2 and V3 represents Varieties ie, Prakash, Rachna and Aman respectively.
21. T1- 0 kg P₂O₅/ha + Prakash
22. T2- 0 kg P₂O₅/ha + Rachna
23. T3- 0 kg P₂O₅/ha + Aman
24. T4- 40 kg P₂O₅/ha + Prakash
25. T5 - 40 kg P₂O₅/ha + Rachna
26. T6- 40 kg P₂O₅/ha + Aman
27. T7- 60 kg P₂O₅/ha + Prakash
28. T8- -60 kg P₂O₅/ha + Rachna
29. T9- - 60 kg P₂O₅/ha + Aman

# 3. RESULTS AND DISCUSSION

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## 3.1 Effect of phosphorus and varieties of plant height (cm)

1. The present investigation resulted that the data on plant height was significantly influenced by application of different concentration of phosphorus and
2. varieties in field pea as shown in Table 1.. Application of different phosphorus treatment
3. (0,40,60 P2O5/ha) showed an increase in plant height as compared to control phosphorus. In all the
4. four stages of recording 30 DAS remain par and it increases significantly up to 60 kg
5. P2O5/ha at 60 DAS. Again, variation of plant height with application of 40 and 60 kg P2O5/ha

1. was found to be more significant recorded in three stages at 60 DAS,90 DAS and at harvest.
2. Application of phosphorus 60 kg P2O5/ha recorded higher plant height due to higher
3. phosphorus level to grow taller which causes a positive effect of phosphorus on root
4. multiplication, nodulation and speeding up the height of the plant. Phosphorus and variety
5. interaction was found to be non-significant for the plant height of pea. These findings were
6. supported by Tripathi *et al.* (2020) and Singh *et al.* (2008). Among the varieties, the
7. maximum height was observed in the variety Aman(V₃). followed by Rachna (V2) and the
8. lowest plant height variety is recorded at Prakash (V1). The differences in plant height
9. among the varieties may be attributed to variations in genetic composition and the rate of
10. cell division at various growth stages. Similarly variation of plant height with different
11. varieties was also reported by Sen *et al.* (2016) in pulse crops.

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## 94 Table 1. Effect of phosphorus and varieties on plant height (cm) of field pea.

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|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatment** | **Plant height (cm)** | | | |
| 30 DAS | 60 DAS | 90 DAS | At Harvest |
| **Phosphorus levels** | | | | |
| **P1 (0 kg P2O5/ha)** | 8.72 | 27.79 | 37.76 | 38.42 |
| **P2 (40 kg P2O5/ha)** | 9.04 | 29.32 | 40.12 | 41.24 |
| **P3 (60 kg P2O5/ha)** | 9.60 | 31.23 | 42.39 | 43.60 |
| **S.Ed (±)** | 0.15 | 0.18 | 0.63 | 0.67 |
| **C.D. (P = 0.05)** | 0.32 | 0.38 | 1.34 | 1.41 |
| **Varieties levels** | | | | |
| **V1 (Prakash)** | 8.91 | 28.74 | 39.27 | 40.45 |
| **V2 (Rachna)** | 9.12 | 29.59 | 39.72 | 40.69 |
| **V3 (Amana)** | 9.33 | 30.00 | 41.29 | 42.12 |
| **S.Ed (±)** | 0.15 | 0.18 | 0.63 | 0.67 |
| **C.D. (P = 0.05)** | 0.32 | 0.38 | 1.34 | 1.41 |

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|  |  |  |  |
| --- | --- | --- | --- |
| TREATMENTS | 30DAS | 60 DAS | 90DAS |
| T1 |  |  |  |
| T2 |  |  |  |
| T3 |  |  |  |
| T4 |  |  |  |
| T5 |  |  |  |
| T6 |  |  |  |
| T7 |  |  |  |
| T8 |  |  |  |
| T9 |  |  |  |

## 97 3.2 Effect of phosphorus and varieties of number of branches per plant

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1. The data on number of branches was found to be significantly influenced by
2. phosphorus and varieties in field pea as shown in Table 2. The effect of different doses of
3. phosphorus on a number of branches per plant was evident from the fact that the number of
4. branches per plant in different does not vary considerably. At 30 DAS the number of
5. branches did not differ significantly over control as well as between 40 and 60 kg P2O5/ha. In
6. the subsequent 3 stages (60, 90 DAS and at harvest) it increases significantly with increased
7. level of phosphorus at 40 and 60 kg P2O5/ha. Phosphorus and variety interaction was found
8. to be non-significant for the number of branches per plant of field pea. An increase in
9. phosphorus level boosts rhizobium activity, which improves N fixation in the root nodules
10. and promotes better growth and development which leads to enhanced cell division causing
11. cells to produce more branches. A similar result was also reported by Bhat *et al.* (2013).
12. However, in the last three stages of recording (60, 90 DAS and at harvest), the maximum
13. number of branches was observed in the variety Aman (V₃) which remains par with Prakash
14. (V₁). Again, Prakash (V₁) remains par with Rachna (V₂) in the last three stages of recording.
15. This finding was supported by Yadahalli *et al*. (2006).

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## Table 2. Effect of phosphorus and varieties on number of branches per plant

1. **of field pea.**

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|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatment** | **Number of branches per plant** | | | |
| **30 DAS** | **60 DAS** | **90 DAS** | **At harvest** |
| **Phosphorus levels** | | | | |
| **P1 (0 kg P2O5/ha)** | 0.99 | 1.44 | 2.60 | 2.70 |
| **P2 (40 kg P2O5/ha)** | 1.21 | 1.92 | 2.71 | 3.06 |
| **P3 (60 kg P2O5/ha)** | 1.33 | 2.24 | 3.10 | 3.31 |
| **S.Ed (±)** | 0.06 | 0.11 | 0.10 | 0.08 |
| **C.D. (P = 0.05)** | 0.13 | 0.24 | 0.21 | 0.18 |
| **Varieties levels** | | | | |
| **V1 (Prakash)** | 1.11 | 1.70 | 2.66 | 2.89 |
| **V2 (Rachna)** | 1.18 | 1.88 | 2.83 | 3.06 |
| **V3 (Amana)** | 1.24 | 2.03 | 2.92 | 3.12 |
| **S.Ed (±)** | 0.06 | 0.11 | 0.10 | 0.08 |
| **C.D. (P = 0.05)** | 0.12 | 0.24 | 0.21 | 0.18 |

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## 121 3.3 Effect of phosphorus and varieties of number of pods per plant

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1. Number of pods per plant data revealed a significant impact of both phosphorus levels and
2. pea varieties in the field experiment as shown in Table 3. The individual effect of phosphorus
3. and varieties on the number of pods per plant of pea could not bring a significant difference
4. in the number of pods per plant. The maximum number of pods per plant is recorded with
5. the application of 60 kg P2O5/ha. The lowest number of pods per plant was recorded at
6. control phosphorus. Phosphorus and variety interaction was found to be non-significant for
7. the number of pods per plant of field pea. An increase in the number of pods per plant might
8. be because of the essential role of phosphorus in photosynthesis, fast energy transfer may
9. have enhanced photosynthetic efficiency and consequently photosynthesis availability which
10. further results in an increase in overall biomass production and plant part translocation. A
11. similar result was also reported by Hangsing *et al*. (2020). Among the variety (V₃) Aman
12. recorded a maximum number of pods per plant as compared to variety (V1) Prakash and
13. (V₂) Rachna. However, (V1) Prakash and (V₂) Rachna did not differ significantly in terms of
14. number of pods per plant. The variation in number of pods per plant might be due to
15. differences in genetic differences. These findings were supported by the findings of Tripathi
16. *et al.* (2020).

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## 140 3.4 Effect of phosphorus and varieties of seed yield (q/ha)

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1. Seed yield data revealed a significant impact of both phosphorus levels and pea varieties in
2. the field experiment as shown in Table 3. Phosphorus also increased the photosynthesis
3. and translocation of assimilates to different plant parts for enhanced growth and yield
4. attributing characters of the crop as observed in the number of pods per plant. The
5. application of 60 kg P2O5/ha resulted in a significant and maximum seed yield. Phosphorus
6. and variety interaction was found to be non-significant for the seed yield of field pea. This
7. may be attributed to enhanced root proliferation, better root development, increased nutrient
8. availability and uptake, improved energy conversion, and boosted plant metabolic activities.
9. Such result was also reported by Khajuria *et al.* (2023) and Tanwar *et al.* (2003). Among the
10. varieties maximum seed yield was recorded in the variety (V₃) Aman while lowest one was
11. recorded in the variety (V1) Prakash. The higher seed yield in (V₃) Aman might be due to
12. higher test weight which was significantly superior to the other two varieties. These findings
13. were supported by the findings of Pan *et al.* (2001r).

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## 156 3.5 Effect of phosphorus and varieties of stover yield (q/ha)

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1. Stover yield data revealed a significant impact of both phosphorus levels and pea varieties in
2. the field experiment as shown in Table 3. Application of phosphorus increases significantly
3. with increased levels of phosphorus up to 60 kg P2O5/ha shows a significant difference in
4. stover yield. The combined effect of phosphorus and varieties on the stover yield of pea was
5. found to be significant. The higher stover yield with a suitable dose of phosphorus might be
6. contributed by better growth of the plant as expressed in terms of plant height, number of
7. branches per plant, and fresh and dry weight of the plant. Similar result was also reported by
8. Siddiqui *et al.* (2022). Maximum stover yield was recorded in the variety (V₃) Aman and the
9. lowest one was recorded in the variety (V1) Prakash. The variation in stover yield may be
10. due to differences in growth characteristics among the varieties, influenced by their genetic
11. makeup. Such variation in stover yield in different varieties was also reported by Yadav *et al.*
12. (2016). Phosphorus and variety interaction was found to be non-significant for the stover
13. yield of field pea.

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## Table 3. Effect of phosphorus and varieties on number of pods per plant, seed

1. **yield (q/ha) and stover yield (q/ha) of field pea.**

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|  |  |  |  |
| --- | --- | --- | --- |
| **Treatment** |  | | |
| **No of pods per plant** | **Seed Yield (q/ha)** | **Stover Yield (q/ha)** |
| **Phosphorus levels** | | | |
| **P1 (0 kg P2O5/ha)** | 8.50 | 10.00 | 26.34 |
| **P2 (40 kg P2O5/ha)** | 10.27 | 14.79 | 28.92 |
| **P3 (60 kg P2O5/ha)** | 11.17 | 19.80 | 29.71 |
| **S.Ed (±)** | 0.08 | 0.28 | 0.31 |
| **C.D. (P = 0.05)** | 0.18 | 0.59 | 0.65 |
| **Varieties levels** | | | |
| **V1 (Prakash)** | 9.74 | 13.70 | 27.59 |
| **V2 (Rachna)** | 9.97 | 14.71 | 28.48 |
| **V3 (Amana)** | 10.24 | 16.17 | 28.91 |
| **S.Ed (±)** | 0.08 | 0.28 | 0.31 |
| **C.D. (P = 0.05)** | 0.18 | 0.59 | 0.65 |

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176 **4.CONCLUSION**

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178 Based on the result from the experiment it can be concluded that the effect of phosphorus on

179 different varieties on growth and yield of field pea (*Pisum sativum* L.) significantly increases

180 the growth parameters, yield attribute characters and yield under 60 Kg P₂O₅/ha + Aman in

181 Utlou, Bishnupur District, Manipur, India.

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# 184 DISCLAIMER (ARTIFICIAL INTELLIGENCE)

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186 I, Poireinganba Khumanthem hereby declare that NO generative AI technologies such as

187 Large Language Models (Chat GPT, COPILOT, etc.) and text-to-image generators have

188 been used during the writing or editing of this manuscript.

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# 191 COMPETING INTERESTS

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193 Authors have declared that no competing interests exist.

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