Performance of Phosphorus Levels and Varieties on Growth Yield and Quality of Pea (*Pisum sativum* L.)

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Abstract— *A field experiment was conducted during the Rabi season in 2023-2024 at the Research farm, Department of Agronomy, AKS University, Satna (M.P.), to evaluate the effect of phosphorus levels and varieties on growth, yield, and quality of pea (Pisum sativum L.). The experiment was laid out in Factorial Randomized Block Design comprising four phosphorus levels viz. 0kg P_2O_5 ha^{-1}, 20kg P_2O_5 ha^{-1}, 40kg P_2O_5 ha^{-1}, 60kg P_2O_5 ha^{-1} and three pea varieties viz. KN-5, Aman, KS-10, with treatments replicated thrice. Results revealed that different levels of phosphorus significantly affected the growth parameters as well as yield attributes and yield of pea. Application of 60kg P_2O_5 ha^{-1} (P_3) recorded maximum plant height at 90 DAS (62.10cm), number of pods per plant (14.32), pod length (8.47cm), grain yield (47.65q ha^{-1}), stover yield (85.23q ha^{-1}), test weight (18.32g), and protein content (23.24%). However, phosphorus levels of 40kg P_2O_5 ha^{-1} (P_2) showed slightly higher harvest index (32.10%). Among the varieties, Aman exhibited the best performance, recording maximum grain yield, protein content, and other yield attributes.*

Keywords— Phosphorus levels, pea varieties, growth, yield, quality, Pisum sativum.

I. INTRODUCTION

Pea (Pisum sativum L.) is one of the most important pulse crops grown during the winter season and is highly valued for its rich nutritional content, including high levels of digestible protein, carbohydrates, vitamins, and minerals. In India, pea is cultivated over an area of 5.97 lakh hectares, contributing to a total production of 8.60 lakh tonnes (Anonymous, 2020) [1]. Madhya Pradesh is a key pea-growing state, with approximately 0.58 lakh hectares under cultivation, producing around 0.48 lakh tonnes (Anonymous, 2020) [2]. Phosphorus is an essential macronutrient, playing a crucial role in plant development, particularly in processes like root formation, energy transformation, and nitrogen fixation. Phosphorus is a component of important molecules like nucleic acids, phospholipids, and ATP. In legumes such as pea, adequate phosphorus availability enhances root nodulation and symbiotic nitrogen fixation, which are vital for improving plant growth and yield (Tsvetkova and Georgiev, 2007) [3]. A deficiency of phosphorus can lead to poor nodulation and lower yields, particularly in low-nutrient soils.

Research has demonstrated that phosphorus application can significantly improve pea growth parameters such as plant height, number of branches, and root development. For instance, Gupta et al. (2000) [4] found that phosphorus application leads to deeper root systems and better nutrient absorption. In pea cultivation, phosphorus enhances pod formation, grain weight, and protein content, making it a key nutrient for maximizing crop productivity (Bhat et al., 2013) [5]. Varietal selection also plays a crucial role in determining crop yield and quality. Different pea varieties exhibit varying responses to phosphorus fertilization, with some showing greater tolerance to low phosphorus conditions or higher yields under optimal phosphorus levels (Singh and Singh, 2017) [6]. Hence, the interaction between phosphorus levels and varieties must be optimized to achieve higher yields and better quality pea production. This study aims to evaluate the performance of different phosphorus levels and varieties of pea on growth, yield, and quality, thereby providing insights into optimal agronomic practices for pea cultivation in phosphorus-deficient regions.

II. MATERIALS AND METHODS

The present investigation was carried out during 2023-2024 in the Rabi season at the Research farm, Department of Agronomy, AKS University, Satna (M.P.). The mean temperature during the experimental period ranged from 5.68ºC (min) to 34.47ºC (max), with relative humidity ranging from 72% (morning) to 30% (evening). The total rainfall received was 50.90 mm. The soil of the experimental field was clay loam in texture, medium in organic carbon (0.58%), available nitrogen (224.33 kg ha^{-1}), available phosphorus (11.87 kg ha^{-1}), and medium in available potassium (204.12 kg ha^{-1}), with a pH of 7.24 and EC of 0.16 ds/m Twelve treatment combinations (P_0V_1, P_0V_2, P_0V_3, P_1V_1, P_1V_2, P_1V_3, P_2V_1, P_2V_2, P_2V_3, P_3V_1, P_3V_2, P_3V_3) were laid out in Factorial Randomized Block Design and replicated thrice. The treatments consisted of four phosphorus levels: P_0 = Control (0kg P_2O_5 ha^{-1}), P_1 = 20kg P_2O_5 ha^{-1}, P_2 = 40kg P_2O_5 ha^{-1}, P_3 = 60kg P_2O_5 ha^{-1}, and three varieties of pea (Pisum sativum L.): V_1 = KN-5, V_2 = Aman, V_3 = KS-10

The experimental plots were fertilized as per the treatments. Single super phosphate (16% P_2O_5) was used as the phosphorus source, while muriate of potash (60% K_2O) was applied as the potassium source. A full recommended dose of potassium (25 kg K_2O ha^{-1}) and nitrogen (25 kg N ha^{-1}) was uniformly applied to each plot as a basal dose before sowing. Phosphorus was applied as per the treatment at the time of sowing. The seeds were sown on November 4, 2023, at a rate of 80kg ha^{-1} in rows spaced 45 cm apart, with 10 cm plant spacing within rows. Proper field preparation, including plowing and leveling, was done prior to sowing. Irrigation was provided whenever necessary, with three irrigations applied during the crop growth period. Standard agronomic practices such as weeding, thinning, and pest control were followed throughout the season

III. RESULTS AND DISCUSSION

3.1 Experimental results on the effect of treatments are explained as under:

The beneficial effect of different levels of phosphorus on mean plant height at 60 DAS, number of leaves per plant at 60 DAS, number of branches per plant, root nodulation, grain yield (q ha^{-1}), stover yield (q ha^{-1}), test weight, harvest index, and protein content were evident during the active growth and maturity period of the pea crop (Pisum sativum L.). Incorporation of 60kg P_2O_5 ha^{-1} (P_3) produced significantly higher mean plant height at 60 DAS (62.10cm), number of leaves per plant at 60 DAS (28.32), and number of branches per plant at 60 DAS (12.45), followed by incorporation of 40kg P_2O_5 ha^{-1} (P_2), while the control treatment (P_0) recorded the lowest values (Table 1). Data on yield and yield-contributing traits such as the number of pods per plant, pod length (cm), grain yield (q ha^{-1}), stover yield (q ha^{-1}), test weight, and harvest index, as influenced by different phosphorus levels, was found to be significant and is presented in Table 2. Incorporation of 60kg P_2O_5 ha^{-1} (P_3) produced the maximum number of pods per plant (14.32), pod length (8.47cm), grain yield (47.65 q ha^{-1}), stover yield (85.23 q ha^{-1}), and test weight (18.32g), followed by incorporation of 40kg and 20kg P_2O_5 ha^{-1}, respectively. However, the highest harvest index (32.10%) was observed when 40kg P_2O_5 ha^{-1} was applied (P_2). Protein content was also influenced by different levels of phosphorus. The highest protein content (23.24%) was observed with the application of 60kg P_2O_5 ha^{-1} (P_3), followed by 40kg and 20kg P_2O_5 ha^{-1}, respectively. The beneficial effect of different varieties on mean plant height at 60 DAS, number of leaves per plant, number of branches per plant, and root nodulation was also evident during the active growth and maturity period of the pea crop. The variety Aman (V_2) recorded maximum plant height at 60 DAS (63.32cm), followed by KS-10 (V_3) (60.89cm). The highest number of pods per plant (14.32), pod length (8.47cm), and grain yield (47.65 q ha^{-1}) were also recorded in Aman (V_2), which was statistically at par with KS-10 (V_3). The yield and yield-contributing traits like number of pods per plant, pod length, grain yield (q ha^{-1}), stover yield (q ha^{-1}), test weight, and harvest index were significantly influenced by different varieties. The highest grain yield (47.65 q ha^{-1}) was obtained with Aman (V_2), which was statistically at par with KS-10 (V_3). In addition, Aman also gave the highest test weight (18.32g) and harvest index (32.10%). Protein content was also influenced by different varieties. Aman recorded the highest protein content (23.24%) compared to other varieties, which might be due to its better nutrient absorption efficiency. These results are in conformity with those of Singh et al. (2021) and Bhat et al. (2013) [5, 9]. The interaction between phosphorus levels and varieties was significant in terms of plant growth, yield, and protein content. The combination of 60kg P_2O_5 ha^{-1} and Aman (P_3V_2) resulted in the best overall performance, including the highest grain yield (47.65 q ha^{-1}), stover yield (85.23 q ha^{-1}), and protein content (23.24%) [5, 9].

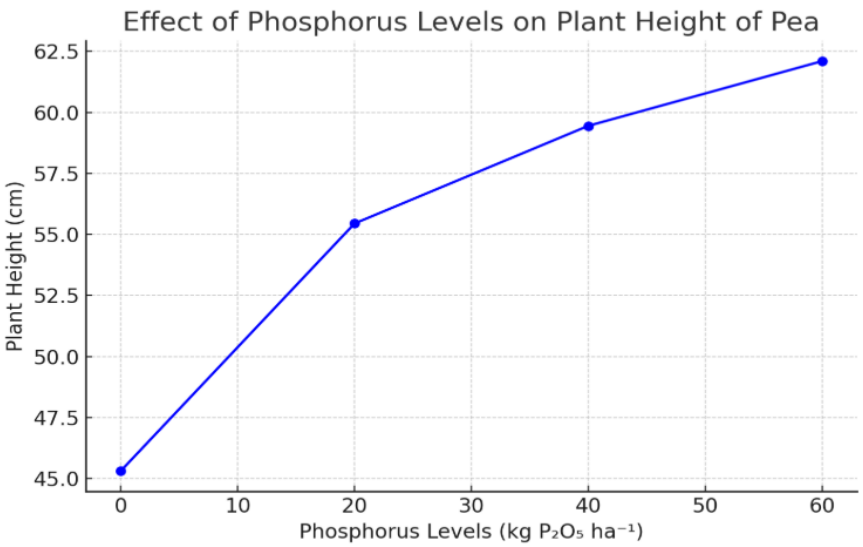

FIGURE 1: Effect of Phosphorus Levels on Plant Height of Pea

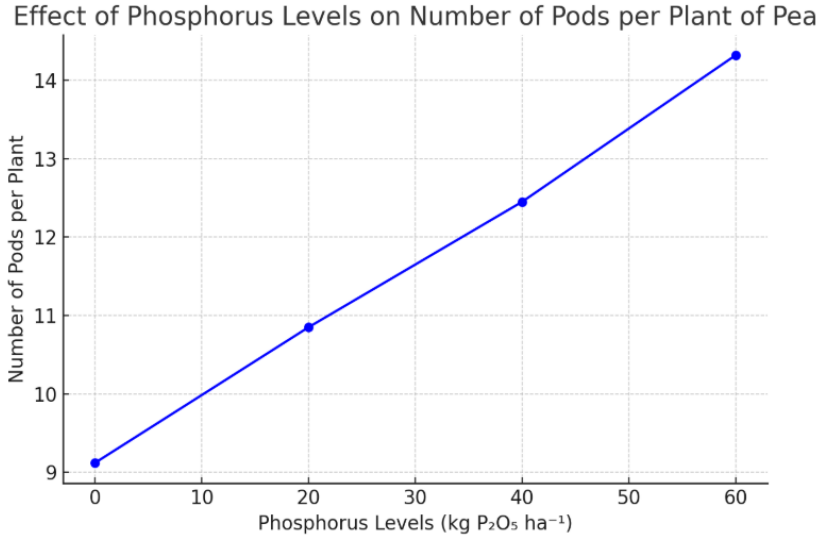

FIGURE 2: Effect of Phosphorus Levels on Number of Pods per Plant of Pea

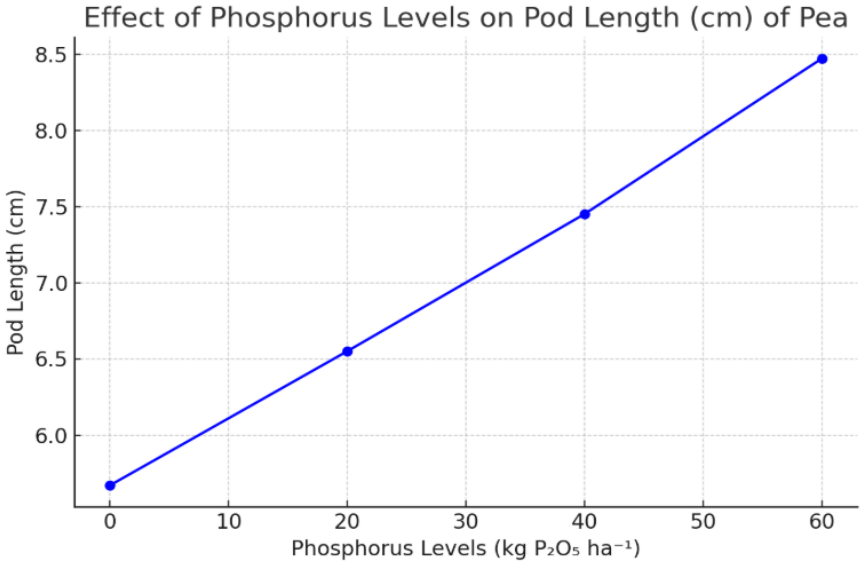

FIGURE 3: Effect of Phosphorus Levels on Pod Length (cm) of Pea

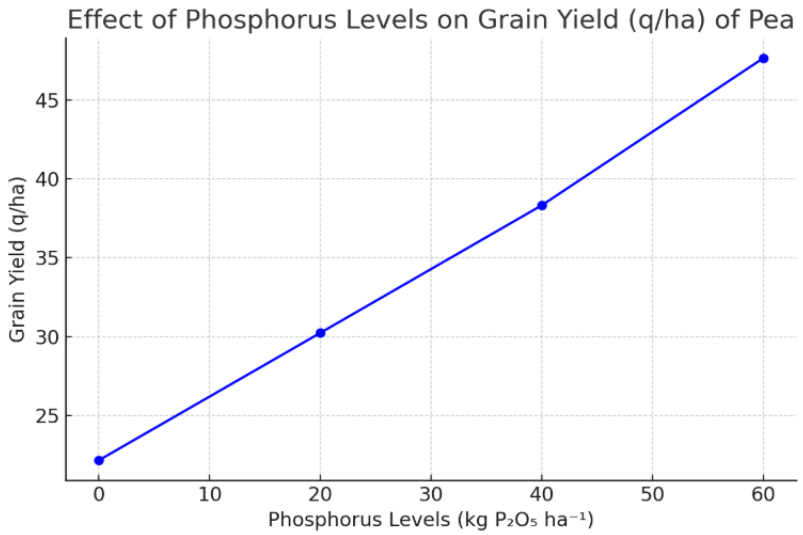

FIGURE 4: Effect of Phosphorus Levels on Grain Yield (q/ha) of Pea

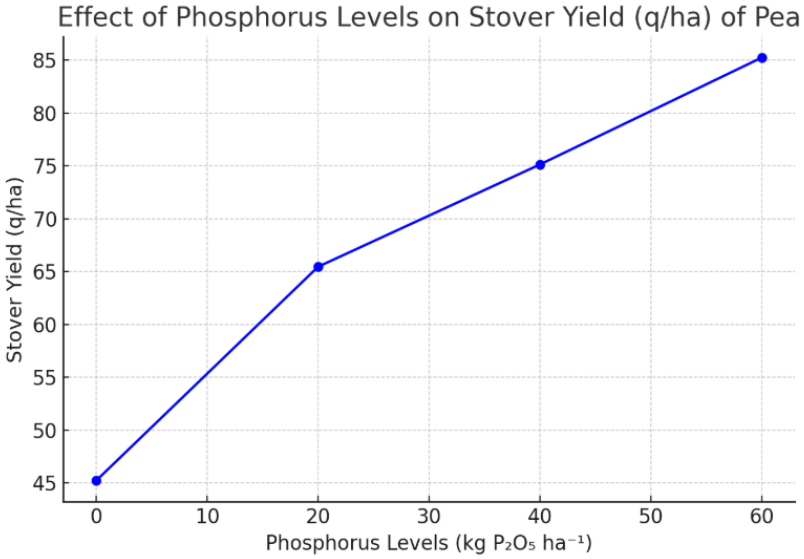

FIGURE 5: Effect of Phosphorus Levels on Stover Yield (q/ha) of Pea

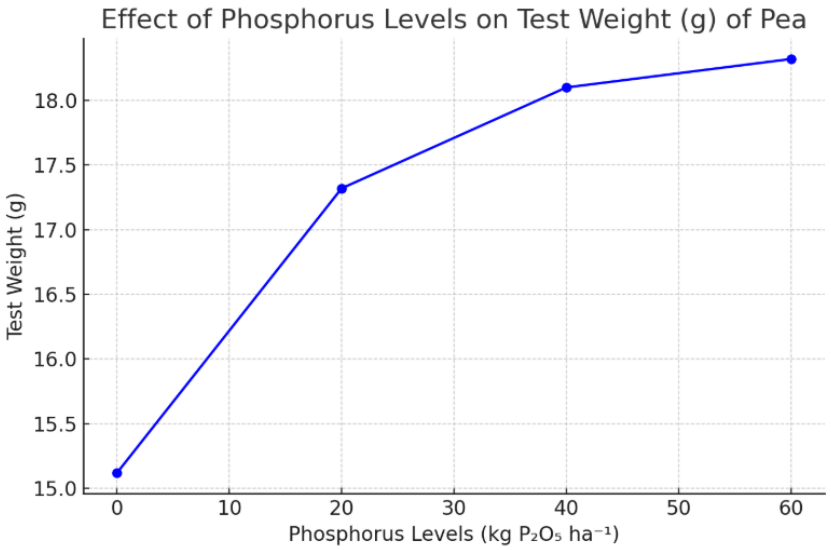

FIGURE 6: Effect of Phosphorus Levels on Test Weight (g) of Pea

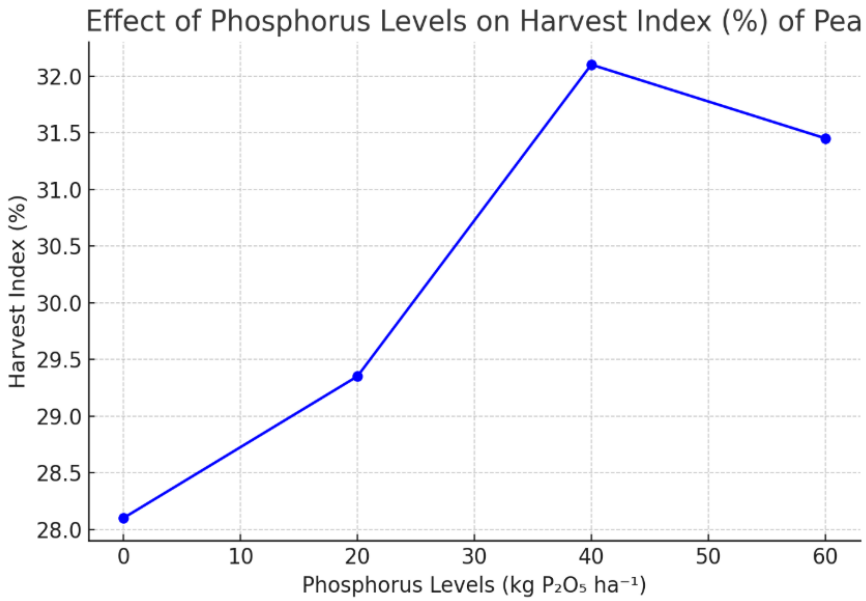

FIGURE 7: Effect of Phosphorus Levels on Harvest Index (%) of Pea

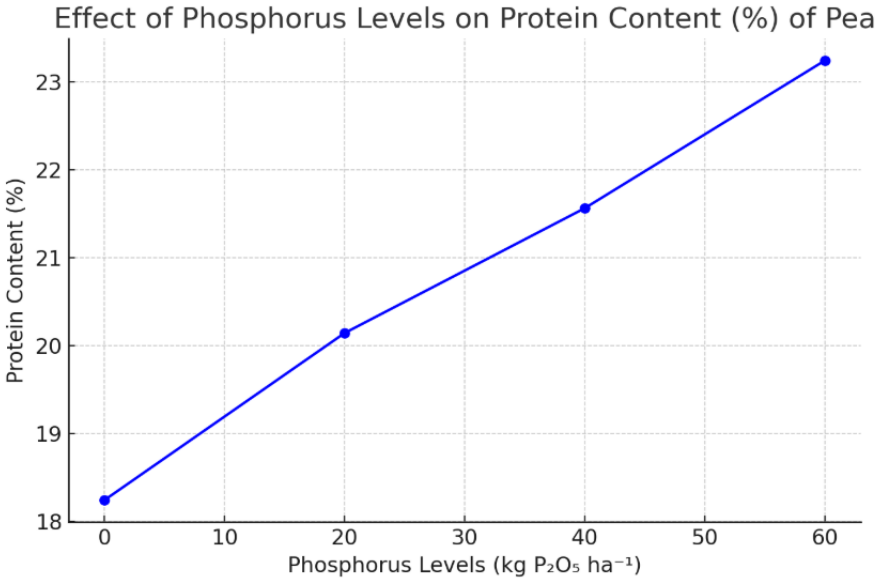

FIGURE 8: Effect of Phosphorus Levels on Protein Content (%) of Pea

IV. SUMMARY AND CONCLUSION

The present study investigated the effect of different phosphorus levels and pea varieties on growth, yield, and quality parameters. The application of phosphorus significantly influenced all growth parameters, including plant height, number of leaves, and branches per plant, with the highest values observed at 60kg P_2O_5 ha^{-1}. Among the varieties, Aman demonstrated superior performance in terms of plant height, number of pods per plant, and overall yield. The maximum grain yield, test weight, and protein content were achieved with the application of 60kg P_2O_5 ha^{-1}, particularly when combined with the Aman variety. This treatment combination produced the highest grain yield per hectare, along with improved stover yield and protein content. In conclusion, the application of 60kg P_2O_5 ha^{-1} is recommended for optimal pea growth and yield, especially when using the Aman variety. These findings suggest that the interaction between phosphorus levels and variety selection plays a critical role in enhancing pea crop productivity, and phosphorus fertilization is essential for maximizing both yield and quality.

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