

Effect of Different levels of Phosphorus and PSB (*Phosphate Solubilizing Bacteria*) with Pea Varieties under Climate Condition of Tikamgarh District

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Abstract

Studies of the field experiment on effect of different levels of phosphorus and PSB with varieties of pea were carried out during Rabi season of 2019-20 at farm, college of Agriculture Tikamgarh (M.P.). Results of studies indicated that height of plant (cm), leaf area plant⁻¹, fresh weight (g) and dry weight (g) of plant recorded at 45, 60 and 80 DAS were found significant influence factors for growth parameters as well as yield attributes number of pod plant⁻¹, number of seed pod⁻¹, weight of seeds plant⁻¹, seed yield ha⁻¹ (q), biological yield ha⁻¹ (q), and harvest index (%) with different pea varieties. Highest height of plant (45.7, 55.4 and 67.3 cm), the maximum leaf area plant⁻¹ (30.8, 36.7 and 46.8 dm²), highest fresh weight of plant (20.3, 44.4 and 58.6 g), maximum dry weight of plant (1.3, 12.3 and 27.2 g) was recorded in Azad Pea-3 + 40 kg P₂O₅ ha⁻¹ at 45, 60 and 80 DAS, respectively. All growth attributes were recorded minimum in Kashi Nandini + 0 kg P₂O₅ ha⁻¹ at the same DAS. The Arkel + 0kg P₂O₅ ha⁻¹ was recorded earliest 50% flowerings (39.6 DAS) while the late days was recorded in the Azad Pea-3 + 40 kg P₂O₅ ha⁻¹. The highest seed yield ha⁻¹ of 18.6 q ha⁻¹ was recorded with Azad Pea-3+ 40kg P₂O₅ ha⁻¹ followed by 17.6 q ha⁻¹ in Arkel+40kg P₂O₅ ha⁻¹. Whereas, the minimum seed yield ha⁻¹ of 14.6 q ha⁻¹ in Kashi Nandini+0kg P₂O₅ were recorded. Azad Pea-3 + 40 kg P₂O₅ ha⁻¹ resulted maximum net return due to highest positive effect on yield and growth parameters.

Key words: Pea, PSB, Phosphorus, Growth & Yield parameters

Introduction

Pea (*Pisum sativum* L.) is a very popular leguminous vegetable crop grown in the cool season throughout the world. In India pea is grown as winter vegetable in the northern plains, while in hilly terrain it is grown as off-season vegetable during summer and winter seasons. In India, pea is primarily grown in the states of Madhya Pradesh, Uttar Pradesh, Bihar, Haryana, Punjab and Maharashtra. The area under this crop in India is 554 thousand hectares with 5524 thousand metric tons production and 9.971 thousand metric tons productivity ha⁻¹ (NHB 2018-19). The area under this crop in Madhya Pradesh is 94.99 thousand hectares which produces 961.55 thousand metric tons. There are several factors, which influence the yielding capacity of the crop. Out of these,

phosphorus deficiency is usually the most important single factor for poor nodulation and low yield of leguminous crops in all soil types^[8].

The other factors which are responsible for yield influence are seed, size, shape of pea varieties, sugar level, season of growing and temperature^[9]. The requirement of phosphorus in pea crop can be applied through in the form of phosphorus fertilizer or with (*PSB*) (*Phosphate Solubilizing Bacteria*) as bio-fertilizer. It was also reported that the aerobic and heterotrophic phosphate solubilizing bacteria found suitable facilitated the availability of phosphorus to pea crop. Large numbers of micro-organism tested and inoculants of *Bacillus megaterium*, *Pseudomonas striata*,

Bacillus polymyxa were found suitable and available for seed inoculation. These bacteria solubilize phosphate in excess quantities for their own requirements and thus make it available to plants for their healthy growth. He has also found efficient in solubilization of low grade rock phosphate and soil fixed phosphate by secreting several organic acids. Under favorable conditions, they can solubilize 20-30% of insoluble phosphate. The application of 60 and 80 kg phosphorus ha⁻¹ significantly increases the seed yield by 11.30 and 13.92 % compare to 40 kg phosphorus ha⁻¹.

Method and Materials

Tikamgarh district lies in the Bundelkhand Zone (Agro-climatic Zone-VIII). It situated in the north-eastern part of Madhya Pradesh. The field experiment was carried out during winter 2019-20 at Research Farm, College of Agriculture, Tikamgarh (M.P.). The meteorological data prevailed during crop season November, 2019 to March, 2020 (Rabi 2019-20) was recorded maximum, minimum and mean temperatures, mean relative humidity and weekly rainfall were recorded at the Meteorological Observatory of research Farm, College of Agriculture, Tikamgarh (M.P.).

The average minimum (13.5 °C) maximum (33.6 °C), Relative humidity (72.8 %) and rainfall (0.053 mm) were recorded from crop period of 46th SMW (Standard Mean Week), 12-18 Nov, 2019 to 10th SMW, 5-11 March, 2020. The soil of field experiment plot were studied for their physical and chemical properties and availability of nutrients levels. The soil was medium black soil having loamy texture. The soil pH (7.86), organic carbon (0.5%), availability of nutrients like nitrogen (203), phosphorus (17.9) and potassium (392) (kg/ha) were recorded.

Genotype has a significant role in productivity as well as quality of the produce. Different varieties have been evolving which show great variation in yield and quality under different climatic conditions. The cultivation of pea for vegetable and seed purpose was gaining importance among the farmers. Keeping this fact in view, a field experiment studies on effect of different levels of phosphorus and *PSB* (*Phosphate Solubilizing Bacteria*) with pea varieties under Tikamgarh district climate condition were conducted during Rabi season of 2019 -20 at, College of Agriculture, Tikamgarh (M.P.).

The experiment design was used as factorial randomized block design with each 3 replication of 12 treatments. The plot size was maintained at 3 m x 2.5 m, distance between plots 0.50 m, distance between replications 1.0 m, spacing between rows to row 30 cm, spacing between plant to plant 10 cm. The seed rate was applied @ 80-100kg ha⁻¹. The pea crop recommended dose of fertilizer 25:60:60 (N: P: K) kg ha⁻¹. The pea varieties were used in experiments as Kashi Nandini, Arkel, Azad Pea -3 with three phosphorus level kg/ha viz., 20, 30 and 40 with 0 level of control. *PSB* was used uniformly with all the treatment before the sowing of the crop. All agronomical cultural practices were carried out as per pea cultivation recommended from field preparation to crop harvesting. The data were recorded for height of plant (cm) at 45, 60 and 80 days of crop, leaf area plant¹(dm²), fresh weight of plant (g), dry weight of plant (g), day to 50% flowering, number of pods plant⁻¹, number of seed pod⁻¹, weight of seed plant⁻¹(g) and seed yield ha⁻¹. All the data obtained with regard to the growth

and yield attributing parameters were

Results and Discussion

The data recorded on growth parameters showed in (Table-1) the results revealed that the significant influence of varieties and phosphorus levels on various growth parameters viz., at 45, 60 and 80 DAS on height of plant (cm), leaf area plant⁻¹ (dm²), fresh weight of plant (g), dry weight of plant and day to 50% flowerings. The significantly maximum height of plant (44.2, 53.3 and 63.2 cm), leaf area plant⁻¹ (28.3, 33.8 and 43.9 dm²), respectively at 45, 60 and 80 DAS was recorded in variety Azad Pea-3, followed by Arkel. However, the minimum height of plant, leaf area plant⁻¹ was observed

analyzed statistically.

under the variety Kashi Nandini at the same DAS, respectively^[1,5,6] in mung bean and in pea^[3]. Application of phosphorus exerted significant influence on growth parameters. Maximum height of plant (cm) at 45, 60 and 80 DAS (41.2, 47.7 and 53.6 cm), leaf area plant⁻¹ at 45, 60 and 80 DAS (24.5, 30.2 and 38.2 dm², respectively) was recorded in phosphorus level 40 kg P₂O₅ ha⁻¹, followed by 30kg P₂O₅ha⁻¹. While minimum height of plant, leaf area plant⁻¹ was recorded in phosphorus levels 0 kg P₂O₅ ha⁻¹ at 45, 60, and 80 DAS, respectively^[6,9].

Table 1 Effect of varieties, phosphorus levels on vegetative parameters of pea

Varieties	Height of plant (cm)			Leaf area plant ⁻¹ (dm ²)			Fresh weight of plant (g)			Dry weight of plant (g)		
	45 DAS	60 DAS	80 DAS	45 DAS	60 DAS	80 DAS	45 DAS	60 DAS	80 DAS	45 DAS	60 DAS	80 DAS
Kashi Nandini	33.2	41.8	44.6	17.3	22.8	31.6	15.0	32.9	38.1	0.4	8.5	19.4
Arkel	37.5	42.7	44.8	20.5	25.6	32.4	15.6	37.7	42.9	0.5	8.8	19.5
Azad Pea-3	44.2	53.3	63.2	28.3	33.8	43.9	17.5	43.1	54.7	1.1	10.9	24.8
CD at 5%	0.1	0.2	0.4	0.3	0.1	0.3	0.5	0.0	0.0	0.0	0.0	0.3
Phosphorus level (p)												
0 Kg P ₂ O ₅	35.7	43.6	47.7	19.4	25.1	33.5	14.4	35.8	42.5	0.6	7.9	18.8
20kg ha ⁻¹ P ₂ O ₅	37.4	45.9	50.5	21.3	26.1	35.1	15.3	37.1	44.2	0.6	8.8	19.6
30kg ha ⁻¹ P ₂ O ₅	38.9	46.5	51.7	22.8	28.2	37.0	16.6	38.6	46.1	0.7	9.9	22.6
40kg ha ⁻¹ P ₂ O ₅	41.2	47.7	53.6	24.5	30.2	38.2	17.7	40	48.2	0.8	10.9	23.7
CD at 5%	0.2	0.2	0.5	0.3	0.1	0.4	0.6	0.0	0.0	0.0	0.0	0.3

Plant biomass (fresh weight and dry weight of plant) was recorded at 45, 60, and 80 DAS revealed significant difference among the varieties. Highest values (fresh weight of plant 17.5, 43.1 and 54.7 g and dry weight of plant 1.1, 10.9 and 24.8 g) were recorded with variety Azad Pea-3 was followed by Arkel. Minimum plant biomass was recorded with variety Kashi Nandini. Genetic makeup might have been the case of differentiation in attaining these parameters under different varieties.

Application of Phosphorus levels exhibited significant influence on plant biomass. Maximum plant biomass was recorded under application of 40 kg P₂O₅ ha⁻¹ at 45, 60 and 80 DAS (fresh weight of plant 17.7, 40.0 and 48.2 g and dry weight of plant 0.8, 10.9 and 23.7 g), followed by 30kg P₂O₅ha⁻¹ at 45, 60 and 80 DAS. Minimum plant biomass was recorded under application of 0 kg P₂O₅ ha⁻¹. Positive influence of phosphorus application on root elongation might have promoted growth of plant as indicated in

plant height and fresh weight of plant. Phosphorus application also increased nodulation in root. Phosphorus is needed to promote the development of extensive root system vigorous seedling. Encouraging vigorous root growth is an important step of promoting nodules development.

Significant influence of varieties and phosphorus levels (Table-2) on number of pods plant⁻¹ number of seed pod⁻¹, weight of seeds plant⁻¹, and seed yield (qha⁻¹). In case of varieties, the highest number of pod plant⁻¹ (31.1) were observed under the variety Azad Pea-3 which was at par with variety Arkel. While lowest number of pods plant⁻¹ (24.8) was recorded in variety Kashi Nandini.

Table 2 Effect of varieties, phosphorus levels on yield attributes parameters of pea

Varieties	Number of pods plant ⁻¹	Number of seed pod ⁻¹	Weight of seed plant ⁻¹	Seed yield (q ha ⁻¹)
Kashi Nandini	24.8	5.8	24.5	15.6
Arkel	26.3	6.5	27.1	16.5
Azad Pea-3	31.1	7.8	35.7	17.6
CD at 5%	0.4	0.1	0.5	0.02
Phosphorus levels				
0 Kg P₂O₅	23.5	5.9	24.5	15.3
20kg ha⁻¹ P₂O₅	26.2	6.2	27.3	16.4
30kg ha⁻¹ P₂O₅	28.2	7.2	31.0	17.0
40kg ha⁻¹ P₂O₅	31.7	7.4	33.7	17.6
CD at 5%	0.5	0.1	0.6	0.02

Significantly maximum number of seeds pod⁻¹ (7.8) were obtained under the variety Azad Pea-3 followed by Arkel. While, lowest number of seed pod⁻¹ (5.8) were recorded in variety Kashi Nandini. These findings were found in agreement with the findings of others^[1]. The maximum number of seeds pods⁻¹ (7.4) was noted under the phosphorus level 40 kg P₂O₅ ha⁻¹, followed by 30kg P₂O₅ha⁻¹. While, it was minimum number of seed pod⁻¹ (5.9) were under phosphorus level 0 kg P₂O₅ ha⁻¹. These yield attributes were

Similar results have been reported earlier^[1,7]. As regards to phosphorus levels, the maximum number of pod plant⁻¹ (31.7) was noted under the phosphorus level 40kg P₂O₅ ha⁻¹ followed by 30kg P₂O₅ ha⁻¹. While minimum in number of pods plant⁻¹ (23.5) were recorded for phosphorus levels of 0 kg P₂O₅ ha⁻¹. The requirement of phosphorus in legumes like pea was higher than other crops or their root development and metabolic activities. Phosphorus was the vital component of DNA, RNA, ATP and photosynthetic system and catalyses a number of biochemical reactions from the beginning of seedling growth through to the formation of grain at maturity^[1,6,7].

increased significantly up to 90 kg P₂O₅ ha⁻¹. Application the improvement in these characters was due to higher photosynthetic activity and translocation of photo-syntheses to sink with phosphorus application. Similar results were reported in the past^[1, 12].

Maximum weight of seeds plant⁻¹ was recorded for variety Azad Pea-3 (35.7 g) followed by Arkel, while variety Kashi Nandini noted minimum weight of seeds plant⁻¹ (24.5 g). Similar results have been reported in the past^[11]. Phosphorus level

40 kg P₂O₅ ha⁻¹ was received maximum weight of seeds plant⁻¹ (33.7 g) followed by 30kg P₂O₅ ha⁻¹. While minimum weight of seeds plant⁻¹ (24.5 g) was observed in phosphorus level 0 kg P₂O₅ ha⁻¹. Among the varieties, maximum seed yield of (17.6 qha⁻¹) was recorded with variety Azad Pea-3 which was at par with Arkel. Minimum seed yield (15.6 q ha⁻¹) was observed in case of variety Kashi

Conclusion

It may be concluded from the findings of the experiment that among the different varieties of pea, Azad Pea-3 recorded superior performance for growth attributes, yield attributes. Among the Phosphorus levels, application of 40 kg P₂O₅ ha⁻¹ showed highest growth and

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6. yield parameters of pea. While in case of treatment combination of varieties and phosphorus levels Azad Pea-3 + 40 kg P₂O₅ ha⁻¹ at 45, 60 and 80 DAS showed superior performance for growth attributes and yield attributes. It also recorded highest net income.
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