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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(8): 2438-2440

www.thepharmajournal.com
Received: 20-05-2023
Accepted: 25-06-2023

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Effect of different levels of nitrogen and phosphorus on growth and yield parameter of the field pea crop (*Pisum sativum* L.)

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Abstract
During the Rabi season of the year 2022-23, The field experiment took place at Crop Research Centre-2, located within the School of Agriculture at ITM University in Gwalior, which is situated in the state of Madhya Pradesh. To investigate the "Effect of Different Levels of Nitrogen and Phosphorus on Growth and Yield Parameter of Field Pea Crop". The experiment was done using a Factorial (RBD) with ten treatments and three replications. Details of treatments are as follow T_1 -totally control, T_2 -N15P25, T_3 -N15P50, T_4 -N15P75, T_5 -N30P15, T_6 -N30P50, T_7 -N30T75, T_8 -N45P25, T_9 -N45P50 and T_{10} -N45P75. The highest growth parameter (plant population, plant height (cm), number of leaves plant^{-1}and dry matter accumulation (g)) and yield (grain yield, straw yield, biological yield, and seed index) was observed in the treatment T_{10} -N45P75 as compared to control treatment but statistically at with the T_6 -N30P50.

Keywords: Nitrogen, phosphorus, field pea, growth parameter, yield attributes

Introduction
Green pea (*Pisum sativum* L.), the Leguminosae family, is the name given to the field pea crop. Field peas are classified as Pisum sativum, a member of the Fabaceae family. The fully developed grains can make chapati, dal, and other delicious dishes. Pea is widely consumed around the world and in human diets. High in amino acids like lysine and tryptophan, carbs, vitamins A and C, calcium, and phosphorus. (Rana *et al*., 2021) [2].

These specimens exhibit significant protein content (ranging from 15.8% to 32.1%), starch content (ranging from 18.6% to 54.1%), oil content (ranging from 0.6% to 5.5%), and soluble carbohydrate content (5%) (Rana *et al*., 2021) [2], along with omega-3 and omega-6 fatty acids. (Arnoldi *et al*., 2015) [1]. Peas' high levels of potassium, calcium, and folate, as well as their digestible fibre content (5.9^{-1}2.7 per cent), have been shown to benefit heart health, digestive health, and cancer prevention. (Murade *et al.*, 2014) [3].

According to FAO, the top field pea producers are Canada (3.5M tonnes), Russia (1.9M tonnes), China (1.4 M tonnes), and Ukraine (1.2M tonnes). In 2020-21, global pea cultivation covered 1.86M hectares. India produced 2.52M tonnes during this period, with Uttar Pradesh leading, followed by Madhya Pradesh and Rajasthan (FAO 2020-21) [4].

Madhya Pradesh (M.P.) is one of India's significant field pea producers. According to the Ministry of Agriculture and Farmers Welfare, Government of India data, Madhya Pradesh (M.P.) is a major pea producer in India. In the 2020-21 season, it cultivated 597K hectares and produced 627K metric tonnes of field peas.

Early application of nitrogen fertilizer greatly influences pea growth by promoting leaves, plant height and stem, and overall vegetative development. Nitrogen enhances protein content and is vital for chlorophyll and protein formation. It boosts nitrogen fixation, accelerates early growth, and imparts a deep green colour. Essential for legumes, low initial nitrogen is crucial for robust beginnings.

Raising pulses without using phosphatic fertilizer is a significant cause of low yield. Many researchers have reported that an appropriate amount of phosphorus is good for legumes' better development, yield, and quality. (Sammauria *et al*., 2009) [8]. It is essential for developing roots, nodulation, blooming, and fruiting in plants. (Murade *et al*., 2014) [7].

Materials and Methods

During the Rabi season of the year 2022-23, The field experiment was conducted at Crop Research Centre-2, situated within the School of Agriculture at ITM University in Gwalior, Madhya Pradesh. The research farm is located at 26.13'N and 78.20'E, and it is 210 m above sea level. The experiment was done using a Factorial (RBD) with ten treatments and three replications. Details of treatments are as follow T_1 -totally control, T_2 -N15P25, T_3 -N15P50, T_4 -N15P75, T_5 -N30P15, T_6 -N30P50, T_7 -N30T75, T_8 -N45P25, T_9 - N45P50 and T_{10} -N45P75. The sowing was done on October 22 2022. Field pea seeds were sown @ 15 kg ha^{-1} in a row at 30 cm and planted 10 cm apart. Observation on growth parameters *viz*. plant height (cm), number of leaves plant^{-1} and dry matter accumulation (g) and yield attributes (grain yield (kg), straw yield (kg), biological yield (kg), and weight of 100 seed) were recorded.

Result and Discussion

Effect of nitrogen and phosphorus on growth parameters at harvest stage

The application of 45 kg N ha^{-1} resulted in the tallest plants, measuring 50.38 cm, *at par* with 30 kg N ha^{-1} (46.90 cm), respectively. The control treatment resulted in the plants having the shortest heights (37.36 cm). As for phosphorus, applying 75 kg P_2O_5 ha^{-1} led to the tallest plants (49.78 cm), followed closely by the plants treated with 50 kg P_2O_5 ha- 1 (46.28 cm), while the absence of phosphorus resulted in the shortest plants (37.36 cm) at harvest stage.

Nitrogen levels significantly influenced the number of leaves plant^{-1}. 45 kg N ha^{-1} treatments produced a higher number of leaves plant^{-1} (70.90) which was *at par* with the 30 kg N ha^{-1} (65.28) compared to the control treatment (49.50). Phosphorus levels also played a role, with 75 kg P_2O_5 ha^{-1} treatments resulting in similar numbers of leaves per plant (69.44), which is at par with the 50 kg P_2O_5 ha^{-1} (64.40), respectively. In contrast, plots without phosphorus exhibited the lowest leaf count (49.50).

Dry matter accumulation, a measure of overall plant growth, was significantly impacted by nitrogen and phosphorus levels. Application of 45 kg N ha^{-1} led to the highest dry matter accumulation (27.46 g plant^{-1}), which is closely related to 30 kg N ha^{-1} (26.25 g plant^{-1}), respectively, outperforming the control treatment (20.87 g plant^{-1}). Similarly, the application of 75 kg P_2O_5 ha^{-1} resulted in the most significant dry matter accumulation (27.40 g plant^{-1}), closely related to 50 kg P_2O_5 ha^{-1} (26.17 g plant^{-1}). At the same time, plots with no phosphorus exhibited the lowest accumulation (20.87 g plant^{-1}).

Effect of nitrogen and phosphorus on yield parameters

Nitrogen and phosphorus concentrations significantly influenced grain yield. The treatments with 45 kg N ha^{-1} and 75 kg P_2O_5 ha^{-1} produced the maximum yields, 21255.68 kg ha^{-1} and 2108.72 kg ha^{-1}, respectively. Comparable results were obtained with 30 kg N ha^{-1} and 50 kg P_2O_5 ha^{-1} (2023.10 kg ha^{-1} and 1997.17 kg ha^{-1}). The control treatment produced the lowest grain yield at 1093.5 kg ha^{-1}. The straw yield was notably affected by nitrogen and phosphorus levels. The application of 45 kg nitrogen ha^{-1} and 75 kg phosphorus ha^{-1} yielded the highest straw outputs, reaching 4272.98 kg ha^{-1} and 4289.38 kg ha^{-1}, respectively. Similar outcomes were observed with 30 kg nitrogen ha^{-1} and 50 kg phosphorus ha^{-1} (4125.76 kg ha^{-1} and 4118.92 kg ha^{-1}), while the control treatment had the lowest straw yield at 2682.52 kg ha^{-1}.

The highest biological yields were attained with 45 kg N ha^{-1} and 75 kg P_2O_5 ha^{-1}, yielding 6406.49 kg ha^{-1} and 6407.39 kg ha^{-1}, separately. Comparable results were obtained with 30 kg N ha^{-1} and 50 kg P_2O_5 ha^{-1} (6148.65 and 6116.09 kg ha^{-1}). The control treatment resulted in the lowest biological yield at 3776.02 kg ha^{-1}.

The application of 45 kg nitrogen ha^{-1} had a marginally higher harvest index of 33.25%, followed closely by 30 kg nitrogen ha^{-1} (32.97%). Similar trends were observed for phosphorus treatments, with 75 kg P_2O_5 ha^{-1} showing a harvest index of 33.02%. The control treatment had the lowest harvest index at 28.94%.

Table 1: Effect of different nitrogen and phosphorus levels on field pea growth parameters at harvest stage

Treatment			Yield attribute	
	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	100 seed weight (%)
Nitrogen (kg ha^{-1})				
15	1622.12	3725.95	5348.07	29.48
30	2023.10	4125.76	6148.86	32.97
45	2125.68	4272.98	6398.65	33.25
SE(m)±	105.83	131.15	183.85	1.85
CD (P=0.05)	314.45	389.66	546.24	NS
Phosphorus (kg ha- 1)				
25	1665.01	3710.83	5375.84	30.00
50	1997.1P7lant height 4118.92N		umber of lea6v1e1s6.09	Dry m3a2t.t6e8r
T7r5 treatment	2108.72 (cm) 4294.93		plant^{-1} 6403.65	Accumulation 33.02
SE(m)±	105.83	131.15	183.85	1.85
Nitrogen (kg ha^{-1} CD (P=0.05)	314.45	389.66	546.24	NS
Contro1l5	1093.50 41.01	2682.52	55.71 3776.02	24.3287.94
N×S intera3c0tion	46.90		65.28	26.25
SE(m)4±5	183.31 50.38	227.15	70.90 318.43	27.436.21
CD (PS=E0.(0m5))± CD (P=0.05)	NS 1.19 NS		1.87 NS	0.54 NS
Phosphorus kg ha- 25	3.54		5.56	1.61
50	1		58.06	24.51
75	42.22		64.40	26.17
SE(m)± CD (P=0.05)	46.28		69.44	27.40
Control N×S interaction	49.78		1.87	0.54

SE(m)± CD (P=0.05)	1.19 3.54 37.36 2.07 NS	5.56 49.50 3.24 NS	1.61 20.87 0.94 NS

Conclusion

The study demonstrates that nitrogen and phosphorus levels significantly influence field peas' growth and yield parameters. Optimal application of these nutrients leads to improved plant height, leaf count, dry matter accumulation, and yield. Notably, 45 kg nitrogen ha^{-1} and 75 kg phosphorus ha^{-1} treatments consistently yielded the best results regarding plant growth, grain yield, straw yield, and biological yield.

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