

Effects of Nitrogen and Phosphorus Application at Different Levels on Performance of Pea (*Pisum sativum* L.) in Agroclimatic Zone-II of Himachal Pradesh

Abstract

During the *Rabi* season of 2023, a field experiment was carried out at Agriculture Farm Chamelti, Shoolini University of Biotechnology and Management Sciences Solan (H.P.). The soil in the experimental field was well-drained, with medium in organic carbon and available nitrogen, but high in available phosphorus and potassium. Four Nitrogen levels *viz.*, N₀- Control, N₁- 15 kg ha⁻¹ + Nano urea (2 ml L⁻¹), N₂- 20 kg ha⁻¹, N₃- 25 kg ha⁻¹ and four levels of Phosphorus *viz.*, P₀- Control, P₁- 20 kg ha⁻¹, P₂- 40 kg ha⁻¹ + Nano DAP (2 ml L⁻¹), P₃- 60 kg ha⁻¹ and GS-10 Variety of Pea was tested in Factorial Randomized Block Design (FRBD) with three replications. The experimental field results showed that applying Nitrogen @ 25 kg ha⁻¹ (N₃) and Phosphorus @ 60 kg ha⁻¹ (P₃) produced maximum growth parameters (plant height, number of branches plant⁻¹, number of leaves plant⁻¹, dry matter accumulation g plant⁻¹), yield contributing traits (pod length, number of pods plant⁻¹, and number of grains pod⁻¹), and yield (grains, stover, and biological). Furthermore, it increased gross returns, net returns, and the B:C ratio when compared to other levels of Nitrogen and Phosphorus.

Keywords: Pea, nitrogen, phosphorus, growth, yield, economics

Introduction

Pea (*Pisum sativum* L.) is a major pulse and vegetable crop of cool season in India as well as world and it belongs to the Leguminosae family. There are two types of peas that are typically grown. Field pea (*Pisum sativum* L. var. *arvense*) is commonly used to make 'dal', whilst Garden pea (*Pisum sativum* L. var. *hortense*) is used as a green vegetable with wrinkled seeds and a sweet taste (Joshi *et al.*, 2020). Garden peas are mostly used as a vegetable and additionally, it is consumed as a pulse. Garden peas are sometimes planted for feed and green manure, and their pods are occasionally fed to farm animals (Phom *et al.*, 2014).

In the world basis, India ranks second to China in production of pea. In India, it is mainly grown in Uttar Pradesh, Madhya Pradesh, Punjab, Jharkhand, Himachal Pradesh, West Bengal, Chhattisgarh and Haryana. having the area of 5,90,000 ha, production 61,30,000 MT and productivity of 10.39 t ha⁻¹ (Anonymous, 2021- 22a). Himachal Pradesh ranks fifth in India with

production 328.80 million tonnes of pea annually over an area of 26 thousand hectare (Anonymous, 2021-22b). In the early stages of growth, nitrogen fertilizers are critical for the development of leaves, stems, and other vegetative parts they also help to raise the protein content of peas (Bunker *et al.*, 2018).

Nitrogen promotes growth in the leaf, stem, and other vegetative tissues. It also increases the amount of protein in peas. It is an essential component of proteins and chlorophyll, as well as a variety of other compounds important to plant metabolism, such as enzymes, phosphatides, alkaloids, vitamins, hormones, and nucleotides. It gives plants a deep green hue, accelerates their early growth, and improves their ability to symbiotically fix nitrogen from the atmosphere. Lowering the amount of nitrogen supplied to legumes during their early stages is critical for a strong start (Sammauria *et al.* 2009). However, adding phosphorus is equally critical for increasing growth and yield (Bunker *et al.*, 2018).

Materials and methods

The experiment was conducted at Agriculture farm Chamelti which is lies in the heart of Solan district of Himachal Pradesh. The soil of experimental field was well drained and medium in organic carbon and available nitrogen while, high in phosphorus and potassium. The climate of this region is generally characterized as sub-humid, sub temperate with cool winters. The maximum temperature ranged from 1.07 to 28.23⁰C. the crop received 203.17 mm rainfall which has been fairly distributed throughout the crop period. The recommended dose (100% NPK 20:60:20 kg ha⁻¹) as per the treatments was applied as a basal dose (at the time field preparation) during last ploughing. However, Nano Urea and Nano DAP were applied as a foliar spray at 70 DAS in respective treatments only. For taking observations point of view, the five plants were randomly selected and tagged in each net plot area. The growth parameters were recorded from the five tagged plant in each treatment and then average value was computed for consideration of final data. The plant height was measured from the tagged plants by using the meter scale from ground level to tip of the plant and then average value was used for final data. Total number of branches and leaves per plant (five tagged plants) was counted manually and then average value was taken for final data. For dry matter accumulation five plants was harvested from the ground levels thereafter sun dried for few days and then oven dry at 65±5 °C till constant weight was achieved and finally average value was used for representation of data in the Table. The yield attributing characteristics were recorded from the tagged plants and then average value was

computed for consideration of final data. At the time of harvesting, firstly border row was removed from each plot and then net plot area was left over in the field for sun dry for 5 days. After sun drying, the biological yield of pea was measured in each plot (net plot area) by using the weighing balance and then grains are removed by manual threshing. Finally yield converted into $q\ ha^{-1}$ by multiplying with appropriate conversion factor. The analysis of cost of cultivation is an important aspect which decides the option for the growers to choose the treatment combination according to their investment capacity and production of crops. The total cost was calculated by adding the expenditure incurred in all kind of operation as per treatment on per hectare basis in terms of $Rs.ha^{-1}$. The gross returns, net returns and B:C ratio was computed by using the formula given below:

$$\text{Gross returns (Rs. ha}^{-1}\text{)} = \text{Grain yield} \times \text{Price} + \text{Stover yield} \times \text{Price}$$

$$\text{Net returns (Rs. ha}^{-1}\text{)} = \text{Gross returns} - \text{Cost of cultivation}$$

$$\text{B:C ratio} = \text{Net returns/Cost of cultivation}$$

Results and Discussion

Growth

Data pertaining to all growth characters is presented in Table 1 and revealed that different levels of nitrogen and phosphorus had significant difference. Among the Nitrogen levels, (N_3) had the tallest plant height (56.9 cm), maximum number of branches $plant^{-1}$ (12.1), number of leaves $plant^{-1}$ (59.0), and dry matter accumulation $g\ plant^{-1}$ (20.27), followed by N_2 and N_1 , despite having the shortest plant height, minimum number of branches $plant^{-1}$, number of leaves $plant^{-1}$, and dry matter $g\ plant^{-1}$ in (N_0).

Amongst the Phosphorus levels, (P_3) had the tallest plant height (56.4 cm), which was statistically equivalent to (P_2). The highest number of branches $plant^{-1}$ (11.6), number of leaves $plant^{-1}$ (58.5), and dry matter output $g\ plant^{-1}$ (20.58) of pea were recorded in (P_3) over the remaining Phosphorus levels. The shortest plant height, minimum number of branches $plant^{-1}$, number of leaves $plant^{-1}$, and dry matter production ($g\ plant^{-1}$) were all recorded under (P_0). This might be due to the Nitrogen and Phosphorus both are involve in chlorophyll synthesis, cell division, increased in cell size, photosynthetic rate and increased root growth of crop plant which expressed significant changes in the morphology. Phosphorus helps in root growth which extract sufficient amount of water from the deeper layer of soil and helps in the overall growth of the crop plant. Timely supplying moisture and additional application of sulphur (source of

phosphorus was single super phosphate which is having 12% sulphur) increased the photosynthetic rate. These results were closely related to Dar *et al.* (2011), Singh *et al.* (2015), Metwaly *et al.* (2018), Singh *et al.* (2018), Shamad *et al.* (2019), Mandloiet *et al.* (2020), Tenikecieret *et al.* (2021), Ram *et al.* (2021) and Gaharwar *et al.* (2023).

Yield attributes

Data pertaining to yield attributing character *viz.*, such as pod length (cm), number of pods per plant, number of grains per pod and seed index (g) were significantly affected by Nitrogen and Phosphorus levels Table 2. Nitrogen levels (N_3) were shown to have a considerably higher maximum pod length (8.6 cm), number of pods plant⁻¹ (11.31), and number of grains pod⁻¹ (10.12) than the remaining Nitrogen levels. Despite being the least pod length (7.00 cm), the lowest number of pods plant⁻¹ (8.87) and number of grains pod⁻¹ (8.21) were reported under (N_0). Among the Phosphorus levels, (P_3) had the highest pod length (8.6 cm), number of pods plant⁻¹ (11.25) and number of grains pod⁻¹ (10.00), followed by P_2 and P_1 , although (P_0) having the shortest pod length (6.9 cm), minimum number of pods plant⁻¹ (8.73), and number of grains pod⁻¹ (8.20). These results are closely related to Sharma *et al.* (2003), Chauhan *et al.* (2010), Dar *et al.* (2011) Kumar *et al.* (2011), Tehria *et al.* (2014), Das *et al.* (2015), Singh *et al.* (2015), Saket *et al.* (2017), Metwaly *et al.* (2018), Shamad *et al.* (2019) and Akarsh *et al.* (2023).

Yield and harvest index

Pea yield is the sum of physicochemical processes occurring in the plant that are influenced by environmental conditions and management approaches. The economic yield of pea depends on several factors, including pod length (cm), number of pods per plant, number of grains per pod, and seed index (g). Data on seed, stover, biological yield and harvest index of pea were affected by the application of different quantities of Nitrogen and Phosphorus and showed a significant difference (Table 3). The application of nitrogen (N_3) resulted in the highest grain yield (19.53 q ha⁻¹), followed by nitrogen (N_1). However, the minimum grain production of 12.07 q ha⁻¹ was observed under Control (N_0) during the course of examination. The application of Nitrogen (N_3), (N_1), and (N_2) enhanced grain yield by 61.08, 39.93, and 18.06%, respectively, as compared to the Ccontrol (N_0). Among the Nitrogen levels, fertilization with Nitrogen (N_3) produced the highest stover production (28.19 q ha⁻¹), followed by (N_1) and (N_2). However, the lowest stover yield (18.53 q ha⁻¹) was achieved under Control (N_0). Amidst of the nitrogen levels, application of Nitrogen (N_3) produced significantly highest biological yield (47.72 q ha⁻¹)

of pea, followed by (N₁) and (N₂). Though, the minimum biological yield of pea (30.60 q ha⁻¹) was recorded under Control (N₀). The nitrogen application had no effect on harvest index of pea, which ranged from 39.44 to 40.92%. The maximum harvest index (40.92%) of pea was obtained with the application of Nitrogen (N₃), followed by (N₁) and (N₂). However, without the application of Nitrogen Control (N₀), had minimum harvest index with the value of 39.44%. The increased grain yield with increase in nitrogen levels might be due to Nitrogen is essential for the synthesis of chlorophyll and amino acids, which enhances photosynthesis. This increased photosynthesis causes a greater buildup of photosynthates, resulting in better yields. Nitrogen also alters the source-to-sink connection, which promoting/enhanced transfer of photosynthates to the plant's reproductive regions.

Among the Phosphorus levels, the application of Phosphorus (P₃) resulted in the highest grain production of pea (19.24 q ha⁻¹) followed by (P₂). However, the minimum grain yield of pea was achieved under Control (P₀). The application of phosphorus (P₃), (P₂) and (P₁) improved grain yield by 62.91, 40.22, and 27.94%, respectively as compared to the Control (P₀). Among the Phosphorus levels, fertilization with Phosphorus (P₃) resulted in the highest stover production of pea (28.07 q ha⁻¹), followed by (P₂) 24.27 q ha⁻¹ and (P₁) 22.29 q ha⁻¹. The lowest stover yield (17.95 q ha⁻¹) of pea was achieved in Control (P₀). Among the Phosphorus levels, fertilization with Phosphorus (P₃) produced significantly highest biological yield (47.31 q ha⁻¹) of pea, followed by (P₂) and (P₁). However, the lowest biological yield of pea was reported under Control (P₀). The application of phosphorus at various levels had no effect on the harvest index, which ranged from 39.68 to 40.66%. Among the various phosphorus levels, (P₃) had the highest harvest index (40.66%), followed by (P₂) and (P₁). However, the Control (P₀) treatment, which received no phosphorus, had the lowest harvest index. Pea grain output increased as the Phosphorus levels may be due to phosphorus helping in grain formation and additional supply of sulphur (indirect) enhance amino acid synthesis. Further addition of phosphorus helps root growth which increased extract moisture from the deeper layer of soil. Application of phosphorus through single super phosphate accumulates more amide substances and their translocation into reproductive organs of crop plants which influencing the growth and yield.

Economic studies

The cultivation costs for Nitrogen and Phosphorus ranged from 44981 to 45636 and 42090 to 47883 Rs. ha⁻¹, respectively. The highest cost of cultivation of pea was obtained with

fertilization of Nitrogen @ 15 kg ha⁻¹ + Nano urea foliar spray (2ml L⁻¹) (N₁) and Phosphorus @ 60 kg ha⁻¹ (P₃), as compared to all other levels of Nitrogen and Phosphorus. While the lowest cultivation cost was achieved under Control (N₀ and P₀). Nitrogen fertilizer (N₃) resulted in the highest gross returns (Rs. 135414 ha⁻¹) for pea, followed by (N₁) and (N₂). However, the minimal gross returns (Rs. 84036 ha⁻¹) for pea were obtained under Control (N₀). The net returns of Pea ranged from Rs. 39055 to 90098 ha⁻¹ across nitrogen levels. The application of nitrogen (N₃) fetched in the highest net returns for pea, followed by nitrogen (N₁) and nitrogen (N₂). However, the minimal net returns (Rs. 39055 ha⁻¹) were obtained under Control (N₀). Among the phosphorus levels, (P₃) gave the highest gross returns with a value of Rs. 133521 ha⁻¹, followed by (P₂) and (P₁). However, the minimum gross returns of pea (Rs. 82199 ha⁻¹) were obtained in treatment Control (P₀). Different levels of phosphorus fertilization had a substantial effect on net returns, ranging from Rs. 40109 to 85638 ha⁻¹. Fertilization with Phosphorus (P₃) had the highest net returns, followed by P₂ and P₁. However, the lowest net returns were observed under Control (P₀). The B:C ratio of pea affected considerably during the research with Nitrogen and Phosphorus levels. Among the Nitrogen and Phosphorus levels, the application of Nitrogen (N₃) and (P₃) resulted in the highest B:C ratio, followed by N₁ and P₂. However, a minimum B:C ratio was observed under Control (N₀ and P₀).

Conclusion

On the basis of experimental findings, it can be concluded that application of Nitrogen @ 25 kg ha⁻¹ (N₃) and Phosphorus @ 60 kg ha⁻¹ (P₃) was exhibited significantly maximum growth parameters (plant height, number of branches plant⁻¹, number of leaves plant⁻¹ and dry matter accumulation g plant⁻¹), yield attributing characteristics (pod length, number of pods plant⁻¹ and number of grains pod⁻¹) and yield (grain, stover and biological). Besides, it also increases gross returns, net returns and B:C ratio over other levels of Nitrogen and Phosphorus.

Table 1: Effect of Nitrogen and Phosphorus Levels on growth parameters of pea at harvest

Treatments	Growth parameters			
	Plant height (cm)	No. of branches plant ⁻¹	No. of leaves plant ⁻¹	Dry matter (g plant ⁻¹)
Nitrogen levels				
N ₀ Control	49.55	10.36	53.18	18.28
N ₁ 15 kg ha ⁻¹ + Nano urea foliar spray (2ml L ⁻¹)	55.02	11.39	56.60	19.69
N ₂ 20 kg ha ⁻¹	53.38	10.69	55.79	19.35
N ₃ 25 kg ha ⁻¹	56.95	12.10	59.03	20.27
Sem ±	0.38	0.11	0.29	0.17
CD (p = 0.05)	1.11	0.32	0.85	0.50
Phosphorus level				
P ₀ Control	49.74	10.71	53.54	18.36
P ₁ 20 kg ha ⁻¹	52.79	10.98	55.61	19.19
P ₂ 40 kg ha ⁻¹ + Nano DAP foliar spray (2ml L ⁻¹)	55.95	11.20	56.92	19.46
P ₃ 60 kg ha ⁻¹	56.43	11.65	58.52	20.58
Sem ±	0.38	0.11	0.29	0.17
CD (p =0.05)	1.11	0.32	0.85	0.50
Interaction	Significant	Significant	Non-significant	Non-significant

Table 2: Yield attributing characteristics of pea as influenced by different levels of Nitrogen and Phosphorus

Treatments	Yield attributing characteristics			
	Pod length (cm)	Number of pods plant ⁻¹	Number of grains pod ⁻¹	Seed index (g)
Nitrogen levels				
N ₀ Control	6.99	8.87	8.21	13.16
N ₁ 15 kg ha ⁻¹ + Nano urea foliar spray (2ml L ⁻¹)	7.95	10.40	9.61	13.42
N ₂ 20 kg ha ⁻¹	7.53	9.65	8.90	13.17
N ₃ 25 kg ha ⁻¹	8.61	11.31	10.12	13.48
Sem ±	0.09	0.14	0.11	0.15
CD (p = 0.05)	0.27	0.41	0.33	NS
Phosphorus levels				
P ₀ Control	6.94	8.73	8.20	13.11
P ₁ 20 kg ha ⁻¹	7.55	9.84	9.17	13.28
P ₂ 40 kg ha ⁻¹ + Nano DAP foliar spray (2ml L ⁻¹)	8.05	10.41	9.49	13.29
P ₃ 60 kg ha ⁻¹	8.55	11.25	9.99	13.53
Sem ±	0.09	0.14	0.11	0.15
CD (p =0.05)	0.27	0.41	0.33	NS
Interaction	Non-significant	Non-significant	Non-significant	Non-significant

Table 3: Effect of Nitrogen and Phosphorus levels on yield (grain, stover, biological) and harvest index of pea

Treatments	Yield (q ha ⁻¹)			Harvest Index (%)
	Grain	Stover	Biological	
Nitrogen levels				
N ₀ Control	12.07	18.53	30.6	39.44
N ₁ 15 kg ha ⁻¹ + Nano urea foliar spray (2ml L ⁻¹)	16.89	24.60	41.49	40.70
N ₂ 20 kg ha ⁻¹	14.25	21.26	35.51	40.12
N ₃ 25 kg ha ⁻¹	19.53	28.19	47.72	40.92
Sem ±	0.32	0.95	1.09	0.91
CD (p = 0.05)	0.94	2.77	3.17	NS
Phosphorus levels				
P ₀ Control	11.81	17.95	29.76	39.68
P ₁ 20 kg ha ⁻¹	15.11	22.29	37.40	40.40
P ₂ 40 kg ha ⁻¹ + Nano DAP foliar spray (2ml L ⁻¹)	16.56	24.27	40.83	40.55
P ₃ 60 kg ha ⁻¹	19.24	28.07	47.31	40.66
Sem ±	0.32	0.95	1.09	0.91
CD (p =0.05)	0.94	2.77	3.17	NS
Interaction	Significant	Significant	Significant	Non-significant

Table 4: Economics of pea as Influenced by Application of Different Levels of Nitrogen and Phosphorus

Treatments	Economics (Rs. ha ⁻¹)			B:C ratio
	Cost of Cultivation	Gross returns	Net returns	
Nitrogen levels				
N ₀ Control	44981	84,036	39055	0.86
N ₁ 15 kg ha ⁻¹ + Nano urea foliar spray (2ml L ⁻¹)	45636	117,172	71536	1.56
N ₂ 20 kg ha ⁻¹	45249	99,020	53771	1.18
N ₃ 25 kg ha ⁻¹	45316	135414	90098	1.98
Sem ±	-	2208	2208	0.04
CD (p = 0.05)	-	6409	6409	0.14
Phosphorus levels				
P ₀ Control	42090	82199	40109	0.95
P ₁ 20 kg ha ⁻¹	44021	104940	60919	1.38
P ₂ 40 kg ha ⁻¹ + Nano DAP foliar spray (2ml L ⁻¹)	47188	114981	67793	1.43
P ₃ 60 kg ha ⁻¹	47883	133521	85638	1.78
Sem ±	-	2208	2208	0.04
CD (p =0.05)	-	6409	6409	0.14
Interaction	-	Significant	Significant	Significant

References

1. Anonymous(2021-22a)-HorticulturalStatistics,2021-2022.AgricultureStatisticsatGlance.DirectoratofofEconomicsandStatistics.GovernmentofIndia. <https://desagri.gov.in/document-report-category/agriculture-statistics-at-a-glance/>(1.00PM 1st August 2023).
2. Anonymous (2021-22a) - Horticultural Statistics, 2021-2022. Agriculture Statistics at a Glance.
3. Anonymous (2021-22b) – (Department of Agriculture and Farmer Welfare).
4. Bhat TA, Gupta M, Ganai MA, Ahanger RA, Bhat HA. Yield, soil health and nutrient utilization of field pea (*Pisum sativum* L.) as affected by phosphorus and Biofertilizers under subtropical conditions of Jammu. International journal of modern plant and animal science. 2013;1(1):1-8.
5. Joshi HN, Varma LR, More SG. Effects of organic nutrients in combination with biofertilizers on uptake N, P, K and yield of garden pea (*Pisum sativum* L.) CV. The Pharma Innovation Journal, 2020;9:385- 389.
6. Phom AC, Kanaujia SP, Chaturvedi HP. Performance of various genotypes of pea under foothill condition of Nagaland. Annals of Plant and Soil Research. 2014;16(4):285-288.
7. Murade NB, Patil DB, Jagtap HD, More SM. Effect of spacing and fertilizer levels on growth and yield of urd bean. The Bioscan. 2014;9(4):1545-1547.
8. Rana C, Sharma A, Sharma KC, Mittal P, Sinha BN, Sharma VK, Chandel A, Thakur H, Kaila V, Sharma P, Rana V. Stability analysis of garden pea (*Pisum sativum* L.) genotypes under North Western Himalayas using joint regression analysis and GGE biplots. Genetic Resources and Crop Evolution. 2021; 68:999-1010.
9. Chauhan HS, Joshi SC, Rana DK. Response of vermicompost on growth and yield of pea (*Pisum sativum* L.)cv.Arkel.Natureand Science. 2010; 8(4):18-21.
10. Kumar J. Effect of phosphorus and sulphur application on performance of vegetablepea (*Pisum sativum* l.) Cv. Pant matar-2. Legume Research-An International Journal.2011;34(4):292-295.
11. RR. Bunker, RK Narolia, PK Pareek, V Nagar, K Kumar, Chnaniya and Omprakash, Effect of nitrogen, phosphorus and bio-fertilizers on growth and yield attributes of garden pea (*Pisum sativum* L.). International Journal Chemical Studies. 2018;6(4), 1701-1704.
12. Mitran T, Meena RS, Lal R, Layek J, Kumar S, Datta R. Role of soil phosphorus on legume production. Legumes for soil health and sustainable management. 2018:487- 510.
13. Tesfaye M, Liu J, Allan DL, Vance CP. Genomic and genetic control of phosphate stress in legumes. Plant Physiology. 2007; 1;144(2):594-603.
14. Sammauria R, Yadav RS, Nagar KC. Performance of cluster bean (*Cyamopsis tetragonoloba*) as influenced by nitrogen and phosphorus fertilization and biofertilizers in Western Rajasthan. Indian Journal of Agronomy. 2009;54(3):319-23.
15. Dar IA, Mir AH, Megna Rashid MR, Nusrat Jan NJ. Effect of different levels of nitrogen and phosphorus on growth and yield of pea (*Pisum sativum* L.) PU-7. New Agriculturist, 2011; 22(2), 199-201.
16. Metwaly EE. An attempt to mitigation of irrigation water deficit stress in pea (*Pisum sativum*, L) plants by phosphorus fertilizer. Journal of Plant Production. 2018; 9(1):101-8.
17. Singh L, Singh SB, Gupta D, Lal MU. Effect of irrigation and nitrogen on growth and yield of field pea varieties. Annals of Plant and Soil Research. 2015; 17(1):96-9.
18. Singh SK, Tomar BS, Shivay YS, Joshi MA, Anand A, Prasad R, Kumari S. Effect of levels and sources of phosphorus on morpho-physiological, seed yield and quality parameters in garden pea

- (*Pisum sativum*). Indian Journal of Agronomy. 2018;63(4):477-81.
19. Shamad A, Maurya KR, Devi B, Singh MK. Effect of phosphorus levels and Rhizobium culture on growth, yield and quality of early varieties of Garden pea (*Pisum sativum* L.). Journal of Pharmacognosy and Phytochemistry. 2019; 8(4):196-9.
 20. Tenikecier HS, Ates E. Yield, some cell wall component and mineral contents of fodder pea (*Pisum sativum* ssp. arvense L. Poir) forage as influenced by cultivar, growth stages and phosphorus application. Journal of Elementology. 2021; 26(2).
 21. Tehria SK, Rana SS, Kumar S. Response of pea (*Pisum sativum* L.) to levels of phosphorus in relation to integrated weed management. Himachal Journal of Agricultural Research. 2014; 40(2):118-25.
 22. Ram L, Jha AK, Patel SK, Kumar A, Kumar A. Response of vermicompost and levels of nitrogen on growth, yield and yield attributes in pea (*Pisum sativum* L.) rhizosphere. The Pharma Innovation Journal. 2021; 10(9):976-81.
 23. Mandloi R, Waskel S, Jatav SK, Tambi KN, Agashe DR. Varietal and Phosphorus Response on Pod Yield of Pea. International Journal of Current Microbiology and Applied Sciences. 2020; 10:213-22.
 24. Gaharwar SS, Singh AK, Mondal BK. Effect of integrated nutrient management on growth, yield and uptake of N, P, K and Zn in pea (*Pisum sativum* L.). The Pharma Innovation Journal. 2023; 12(11): 1757-1760.
 25. Das RA, Mandal RE, Chattopadhyay SB, Thapa UM. Synergistic influence of macro nutrient, micro nutrient and bio-fertilizer on root nodulation, growth and yield of garden pea (*Pisum sativum* L.). The Bioscan. 2015;10(1):291-7.
 26. Sharma AK, Singh SP and Sarma MK (2003) Genetic variability, heritability and character association in pea (*Pisum sativum* L.). Crop Res 26: 135-139.