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## Response of nitrogen and phosphorus levels on growth and yield of barley (*Hordeum vulgare* L.)

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### Abstract

A field experiment was conducted during 2024-25 at Agricultural Research Farm, School of Agricultural Sciences, Jaipur National University, Jaipur, Rajasthan to evaluate the “Performance of Barley (*Hordeum vulgare* L.) as Influenced by Varying Levels of Nitrogen and Phosphorus”. The experiment was laid out in Factorial Randomized Block Design with three replications. The field trial consisted 12 treatments combinations viz., four nitrogen levels (i) control, (ii) 40 kg N ha<sup>-1</sup>, (iii) 80 kg N ha<sup>-1</sup> and (iv) 120 kg N ha<sup>-1</sup>, while three phosphorus levels viz., (i) control, (ii) 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> and (iii) 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. The result indicted that application of the 120 kg N ha<sup>-1</sup> recorded maximum growth parameters viz., plant height, number of tillers meter<sup>-1</sup> row length, dry matter accumulation (DMA), CGR and RGR; maximum yield attributes and yield viz., spike length (9.92), number of grains spike<sup>-1</sup> (45.47), grain weight plant<sup>-1</sup> (12.50), test weight (43.80 g), grain yield (4175 kg ha<sup>-1</sup>), straw yield (5318 kg ha<sup>-1</sup>) and harvest index (43.57 of the barley. Moreover, Among the phosphorus levels, the application of 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> gave significantly higher growth parameters viz., plant height, number of tillers meter<sup>-1</sup> row length, DMA, CGR and RGR; maximum yield attributes and yield viz., spike length (9.81), number of grains spike<sup>-1</sup> (44.96), grain weight plant<sup>-1</sup> (12.36), test weight (43.32 g), grain yield (4112 kg ha<sup>-1</sup>), straw yield (5403 kg ha<sup>-1</sup>) and harvest index (42.81%) of the barley.

**Keywords:** Barley, nitrogen, phosphorus, growth, yield, quality, economics

### Introduction

Barley (*Hordeum vulgare* L.) is the fourth most important cereal crop in the world, next to rice, wheat, and maize both in terms of production and acreage in the world. It is also considered one of the ancient crops which was domesticated by human beings due to its various characteristics such as wider adaptability and hardiness. Barley can be grown successfully in tropical and sub-tropical climatic conditions. In terms of agroecology, extremes in latitude, longitude, and altitude are well-known and widely accepted. Barley is considered as a poor man's crop because of its low input requirements and better adaptability to extreme conditions like salinity, drought, alkalinity, and marginal lands (Dahiya *et al.* 2019) <sup>[1]</sup>.

Barley, commonly known as “Jau” in India, is primarily grown as a rabi season crop. It thrives best under temperatures of 12-15 °C during the growth phase and around 30-32 °C at the time of maturity. Compared to other small grain crops, barley exhibits greater tolerance to dry heat. Globally, barley is cultivated on approximately 70 million hectares, producing around 160 million tonnes. In India, it holds the second position after wheat in terms of area and production among rabi crops. The crop covers about 0.65 million hectares, with a total production of 0.17 million tonnes and an average productivity of 2.4 tonnes ha<sup>-1</sup> (DES 2024) <sup>[2]</sup>.

Barley ranks as the fourth most important cereal crop due to its high nutritional value and its richness in proteins and B-group vitamins, making it a vital contributor to food security. The whole grain of barley typically contains 65-68% starch, 15-17% high-quality protein, 2-3% free lipids, 4-9% β-glucans, and 1.5-2.5% minerals. Its protein quality surpasses that of maize and beans, as it supplies all eight essential amino acids beneficial for human health (Mali *et al.*, 2017) <sup>[3]</sup>. Barley serves a wide range of purposes and holds significant economic importance, particularly for the brewing industry. It is commonly used in the preparation of bread, soups,

stews, and various breakfast cereals. A major portion of barley production is utilized as animal feed, while malted barley is a key ingredient in alcoholic beverages such as beer and whisky. Additionally, it is processed into flavouring agents, vinegar, sweeteners, and malt flour. The brewing and livestock sectors are the primary consumers of barley worldwide (Tuppad *et al.* 2023) <sup>[4]</sup>.

It is incorrect to assume that barley can grow successfully with little or no nitrogen (N) supply. Barley is highly sensitive to nitrogen deficiency, and inadequate nitrogen availability significantly affects its growth and productivity. Low nitrogen levels are associated with reduced yield, poor grain formation, and inferior grain quality, similar to effects observed in other cereal crops. Such deficiencies can ultimately contribute to declining productivity and increased food insecurity (Devaraja *et al.* 2006) <sup>[5]</sup>. Among the essential nutrients required for crop growth, barley is especially sensitive to nitrogen deficiency and shows a strong response to nitrogen fertilization. Nitrogen (N) plays a vital role in the growth and metabolic activities of barley plants. It is a key constituent of proteins and nucleic acids and is essential for various metabolic and physiological processes that regulate overall plant development and productivity (Debey *et al.* 2018) <sup>[6]</sup>. N is a fundamental element of amino acids, which serve as the building blocks of plant proteins and enzymes. It plays a crucial role in enhancing crop productivity, contributing to more than 50% of yield improvement under optimal growing conditions. Among all mineral nutrients, nitrogen is the most critical for cereal crops, as achieving high yields depends on an adequate nitrogen supply. Additionally, cereal grains generally contain about 6% nitrogen in their storage protein reserves (Kassa and Sorsa 2015) <sup>[7]</sup>. Therefore, the grain yield, protein concentration, and kernel quality of barley are closely influenced by the availability of nitrogen in the soil (Singh *et al.* 2020) <sup>[8]</sup>. Phosphorus (P) is an essential nutrient that supports plant growth and metabolic functions. It represents the second most common nutrient deficiency in cereal-based cropping systems worldwide, following nitrogen deficiency. Phosphorus is also a vital structural component of various metabolically active compounds that play key roles in plant physiological processes (Tripathi *et al.* 2013) <sup>[9]</sup>. However, the concentration and solubility of phosphorus (P) in soils are generally low because of its strong tendency to interact with other soil components. This characteristic makes phosphorus one of the most limiting nutrients for plant growth. The chemical reactions of phosphorus within the soil greatly influence both crop development and the overall efficiency of applied fertilizers. (Korde *et al.* 2024) <sup>[10]</sup>.

Among the various factors affecting crop productivity, the availability of nitrogen and phosphorus plays a crucial role and must be carefully managed to realize the maximum yield potential of barley. Considering this, the present field experiment was undertaken to study the effect of these nutrients on the growth and yield performance of the crop.

## Materials and Methods

The field experiment was conducted during *rabi* seasons of 2024-25 at Agricultural Research Farm, School of Agricultural Sciences, Jaipur national University, Jaipur, Rajasthan. Soil of the experimental field was sandy in texture having pH 7.58, organic carbon (OC) (0.43%), available nutrient (N) 217.30; phosphorus (P) 20.28 and potassium (K) 219.20 kg/ha. The experiment was laid out in factorial randomized block design with three replications. The field trial consisted of 12 treatments combinations viz., four nitrogen levels (i) control, (ii) 40 kg N ha<sup>-1</sup>, (iii) 80 kg N ha<sup>-1</sup> and (iv) 120 kg N ha<sup>-1</sup>, while three

phosphorus levels viz., (i) control, (ii) 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> and (iii) 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. The barley variety 'RD 2035' was sown @ 100 kg seed ha<sup>-1</sup> with spacing of 22.5 cm x 5 cm. The two irrigations are applied. All agricultural practices were kept uniform in all the plots.

## Results and Discussion

### Growth parameters

#### Effect of nitrogen levels

The different levels of nitrogen significantly enhanced the growth parameters of the barley (Table 1). The significantly maximum plant height (25.76 cm at 30 DAS; 70.52 cm at 60 DAS; 91.40 cm at 90 DAS and 94.01 cm at harvest) and number of tillers meter<sup>-1</sup> row length (40.23 at 30 DAS; 75.72 at 60 DAS; 79.26 at 90 DAS and 77.02 at harvest) were recorded with the application of 120 kg N ha<sup>-1</sup> and found at par with 80 kg N ha<sup>-1</sup>. It was due to the availability of nitrogen in sufficient amount as required by the plants. Nitrogen enhances profuse vegetative growth and is responsible for cell division, cell elongation and protein synthesis resulting higher photosynthetic capacity of plants. These results were in agreement with the findings of Todarmal *et al.* (2014) <sup>[11]</sup>, Kumar *et al.* (2018) <sup>[12]</sup>, Parashar *et al.* (2020) <sup>[13]</sup>.

Moreover, the DMA (10.09 g meter<sup>-1</sup> row length at 30 DAS; 59.08 g meter<sup>-1</sup> row length at 60 DAS; 381.58 g meter<sup>-1</sup> row length at 90 DAS and 386.46 g meter<sup>-1</sup> row length at harvest), significantly higher with the application of 120 kg N ha<sup>-1</sup> and found at par with 80 kg N ha<sup>-1</sup> (Table 1). This effect may be attributed to nitrogen, which is a key component of nucleic acids, chlorophyll, and enzymes, playing a central role in the metabolic processes that regulate the vegetative growth of plants. Higher dry matter accumulation was observed due to active tillering and the development of growth-related characteristics. These results are also in close agreement with the finding of Terefe *et al.* (2018) <sup>[14]</sup>, Todarmal *et al.* (2014) <sup>[11]</sup> and Zeidan *et al.* (2007) <sup>[15]</sup>.

#### Effect of phosphorus levels

The different levels of phosphorus significantly enhanced the growth parameters of the barley (Table 1). The significantly maximum plant height (25.44 cm at 30 DAS; 69.62 cm at 60 DAS; 90.39 cm at 90 DAS and 92.97 cm at harvest) and number of tillers meter<sup>-1</sup> row length (39.78 at 30 DAS; 74.89 at 60 DAS; 78.38 at 90 DAS and 76.16 at harvest) were recorded with the application of 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. The increased application of phosphorus fertilizer promotes the development of the plant root system, enhancing the uptake of nutrients, particularly phosphorus. This improved nutrient absorption subsequently contributes to better growth and development of the crop (Colomb *et al.*, 2000) <sup>[16]</sup>.

Moreover, the DMA (9.98 g meter<sup>-1</sup> row length at 30 DAS; 58.42 g meter<sup>-1</sup> row length at 60 DAS; 377.36 g meter<sup>-1</sup> row length at 90 DAS and 382.18 g meter<sup>-1</sup> row length at harvest) significantly higher with the application of 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> (Table 1). The beneficial effect of phosphorus fertilization on plant growth may be attributed to its involvement in numerous enzymatic reactions throughout the plant. This enhances growth efficiency, including hormone and protein synthesis, and improves the metabolism of photosynthetic products. Ali *et al.* (2020) <sup>[17]</sup> also obtained similar results.

### Yield attributes and yield

#### Effect of nitrogen levels

The different levels of nitrogen significantly enhanced the yield

attributes and yield of the barley crop (Table 2). The maximum spike length (9.92 cm), number of grains spike<sup>-1</sup> (45.47), grain weight plant<sup>-1</sup> (12.50 g), test weight (43.80 g), grain yield (4175 kg ha<sup>-1</sup>), stover yield (5318 kg ha<sup>-1</sup>) and harvest index (43.57%) were significantly recorded with the application of 120 kg N ha<sup>-1</sup> and found at par with 80 kg N ha<sup>-1</sup>. (Table 2). The enhancement of these traits can be attributed to nitrogen application, which promoted vigorous growth during the early stages, resulting in greater plant height, increased leaf area, more tillers, and higher dry matter accumulation. The abundant tillering from sufficient nitrogen, combined with increased photosynthate production and its translocation to reproductive organs, was primarily responsible for the improved yield attributes of barley. Similar results were also reported by Devaraja and Hegde (2006) [5]; Parashar *et al.* (2020) [13]; Patel and Meena (2018) [18] and Neelam *et al.* (2018) [19].

### Effect of phosphorus levels

The different levels of phosphorus significantly enhanced the yield attributes and yield of the barley crop (Table 2). The maximum spike length (9.81 cm), number of grains spike<sup>-1</sup> (44.96), grain weight plant<sup>-1</sup> (12.36), test weight (43.32g), grain yield (4112 kg ha<sup>-1</sup>), stover yield (5403 kg ha<sup>-1</sup>) and harvest index (42.81%) were significantly recorded with the application of 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> (Table 2). Enhanced phosphorus availability improves yield-related traits in plants by stimulating root growth, increasing nutrient concentration, and accelerating cell division and elongation. This supports greater root branching, tiller formation, plant height, and dry matter accumulation, which collectively enhance leaf photosynthetic activity. Moreover, higher phosphorus supply promotes more efficient translocation of assimilates, contributing to improved yield attributes. Similar results were reported by Sharma *et al.* (2012) [20]; Satish *et al.* (2017) [21], Korde *et al.* (2024) [10] Yadav *et al.* (2025) [22] and Meena *et al.* (2025) [23].

**Table 1:** Effect of nitrogen levels and phosphorus levels on growth parameters of barley

| Treatments                                           | Plant height (cm) |        |        |            | Number of tillers meter <sup>-1</sup> row length |        |        |            | DMA (g/meter row length) |        |        |            |
|------------------------------------------------------|-------------------|--------|--------|------------|--------------------------------------------------|--------|--------|------------|--------------------------|--------|--------|------------|
|                                                      | 30 DAS            | 60 DAS | 90 DAS | At harvest | 30 DAS                                           | 60 DAS | 90 DAS | At harvest | 30 DAS                   | 60 DAS | 90 DAS | At harvest |
| <b>Nitrogen levels</b>                               |                   |        |        |            |                                                  |        |        |            |                          |        |        |            |
| Control                                              | 18.65             | 50.85  | 69.20  | 71.16      | 30.46                                            | 57.34  | 60.01  | 58.31      | 7.64                     | 44.73  | 289.10 | 292.62     |
| 40 kg N ha <sup>-1</sup>                             | 21.62             | 59.07  | 78.48  | 80.71      | 34.54                                            | 65.02  | 68.05  | 66.13      | 8.67                     | 50.73  | 327.75 | 331.84     |
| 80 kg N ha <sup>-1</sup>                             | 25.32             | 69.30  | 90.02  | 92.59      | 39.62                                            | 74.58  | 78.06  | 75.85      | 9.94                     | 58.18  | 375.82 | 380.62     |
| 120 kg N ha <sup>-1</sup>                            | 25.76             | 70.52  | 91.40  | 94.01      | 40.23                                            | 75.72  | 79.26  | 77.02      | 10.09                    | 59.08  | 381.58 | 386.46     |
| S.Em±                                                | 0.14              | 0.39   | 0.44   | 0.46       | 0.20                                             | 0.37   | 0.39   | 0.37       | 0.05                     | 0.29   | 1.85   | 1.88       |
| CD (p=0.05)                                          | 0.49              | 1.36   | 1.54   | 1.58       | 0.68                                             | 1.27   | 1.33   | 1.30       | 0.17                     | 0.99   | 6.40   | 6.50       |
| <b>Phosphorus levels</b>                             |                   |        |        |            |                                                  |        |        |            |                          |        |        |            |
| Control                                              | 19.02             | 51.87  | 70.35  | 72.35      | 30.96                                            | 58.29  | 61.01  | 59.28      | 7.77                     | 45.48  | 293.89 | 297.48     |
| 30 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup> | 24.06             | 65.81  | 86.09  | 88.54      | 37.89                                            | 71.32  | 74.65  | 72.54      | 9.51                     | 55.64  | 359.43 | 363.99     |
| 60 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup> | 25.44             | 69.62  | 90.39  | 92.97      | 39.78                                            | 74.89  | 78.38  | 76.16      | 9.98                     | 58.42  | 377.36 | 382.18     |
| S.Em±                                                | 0.05              | 0.14   | 0.16   | 0.17       | 0.07                                             | 0.13   | 0.14   | 0.14       | 0.02                     | 0.10   | 0.67   | 0.68       |
| CD (p=0.05)                                          | 0.15              | 0.43   | 0.48   | 0.50       | 0.21                                             | 0.40   | 0.42   | 0.41       | 0.05                     | 0.31   | 2.01   | 2.04       |

**Table 2:** Effect of nitrogen levels and phosphorus levels on yield attributes and yield of barley

| Treatments                                           | Yield attributes  |                                   |                                      |                 | Yield                              |                                    |                   |
|------------------------------------------------------|-------------------|-----------------------------------|--------------------------------------|-----------------|------------------------------------|------------------------------------|-------------------|
|                                                      | Spike length (cm) | No. of grains spike <sup>-1</sup> | Grain weight plant <sup>-1</sup> (g) | Test weight (g) | Grain yield (kg ha <sup>-1</sup> ) | Straw yield (kg ha <sup>-1</sup> ) | Harvest index (%) |
| <b>Nitrogen levels</b>                               |                   |                                   |                                      |                 |                                    |                                    |                   |
| Control                                              | 7.51              | 34.43                             | 9.47                                 | 33.17           | 2800                               | 4201                               | 39.97             |
| 40 kg N ha <sup>-1</sup>                             | 8.51              | 39.04                             | 10.74                                | 37.61           | 3375                               | 4675                               | 41.32             |
| 80 kg N ha <sup>-1</sup>                             | 9.77              | 44.78                             | 12.31                                | 43.14           | 4090                               | 5290                               | 42.90             |
| 120 kg N ha <sup>-1</sup>                            | 9.92              | 45.47                             | 12.50                                | 43.80           | 4175                               | 5318                               | 43.57             |
| S.Em±                                                | 0.05              | 0.22                              | 0.06                                 | 0.21            | 28                                 | 27                                 | 0.05              |
| CD (p=0.05)                                          | 0.17              | 0.76                              | 0.21                                 | 0.74            | 95                                 | 94                                 | 0.16              |
| <b>Phosphorus levels</b>                             |                   |                                   |                                      |                 |                                    |                                    |                   |
| Control                                              | 7.63              | 35.00                             | 9.62                                 | 33.72           | 2871                               | 4121                               | 40.60             |
| 30 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup> | 9.34              | 42.82                             | 11.78                                | 41.26           | 3846                               | 5088                               | 42.41             |
| 60 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup> | 9.81              | 44.96                             | 12.36                                | 43.32           | 4112                               | 5403                               | 42.81             |
| S.Em±                                                | 0.02              | 0.08                              | 0.02                                 | 0.08            | 10                                 | 15                                 | 0.03              |
| CD (p=0.05)                                          | 0.05              | 0.24                              | 0.07                                 | 0.23            | 30                                 | 45                                 | 0.08              |

### Conclusion

The application of 120 kg N ha<sup>-1</sup> with 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> was suitable to attain the higher growth parameters and yield attributes and yield of barley it was significantly at par with the application of 80 kg N ha<sup>-1</sup> with 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>.

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### References

1. Dahiya S, Singh J, Singh B, Khedwal RS. Yield and quality of malt barley (*Hordeum distichum* L.) as influenced by seed rate, row spacing and nitrogen levels. Appl Biol Res. 2019;21(1):35-40.
2. DES. Directorate of Economics and Statistics, Ministry of Agriculture. 2024. [www.agri.com](http://www.agri.com)
3. Mali H, Choudhary J, Kumar A, Singh A, Chopra R. Growth, quality, and yield of barley (*Hordeum vulgare* L.) as influenced by varieties and precision nutrient management practices. J Pharmacogn Phytochem. 2017;6:35-41.

4. Tuppad P, Kishore A, Kharad SS, Sharma JD. Effect of nitrogen levels on the growth and yield of barley (*Hordeum vulgare* L.) varieties. *Eco Env Cons*. 2023;29(1):156-60.
5. Devaraja M, Hedge R, Rajendra. Yield attributes of malt barley (*Hordeum vulgare* L.) as influenced by nitrogen, phosphorus, potassium and their correlation and regression with yield. *Agric Sci Dig*. 2006;26(1):48-50.
6. Dubey SN, Tiwari A, Pandey VK, Singh V, Singh G. Effects of nitrogen levels and its application on growth parameters of barley (*Hordeum vulgare* L.). *J Pharmacogn Phytochem*. 2018;7(1):333-8.
7. Kassa M, Sorsa Z. Effect of nitrogen and phosphorus fertilizer rates on yield and yield components of barley (*Hordeum vulgare* L.) varieties at Damot Gale District, Wolaita Zone. *Am J Agric For*. 2015;3:271-5.
8. Singh R, Reddy MD, Pandey G, Kumar A. Effect of different levels of phosphorus on performance of barley (*Hordeum vulgare* L.). *J Pharmacogn Phytochem*. 2020;9(3):363-6.
9. Tripathi BN, Kumar RS, Kumar A. Effect of phosphorus and potash levels alone and in conjunction with FYM on rice-wheat cropping system. *Ann Plant Soil Res*. 2013;15(2):145-8.
10. Korde R, Singh AK, Maskey V. Impact of phosphorus levels on barley (*Hordeum vulgare* L.) crop productivity and nutrition under Satna conditions. *Int J Adv Biochem Res*. 2024;8(2):286-8.
11. Todarmal, Phogat SB, Kumar S, Singh B. Effect of nitrogen on yield and quality of barley (*Hordeum vulgare*) genotypes. *Indian J Agron*. 2014;59(1):171-4.
12. Kumar R, Yadav S, Nand V, Verma SK, Yadav N, Kumari A. Effect of different nitrogen levels and varieties on yield of barley (*Hordeum vulgare* L.) under sodic soil. *Multilogic Sci*. 2018;8:242-5.
13. Parashar A, Sharma S, Dogra P, Parashar K, Tyagi BS. Response of malt barley (*Hordeum vulgare* L.) varieties to different levels of nitrogen and sulphur application under agro-climatic zone IIIa (Semi-arid eastern plain zone) of Rajasthan. *Int J Chem Stud*. 2020;8(4):2059-62.
14. Terefe D, Desalegn T, Ashagre H. Effect of nitrogen fertilizer levels on grain yield and quality of malt barley (*Hordeum vulgare* L.) varieties at Wolmera district, central highland of Ethiopia. *Int J Res Stud Agric Sci*. 2018;4(4):29-43.
15. Zeidan MS. Response of some barley cultivars to nitrogen sources and rates grown in alkaline sandy soil. *Res J Agric Biol Sci*. 2007;3(6):934-938.
16. Colomb B, Kinivy R, Debaeke PH. Effect of soil phosphorus on leaf development and senescence dynamics of field-grown maize. *Agron J*. 2000;92(3):428-435.
17. Ali A, Asif M, Adnan M, Aziz A, Hayyat MS, Saleem MW, *et al*. Effect of different levels of phosphorus on growth, yield and quality of wheat (*Triticum aestivum* L.). *Int J Bot Stud*. 2020;5:64-8.
18. Patel NA, Meena M. Relative performance of barley (*Hordeum vulgare*) cultivars under saline water condition. *Int J Curr Microbiol Appl Sci*. 2018;7(10):1724-33.
19. Neelam, Singh B, Khippal A, Mukesh, Satpal. Effect of different nitrogen levels and biofertilizers on yield and economics of feed barley. *J Cereal Res*. 2018;10(3):214-8.
20. Sharma YK, Singh H, Mandal N. Effect of phosphorus and copper levels on yield and nutrients uptake by wheat. *Ann Plant Soil Res*. 2012;14(2):136-8.
21. Satish M, Ali A, Singh AK, Singh G, Singh RR. Response of late sown wheat to phosphorus and zinc nutrition in eastern Uttar Pradesh. *Ann Plant Soil Res*. 2017;19(1):23-8.
22. Yadav RL, Singh A, Tamboli YA, Bansal RK, Chaudhary GR, Yadav MK. Influence of fertility levels on growth and yield attributes of different wheat (*Triticum aestivum* L.) varieties under semi-arid conditions of Rajasthan. *Int J Res Agron*. 2025;8(10):171-4.
23. Meena R, Singh A, Tamboli YA, Bansal RK, Yadav MK. Impact of integrated nutrient management on growth and yield of barley (*Hordeum vulgare* L.). *Int J Res Agron*. 2025;8(10):604-607.