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Research Article

IMPACT OF NITROGEN LEVELS AND DATE OF SOWING ON GROWTH, YIELD AND QUALITY OF BARLEY (*Hordeum vulgare* L.)

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Abstract: In order to study the response of nitrogen and dates of sowing on growth, yield and quality of barley (*Hordeum vulgare* L.), a field experiment was conducted at the Research plot, Department of Agronomy, AKS University, Satna, (MP) during *Rabi* season of 2022-2023. Twelve treatment combinations were drawn from four levels of nitrogen, *i.e.*, Control (N_0), 45 kg N/ha (N_1), 60 kg N/ha (N_2) and 75 kg N/ha (N_3) and three dates of sowing, *i.e.,* 3rd week of November (D_1), 4th week of November (D_2) and 1st week of December (D_3). The treatment combinations were arranged in Factorial RCBD and replicated thrice. Results revealed that amongst the nitrogen levels, application of 75 kg N/ha produced maximum plant height at 90 DAS (80.48 cm), number of leaves/plant at 90 DAS (10.58), average fresh weight/plant (39.02), length of spike (8.37 cm), number of seeds/spike (39.60), test weight (42.73 g), seed yield (41.56 q ha^{-1}), straw yield (50.32 q ha^{-1}), harvest index (45.19 %), protein content (11.11 %). Different dates of sowing also responded significantly to the above-mentioned parameters. among different dates of sowing, maximum plant height at 90 DAS (72.24 cm), number of leaves/plant at 90 DAS (10.12), average fresh weight (35.42 g), length of spike (7.68 cm), number of seeds/spike (38.83), test weight (40.41 g), seed yield (35.27 q ha^{-1}), straw yield (45.57 q ha^{-1}), harvest index (43.36 %), protein content (9.78 %) was obtained with the sowing date of 3rd week of November.

Keywords: *Barley, Date of sowing, Nitrogen*

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Introduction

Barley (*Hordeum vulgare* L.), after wheat, rice, and maize, is the fourth most significant cereal crop in the world. It is a resilient crop grown all across the temperate, tropical, and subtropical parts of the world. In India, barley is mainly grown in the northern plains and is concentrated in the states of Rajasthan, Haryana, Punjab, Madhya Pradesh, and western Uttar Pradesh. Globally, barley was grown on almost 51.50 million hectares with a production of 142.01 million tonnes. In India, barley was cultivated on approximately 7.72 lakh hectares during 2019-20 and produced around 17.26 lakh tonnes of grain with an average yield of 2522 kg/ha [1]. Barley exhibits a strong susceptibility to insufficient nitrogen, and the direct manifestation of this nitrogen response is observable in the plant. In contrast to other crops, inadequate or poor nutrition has been linked to reduced yield and grain quality in barley. This problem additionally worsens the already existing food insecurity [2]. Nitrogen is an essential component of amino acids necessary for protein synthesis and other related compounds. It plays a vital role in nearly all plant metabolic processes and is a fundamental part of chlorophyll, which is responsible for plant food production through photosynthesis. Nitrogen promotes rapid growth, enhances leaf size and quality, and facilitates the development of fruits and seeds. The limiting nutrient for plant growth and development is typically nitrogen. Nitrogen fertilizer significantly affected plant height, shoots per meter square, spike length, number of kernels per spike, test weight, and kernel yield [3]. Nitrogen plays an important role in plant metabolism. The sowing date is one of the crucial aspects of increasing yield output since it determines the ideal time for sowing the crop. Adjusting the sowing dates can aid in adapting to the changing climate, thereby mitigating its detrimental effects on the growth and development of barley. In addition, the sowing date plays a crucial role in controlling barley production, particularly in dual-purpose barley, as it significantly enhances both forage and grain yields. Therefore, it is important to keep the correct sowing date in order to use harness the resources efficiently.

Materials and methods

The present experiment was conducted during the *Rabi* season of 2022-2023 at the Research plot, Department of Agronomy, AKS University, Sherganj, Satna (M.P.). The experimental site is situated in the semi-arid region of Satna district. The soil had organic carbon, available nitrogen, available phosphorus and medium in available potassium, having pH (7.4) and EC (0.17 ds /m). the experiment consisted of four nitrogen levels *i.e.*, Control (N_0), 45 kg N/ha (N_1), 60 kg N/ha (N_2) and 75 kg N/ha (N_3) and three dates of sowing, *i.e.*, 3rd week of November (D_1), 4th week of November (D_2) and 1st week of December (D_3). A total of twelve treatment combinations were compared using a factorial randomized block design, and the treatment combinations were replicated three times. Seeds of barley variety 'JB-1' at the rate of 100kg/ha were sown at a distance of 20 cm apart. Phosphorus and potassium were supplied by SSP and MOP at the rate of 40 kg P_2O_5 + 20 kg K_2O, and nitrogen was supplied through urea as per the treatments. The complete doses of phosphorus and potassium were evenly applied as a basal dose in each plot. Nitrogen was applied through urea in two split doses *i.e.*, at sowing and at 30 DAS during the first irrigation.

Results and discussion

Application of different nitrogen levels significantly improved growth characteristics and yield and yield attributes of barley.

Application of nitrogen @ 75 kg ha^{-1} produced maximum plant height at 90 DAS (80.48 cm), number of leaves plant-1 at 90 DAS (10.58), average fresh weight (39.02 g) which was followed by the application of nitrogen @ 60 kg ha^{-1}. All above-mentioned growth parameters were found to be lowest without applying nitrogen (control). Nitrogen is a key nutrient for plant growth and is essential to the growth and yield of crops. Due to its impact on numerous physiological processes, including protein synthesis, leaf area expansion, and chlorophyll formation, nitrogen is particularly significant in the case of barley.

Table-1 Effect of nitrogen levels and dates of sowing on growth, yield and quality of barley

Treatments	Plant height (cm) at 90 DAS	Number of leaves per plant at 90 DAS	Average fresh weight (g)	Length of spikes (cm)	Number of seeds per spike	Test weight (g)	Seed yield (q/ha)	Straw yield (q/ha)	Harvest index (%)	Protein content (%)
Nitrogen levels										
N_0	55.82	7.76	28.65	6.19	35.09	37.74	25.92	36.51	41.53	7.84
N_1	65.06	9.22	31.08	6.82	37.53	38.64	28.68	39.98	41.76	8.98
N_2	74.63	9.67	34.61	7.77	37.73	40.04	36.27	46.67	43.73	9.84
N_3	80.48	10.58	39.02	8.37	39.60	42.73	41.56	50.32	45.19	11.11
S.Em±	0.46	0.14	0.35	0.08	0.33	0.21	0.64	0.85	0.37	0.10
C.D.(p=0.05)	1.35	0.40	1.03	0.23	0.98	0.62	1.89	2.50	1.09	0.30
Dates of sowing										
D_1	72.24	10.12	35.42	7.68	38.83	40.41	35.27	45.57	43.36	9.78
D_2	69.18	9.53	33.37	7.38	37.73	39.98	33.58	43.60	43.24	9.39
D_3	65.57	8.27	31.23	6.80	35.90	38.97	30.48	40.94	42.56	9.16
S.Em±	0.40	0.12	0.30	0.07	0.29	0.18	0.56	0.74	0.32	0.09
C.D.(p=0.05)	1.17	0.35	0.89	0.2	0.85	0.54	1.64	2.17	NS	0.26

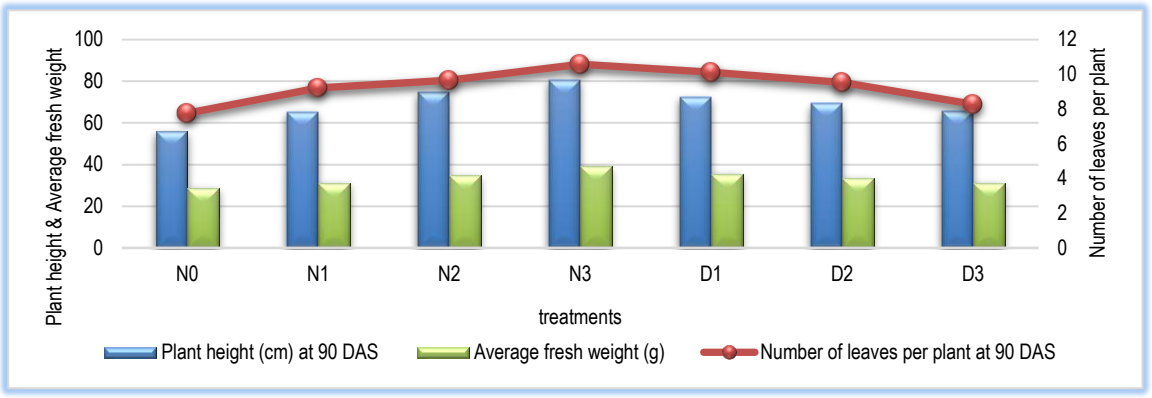

Fig-1 Effect of nitrogen levels and dates of sowing on growth attributes of barley

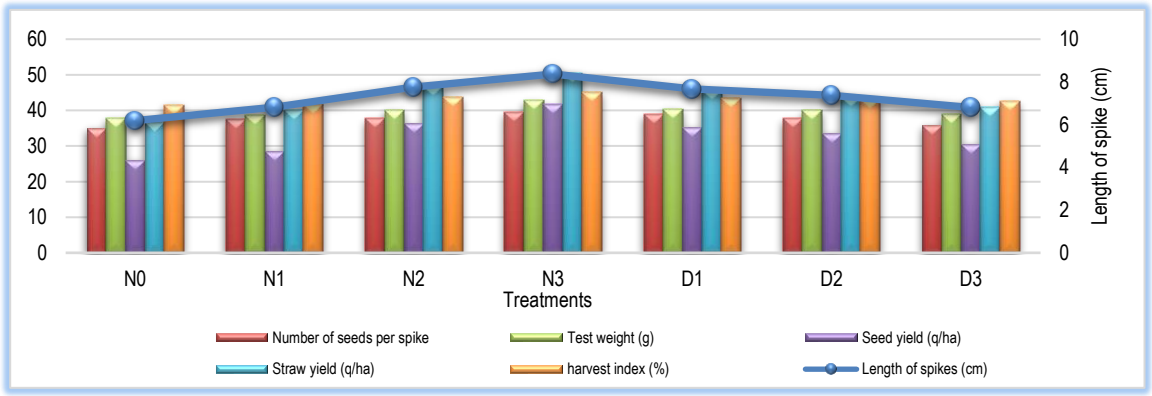

Fig-2 Effect of nitrogen levels and dates of sowing on yield attributes and yield of barley

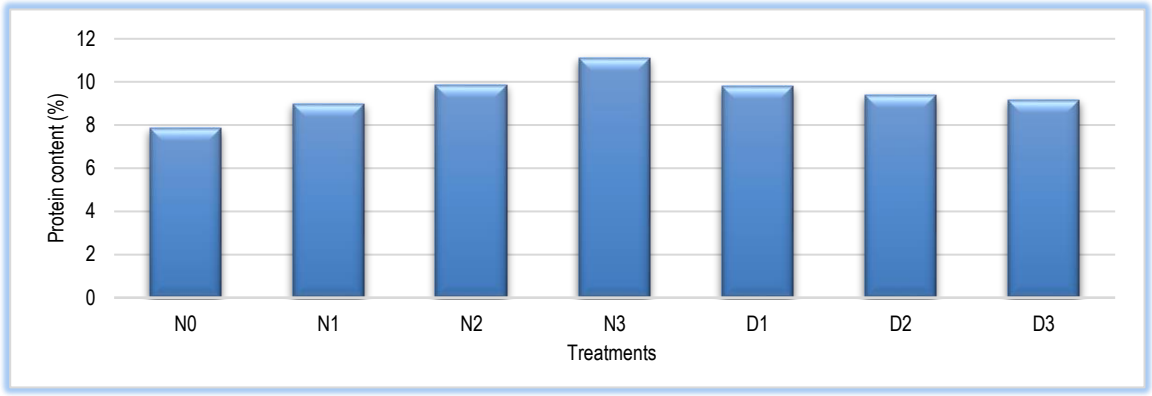

Fig-3 Effect of nitrogen levels and dates of sowing on protein content of barley

A sufficient nitrogen supply encourages active vegetative development, boosts the creation of tillers, and improves growth in general. Similar results were reported by Chopra, *et al*., (2016) [4], Sandhu, *et al*., (2017) [5], Kumar, *et al*., (2021) [6], Singh, *et al*., (2022) [7].

Data regarding yield and yield contributing traits such as length of spikes (cm), number of seeds/spike, test weight (g), seed yield (q ha^{-1}), straw yield (q ha^{-1}) and harvest index (%) were also influenced significantly by the application of different nitrogen levels. Application of nitrogen @ 75 kg ha^{-1} produced plants with a maximum length of spikes (8.37 cm), number of seeds/spike (39.60), test weight (42.73 g), seed yield (41.56 q ha^{-1}), straw yield (50.32 q ha^{-1}), harvest index (45.19 %), followed by application of nitrogen @ 60 kg ha^{-1}. While these traits were recorded as lowest from the plots that did not receive any dose of nitrogen (control). The application of nitrogen encouraged the vigorous vegetative growth that bore more branches, inflorescence, and leaves which contributed to better photosynthesis, ultimately leading to augmented yield attributes and yield under elevated nitrogen levels. Similar results were reported by Chopra, *et al*., (2016) [4], Singh, *et al*., (2013) [8], Pankaj, *et al*., (2015) [9], Trivedi, *et al*., (2022) [10], Singh and Debbarma (2023) [11].

With the application of different amounts of nitrogen, protein content was also influenced. The highest protein content (11.11 %) was obtained by applying nitrogen @ 75 kg ha^{-1}, followed by application of nitrogen @ 60 kg ha^{-1}. Protein content was minimum under control treatment. Nitrogen is the integral element in amino acids that are the building blocks of protein content; therefore, when the level of nitrogen was elevated, consequently the content of protein was also enhanced. A similar result was reported by Kumar, *et al*., (2021) [6].

During the active growth and maturity period of barley, the beneficial effects of different sowing dates on plant height, number of leaves plant-1, average fresh weight (g), length of spikes (cm), number of seeds/spike, test weight (g), grain yield (q ha^{-1}), straw yield (q ha^{-1}) and protein content (%) were evident.

A noteworthy maximum plant height at 90 DAS (81.36 cm), number of leaves plant-1 at 90 DAS (50.28) and average fresh weight (35.42 g) was noted when the barley crop was sown on the 3rd week of November, followed by the sowing date of the 4th week of November. The above parameters were lowest with the most delayed sowing time (1st week of December). By sowing at the right moment, the crop might benefit from a favourable environment during crucial growth phases. This leads to enhanced root growth, increased tillering, and higher biomass accumulation, all of which ultimately increase the vegetative growth of plants. However, planting too early exposes the crop to unfavourable weather conditions that may harm germination and early growth, such as frost or severe heat. The result agrees with the findings of Ram and Dhaliwal (2012) [12], Choudhary, *et al*., (2014) [13], Galav and Bharose (2017) [14], Parashar, *et al*., (2020) [15].

Yield and yield attributes were also influenced significantly by different sowing dates. The maximum length of spikes (7.68 cm), number of seeds/spike (38.83), test weight (40.41 g), seed yield (35.27 q ha^{-1}), straw yield (45.57 q ha^{-1}) was produced by the plants when the crop was sown on 3rd week of November, followed by sowing on 4th week of November. While these traits were recorded to be lowest with the most delayed sowing time (1st week of December). The harvest index did not differ significantly due to the influence of sowing dates.

Better performance of the crop under earlier sowing time is mainly due to luxurious plant growth. Increased tiller with more leaves contributed to higher photosynthesis and better dry matter partitioning due to that augmented yield was observed under earlier sowing time. Similar results were also documented by Similar results were reported by Choudhary, *et al*., (2014) [13], Galav and Bharose (2017) [14], Parashar, *et al*., (2020) [15]. Protein content was also significantly influenced by different sowing dates. Sowing in 3rd week of November led to the highest protein content (9.78 %), followed by sowing on 4th week of November. The lowest protein content was obtained when the barley crop was sown on 1st December. Earlier sowing may have provided favourable growing conditions, which led to better root growth and uptake of nitrogen; therefore, the protein content under an earlier planting date was observed.

Conclusion

Based on the one-year experiment, it can be concluded that nitrogen @ 75 kg per ha and sowing on 3rd week of November was found to be effective in order to fetch higher seed yield (41.56 and 35.27 q/ha, respectively) and straw yield (50.56 and 45.57 q/ha, respectively).

Application of research: The study seeks to delve into the appropriate dose of nitrogen and optimum sowing date to fetch a better yield of barley.

Research Category: Agronomy

Abbreviations: kg ha^{-1}-kilogram per hectare, q ha^{-1}-quintal per hectare

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Study area / Sample Collection: Research plot, Department of Agronomy, AKS University, Satna, Madhya Pradesh, 485001 India

Cultivar / Variety / Breed name: Barley (*Hordeum vulgare* L.)

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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