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Shiv Shanker
 Ph.D. Research Scholar,
 Department of Agronomy, R.
 B. S. College, Bichpuri Agra,
 Uttar Pradesh, India

Rajvir Singh
 Professor, Department of
 Agronomy, R. B. S. College,
 Bichpuri Agra, Uttar Pradesh,
 India

Corresponding Author:
Shiv Shanker
 Ph.D. Research Scholar,
 Department of Agronomy, R.
 B. S. College, Bichpuri Agra,
 Uttar Pradesh, India

Effect of nitrogen and hydrogel levels on soil moisture, relative water and consumptive use of Barley (*Hordeum vulgare* L.)

Shiv Shanker and Rajvir Singh

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Abstract

A field experiment was conducted during the *Rabi* seasons of 2021-22 and 2022-23 at Agricultural Research Farm, Department of Agronomy, Raja Balwant Singh College, Bichpuri (Agra). The variables involved in this study were Irrigation scheduling (Main plot) *viz.*, control (No irrigation, I₀), Active tillering at 30-35 DAS (I₁) and Active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I₂) along with Nitrogen levels (Sub plot) *viz.*, 75% RDN (45 kg N) + 30 kg P₂O₅ + 20 kg K₂O (N₁) and 100% RDN (60 kg N) + 30 kg P₂O₅ + 20 kg K₂O (N₂); C. Hydrogel levels (Sub-sub plot) *viz.*, control (No hydrogel, H₀), Pusa Hydrogel @ 2.5 kg ha⁻¹ (H₁), Pusa Hydrogel @ 5.0 kg ha⁻¹ (H₂) and Pusa Hydrogel @ 7.5 kg ha⁻¹ (H₃). Thus, all factors were compared in a split plot design with three replications. Results revealed that the application of Pusa Hydrogel @ 7.5 kg ha⁻¹ (H₃) significantly enhanced water-related parameters of barley crop. The treatment recorded the highest soil moisture content (20.85–20.88%), soil moisture extraction (13.60–13.64%), water use efficiency (16.21–16.26 kg ha⁻¹ mm), consumptive use of water (30.12–30.18 cm), and relative water content (73.80–73.98%), while the lowest values for all these parameters were observed under the control (no hydrogel).

Keywords: Hydrogel levels, nitrogen, Pusa Hydrogel, RDN, DAS

Introduction

Barley (*Hordeum vulgare* L.) is widely grown across a range of environments as a rainfed or irrigated crop. (Singh *et al.* 2024) ^[1]. It is grown with levels care and less manurial requirement. (Singh *et al.*, 2022) ^[4]. Globally 70% of barley production is used as animal fodder, while 30% as a source of fermentable material for beer and certain distilled beverages and as a component of various foods. It is used in soups and stews and in barley bread of various cultures, barley grains are commonly made into malt in all traditional and ancient method of preparation. (Singhal, *et al.*, 2023) ^[1]. Barley has a long history of cultivation and is recognized as one of the oldest cultivated grains. (Singh *et al.*, 2023) ^[1]. The limited availability of water resources in arid and semi-arid regions poses a significant challenge to sustainable agriculture, with drought stress projected to cause up to a 30% reduction in global crop production by 2025. (Singh *et al.*, 2024) ^[1].

Hydrogel are water-absorbing polymers that swell many times their size and act as water retention granules in agriculture. They improve soil water-holding capacity, enhance soil properties, and increase irrigation efficiency, especially in arid and semi-arid regions. (Gupta *et al.*, 2025) ^[2]. Agricultural hydrogels are referred to as water retention granules because they swell to many times their original size when they come in contact with water. It has been widely proposed over the last 40 years for agricultural use with the aim to ameliorate water availability for plants, by increasing water holding properties of growing media. (Gupta *et al.*, 2025) ^[2]. Fertilizer N management strategies need to be formulated to address the challenges of increasing agricultural productivity and improving sustainability. Split applications of nitrogen at different crop development stages. (Singh *et al.*, 2023) ^[1]. Use of higher level of fertilizers, irrigation and sometimes reverting to older cultivars for specific needs and increase in the mechanized harvesting may lead to further losses due to lodging. (Archana, *et al.*, 2023) ^[1].

Materials and Methods

The field experiment was carried out during *rabi* season of 2021-22 and 2022-23 at Agricultural Research Farm, Department of Agronomy, R.B.S. College, Bichpuri, Agra (U.P.). The research farm is situated at about 11 km to the west of Agra on Agra-Bharatpur Road at latitude of 27° 02' N and longitude of 77° 09' E with an elevation of 163.4 m above the mean sea level. This region falls under south-western semi-arid zone of Uttar Pradesh. A “Split plot Design” with three irrigation scheduling (main plot), Two levels of nitrogen (sub plot) and four levels of hydrogel (sub-sub plot) replicated three times was adopted. Barley variety BH-946 is a high yielding six rows feed barley variety developed by CCSHAU, Hisar for cultivation under timely sown, irrigated conditions of Uttar Pradesh. Seed was treated with Agrosan GN @ 2g kg⁻¹ seed. The sowing was done in furrows 6 cm depth at a distance of 18 cm. Apart, the seed rate of 100 kg ha⁻¹. Nitrogen, phosphorus, and potassium fertilizers were administered as urea, DAP, and muriate of potash at the rates of 150, 60, and 40 kg/ha, respectively. The entire amount of phosphorus and potassium, along with half of the nitrogen, was applied during sowing, while the remaining nitrogen was added after the first irrigation. Pusa hydrogel is an indigenous product designed and developed by IARI, New Delhi to enhance the crop productivity per unit available water and nutrients, particularly in moisture stress agriculture.

Results and Discussion

Water use studies

The data regarding to the water use studies *viz.*, soil moisture content at 0-30 cm soil depth (At sowing, before irrigation, after irrigation and at harvest), soil moisture extraction pattern 0-30 cm depth, water use efficiency (kg ha⁻¹ mm), consumptive use of water (cm) and relative water content (%) are presented in tables from 1 and 2 and depicted in figures from 4.8 (a) to 4.8 (b), respectively. It is evident from the data that all the water use studies of the

crop were influenced due to irrigation scheduling, nitrogen levels and hydrogel levels during both the year of experimentation.

Soil moisture content at 0-30 cm soil depth (At sowing, before irrigation, after irrigation and at harvest):

Effect of Irrigation Scheduling on Soil Moisture Content

Irrigation scheduling significantly influenced soil moisture content at all crop growth stages (Table 1). The pooled data indicated that the highest soil moisture content was recorded under treatment I₂ (irrigation at active tillering, flag leaf, and milking stages), with values of 6.17%, 15.25%, 26.16%, and 20.83% at sowing, before irrigation, after irrigation, and at harvest, respectively. The treatment I₁ (irrigation at active tillering only) recorded intermediate moisture levels, while the control (I₀), which received no irrigation, maintained the lowest moisture throughout the growth period. The enhanced soil moisture under I₂ may be attributed to timely irrigation at critical stages, which maintained favorable water balance and reduced soil moisture depletion. Similar trends were reported by Kumar *et al.* (2025) and Gupta *et al.* (2025) [5, 2], who observed that multiple irrigations at key phenological stages enhanced soil moisture storage and improved crop growth.

Effect of Nitrogen Levels on Soil Moisture

Nitrogen application exhibited a positive effect on soil moisture retention. The pooled results showed that 100% RDN (N₂) resulted in higher soil moisture (6.18%, 15.49%, 26.33%, and 20.77%) compared with 75% RDN (N₁). This improvement could be ascribed to increased root proliferation and canopy development under higher nitrogen supply, which enhanced water uptake and reduced surface evaporation. These findings corroborate the results of Gupta, *et al.* (2025) and Rathor, *et al.* (2025) [2], who noted that adequate nitrogen fertilization improves the soil–plant–water relationship through better vegetative growth and higher transpiration efficiency.

Table 1: Water use studies of barley as influenced by Irrigation scheduling, Nitrogen levels and hydrogel levels of crop growth

Treatments	Soil moisture content at 0-30 cm soil depth (%)												
	Notations	At sowing			Before irrigation			After irrigation			At harvest		
		2021-22	2022-23	Pool ed	2021-22	2022-23	Pool ed	2021-22	2022-23	Pool ed	2021-22	2022-23	Pool ed
A. Main plot: Irrigation scheduling - 03													
Control (No irrigation)	I ₀	5.33	5.39	5.36	12.12	12.22	12.17	20.74	20.81	20.77	19.12	19.19	19.15
Active tillering at 30-35 DAS	I ₁	5.82	5.85	5.83	14.81	14.89	14.85	25.5	25.6	25.55	20	20.21	20.2
Active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS	I ₂	6.16	6.18	6.17	15.2	15.29	15.25	26.1	26.23	26.16	20.8	20.86	20.83
SE(m)±		0.12	0.13	0.13	0.14	0.14	0.14	0.17	0.2	0.18	0.21	0.23	0.22
C.D. (P = 0.05)		0.35	0.4	0.38	0.41	43	0.42	0.52	0.58	0.55	0.61	0.64	0.62
B. Sub plot: Nitrogen levels – 02													
75% RDN (45 kg N) + 30 kg P2O5 + 20 kg K2O)	N ₁	5.8	5.87	5.83	15.1	15.13	15.12	25.61	25.76	25.69	20.12	20.19	20.15
100% RDN (60 kg N)+ 30 kg P2O5 + 20 kg K2O)	N ₂	6.17	6.19	6.18	15.46	15.51	15.49	26.22	26.43	26.33	20.74	20.81	20.77
SE(m)±		0.14	0.16	0.15	0.11	0.12	0.12	0.21	0.22	0.22	0.2	0.21	0.2
C.D. (P = 0.05)		0.44	0.49	0.46	0.34	0.37	0.35	0.6	0.66	0.63	0.58	0.59	0.58
C. Sub-sub plot: Hydrogel levels – 04													
Control (No Hydrogel)	H ₀	4.7	4.81	4.75	14.3	14.32	14.31	24.14	24.22	24.18	19.14	19.18	19.16
Pusa Hydrogel @ 2.5 Kg ha ⁻¹	H ₁	5.3	5.4	5.35	14.81	14.83	14.82	25.42	25.49	24.45	20.06	20.1	20.08
Pusa Hydrogel @ 5.0 Kg ha ⁻¹	H ₂	5.9	5.93	5.91	15.34	15.39	15.3	26.31	26.36	26.3	20.35	20.42	20.3

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Pusa Hydrogel @ 7.5 kg ha ⁻¹	H ₃	6.15	6.17	6.16	15.82	15.96	15.89	26.88	26.92	26.9	20.85	20.88	20.86
SE(m)±		0.17	0.18	0.17	0.17	0.19	0.18	0.19	0.2	0.19	0.2	0.21	0.21
C.D. (P = 0.05)		0.51	0.52	0.51	0.49	0.5	0.53	0.59	0.62	0.6	0.58	0.6	0.59

Effect of Hydrogel Levels on Soil Moisture

Application of hydrogel significantly increased soil moisture content across all growth stages. The pooled data revealed that soil moisture increased progressively with increasing hydrogel levels, reaching a maximum under H₃ (Pusa Hydrogel @ 7.5 kg ha⁻¹) with 6.16%, 15.89%, 26.90%, and 20.86% at the respective stages. The enhancement in soil moisture under hydrogel application can be attributed to its high water-holding capacity, which allows gradual release of water to the root zone during moisture stress periods. Similar results were reported by Kumar, *et al.* (2025) and Gupta, *et al.* (2025) ^[5, 2], who found that hydrogel application improved soil moisture retention and water use efficiency in cereals grown under limited irrigation.

Effect of Irrigation Scheduling on Water Use Parameters

Irrigation scheduling exerted a significant influence on soil moisture extraction pattern, water use efficiency (WUE), consumptive use of water, and relative water content (RWC) of barley (Table 2). The pooled data revealed that the treatment I₂ (irrigation at active tillering, flag leaf, and milking stages) recorded the highest soil moisture extraction (13.59%), water use efficiency (16.23 kg ha⁻¹ mm⁻¹), consumptive use (30.33 cm), and relative water content (75.52%), followed by I₁ (irrigation at active tillering stage only). The lowest values were observed under I₀ (no irrigation). The higher soil moisture extraction and water use efficiency under I₂ may be attributed to the availability of sufficient soil moisture during critical growth stages, leading to enhanced physiological activity and biomass production. These results are consistent with the findings of Kumar *et al.* (2025) and Verma *et al.* (2025) ^[5, 15], who reported that multiple irrigations improve plant water status and optimize water use efficiency in cereals under semi-arid conditions.

Effect of Nitrogen Levels on Water Use Efficiency and Moisture Parameters

Nitrogen fertilization significantly affected all water use parameters. The pooled data indicated that 100% RDN (N₂) maintained higher soil moisture extraction (13.61%), water use efficiency (16.23 kg ha⁻¹ mm⁻¹), consumptive use (29.96 cm), and relative water content (74.25%) compared with 75% RDN (N₁). The improvement in water use efficiency and relative water content with higher nitrogen supply could be attributed to better canopy development, enhanced photosynthetic activity, and improved root growth, leading to greater water uptake and reduced losses through evaporation. Similar observations were made by Islamuddeen *et al.* (2022) and Verma *et al.* (2025) ^[4, 15], who reported that adequate nitrogen fertilization improves plant water relations by maintaining higher leaf water potential and stomatal conductance.

Effect of Hydrogel Application on Water Use and Moisture Retention

Hydrogel application significantly improved soil moisture extraction, water use efficiency, consumptive use, and relative water content. Among the treatments, H₃ (Pusa Hydrogel @ 7.5 kg ha⁻¹) recorded the highest pooled soil moisture extraction (13.62%), water use efficiency (16.24 kg ha⁻¹ mm⁻¹), consumptive use (30.15 cm), and relative water content (73.89%), followed by H₂ (5.0 kg ha⁻¹). The lowest values were observed in the control (H₀). The improvement in water-related parameters with increasing hydrogel levels is attributed to the superior water absorption and retention properties of hydrogel, which enhance soil water availability during crop growth and minimize drought stress. These findings agree with those of Gupta, *et al.* (2025) and Gupta, *et al.* (2025) ^[2, 3], who demonstrated that hydrogels act as soil conditioners, increasing water-holding capacity and improving crop water use efficiency under limited moisture conditions.

Table 2: Water use studies of barley as influenced by Irrigation scheduling, Nitrogen levels and hydrogel levels of crop growth

Treatments	Water use studies												
	Soil moisture extraction pattern 0-30 cm depth (%)				Water use efficiency (kg ha ⁻¹ mm)			Consumptive use of water (cm)			Relative water content (%)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	
A. Main plot: Irrigation scheduling - 03													
Control (No irrigation)	I ₀	10.9	10.94	10.92	13.21	13.3	13.26	28.24	28.37	28.3	63.41	63.54	63.48
Active tillering at 30-35 DAS	I ₁	12.14	12.17	12.15	14.7	14.75	14.72	29.61	29.66	29.63	70.2	70.42	70.31
Active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS	I ₂	13.56	13.63	13.59	16.2	16.26	16.23	30.27	30.39	30.33	75.48	75.56	75.52
SE(m)±		0.2	0.22	0.21	0.27	0.29	0.28	0.22	0.26	0.23	1.62	1.65	1.63
C.D. (P = 0.05)		0.61	0.65	0.63	0.81	0.84	0.82	0.64	0.68	0.66	4.81	4.93	4.87
B. Sub plot: Nitrogen levels – 02													
75% RDN (45 kg N + 30 kg P ₂ O ₅ + 20 kg K ₂ O)	N ₁	12.95	12.97	12.96	15.2	15.27	15.23	29.03	29.2	29.11	70.2	70.42	70.31
100% RDN (60 kg N + 30 kg P ₂ O ₅ + 20 kg K ₂ O)	N ₂	13.58	13.63	13.61	16.18	16.28	16.23	29.92	29.99	29.96	74.18	74.32	74.25
SE(m)±		0.19	0.2	0.19	0.29	0.3	0.29	0.22	0.23	0.23	1.1	1.14	1.12

C.D. (P = 0.05)		0.58	0.59	0.58	0.86	0.89	0.87	0.63	0.67	0.65	3.28	3.43	3.35
C. Sub-sub plot: Hydrogel levels – 04													
Control (No Hydrogel)	H ₀	11.6	11.8	11.7	13.0 1	13.0 9	13.0 5	27.42	27.48	27.45	64.2	64.32	64.26
Pusa Hydrogel @ 2.5 Kg ha ⁻¹	H ₁	12.4	12.48	12.44	14.2 9	14.3 6	14.3 2	28.21	28.41	28.31	68.1	68.56	68.53
Pusa Hydrogel @ 5.0 Kg ha ⁻¹	H ₂	13.1	13.13	13.11	16.0 2	16.0 9	16.0 5	29.74	29.83	29.78	71.36	71.48	71.42
Pusa Hydrogel @ 7.5 kg ha ⁻¹	H ₃	13.6	13.64	13.62	16.2 1	16.2 6	16.2 4	30.12	30.18	30.15	73.8	73.98	73.89
SE(m)±		0.2	0.22	0.21	0.28	0.29	0.28	0.21	0.24	0.23	1.06	1.08	1.07
C.D. (P = 0.05)		0.61	0.65	0.63	0.84	0.86	0.85	0.65	0.69	0.67	3.16	3.22	3.19

Conclusion

The results concluded that irrigation scheduling, nitrogen levels, and hydrogel application significantly influenced soil moisture dynamics, water use efficiency, and relative water content in barley. The treatment with three irrigations at critical growth stages, along with 100% RDN and Pusa Hydrogel @ 7.5 kg ha⁻¹, consistently recorded the highest values for all water-related parameters. This combination effectively enhanced soil moisture retention and crop water use efficiency. The integration of proper irrigation, nutrient management, and hydrogel application proved most efficient for sustaining barley productivity under limited moisture conditions.

References

1. Archana K, Singh V, Kumar H, Singh R. Optimization of NPK fertilization in conjunction with plant growth regulators affecting productivity and profitability of wheat (*Triticum aestivum* L.). J Rural Agric Res. 2023;23(2):56-60.
2. Gupta A, Singh R, Singh K, Singh AC, Babu S, Kumar R, *et al.* Influence of hydrogel and nutrient management on wheat (*Triticum aestivum* L.) growth and development under limited irrigation conditions. Int J Res Agron. 2025;8(9):709-714.
3. Gupta A, Singh R, Singh K, Singh AC, Babu S, Kumar R, *et al.* Effect of hydrogel and nutrient management on wheat (*Triticum aestivum* L.) productivity under limited irrigation conditions. Int J Res Agron. 2025;8(9):754-759.
4. Islamuddeen, Singh R, Babu S. Effect of integrated nutrient management on barley (*Hordeum vulgare* L.) productivity under different sowing dates. J Rural Agric Res. 2022;22(1):43-46.
5. Kumar K, Maurya SP, Singh SB, Singh V. Effect of irrigation regimes on growth and yield of barley (*Hordeum vulgare* L.) varieties. Int J Agric Food Sci. 2025;7(8):418-422.
6. Kumar S, Singh R, Singh V, Singh D. Precision nitrogen management in wheat (*Triticum aestivum* L.) for enhanced growth and yield by green seeker tool. Int J Agric Food Sci. 2025;7(6):39-43.
7. Rathor A, Singh R, Babu S, Kumar H, Kumar K, Chaubey P, *et al.* Enhancing nutrient use efficiency through nano-fertilizer in barley (*Hordeum vulgare* L.). Int J Agric Food Sci. 2025;7(9):472-477.
8. Singh D, Uma VS, Kumar S. Performances of wheat (*Triticum aestivum* L.) varieties at different levels of nitrogen under late sown condition. Int J Agric Food Sci. 2025;7(6):34-38.
9. Singh K, Singh R, Singh RB, Singh V. Effect of nano-nitrogen fertilization on yield attributes and yield of barley (*Hordeum vulgare* L.). J Rural Agric Res. 2023;23(2):87-90.
10. Singh M, Singh R, Babu S. Performance of nitrogen fertilization and plant growth regulators on productivity of wheat (*Triticum aestivum* L.) under Western Uttar Pradesh. J Rural Agric Res. 2022;22(1):54-57.
11. Singh R, Kumar R, Singh AC, Babu S, Kumar J, Singh K, *et al.* Effect of silicon application and irrigation scheduling on productivity and profitability of barley (*Hordeum vulgare* L.). J Rural Agric Res. 2024;24(1):49-53.
12. Singh R, Singh S, Singh V, Kumar H, Singh K, Kumar J. Impact of nano-nitrogenous fertilization on productivity and profitability of barley (*Hordeum vulgare* L.). J Rural Agric Res. 2024;24(1):110-114.
13. Singhal KS, Singh G, Mishra NM, Rohit, Singh V. Studies on genetic variability, heritability, genetic advance, correlation in barley. Int Res J Modern Eng Technol Sci. 2023;5(6):4491-4496.
14. Summan RS, Kumar H, Kumar K, Chaubey P, Chaudhary S, Singh M, *et al.* Response of barley (*Hordeum vulgare* L.) varieties to different dates of sowing under irrigated conditions. Int J Res Agron. 2025;8(9):641-644.
15. Verma DK, Shankar S, Singh V. Effect of potassium levels on productivity and profitability of wheat (*Triticum aestivum* L.) varieties. Int J Agric Food Sci. 2025;7(6):72-75.