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Effect of irrigation scheduling, nitrogen and hydrogel levels on productivity and profitability of Barley (*Hordeum vulgare* L.)

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Abstract
In order to study the entitled "Effect of Irrigation scheduling, Nitrogen and Hydrogel levels on productivity and profitability of Barley (*Hordeum vulgare* L.)" was conducted at the Agricultural Research Farm (Department of Agronomy), Raja Balwant Singh College, Bichpuri (Agra). The variables (Three factors) involved in this study; A. Irrigation scheduling (Main plot) *viz.*, control (No irrigation, I_0), Active tillering at 30-35 DAS (I_1) and Active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2); B. Nitrogen levels (Sub plot) *viz.*, 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) and 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2); C. Hydrogel levels (Sub-sub plot) *viz.*, control (No hydrogel, H_0), Pusa Hydrogel @ 2.5 kg ha^{-1} (H_1), Pusa Hydrogel @ 5.0 kg ha^{-1} (H_2) and Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3). Thus, all factors were compared in a split plot design with three replications. Different studies were made in this experiment *viz.*, Growth and development (Germination counts at 15 DAS and crop stand, plant height (cm), Fresh and Dry matter accumulation (g) per 25 cm row length, leaf area index, crop growth rate (g m^{-2} day^{-1}) and relative growth rate (g g^{-1} day^{-1}) estimated between 30-60, 60-90 DAS and 90 DAS to at harvest); Yield attributes *viz.*, Effective tillers m^{-2}, length of spike (cm), spikelet's $spike^{-1}$, number of spike m^{-2}, number of grains $spike^{-1}$, grain weight $spike^{-1}$ (g) and test weight (g); Yield studies (Per hectare) *viz.*, biological yield (q ha^{-1}), grain yield (q ha^{-1}), straw yield (q ha^{-1}) and harvest index (%) and economics *viz.*, cost of cultivation (₹ ha^{-1}), gross returns (₹ ha^{-1}), net returns (₹ ha^{-1}) and Net B: C ratio, during *Rabi* seasons of 2021-22 and 2022-23. Applying of water at active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS along with 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) and Pusa Hydrogel @ 7.5 kg ha^{-1} recorded higher crop growth, yield attributes and yield of barley. Highest economic returns were fetched with the application of three irrigation at active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS along with 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) and Pusa Hydrogel @ 7.5 kg ha^{-1}. However, the maximum net B: C ratio was fetched with the application of three irrigation at active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS along with 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) and Pusa Hydrogel @ 5.0 kg ha^{-1}.

Keywords: Barley, irrigation scheduling, nitrogen and hydrogel levels

1. Introduction
Barley (*Hordeum vulgare* L.) is an ancient cereal grain, which upon domestication has evolved largely a food grain to a feed and malting grain. Barley can grow in a wide range of environment than any other cereal, including extremes of latitude, longitude and high altitude. It is frequently being described as the most cosmopolitan of the crops and also considered as poor man's crop because of the low input requirement and better adaptability to draught, salinity, alkalinity and marginal land. Barley (*Hordeum vulgare* L.) is popularly known as "Jau" in Hindi and one of the most important cereal crops of world. Among cereals, it ranks fourth with respect to area and production after wheat, rice and maize. Barley grain is mostly used as feed for animals, malt, and food for human consumption. It is also a valuable input for industries for extracting malt. Malt is the second largest use of barley to be utilized in brewing, distillation, baby foods, cocoa malt drinks and ayurvedic medicines. Its straw is a good quality dry fodder for livestock (Meena *et al.*, 2012) [47]. Globally barley production is 149.53 million tonnes in 2022-2023 and increase of 4.06 million tonnes or 2.79% around the globe than previous year. The European Union is the world's largest

producer of barley produces about 51.45 million metric tonnes followed by Russia (21.5) and Australia (13.7) million metric tonnes. India accounts for only around one percent of the world barley production. India's annual production of barley has been steadily around 1.2- 1.7 million tonnes in the recent years, with a production of 1.4 million tonnes in the year 2022-23 (FAOSTAT, 2023) [21]. The major producers of Barley in the country are Rajasthan (47%), Uttar Pradesh (40.11%), Haryana (11%), Madhya Pradesh (7.3%) and Punjab (6.05%). Some cultivation is also undertaken in Bihar, Himachal Pradesh, and Uttaranchal. Uttar Pradesh has first position in acreage but when it comes to production stood in second position in barley cultivation due to low yield levels. Rajasthan emerges as India's largest barley producing state in 2024, leveraging its vast open spaces and favourable climate. Its predominantly arid and semi-arid regions, notably in districts like Jodhpur, Nagaur, and Bikaner, foster optimal conditions for barley cultivation. The state prioritizes advanced farming techniques and breeding practices to enhance barley yields, underscoring its leadership in agricultural innovation within the barley sector. Rajasthan stands as the largest barley producing state in India, leveraging its vast open spaces and favourable climate, followed by Uttar Pradesh, Punjab and Madhya Pradesh (PIB, 2024) [56].

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. Hydrogel is insoluble, hydrophilic in nature and can absorb large quantity of water (Schacht, 2004) [63]. Hydrogels have great potential in areas where opportunity for irrigation is limited and can increase the water availability during crop establishment. The capacity of the hydrogel to absorb and retain water is as much as 80-180 times its original volume (Bowman and Evans, 1991) [13] while on weight basis it can absorb as high as 400-800 times its original weight. The hydrogels can also modify various physical properties of soil like infiltration rates, density, soil structure and compaction, etc. Various reports have suggested the beneficial impact of hydrogel in crop growth and soil properties. Hydrogel applied at the rate of 5 kg ha^{-1} along with farm yard manure (FYM) in an alluvial sandy loam soil significantly impacted hydrological properties of soil like the field capacity, plant available water content, relative field capacity and saturated hydraulic conductivity (Narjary and Aggarwal, 2014) [51]. Grain yield, nutrient uptake and water-use efficiency improved in winter wheat when hydrogel was applied at the rate of 5 kg ha^{-1} in a sandy loam soil (Tyagi *et al*., 2015) [77] while in a clay loam soil with the same dose of hydrogel application along with recommended dose of fertilizer, 8.48% increase in yield was observed (Borivoj *et al.*, 2006) [12]. Barley cultivation in India was facing stiff challenges in terms of area with wheat in winter season, as the crop was considered less remunerative due to less MSP and market price, resulting drastic reduction in area and production. Recent changes in situation triggered by the industrial demand in malting and brewing has given it a new lease of life and it is becoming commercial crop. Contract farming on larger scale has started in Punjab, Haryana and Rajasthan. The new challenges for production and protection technologies in addition to the genetic improvement are being envisaged because of its shift to optimally managed conditions. We may also have to look for lodging resistance through new plant type in addition to the requirements of genetic resistance to biotic and abiotic stresses and better grain quality. The changing climate and shortage of water are general problems of crop production and barley cultivation can be a good option to mitigate with such challenges. Therefore, in view of the above consideration the present investigation was conducted to assess the effect of irrigation scheduling, nitrogen and hydrogel levels on growth and yield of barley, to work out the economics of the treatments.

2. Methodology

In order to study the "Effect of Irrigation scheduling, Nitrogen and Hydrogel levels on productivity and profitability of Barley (*Hordeum vulgare* L.)" a field experiment was conducted at Agricultural Research Farm of Raja Balwant Singh College, Bichpuri, Agra during Rabi seasons of 2021-22 and 2022-23. The experimental materials used, experimental techniques and methodology adopted during the course of investigation. The present field experiment was carried out at the Agricultural Research Farm of Raja Balwant Singh College, Agra which is situated at the distance of about 11 km away from Agra city on Agra-Bharatpur road at an elevation (altitude) of 163.4 metre above mean sea level with 27.2º N latitude and 77.9º E longitude with all required facilities for cultivation of above mentioned experiment crop. The region has a semi-arid and sub-tropical climate with hot and dry summers and severe cold winters. The soil of the experimental field was gangetic alluvial with calcareous layer at the depth of about 1.5 m to 2.0 m and was well drained. To know the exact nature and physico-chemical properties of the experimental soil, a composite soil sample from the surface of soil (0-15 cm depth) was taken before application of fertilizers and sowing of the experimental plot with the help of an auger and subjected to mechanical and chemical analysis showed that the percentage of fine sand in the soil was more in comparison to other components. Thus, on the basis of above fractional analysis, the soil is categorized as a sandy loam having low aggregation. The results of the chemical analysis presented in Table 3.1 revealed that the soil of the experimental field was deficient in available total nitrogen (N), low in organic carbon; medium in available phosphorus (P_2O_5) and fairly rich in potassium (K_2O) content and the soil was slightly alkaline in reaction. 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. It is resistant to lodging, yellow rust and leaf blight. The average grain yield potential of this variety is about 51.87 q ha^{-1} and grain size is very bold. 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} (seed rate was adjusted by taking weight of 1000 seeds 40 g) was used. The sowing was done on 05/11/2021 and 10/11/2022 with the help of kudali and was covered by light planking. To fulfill the requirement of objectives of the investigation field experiment was conducted during Rabi season of 2021-22 and 2022-23. 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. Other details about treatments are given below:

Table 1: Treatment details with notations

S. No.	Treatments	Notations
A.	**Main plot: Irrigation scheduling - 3**	
1.	Control (no irrigation)	I_0
2.	Active tillering at 30-35 DAS	I_1
3.	Active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS	I_2
B.	**Sub plot: Nitrogen levels - 2**	
1.	75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_1
2.	100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_2
C.	**Sub-sub plot: Hydrogel levels- 4**	
1.	Control (No Hydrogel)	H_0
2.	Pusa Hydrogel @ 2.5 Kg ha^{-1}	H_1
3.	Pusa Hydrogel @ 5.0 Kg ha^{-1}	H_2
4.	Pusa Hydrogel @ 7.5 kg ha^{-1}	H_3

3. Results

The results of the experiment entitled "Effect of Irrigation scheduling, Nitrogen and Hydrogel levels on productivity and profitability of Barley (*Hordeum vulgare* L.)" have been presented in this chapter with tables and their analysis of the variance.

3.1 Growth characters

3.1.1 Germination counts and crop stand

Effect of irrigation scheduling

The data regarding to the germination count at 15 DAS and crop stands are presented in table-2. Germination count at 15 DAS were influenced non-significantly and crop stands were influenced significantly due to irrigation scheduling at 30, 60, 90 DAS and at harvest during both the year of experimentation. Highest germination count (31.65, 32.42 and 32.03) at 15 DAS and crop stands (94.36, 94.92 and 94.64) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) at harvest during first year, second year and pooled, respectively. Active tillering at 30-35 DAS (I_1) was found at par with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) at 60 DAS during both the year of study and pooled, respectively. The magnitude increment in crop stands with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 17.85%, 17.57% and 17.72%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest germination counts 29.56, 30.26 and 29.92 at 15 DAS and crop stands 79.91, 80.58 and 80.24 were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest germination count (31.88, 32.86 and 32.37) at 15 DAS and crop stands (93.81, 94.35 and 94.08) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. Application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) was found at par with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at 60 DAS during both the year of study and pooled, respectively. The magnitude increment in crop stands with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 10.18%, 09.97% and 10.92%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest germination counts 30.71, 31.09 and 30.90 at 15 DAS and crop stands 85.14, 85.79 and 85.46 were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest germination count (31.94, 32.88 and 32.41) at 15 DAS and crop stands (97.89, 98.74 and 98.31were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at 60 and 90 DAS during both the year of study and pooled, respectively. The magnitude increment in crop stands with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 14.73, 14.89% and 14.80%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest germination counts 29.18, 30.03 and 29.60 at 15 DAS and crop stands 85.32, 85.94 and 85.63 were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.1.2 Plant height (cm)

Effect of irrigation scheduling

The data pertaining to the plant height (cm) are presented in table-3. Plant height (cm) were influenced significantly due to irrigation scheduling at 60, 90 DAS and at harvest, except 30 DAS during both the year of experimentation. Highest plant height (74.21, 74.92 and 74.56 cm) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) at harvest during first year, second year and pooled, respectively. Active tillering at 30-35 DAS (I_1) was found at par with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) at 60 DAS during both the year of study and pooled, respectively. The magnitude increment in plant height (cm) with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 08.65%, 08.67% and 08.65%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest plant height 68.14, 68.78 and 68.46 cm were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest plant height (78.46, 78.22 and 78.34 cm) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year,

second year and pooled, respectively. Application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) was found at par with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at 90 DAS during both the year of study and pooled, respectively. The magnitude increment in plant height with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 05.86%, 04.55% and 05.21%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest plant height 74.11, 74.81 and 74.46 cm were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest plant height (78.41, 79.18 and 78.79) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at 90 DAS and at harvest during both the year of study and pooled, respectively. The magnitude increment in plant height (cm) with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 10.25%, 09.14% and 10.39%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest plant height 71.12, 71.63 and 71.37 cm were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.1.3 Dry matter accumulation (Fresh weight, g) per 25 cm row length

Effect of irrigation scheduling

The data regarding to the fresh weight (g) are presented in table-4 (a). Fresh weight (g) were influenced significantly due to irrigation scheduling at 30, 60, 90 DAS and at harvest during both the year of experimentation. Highest fresh weight (305.10, 309.94 and 307.52 g) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) at harvest during first year, second year and pooled, respectively. Active tillering at 30-35 DAS (I_1) was found at par with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) at 60 DAS during both the year of study and pooled, respectively. The magnitude increment in fresh weight (g) with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 10.84%, 10.98% and 10.58%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest fresh weight 276.90, 279.26 and 278.08 (g) were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest fresh weight (310.41, 327.14 and 314.77 g) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in fresh weight (g) with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 04.56%, 04.44% and 04.50%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest fresh weight 296.86, 313.21 and 305.03 (g) were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest fresh weight (312.46, 319.20 and 315.83 g) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Pusa Hydrogel @ 2.5 Kg ha^{-1} (H_1) was found at par with the application Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) and Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at 60 DAS during both the year of study and pooled, respectively. The magnitude increment in fresh weight (g) with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 10.32%, 12.79% and 10.84%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest fresh weight 283.21, 286.66 and 284.93 (g) were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.1.4 Dry matter accumulation (Dry weight, g) per 25 cm row length

Effect of irrigation scheduling

The data regarding to the dry weight (g) are presented in table-4 (b). Dry weight (g) were influenced significantly due to irrigation scheduling at 30, 60, 90 DAS and at harvest during both the year of experimentation. Highest dry weight (142.53, 144.16 and 143.34 g) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) at harvest during first year, second year and pooled, respectively. Active tillering at 30-35 DAS (I_1) was found at par with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) at 60 DAS during both the year of study and pooled, respectively. The magnitude increment in dry weight (g) with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 09.12%, 09.44% and 09.28%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest dry weight 130.61, 131.72 and 131.16 (g) were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest dry weight (143.62, 144.75 and 144.18 g) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. Application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) was found at par with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at 60 DAS. The magnitude increment in dry weight (g) with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 03.97%, 03.98% and 03.98%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest dry weight 138.13, 139.20 and 138.66 (g) were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest dry weight (145.71, 146.86 and 146.28 g) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at 90 DAS and at harvest during both the year of study and pooled, respectively. The magnitude increment in dry weight (g) with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 08.55%, 08.36% and 08.45%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest dry weight 134.23, 135.52 and 134.87 (g) were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.1.5 Leaf area index (%)

Effect of irrigation scheduling

The data regarding to the leaf area index (%) are presented in table-5. Leaf area index (%) were influenced significantly due to irrigation scheduling at 60, 90 DAS and at harvest, except 30 DAS during both the year of experimentation. Highest leaf area index (4.57, 4.59 and 4.58 %) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) at harvest during first year, second year and pooled, respectively. Active tillering at 30-35 DAS (I_1) was found at par with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) at 60, 90 DAS and at harvest during both the year of study and pooled, respectively. The magnitude increment in leaf area index (%) with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 09.85%, 10.00% and 10.09%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest leaf area index 4.16, 4.17 and 4.16 % were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest leaf area index (4.57, 4.58 and 4.58 %) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. Application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) was found at par with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at 60, 90 DAS and at harvest. The magnitude increment in leaf area index (%) the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 05.54%, 2.46% and 04.09%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest leaf area index 4.33, 4.47 and 4.40 % were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest leaf area index (4.64, 4.65 and 4.65 %) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Pusa Hydrogel @ 2.5 Kg ha^{-1} (H_1) was found at par with the application of Pusa Hydrogel @ 5.0 kg ha^{-1} (H_2), and Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at 60, 90 DAS and at harvest during both the year of study and pooled, respectively. The magnitude increment in leaf area index (%) with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 18.97%, 18.62% and 18.92%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest leaf area index 3.90, 3.92 and 3.91 % were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.1.6 Crop growth rate (g m^{-2} day^{-1})

Effect of irrigation scheduling

The data regarding to the crop growth rate (g m^{-2} day^{-1}) are presented in table-6. Crop growth rate (g m^{-2} day^{-1}) were influenced significantly due to irrigation scheduling at 60-90 DAS and 90 DAS-at harvest, except 30-60 DAS during both the year of experimentation. Highest crop growth rate (g m^{-2} day^{-1}) (3.98, 4.05 and 4.01) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) at harvest during first year, second year and pooled, respectively. Active tillering at 30-35 DAS (I_1) was found at par with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) at 60-90 DAS and 90 DAS-at harvest during both the year of study and pooled, respectively. The magnitude increment in crop growth rate (g m^{-2} day^{-1}) with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 14.69%, 14.40% and 14.57%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest crop growth rate (g m^{-2} day^{-1}) 3.47, 3.54 and 3.50 were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest crop growth rate (g m^{-2} day^{-1}) (3.99, 4.02 and 4.00) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. Application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) was found at par with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at 60-90 DAS and 90 DAS-at harvest. The magnitude increment in crop growth rate (g m^{-2} day^{-1}) the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 19.46%, 20.00% and 19.76%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest crop growth rate (g m^{-2} day^{-1}) 3.34, 3.35 and 3.34 were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest crop growth rate (g m^{-2} day^{-1}) (3.99, 4.04 and 4.01) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at 60-90 DAS and 90 DAS-at harvest during both the year of study and pooled, respectively. The magnitude increment in crop growth rate (g m^{-2} day^{-1}) with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of

34.79%, 35.11% and 35.01%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest crop growth rate (g m^{-2} day^{-1}) 2.96, 2.99 and 2.97 were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.1.7 Relative growth rate (mg g^{-1} day^{-1})

Effect of irrigation scheduling

The data pertaining to the relative growth rate (mg g^{-1} day^{-1}) are presented in table-7. Relative growth rate (mg g^{-1} day^{-1}) were influenced significantly due to irrigation scheduling at 90 DAS-at harvest, except 30-60 DAS and 60-90 DAS during both the year of experimentation. Highest relative growth rate (mg g^{-1} day^{-1}) (5.94, 5.98 and 5.96) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) at harvest during first year, second year and pooled, respectively. Active tillering at 30-35 DAS (I_1) was found at par with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) at 90 DAS-at harvest during both the year of study and pooled, respectively. The magnitude increment in relative growth rate (mg g^{-1} day^{-1}) with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 22.47%, 20.08% and 21.38%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest relative growth rate (mg g^{-1} day^{-1}) 4.85, 4.98 and 4.91 were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest relative growth rate (mg g^{-1} day^{-1}) (5.87, 5.89 and 5.88) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. Application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) was found at par with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at 90 DAS-at harvest. The magnitude increment in relative growth rate (mg g^{-1} day^{-1}) the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 13.75%, 13.26% and 13.73%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest relative growth rate (mg g^{-1} day^{-1}) 05.16, 05.20 and 05.17 were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest relative growth rate (mg g^{-1} day^{-1}) (5.96, 5.99 and 5.97) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at 90 DAS-at harvest during both the year of study and pooled, respectively. The magnitude increment in relative growth rate (mg g^{-1} day^{-1}) with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 48.25%, 47.53% and 47.77%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest relative growth rate (mg g^{-1} day^{-1}) 4.02, 4.06 and 4.04 were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.2 Yield attributes

3.2.1 Effective tillers m^{-2}

Effect of irrigation scheduling

The data pertaining to the effective tillers m^{-2} are presented in table-8 (a). Effective tillers m^{-2} was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest effective tillers m^{-2} (305.95, 306.93 and 306.44) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in relative water content (%) with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 22.17%, 22.01% and 22.09%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest effective tillers m^{-2} 250.42, 251.56 and 250.99 were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest effective tillers m^{-2} (317.81, 318.74 and 318.27) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in effective tillers m^{-2} the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 05.90%, 04.87% and 05.38%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest effective tillers m^{-2} 300.08, 303.93 and 302.00 were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest effective tillers m^{-2} (320.59, 321.14 and 320.56) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during both the year of study and pooled, respectively. The magnitude increment in effective tillers m^{-2} with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 25.51%, 20.90% and 24.12%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest effective tillers m^{-2} 255.41, 261.09 and 258.25 were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.2.2 Length of spike (cm)

Effect of irrigation scheduling

The data regarding to the length of spike (cm) are presented in table-8 (a). Length of spike (cm) was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest length of spike (8.34, 8.68 and 8.51 cm) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at

harvest during first year, second year and pooled, respectively. The magnitude increment in length of spike (cm) with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 49.73%, 53.90% and 51.96%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest length of spike 5.57, 5.64 and 5.60 cm were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest length of spike (8.30, 8.41 and 8.35 cm) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in length of spike (cm) the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 20.81%, 20.65% and 20.66%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest length of spike 6.87, 6.97 and 6.92 cm were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest length of spike (8.60, 8.81 and 8.70 cm) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during both the year of study and pooled, respectively. The magnitude increment in length of spike (cm) with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 43.57%, 46.34% and 45.00%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest length of spike 5.99, 6.02 and 6.00 cm were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.2.3 Spikelet's $spike^{-1}$

Effect of irrigation scheduling

The data regarding to the spikelet's $spike^{-1}$ are presented in table-8 (a). Spikelet's $spike^{-1}$ was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest spikelet's $spike^{-1}$ (23.26, 23.84 and 23.55) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in spikelet's $spike^{-1}$ with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 54.48%, 53.50% and 54.22%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest spikelet's $spike^{-1}$ 15.02, 15.53 and 15.24 were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels: Highest spikelet's $spike^{-1}$ (24.72, 24.91 and 24.81) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in spikelet's $spike^{-1}$ the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 22.74%, 22.46% and 22.57%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest spikelet's $spike^{-1}$ 20.14, 20.34 and 20.24 were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest spikelet's $spike^{-1}$ (25.00, 25.68 and 25.34) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during both the year of study and pooled, respectively. The magnitude increment in spikelet's $spike^{-1}$ with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 64.90%, 67.84% and 66.38%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest spikelet's $spike^{-1}$ 15.16, 15.30 and 15.23 were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.2.4 Number of spike m^{-2}

Effect of irrigation scheduling

The data regarding to the number of spike m^{-2} are presented in table-8 (a). Number of spike m^{-2} was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest number of spike m^{-2} (293.60, 294.60 and 294.05) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in number of spike m^{-2} with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 21.32%, 21.74% and 21.22%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest number of spike m^{-2} 242.00, 243.12 and 242.56 were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest number of spike m^{-2} (300.16, 301.03 and 300.59) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in number of spike m^{-2} the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 04.58%, 04.62% and 04.60%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest number of spike m^{-2} 287.00, 287.71 and 287.35 were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest number of spike m^{-2} (303.84, 304.26 and 304.05) were recorded with the application of Pusa Hydrogel @ 7.5

kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during both the year of study and pooled, respectively. The magnitude increment in number of spike m^{-2} with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 24.43%, 23.52% and 23.98%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest number of spike m^{-2} 244.17, 246.32 and 245.24 were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.2.5 Number of grains spike^{-1}

Effect of irrigation scheduling: The data pertaining to the number of grains spike^{-1} are presented in table-8 (b). Number of grains spike^{-1} was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest number of grains spike^{-1} (38.95, 39.36 and 39.15) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in number of grains spike^{-1} with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 08.25%, 08.37% and 08.29%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest number of grains spike^{-1} 35.98, 36.32 and 36.15 were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest number of grains spike^{-1} (40.88, 41.44 and 41.01) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in number of grains spike^{-1} the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 08.69%, 08.77% and 08.75%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest number of grains spike^{-1} 37.61, 37.82 and 37.71 were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels: Highest number of grains spike^{-1} (41.83, 42.03 and 41.98) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) followed by Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) and Pusa Hydrogel @ 2.5 Kg ha^{-1} (H_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in number of grains spike^{-1} with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 15.13%, 11.75% and 13.55%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest number of grains spike^{-1} 36.33, 37.61 and 36.97 were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.2.6 Grain weight spike^{-1} (g)

Effect of irrigation scheduling

The data pertaining to the grain weight spike^{-1} (g) are presented in table-8 (b). Grain weight spike^{-1} (g) was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest grain weight spike^{-1} (4.15, 4.25 and 4.20 g) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in grain weight spike^{-1} (g) with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 70.78%, 69.32% and 70.04%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest grain weight spike^{-1} 2.43, 2.51 and 2.47 (g) were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest grain weight spike^{-1} (3.34, 3.51 and 3.42 g) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in grain weight spike^{-1} (g) the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 10.59%, 11.07% and 10.67%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest grain weight spike^{-1} 3.02, 3.16 and 3.09 (g) were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest grain weight spike^{-1} (3.95, 4.26 and 4.10 g) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) followed by Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) and Pusa Hydrogel @ 2.5 Kg ha^{-1} (H_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in grain weight spike^{-1} (g) with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 60.56%, 71.77% and 65.99%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest grain weight spike^{-1} 2.46, 2.48 and 2.47 (g) were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.2.7 Test weight (g)

Effect of irrigation scheduling

The data pertaining to the test weight (g) are presented in table-8 (b). Test weight (g) was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest test weight (40.43, 40.64 and 40.53 g) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in test weight (g) with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 07.75%, 6.86% and 06.91%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest test weight 37.80, 38.03 and 37.91 (g) were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest test weight (40.31, 40.90 and 40.60 g) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in test weight (g) the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 07.03%, 07.91% and 07.46%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest test weight 37.66, 37.90 and 37.78 (g) were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest test weight (40.95, 41.03 and 40.99 g) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) followed by Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) and Pusa Hydrogel @ 2.5 Kg ha^{-1} (H_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in test weight (g) with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 06.17%, 05.58% and 05.88%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest test weight 38.57, 38.86 and 38.71 (g) were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.3 Yield studies (q ha^{-1})

3.3.1 Biological yield (q ha^{-1})

Effect of irrigation scheduling

The data pertaining to the biological yield (q ha^{-1}) are presented in table-9. Biological yield (q ha^{-1}) was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest biological yield (129.64, 130.26 and 129.95 q ha^{-1}) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in biological yield (q ha^{-1}) with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 11.97%, 12.04% and 12.00%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest biological yield (115.78, 116.26 and 116.02 q ha^{-1}) were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels: Highest biological yield (125.67, 125.72 and 125.69 q ha^{-1}) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in biological yield (q ha^{-1}) the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 04.18%, 03.46% and 03.82%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest biological yield (120.62, 121.51 and 121.06 q ha^{-1}) were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels: Highest biological yield (132.34, 132.87 and 132.60 q ha^{-1}) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) followed by Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) and Pusa Hydrogel @ 2.5 Kg ha^{-1} (H_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in biological yield (q ha^{-1}) with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 08.43%, 08.82% and 08.62%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest biological yield (122.05, 122.10 and 122.07 q ha^{-1}) were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.3.2 Grain yield (q ha^{-1})

Effect of irrigation scheduling

The data regarding to the grain yield (q ha^{-1}) are presented in table-9. Grain yield (q ha^{-1}) was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest grain yield (49.66, 50.22 and 49.94 q ha^{-1}) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in grain yield (q ha^{-1}) with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 28.51%, 29.23% and 28.87%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest grain yield (38.64, 38.86 and 38.75 q ha^{-1}) were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels: Highest grain yield (48.59, 48.84 and 48.71 q ha^{-1}) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in grain yield (q ha^{-1}) the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 04.31%, 03.49% and 03.90%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest grain yield (46.58, 47.19 and 46.88 q ha^{-1}) were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest grain yield (51.13, 51.37 and 51.25 q ha^{-1}) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) followed by Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) and Pusa Hydrogel @ 2.5 Kg ha^{-1} (H_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in grain yield (q ha^{-1}) with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 20.05%, 20.53% and 20.30%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest grain yield (42.59, 42.62 and 42.60 q ha^{-1}) were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.3.3 Straw yield (q ha^{-1})

Effect of irrigation scheduling: The data pertaining to the straw yield (q ha^{-1}) are presented in table-9. Straw yield (q

ha^{-1}) was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest straw yield (79.98, 80.04 and 80.01 q ha^{-1}) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in straw yield (q ha^{-1}) with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 03.68%, 03.41% and 03.54%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Lowest straw yield (77.14, 77.40 and 77.27 q ha^{-1}) were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest straw yield (77.08, 77.10 and 77.09 q ha^{-1}) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in straw yield (q ha^{-1}) the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 04.10%, 03.74% and 03.77%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Lowest straw yield (74.04, 74.32 and 74.18 q ha^{-1}) were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest straw yield (81.21, 81.50 and 81.35 q ha^{-1}) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) followed by Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) and Pusa Hydrogel @ 2.5 Kg ha^{-1} (H_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in straw yield (q ha^{-1}) with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 02.20%, 02.54% and 02.36%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest straw yield (79.46, 79.48 and 79.47 q ha^{-1}) were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.3.4 Harvest index (%)

Effect of irrigation scheduling

The data regarding to the harvest index (%) are presented in table-9. Harvest index (%) was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest harvest index (38.30, 38.55 and 38.42 %) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. Lowest harvest index (33.37, 33.42 and 33.39 %) were recorded with control (No irrigation) at harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest harvest index (38.66, 38.84 and 38.75 %) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. Lowest harvest index (38.61, 38.83 and 38.72 %) were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest harvest index (38.64, 38.66 and 38.65 %) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with the application of Pusa Hydrogel @ 7.5 Kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Lowest harvest index (34.89, 34.90 and 34.90 %) were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively.

3.4 Economics

3.4.1 Cost of cultivation (₹ ha^{-1})

Effect of irrigation scheduling

The data regarding to the cost of cultivation (₹ ha^{-1}) are presented in table-10. Cost of cultivation (₹ ha^{-1}) was influenced non-significantly due to irrigation scheduling after harvest during both the year of experimentation. Highest cost of cultivation (₹ 33423, 33423 and 33423 ha^{-1}) was recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) after harvest during first year, second year and pooled, respectively. Lowest cost of cultivation (₹ 30783, 30783 and 30783 ha^{-1}) was recorded with control (No irrigation) after harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest cost of cultivation (₹ 32042, 32042 and 32042 ha^{-1}) was recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) after harvest during first year, second year and pooled, respectively. Lowest cost of cultivation (₹ 31870, 31870 and 31870 ha^{-1}) was recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) after harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest cost of cultivation (₹ 33291, 33291 and 33291 ha^{-1}) was recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) followed by Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) and Pusa Hydrogel @ 2.5 Kg ha^{-1} (H_2) after harvest during first year, second year and pooled, respectively. Lowest cost of cultivation (₹ 30621, 30621 and 30621 ha^{-1}) was recorded with control (No hydrogel) after harvest during first year, second year and pooled, respectively.

3.4.2 Gross returns (₹ ha^{-1})

Effect of irrigation scheduling

The data regarding to the gross returns (₹ ha^{-1}) are presented in table-10. Gross returns (₹ ha^{-1}) were influenced significantly due to irrigation scheduling after harvest during both the year of experimentation. Highest gross returns (₹ 127444, 130134 and 128789 ha^{-1}) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) after harvest during first year, second year and pooled, respectively. Lowest gross returns (₹ 108103, 109976 and 109042 ha^{-1}) were recorded with control (No

irrigation) after harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest gross returns (₹ 123992, 126263 and 125127 ha^{-1}) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) after harvest during first year, second year and pooled, respectively. Lowest gross returns (₹ 118952, 121748 and 120350 ha^{-1}) were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) after harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest gross returns (₹ 130534, 132890 and 131712 ha^{-1}) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3). Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with Pusa Hydrogel @ 7.5 Kg ha^{-1} (H_3) after harvest during first year, second year and pooled, respectively. Lowest gross returns (₹ 115820, 117372 and 116596 ha^{-1}) was recorded with control (No hydrogel) after harvest during first year, second year and pooled, respectively.

3.4.3 Net returns (₹ ha^{-1})

Effect of irrigation scheduling

The data regarding to the net returns (₹ ha^{-1}) are presented in table-10. Net returns (₹ ha^{-1}) were influenced significantly due to irrigation scheduling after harvest during both the year of experimentation. Highest net returns (₹ 94021, 96711 and 95366 ha^{-1}) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) after harvest during first year, second year and pooled, respectively. Lowest net returns (₹ 77325, 79193 and 78259 ha^{-1}) were recorded with control (No irrigation) after harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest net returns (₹ 91950, 94221 and 93085 ha^{-1}) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) after harvest during first year, second year and pooled, respectively. Lowest net returns (₹ 87082, 89878 and 88480 ha^{-1}) were recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) after harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest net returns (₹ 97243, 99599 and 98421 ha^{-1}) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3). Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with Pusa Hydrogel @ 7.5 Kg ha^{-1} (H_3) after harvest during first year, second year and pooled, respectively. Lowest net returns (₹ 85199, 86751 and 85975 ha^{-1}) was recorded with control (No hydrogel) after harvest during first year, second year and pooled, respectively.

3.4.4 Net B: C ratio

Effect of irrigation scheduling

The data pertaining to the net B: C ratio is presented in table-10. Net B: C ratio was influenced significantly due to irrigation scheduling after harvest during both the year of experimentation. Highest net B: C ratio (2.81, 2.89 and 2.85) was recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) after harvest during first year, second year and pooled, respectively. Lowest net B: C ratio (2.51, 2.57 and 2.54) was recorded with control (No irrigation) after harvest during first year, second year and pooled, respectively.

Effect of nitrogen levels

Highest net B: C ratio (2.86, 2.94 and 2.90) was recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) after harvest during first year, second year and pooled, respectively. Lowest B: C ratio (2.73, 2.82 and 2.77) was recorded with the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) after harvest during first year, second year and pooled, respectively.

Effect of hydrogel levels

Highest net B: C ratio (2.92, 2.99 and 2.95) was recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3). It was also found at par with Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) after harvest during first year, second year and pooled, respectively. Lowest net B: C ratio (2.78, 2.83 and 2.80) was recorded with control (No hydrogel) after harvest during first year, second year and pooled, respectively.

4. Discussion

The experiment entitled **"**Effect of Irrigation scheduling, Nitrogen and Hydrogel on productivity and profitability of Barley (*Hordeum vulgare* L.)" was conducted to investigate the effect of irrigation scheduling, nitrogen and hydrogel levels mainly on growth, yield and quality of barley have been presented in the foregoing pages. An examination of the data recorded there in reveals several points of interest which are discussed here in conjunction with the findings of the other workers, It may be noted that in the present study the yield of grain showed, to a considerable extent, a positive correlation with the supplementary growth observations taken such as plant height, number of tillers per linear metre and dry matter accumulation; and it is felt that the assessment of experimental treatment effects by such supplementary data has been reasonably justified, In an experiment where the effects of time of irrigation, in particular, are to be examined, weather conditions are likely to influence the treatment effects, and hence variations in the meteorological data have also have been given due to consideration in this discussion. Grain yield is a multifaceted characteristic that is influenced by numerous traits. Agronomic techniques, fertility condition, environmental considerations, and other management techniques used both before and during experiments all have a significant impact on a crop's prospective yield. Irrigation scheduling, nitrogen and hydrogel levels are thought to be crucial elements in maximizing plant population. Significant difference in barley production and quality was noted during the experiment's results presentation as a result of several treatments. A review of the information provided therein turned up a number of noteworthy findings, which are examined here in conjunction with our own observations and the research of other experts. On the outset it may be pointed out that the performance of the barley crop was significantly better during 2021-22 as compared to that in 2022-23. It is felt that the climatic vicissitudes which prevailed during the two crop season were mainly responsible for this difference. It may be recalled that in the

first year, in general, growing period was some-what cooler with higher intensity of humidity as compared to that in the second year particularly in the juvenile stage which, it appears, might have helped reducing the moisture losses from the experimental area. The reduced loss of moisture in the first year appears to have benefitted the crop at later stages which becomes evident by lesser mortality of shoots recorded at advanced stages. In other words, the crop faced with lasses water stress conditions in the first year and hence crop performance, as judged by crop stand was superior in that year. It is well recognised that of the various meteorological parameters, temperature plays very vital role in the growth and physio - developmental activities of a plant. During the course of present study, it was observed that, on an average, the first year experienced comparatively lower quantum of temperature than that in the second on, particularly at the tillering phase. The low temperature, both minimum and maximum, at tillering stage coupled with high humidity at tillering and thereafter in the first year appear to be the main reason for better growth and development of the crop in that year. Another point worth mentioning is that the crop was sown 5 days earlier in the first year than in the second year. In spite of the early sowing, the crop matured latter than that in the second year. This clearly shown that due to prolonged growth period and better seed setting and more yield of the crop. Thus, when all the weather parameters are taken into consideration, it would prevail in the first years were mainly responsible for overall better performance of the crop in the year.

The two most economic characteristics of any crop are the grain and straw yields. In a study like this, the effects of irrigation treatments on them need special consideration. It may be pointed out that yield of a crop is dependent upon the yield per plant, and number of shoots present per unit area, while per plant yield is dependent upon number of ear bearing shoots and ear head characters such as spike length, number and weight of grains per spike and 1000-grnin weight. The data pertaining to the yield attributes *viz.*, Effective tillers m^{-2}, length of spike (cm), spikelet's $spike^{-1}$, no. of spike m^{-2}, no. of grains $spike^{-1}$, grain weight $spike^{-1}$ (g) and test weight (g) are presented in tables from 4.9 (a) and 4.9 (b) Effective tillers m^{-2} was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest effective tillers m^{-2} (305.95, 306.93 and 306.44) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in relative water content (%) with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 22.17%, 22.01% and 22.09%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Highest effective tillers m^{-2} (317.81, 318.74 and 318.27) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. Highest effective tillers m^{-2} (320.59, 321.14 and 320.56) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during both the year of study and pooled, respectively. The magnitude increment in effective tillers m^{-2} with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 25.51%, 20.90% and 24.12%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. It is due to higher availability of the nutrients in concern treatment. Attributes was rapid in this treatment due to sufficiency of the irrigation, nutrients and hydrogel available to the crop in association with other inputs *viz*., moisture, oxygen, solar radiation and space. These results are in agreement with the findings of Muhammad *et al*., (2022) [50], Yadav *et al.*, (2023) [82] and Abhishek *et al.*, (2024) [1]. Number of spike m^{-2} was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest number of spike m^{-2} (293.60, 294.60 and 294.05) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in number of spike m^{-2} with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 21.32%, 21.74% and 21.22%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Highest number of spike m^{-2} (300.16, 301.03 and 300.59) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in number of spike m^{-2} the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 04.58%, 04.62% and 04.60%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Highest number of spike m^{-2} (303.84, 304.26 and 304.05) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during both the year of study and pooled, respectively. The magnitude increment in number of spike m^{-2} with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 24.43%, 23.52% and 23.98%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Almost similar findings were also reported by Aslam *et al*., (2015) [8], Kauzegaran *et al*., (2015) [33], Mitra and Das (2015) [48], Hingonia *et al.*, (2016) [23], Mukherjee (2016) [49], Verma *et al.*, (2017) [81], Kaur *et al.*, (2018) [32], Ararssa *et al*., (2019) [7], Kaur *et al.*, (2019) [31], Khan *et al.*, (2020) [36], Upadhyay *et al.*, (2021) [79], Muhammad *et al*., (2022) [50], Yadav *et al.*, (2023) [82] and Abhishek *et al.*, (2024) [1]. Number of grains $spike^{-1}$ was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest number of grains $spike^{-1}$ (38.95, 39.36 and 39.15) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. Highest number of grains $spike^{-1}$ (40.88, 41.44 and 41.01) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in number of grains $spike^{-1}$ the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 08.69%, 08.77% and 08.75%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg

K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Highest number of grains spike^{-1} (41.83, 42.03 and 41.98) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) followed by Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) and Pusa Hydrogel @ 2.5 Kg ha^{-1} (H_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in number of grains spike^{-1} with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 15.13%, 11.75% and 13.55%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. It is due to higher availability of the nutrients in concern treatment. Attributes was rapid in this treatment due to sufficiency of the irrigation, nutrients and hydrogel available to the crop in association with other inputs *viz*., moisture, oxygen, solar radiation and space. These results are in agreement with the findings of Alazmani (2015) [5], Aleminew and Legas (2016) [6], Pankaj *et al*., (2017) [55], Puniya *et al*., (2018) [57], Ahmed and Hassan (2019) [4], Kassie and Tesfaye (2019) [30], Ullah *et al.,* (2019) [78], Khan *et al.,* (2020) [36], Upadhyay *et al.,* (2021) [79], Muhammad *et al*., (2022) [50]and Yadav *et al.,* (2023) [82]. Highest test weight (40.43, 40.64 and 40.53 g) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. Highest test weight (40.31, 40.90 and 40.60 g) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in test weight (g) the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 07.03%, 07.91% and 07.46%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Highest test weight (40.95, 41.03 and 40.99 g) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) followed by Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) and Pusa Hydrogel @ 2.5 Kg ha^{-1} (H_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in test weight (g) with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 06.17%, 05.58% and 05.88%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest test weight 38.57, 38.86 and 38.71 (g) were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively. Almost similar findings were also reported by Khan *et al.,* (2020) [36], Upadhyay *et al.,* (2021) [79], Muhammad *et al*., (2022) [50] and Yadav *et al.,* (2023) [82].

In the present study the best performance, both in respect of growth and yield contributing characters was obtained in plots irrigated at active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) stage. The highest grain and straw production with this irrigation at this stage may mainly be attributed to such overall improvements in growth behaviour and yield contributing characters. As expected, the next highest yield was obtained with the treatment, irrigation given at active tillering at 30-35 DAS stage. Here again, there existed a positive correlation amongst growth, yield-contributing characters and final grain yield. The data pertaining to the per hectare yield studies (q ha^{-1}) *viz.,* Biological yield (q ha^{-1}), grain yield (q ha^{-1}), straw yield (q ha^{-1}) and harvest index (%). Biological yield (q ha^{-1}) was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest biological yield (129.64, 130.26 and 129.95 q ha^{-1}) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in biological yield (q ha^{-1}) with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 11.97%, 12.04% and 12.00%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Highest biological yield (125.67, 125.72 and 125.69 q ha^{-1}) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in biological yield (q ha^{-1}) the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 04.18%, 03.46% and 03.82%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1). Highest biological yield (132.34, 132.87 and 132.60 q ha^{-1}) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) followed by Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) and Pusa Hydrogel @ 2.5 Kg ha^{-1} (H_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in biological yield (q ha^{-1}) with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 08.43%, 08.82% and 08.62%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. It is due to higher availability of the nutrients in concern treatment. Yield (q ha^{-1}) was rapid in this treatment due to sufficiency of the irrigation, nutrients and hydrogel available to the crop in association with other inputs *viz*., moisture, oxygen, solar radiation and space. These results are in agreement with the findings of Li *et al.,* (2010) [44], Ram *et al.,* (2011) [59], Bashir *et al.,* (2012), Khokhar *et al*., (2013), Shirazi *et al*., (2014) [69], Aslam *et al*., (2015) [8], Kauzegaran *et al*., (2015) [33], Mitra and Das (2015) [48], Hingonia *et al.,* (2016) [23], Mukherjee (2016) [49], Verma *et al.,* (2017) [81], Kaur *et al.,* (2018) [32], Ararssa *et al*., (2019) [7], Kaur *et al.,* (2019) [31], Choudhary *et al.,* (2020) [16], Julie (2021) [28], Kumawat *et al.,* (2022) [42], Choudhary *et al.,* (2023) [15] and Naser *et al.,* (2023) [52]. Grain yield (q ha^{-1}) was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest grain yield (49.66, 50.22 and 49.94 q ha^{-1}) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in grain yield (q ha^{-1}) with the application of active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) was tune of 28.51%, 29.23% and 28.87%, over control (No irrigation) at harvest during first year, second year and pooled, respectively. Highest grain yield (48.59, 48.84 and 48.71 q ha^{-1}) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in grain yield (q ha^{-1}) the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 04.31%, 03.49% and 03.90%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1) at harvest during first year, second year and pooled, respectively. Highest grain yield (51.13, 51.37 and

51.25 q ha^{-1}) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) followed by Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) and Pusa Hydrogel @ 2.5 Kg ha^{-1} (H_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in grain yield (q ha^{-1}) with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 20.05%, 20.53% and 20.30%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Lowest grain yield (42.59, 42.62 and 42.60 q ha^{-1}) were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively. Grain yield (q ha^{-1}) was rapid in this treatment due to sufficiency of the irrigation, nutrients and hydrogel available to the crop in association with other inputs *viz*., moisture, oxygen, solar radiation and space. Almost similar findings were also reported by Sharma and Verma (2010) [67], Shafi *et al*., (2011) [64], Meena *et al*., (2012) [47], Wang *et al*., (2012), Fazal *et al*., (2013) [22], Massoudifar *et al*., (2013) [46], Singh *et al*., (2013) [70], Aghdam and Samadiyan (2014) [3], Shirazi *et al*., (2014) [69], Alazmani (2015) [5], Aleminew and Legas (2016) [6], Pankaj *et al*., (2017) [55], Puniya *et al*., (2018) [57], Ahmed and Hassan (2019) [4], Kassie and Tesfaye (2019) [30], Ullah *et al*., (2019) [78], Khan *et al*., (2020) [36], Upadhyay *et al*., (2021) [79], Muhammad *et al*., (2022) [50] and Yadav *et al*., (2023) [82]. Straw yield (q ha^{-1}) was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest straw yield (79.98, 80.04 and 80.01 q ha^{-1}) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. Highest straw yield (77.08, 77.10 and 77.09 q ha^{-1}) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. The magnitude increment in straw yield (q ha^{-1}) the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) was tune of 04.10%, 03.74% and 03.77%, over the application of 75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_1). Highest straw yield (81.21, 81.50 and 81.35 q ha^{-1}) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) followed by Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) and Pusa Hydrogel @ 2.5 Kg ha^{-1} (H_1) at harvest during first year, second year and pooled, respectively. The magnitude increment in straw yield (q ha^{-1}) with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) was tune of 02.20%, 02.54% and 02.36%, over control (No hydrogel) at harvest during first year, second year and pooled, respectively. Harvest index (%) was influenced significantly due to irrigation scheduling at harvest during both the year of experimentation. Highest harvest index (38.30, 38.55 and 38.42 %) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1) at harvest during first year, second year and pooled, respectively. Highest harvest index (38.66, 38.84 and 38.75 %) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) at harvest during first year, second year and pooled, respectively. Highest harvest index (38.64, 38.66 and 38.65 %) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with the application of Pusa Hydrogel @ 7.5 Kg ha^{-1} (H_3) at harvest during first year, second year and pooled, respectively. Lowest harvest index (34.89, 34.90 and 34.90 %) were recorded with control (No hydrogel) at harvest during first year, second year and pooled, respectively. Harvest index (%) was rapid in this treatment due to sufficiency of the irrigation, nutrients and hydrogel available to the crop in association with other inputs *viz*., moisture, oxygen, solar radiation and space. Almost similar findings were also reported by Nazarli *et al*., (2010) [53], Ezzat *et al*., (2011) [21], Khadem *et al*., (2011) [35], Lakshami (2011) [43], Rehman *et al*., (2011) [60], Agaba *et al*., (2012) [2], Malekian *et al*., (2012) [45], Barihi *et al*., (2013) [9], Dabhi *et al*., (2013) [17], Jalilian and Mohsennia (2013) [26], Rostampour (2013) [61], Waly *et al*., (2013), Tyagi *et al*., (2015) [77], Roy *et al*., (2019) [62], Shikha *et al*., (2019) [68] and Shankarappa *et al*., (2020) [65].

The economic assessment of treatments within agronomic crop research holds paramount significance in determining their feasibility. In contemporary agriculture, prioritizing maximal profit has superseded the quest for maximum yield. Evaluating diverse treatments hinges primarily on their economic sustainability. This evaluation encompasses cost of cultivation, gross returns, net returns and the benefit-to-cost ratio on a per-hectare basis. The economics has been expressed in terms of cost of cultivation (₹ ha^{-1}), gross returns (₹ ha^{-1}), net returns (₹ ha^{-1}) and B: C ratio as influenced by different treatments of this investigation has been presented in table-11. Cost of cultivation (₹ ha^{-1}) was influenced non-significantly due to irrigation scheduling after harvest during both the year of experimentation. Highest cost of cultivation (₹ 33423, 33423 and 33423 ha^{-1}) was recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1), Highest cost of cultivation (₹ 32042, 32042 and 32042 ha^{-1}) was recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2), Highest cost of cultivation (₹ 33291, 33291 and 33291 ha^{-1}) was recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3) followed by Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) and Pusa Hydrogel @ 2.5 Kg ha^{-1} (H_2) after harvest during first year, second year and pooled, respectively. Almost similar findings were also reported by Singh (2017) [74], Choudhary *et al*., (2018) [14], Kaur *et al*., (2018) [32], Puniya *et al*., (2018) [57], Kumar *et al*., (2019) [31], Kaur *et al*., (2019) [31], Prasad *et al*., (2019) [58], Kumar *et al*., (2020) [72], Singh *et al*., (2020) [65] (a), Singh *et al*., (2020) [65] (b), Jat *et al*., (2021) [27], Sunag *et al*., (2021) [75], Kavita *et al*., (2022) [34], Kishor *et al*., (2022) [38] and Karol *et al*., (2023) [29]. Gross returns (₹ ha^{-1}) were influenced significantly due to irrigation scheduling after harvest during both the year of experimentation. Highest gross returns (₹ 127444, 130134 and 128789 ha^{-1}) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1), Highest gross returns (₹ 123992, 126263 and 125127 ha^{-1}) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2), Highest gross returns (₹ 130534, 132890 and 131712 ha^{-1}) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3). Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with Pusa Hydrogel @ 7.5 Kg ha^{-1} (H_3) after harvest during first year, second year and pooled, respectively. Net returns (₹ ha^{-1}) were influenced significantly due to irrigation scheduling after harvest during both the year of

experimentation. Highest net returns (₹ 94021, 96711 and 95366 ha^{-1}) were recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1), Highest net returns (₹ 91950, 94221 and 93085 ha^{-1}) were recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2) after harvest during first year, second year and pooled, respectively. Highest net returns (₹ 97243, 99599 and 98421 ha^{-1}) were recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3). Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) was found at par with Pusa Hydrogel @ 7.5 Kg ha^{-1} (H_3) after harvest during first year, second year and pooled, respectively. Almost similar findings were also reported by Meena *et al*., (2012) [47], Jai *et al.,* (2015) [25], Mitra and Das (2015) [48], Singh *et al.,* (2015) [25], Kumar *et al.,* (2016) [23], Mukherjee (2016) [49], Tomar *et al.,* (2016) [76], Neelam *et al.,* (2017) [54], Singh (2017) [74], Choudhary *et al.,* (2018) [14], Kaur *et al.,* (2018) [32], Puniya *et al*., (2018) [57], Kumar *et al.,* (2019) [31], Kaur *et al.,* (2019) [31], Prasad *et al.,* (2019) [58], Kumar *et al.,* (2020) [72], Singh *et al.,* (2020) (a), Singh *et al.,* (2020) [65] (b), Jat *et al.,* (2021) [27], Sunag *et al.,* (2021) [75], Kavita *et al.,* (2022) [34], Kishor *et al.,* (2022) [38] and Karol *et al.,* (2023) [29]. Net B: C ratio was influenced significantly due to irrigation scheduling after harvest during both the year of experimentation. Highest net B: C ratio (2.81, 2.89 and 2.85) was recorded with active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS (I_2) followed by active tillering at 30-35 DAS (I_1), Highest net B: C ratio (2.86, 2.94 and 2.90) was recorded with the application of 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) (N_2), Highest net B: C ratio (2.92, 2.99 and 2.95) was recorded with the application of Pusa Hydrogel @ 7.5 kg ha^{-1} (H_3). It was also found at par with Pusa Hydrogel @ 5.0 Kg ha^{-1} (H_2) after harvest during first year, second year and pooled, respectively. Lowest net B: C ratio (2.78, 2.83 and 2.80) was recorded with control (No hydrogel) after harvest during first year, second year and pooled, respectively. Almost similar findings were also reported by Meena *et al*., (2012) [47], Jai *et al.,* (2015) [25], Mitra and Das (2015) [48], Singh *et al.,* (2015) [25], Kumar *et al.,* (2016) [23], Mukherjee (2016) [49], Tomar *et al.,* (2016) [76], Neelam *et al.,* (2017) [54], Singh (2017) [74], Choudhary *et al.,* (2018) [14], Kaur *et al.,* (2018) [32], Puniya *et al*., (2018) [57], Kumar *et al.,* (2019) [31], Kaur *et al.,* (2019) [31], Prasad *et al.,* (2019) [58], Kumar *et al.,* (2020) [72], Singh *et al.,* (2020) (a), Singh *et al.,* (2020) [65] (b), Jat *et al.,* (2021) [27], Sunag *et al.,* (2021) [75], Kavita *et al.,* (2022) [34], Kishor *et al.,* (2022) [38] and Karol *et al.,* (2023) [29].

Table 2: Germination count at 15 DAS and crop stand metre^{-1} row length of barley as influenced by Irrigation scheduling, Nitrogen levels and hydrogel levels of crop growth

Treatments	Notations	Germination count			Crop stand metre^{-1} row length											
		15 DAS			30 DAS			60 DAS			90 DAS			At harvest		
		2021-22	2022-23	Pooled	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	29.56	30.26	29.91	31.94	32.31	32.12	53.20	54.31	53.75	81.29	81.84	81.56	79.91	80.58	80.24
Active tillering at 30-35 DAS	I_1	30.07	30.98	30.52	34.81	35.56	35.18	58.63	59.14	58.88	85.69	86.07	85.88	83.47	84.88	84.17
Active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS	I_2	31.65	32.42	32.03	36.76	37.62	37.19	62.03	63.10	62.11	93.36	94.21	93.78	94.36	94.92	94.64
SE(m)±		0.64	0.68	0.66	0.65	0.69	0.67	1.16	1.31	1.23	1.30	1.37	1.33	1.20	1.42	1.31
C.D. (P = 0.05)		NS	NS	NS	1.79	1.86	1.82	3.45	3.98	3.71	4.07	4.20	4.13	3.47	4.23	3.85
B. Sub plot- Nitrogen levels - 02																
75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_1	30.71	31.09	30.90	32.41	32.82	32.61	62.03	63.17	62.60	85.68	86.17	85.92	85.14	85.79	85.46
100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_2	31.88	32.86	32.37	37.52	38.06	37.79	66.94	67.58	67.26	94.04	95.21	94.62	93.81	94.35	94.08
SE(m)±		0.69	0.74	0.71	0.72	0.76	0.74	1.65	1.67	1.66	1.92	1.95	1.93	1.71	1.75	1.73
C.D. (P = 0.05)		NS	NS	NS	2.12	2.26	2.19	4.92	4.98	4.95	5.78	5.93	5.85	5.12	5.26	5.19
C. Sub-sub plot: Hydrogel levels - 04																
Control (No Hydrogel)	H_0	29.18	30.03	29.60	33.20	33.71	33.45	56.90	57.36	57.13	85.78	86.21	85.99	85.32	85.94	85.63
Pusa Hydrogel @ 2.5 Kg ha^{-1}	H_1	30.66	31.72	31.19	35.24	36.09	35.66	59.17	60.38	59.77	91.06	91.89	91.47	90.89	91.21	91.00
Pusa Hydrogel @ 5.0 Kg ha^{-1}	H_2	31.05	32.14	31.59	36.13	37.16	36.64	64.58	65.63	65.10	92.83	93.36	93.09	92.14	92.96	92.55
Pusa Hydrogel @ 7.5 kg ha^{-1}	H_3	31.94	32.88	32.41	37.98	38.55	38.26	67.71	68.59	68.15	98.37	99.47	98.92	97.89	98.74	98.31
SE(m)±		0.71	0.78	0.74	0.28	0.33	0.30	0.71	0.80	0.75	1.87	1.93	1.90	1.88	1.91	1.89
C.D. (P = 0.05)		NS	NS	NS	0.83	0.98	0.90	2.09	2.41	2.25	5.58	6.11	5.84	5.63	5.72	5.67

Table 3: Plant height (cm) of barley as influenced by Irrigation scheduling, Nitrogen levels and hydrogel levels of crop growth

Treatments	Notations	Plant height (cm)											
		30 DAS			60 DAS			90 DAS			At harvest		
		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	16.72	16.95	16.83	44.02	44.38	44.20	68.16	68.67	68.41	68.14	68.78	68.46
Active tillering at 30-35 DAS	I_1	17.06	17.83	17.44	46.14	46.65	46.39	70.28	71.81	71.04	71.03	71.67	71.35
Active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS	I_2	17.81	18.12	17.96	47.23	48.09	47.66	74.41	75.12	74.76	74.21	74.92	74.56
SE(m)±		0.42	0.46	0.44	0.61	0.65	0.63	0.69	0.76	0.72	0.92	1.01	0.96
C.D. (P = 0.05)		NS	NS	NS	1.82	1.93	1.87	2.06	2.24	2.15	2.72	2.97	2.84
B. Sub plot- Nitrogen levels - 02													
75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_1	17.85	18.13	17.99	46.17	46.78	46.47	74.38	74.91	74.64	74.11	74.81	74.46

100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_2	18.03	19.22	18.62	48.05	48.89	48.47	76.17	77.02	76.59	78.46	78.22	78.34
SE(m)±		0.40	0.43	0.41	0.63	0.66	0.64	0.67	0.72	0.69	1.02	1.07	1.04
C.D. (P = 0.05)		NS	NS	NS	1.84	2.03	1.93	1.97	2.14	2.05	3.02	3.16	3.09
C. Sub-sub plot: Hydrogel levels - 04													
Control (No Hydrogel)	H_0	17.04	17.92	17.48	45.03	45.56	45.29	71.19	71.68	71.43	71.12	71.63	71.37
Pusa Hydrogel @ 2.5 Kg ha^{-1}	H_1	17.83	18.14	17.98	46.21	47.71	46.96	74.23	74.82	74.52	74.07	74.84	74.45
Pusa Hydrogel @ 5.0 Kg ha^{-1}	H_2	18.26	19.29	18.77	48.06	48.92	48.49	76.12	76.79	76.45	76.39	77.12	76.75
Pusa Hydrogel @ 7.5 kg ha^{-1}	H_3	19.17	20.21	19.69	49.14	49.78	49.46	77.26	78.31	77.78	78.41	79.18	78.79
SE(m)±		0.37	0.39	0.38	0.39	0.43	0.41	0.49	0.59	0.54	0.69	0.70	0.69
C.D. (P = 0.05)		NS	NS	NS	1.12	1.18	1.15	1.42	1.65	1.54	2.02	2.06	2.04

Table 4 (a): Dry matter accumulation (fresh weight, g) of 25 cm row length of barley as influenced by Irrigation scheduling, Nitrogen levels and hydrogel levels of crop growth

Treatments	Notations	Dry matter accumulation (fresh weight, g) of 25 cm row length											
		30 DAS			60 DAS			90 DAS			At harvest		
		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	23.91	24.67	24.29	42.20	43.61	42.90	107.81	110.86	109.33	276.90	279.26	278.08
Active tillering at 30-35 DAS	I_1	26.56	27.86	27.21	52.42	54.70	53.56	125.62	128.20	126.91	290.36	293.56	291.96
Active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS	I_2	30.70	33.54	32.12	56.51	60.34	58.42	145.90	151.30	148.60	305.10	309.94	307.52
SE(m)±		0.47	0.57	0.52	1.43	1.92	1.68	2.62	2.75	2.68	3.14	3.39	3.26
C.D. (P = 0.05)		1.38	1.72	1.55	4.26	5.70	4.98	7.87	8.23	8.05	9.36	10.16	9.76
B. Sub plot- Nitrogen levels - 02													
75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_1	30.82	33.63	32.22	54.45	55.88	55.16	140.16	143.40	141.78	296.86	313.21	305.03
100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_2	37.28	42.51	39.89	63.55	65.80	64.67	153.98	160.92	157.45	310.41	327.14	318.77
SE(m)±		1.46	1.85	1.65	2.15	2.62	2.38	2.65	2.87	2.76	3.29	3.70	3.49
C.D. (P = 0.05)		4.33	5.51	4.92	6.41	7.88	7.14	7.90	8.62	8.26	9.82	11.12	10.47
C. Sub-sub plot: Hydrogel levels - 04													
Control (No Hydrogel)	H_0	24.86	27.35	26.10	41.85	47.06	44.45	134.05	138.28	136.16	283.21	286.66	284.93
Pusa Hydrogel @ 2.5 Kg ha^{-1}	H_1	30.22	34.62	32.42	50.50	53.73	52.11	140.80	144.60	142.70	294.80	296.18	295.49
Pusa Hydrogel @ 5.0 Kg ha^{-1}	H_2	36.12	39.73	37.92	52.12	56.14	54.13	147.87	150.88	149.37	304.23	308.29	306.26
Pusa Hydrogel @ 7.5 kg ha^{-1}	H_3	39.40	42.51	40.95	54.50	59.16	56.83	154.40	159.40	156.90	312.46	319.20	315.83
SE(m)±		0.88	0.93	0.90	0.80	1.05	0.92	1.89	1.95	1.92	2.51	2.75	2.63
C.D. (P = 0.05)		2.62	2.75	2.68	2.38	3.09	2.73	5.61	5.74	5.67	7.50	8.23	7.86

Table 4 (b): Dry matter accumulation (dry weight, g) of 25 cm row length of barley as influenced by Irrigation scheduling, Nitrogen levels and hydrogel levels of crop growth

Treatments	Notations	Dry matter accumulation (dry weight, g) of 25 cm row length											
		30 DAS			60 DAS			90 DAS			At harvest		
		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	7.94	8.28	8.11	16.86	17.41	17.13	50.14	51.61	50.87	130.61	131.72	131.16
Active tillering at 30-35 DAS	I_1	8.86	9.32	9.09	20.92	21.63	21.27	58.20	59.54	58.87	136.60	137.82	137.28
Active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS	I_2	10.20	11.22	10.71	22.52	23.74	23.13	66.32	68.81	67.56	142.53	144.16	143.34
SE(m)±		0.29	0.33	0.31	0.92	1.02	0.97	1.73	1.90	1.81	1.96	2.02	1.99
C.D. (P = 0.05)		0.88	1.02	0.95	2.72	3.10	2.91	5.16	5.72	5.44	5.91	6.01	5.96
B. Sub plot- Nitrogen levels - 02													
75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_1	10.26	11.31	10.78	20.54	21.35	20.94	62.29	63.44	62.86	138.13	139.20	138.66
100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_2	12.14	14.43	13.28	23.71	24.83	24.27	68.13	71.52	69.82	143.62	144.75	144.18
SE(m)±		0.55	0.67	0.61	1.08	1.16	1.12	1.69	2.01	1.85	1.80	1.85	1.82
C.D. (P = 0.05)		1.61	1.92	1.76	3.19	3.48	3.33	5.15	6.07	5.61	5.40	5.52	5.46
C. Sub-sub plot: Hydrogel levels - 04													
Control (No Hydrogel)	H_0	8.32	9.36	8.84	19.01	21.13	20.07	62.34	64.01	63.17	134.23	135.52	134.87
Pusa Hydrogel @ 2.5 Kg ha^{-1}	H_1	10.21	11.54	10.87	21.04	22.64	21.84	65.17	66.88	66.02	138.07	139.40	138.73
Pusa Hydrogel @ 5.0 Kg ha^{-1}	H_2	12.09	13.56	12.82	22.36	25.02	23.69	68.14	70.91	69.52	142.16	143.34	142.75
Pusa Hydrogel @ 7.5 kg ha^{-1}	H_3	13.24	14.72	13.98	24.12	26.37	25.24	70.83	72.64	71.73	145.71	146.86	146.28
SE(m)±		0.33	0.38	0.35	0.42	0.43	0.42	0.89	0.94	0.91	1.22	1.25	1.22
C.D. (P = 0.05)		1.02	1.10	1.06	1.25	1.28	1.26	2.70	2.81	2.75	3.61	3.74	3.67

Table 5: Leaf area index (%) of barley as influenced by Irrigation scheduling, Nitrogen levels and hydrogel levels of crop growth

Treatments	Notations	Leaf area index (%)											
		30 DAS			60 DAS			90 DAS			At harvest		
		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	1.39	1.40	1.39	3.70	3.74	3.72	4.10	4.12	4.11	4.16	4.17	4.16

Active tillering at 30-35 DAS	I_1	1.44	1.45	1.44	3.82	3.87	3.84	4.25	4.34	4.29	4.32	4.42	4.37
Active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS	I_2	1.46	1.47	1.46	3.99	4.05	4.02	4.50	4.55	4.52	4.57	4.59	4.58
SE(m)±		0.02	0.02	0.02	0.09	0.10	0.09	0.14	0.15	0.15	0.14	0.15	0.14
C.D. (P = 0.05)		NS	NS	NS	0.28	0.30	0.29	0.39	0.42	0.40	0.40	0.41	0.41
B. Sub plot- Nitrogen levels - 02													
75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_1	1.44	1.45	1.44	3.86	3.87	3.86	4.25	4.36	4.30	4.33	4.47	4.40
100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_2	1.46	1.47	1.46	3.99	4.06	3.86	4.51	4.52	4.51	4.57	4.58	4.58
SE(m)±		0.02	0.02	0.02	0.09	0.11	0.10	0.13	0.14	0.13	0.14	0.16	0.15
C.D. (P = 0.05)		NS	NS	NS	0.29	0.31	0.30	0.40	0.41	0.41	0.40	0.42	0.41
C. Sub-sub plot: Hydrogel levels - 04													
Control (No Hydrogel)	H_0	1.39	1.40	1.39	3.35	3.36	3.35	3.85	3.86	3.85	3.90	3.92	3.91
Pusa Hydrogel @ 2.5 Kg ha^{-1}	H_1	1.47	1.48	1.47	3.61	3.75	3.68	4.25	4.27	4.26	4.25	4.27	4.26
Pusa Hydrogel @ 5.0 Kg ha^{-1}	H_2	1.49	1.50	1.49	3.77	3.83	3.80	4.34	4.37	4.31	4.42	4.48	4.45
Pusa Hydrogel @ 7.5 kg ha^{-1}	H_3	1.50	1.52	1.51	3.99	4.03	4.01	4.55	4.58	4.56	4.64	4.65	4.65
SE(m)±		0.02	0.03	0.03	0.08	0.09	0.08	0.09	0.11	0.10	0.12	0.13	0.13
C.D. (P = 0.05)		NS	NS	NS	0.25	0.26	0.25	0.28	0.30	0.29	0.36	0.37	0.37

Table 6: Crop growth rate (g/m^2/day) of barley as influenced by Irrigation scheduling, Nitrogen levels and hydrogel levels of crop growth]

Treatments	**Notations**	**Crop growth rate (g/m^2/day)**								
		30-60 DAS			60-90 DAS			**90-At harvest**		
		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	9.64	9.73	9.69	7.10	7.16	7.13	3.47	3.54	3.50
Active tillering at 30-35 DAS	I_1	10.06	10.08	10.07	7.26	7.32	7.29	3.61	3.69	3.65
Active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS	I_2	10.10	10.11	10.11	7.80	7.86	7.83	3.98	4.05	4.01
SE(m)±		0.23	0.24	0.24	0.24	0.24	0.24	0.17	0.18	0.17
C.D. (P = 0.05)		NS	NS	NS	0.67	0.69	0.68	0.48	0.49	0.48
B. Sub plot- Nitrogen levels - 02										
75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_1	10.07	10.09	10.08	7.29	7.34	7.31	3.34	3.35	3.34
100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_2	10.11	10.12	10.12	7.81	7.83	8.32	3.99	4.02	4.00
SE(m)±		0.24	0.24	0.24	0.20	0.22	0.21	0.21	0.23	0.22
C.D. (P = 0.05)		NS	NS	NS	0.63	0.66	0.64	0.65	0.67	0.66
C. Sub-sub plot: Hydrogel levels - 04										
Control (No Hydrogel)	H_0	9.23	9.27	9.25	6.91	6.98	6.94	2.96	2.99	2.97
Pusa Hydrogel @ 2.5 Kg ha^{-1}	H_1	9.89	9.93	9.91	7.26	7.30	7.28	3.12	3.18	3.15
Pusa Hydrogel @ 5.0 Kg ha^{-1}	H_2	10.05	10.08	10.06	7.71	7.75	7.73	3.64	3.71	3.68
Pusa Hydrogel @ 7.5 kg ha^{-1}	H_3	10.11	10.12	10.12	7.85	7.87	7.86	3.99	4.04	4.01
SE(m)±		0.22	0.23	0.23	0.22	0.23	0.22	0.24	0.26	0.25
C.D. (P = 0.05)		NS	NS	NS	0.65	0.66	0.65	0.71	0.75	0.73

Table 7: Relative growth rate (mg/g/day) of barley as influenced by Irrigation scheduling, Nitrogen levels and hydrogel levels of crop growth

Treatments	**Notations**	**Relative growth rate (mg/g/day)**								
		30-60 DAS			60-90 DAS			90-At harvest		
		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	65.02	65.04	65.03	19.89	19.94	19.91	4.85	4.28	4.91
Active tillering at 30-35 DAS	I_1	65.08	65.13	65.10	20.08	20.16	20.12	5.62	5.64	5.63
Active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS	I_2	65.15	65.20	65.17	20.40	20.72	20.56	5.94	5.98	5.96
SE(m)±		1.23	1.31	1.27	0.54	0.57	0.55	0.20	0.21	0.21
C.D. (P = 0.05)		NS	NS	NS	NS	NS	NS	0.61	0.64	0.63
B. Sub plot- Nitrogen levels - 02										
75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_1	65.95	66.41	66.18	20.19	20.23	20.21	5.16	5.20	5.17
100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_2	66.20	66.63	66.41	20.46	20.51	20.48	5.87	5.89	5.88
SE(m)±		1.15	1.25	1.20	0.61	0.63	0.62	0.25	0.26	0.26
C.D. (P = 0.05)		NS	NS	NS	NS	NS	NS	0.72	0.76	0.74
C. Sub-sub plot: Hydrogel levels - 04										
Control (No Hydrogel)	H_0	65.62	65.79	65.70	19.74	19.79	19.76	4.02	4.06	4.04
Pusa Hydrogel @ 2.5 Kg ha^{-1}	H_1	65.94	65.99	65.97	19.92	19.96	19.94	4.70	4.80	4.75
Pusa Hydrogel @ 5.0 Kg ha^{-1}	H_2	66.32	66.65	66.33	20.21	20.24	20.23	5.43	5.45	5.44
Pusa Hydrogel @ 7.5 kg ha^{-1}	H_3	66.65	66.72	66.43	20.61	20.73	20.67	5.96	5.99	5.97
SE(m)±		0.98	0.99	0.98	0.56	0.58	0.57	0.22	0.23	0.23
C.D. (P = 0.05)		NS	NS	NS	NS	NS	NS	0.65	0.67	0.66

Table 8 (a): Yield attributes of barley as influenced by Irrigation scheduling, Nitrogen levels and hydrogel levels

Treatments	Notations	Yield attributes											
		Effective tillers m^{-2}			Length of spike (cm)			Spikelet's $spike^{-1}$			No. of spike m^{-2}		
		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	250.42	251.56	250.99	5.57	5.64	5.60	15.02	15.53	15.27	242.00	243.12	242.56
Active tillering at 30-35 DAS	I_1	280.17	281.63	280.90	7.32	7.35	7.33	20.12	20.64	20.38	270.42	271.48	270.95
Active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS	I_2	305.95	306.93	306.44	8.34	8.68	8.51	23.26	23.84	23.55	293.60	294.60	294.05
SE(m)±		0.92	1.11	1.01	0.25	0.29	0.27	0.35	0.37	0.36	1.03	1.05	1.04
C.D. (P = 0.05)		2.80	3.41	3.10	0.73	0.84	0.78	1.08	1.10	1.09	3.02	3.10	3.06
B. Sub plot- Nitrogen levels - 02													
75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_1	300.08	303.93	302.00	6.87	6.97	6.92	20.14	20.34	20.24	287.00	287.71	287.35
100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_2	317.81	318.74	318.27	8.30	8.41	8.35	24.72	24.91	24.81	300.16	301.03	300.59
SE(m)±		1.37	1.43	1.40	0.14	0.15	0.14	0.48	0.51	0.49	0.99	1.02	1.00
C.D. (P = 0.05)		4.09	4.26	4.17	0.40	0.43	0.41	1.44	1.52	1.48	2.98	3.04	3.01
C. Sub-sub plot: Hydrogel levels - 04													
Control (No Hydrogel)	H_0	255.41	261.09	258.25	5.99	6.02	6.00	15.16	15.30	15.23	244.17	246.32	245.24
Pusa Hydrogel @ 2.5 Kg ha^{-1}	H_1	300.75	300.84	300.75	6.50	6.83	6.66	21.73	21.92	21.82	283.67	284.63	284.15
Pusa Hydrogel @ 5.0 Kg ha^{-1}	H_2	315.12	315.68	315.40	7.91	8.06	7.98	23.34	23.53	23.43	297.14	298.25	297.69
Pusa Hydrogel @ 7.5 kg ha^{-1}	H_3	320.59	321.14	320.56	8.60	8.81	8.70	25.00	25.68	25.34	303.84	304.26	304.05
SE(m)±		2.10	2.19	2.14	0.24	0.26	0.25	0.52	0.53	0.52	2.13	2.18	2.15
C.D. (P = 0.05)		6.32	6.54	6.43	0.69	0.75	0.72	1.54	1.57	1.55	6.70	6.76	6.43

Table 8 (b): Yield attributes of barley as influenced by Irrigation scheduling, Nitrogen levels and hydrogel levels

Treatments	Notations	Yield attributes								
		No. of grains $spike^{-1}$			Grain weight $spike^{-1}$ (g)			**Test weight (g)**		
		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	35.98	36.32	36.15	2.43	2.51	2.47	37.80	38.03	37.91
Active tillering at 30-35 DAS	I_1	37.53	37.90	37.71	3.81	3.89	3.85	39.56	39.71	39.63
Active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS	I_2	38.95	39.36	39.15	4.15	4.25	4.20	40.43	40.64	40.53
SE(m)±		0.46	0.48	0.47	0.11	0.12	0.12	0.26	0.29	0.27
C.D. (P = 0.05)		1.38	1.42	1.40	0.30	0.35	0.32	0.79	0.85	0.82
B. Sub plot- Nitrogen levels - 02										
75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_1	37.61	37.82	37.71	3.02	3.16	3.09	37.66	37.90	37.78
100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_2	40.88	41.14	41.01	3.34	3.51	3.42	40.31	40.90	40.60
SE(m)±		0.42	0.44	0.43	0.11	0.12	0.11	0.20	0.22	0.21
C.D. (P = 0.05)		1.24	1.29	1.26	0.30	0.33	0.31	0.61	0.65	0.63
C. Sub-sub plot: Hydrogel levels - 04										
Control (No Hydrogel)	H_0	36.33	37.61	36.97	2.46	2.48	2.47	38.57	38.86	38.71
Pusa Hydrogel @ 2.5 Kg ha^{-1}	H_1	38.83	39.58	39.20	2.60	2.72	2.66	39.06	40.26	39.66
Pusa Hydrogel @ 5.0 Kg ha^{-1}	H_2	39.52	40.44	39.98	3.12	3.63	3.37	39.68	39.93	39.80
Pusa Hydrogel @ 7.5 kg ha^{-1}	H_3	41.83	42.03	41.98	3.95	4.26	4.10	40.95	41.03	40.99
SE(m)±		0.22	0.24	0.23	0.17	0.20	0.18	0.19	0.22	0.20
C.D. (P = 0.05)		0.65	0.72	0.68	0.51	0.59	0.55	0.59	0.65	0.62

Table 9: Yield studies (q ha^{-1}) of barley as influenced by Irrigation scheduling, Nitrogen levels and hydrogel levels

Treatments	Notations	Yield studies											
		Biological yield (q ha^{-1})			Grain yield (q ha^{-1})			Straw yield (q ha^{-1})			Harvest index (%)		
		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	115.78	116.26	116.02	38.64	38.86	38.75	77.14	77.40	77.27	33.37	33.42	33.39
Active tillering at 30-35 DAS	I_1	122.91	123.43	123.17	43.29	44.20	43.74	79.62	79.23	79.42	35.22	35.80	35.51
Active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS	I_2	129.64	130.26	129.95	49.66	50.22	49.94	79.98	80.04	80.01	38.30	38.55	38.42
SE(m)±		0.62	0.64	0.63	0.43	0.46	0.44	0.12	0.24	0.18	0.14	0.16	0.15
C.D. (P = 0.05)		1.84	1.93	1.88	1.29	1.35	1.32	0.34	0.70	0.52	0.41	0.47	0.44
B. Sub plot- Nitrogen levels - 02													
75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_1	120.62	121.51	121.06	46.58	47.19	46.88	74.04	74.32	74.18	38.61	38.83	38.72
100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_2	125.67	125.72	125.69	48.59	48.84	48.71	77.08	77.10	77.09	38.66	38.84	38.75
SE(m)±		0.34	0.37	0.35	0.32	0.34	0.33	0.11	0.14	0.12	0.13	0.15	0.14
C.D. (P = 0.05)		1.01	1.12	1.06	0.96	0.99	0.97	0.32	0.39	0.35	0.40	0.44	0.42
C. Sub-sub plot: Hydrogel levels - 04													

Control (No Hydrogel)	H_0	122.05	122.10	122.07	42.59	42.62	42.60	79.46	79.48	79.47	34.89	34.90	34.90
Pusa Hydrogel @ 2.5 Kg ha^{-1}	H_1	123.76	124.43	124.09	43.76	44.21	43.98	80.00	80.22	80.11	35.36	35.53	35.44
Pusa Hydrogel @ 5.0 Kg ha^{-1}	H_2	130.14	130.34	130.24	49.61	49.79	49.70	80.53	80.55	80.54	38.12	38.20	38.16
Pusa Hydrogel @ 7.5 kg ha^{-1}	H_3	132.34	132.87	132.60	51.13	51.37	51.25	81.21	81.50	81.35	38.64	38.66	38.65
SE(m)±		0.53	0.56	0.54	0.55	0.55	0.55	0.10	0.11	0.10	0.20	0.29	0.24
C.D. (P = 0.05)		1.56	1.67	1.61	1.62	1.69	1.65	0.30	0.31	0.30	0.59	0.84	0.71

Table 10: Economics & Net B: C ratio of barley as influenced by Irrigation scheduling, Nitrogen levels and hydrogel levels of crop growth

Treatments	Notations	Economics (₹ ha^{-1}) & Net B: C ratio											
		Cost of cultivation			Gross returns (₹ ha^{-1})			Net returns (₹ ha^{-1})			Net B: C ratio		
		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	30783	30783	30783	108108	109976	109042	77325	79193	78259	2.51	2.57	2.54
Active tillering at 30-35 DAS	I_1	31663	31663	31663	117036	119805	118420	85373	88142	86757	2.69	2.78	2.73
Active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS	I_2	33423	33423	33423	127444	130134	128789	94021	96711	95366	2.81	2.89	2.85
SE(m)±		-	-	-	2779	3154	2966	2676	2833	2755	0.03	0.04	0.03
C.D. (P = 0.05)		-	-	-	8326	9451	8889	8029	8498	8263	0.08	0.10	0.09
B. Sub plot- Nitrogen levels - 02													
75% RDN (45 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_1	31870	31870	31870	118952	121748	120350	87082	89878	88480	2.73	2.82	2.77
100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O)	N_2	32042	32042	32042	123992	126263	125127	91950	94221	93085	2.86	2.94	2.90
SE(m)±		-	-	-	1366	1495	1431	1422	1441	1432	0.03	0.04	0.03
C.D. (P = 0.05)		-	-	-	4095	4479	4287	4261	4320	4291	0.09	0.11	0.10
C. Sub-sub plot: Hydrogel levels - 04													
Control (No Hydrogel)	H_0	30621	30621	30621	115820	117372	116596	85199	86751	85975	2.78	2.83	2.80
Pusa Hydrogel @ 2.5 Kg ha^{-1}	H_1	31511	31511	31511	118016	120415	119215	86505	88904	87704	2.83	2.91	2.87
Pusa Hydrogel @ 5.0 Kg ha^{-1}	H_2	32401	32401	32401	127694	129737	128715	95293	97336	96314	2.94	3.00	2.97
Pusa Hydrogel @ 7.5 kg ha^{-1}	H_3	33291	33291	33291	130534	132890	131712	97243	99599	98421	2.92	2.99	2.95
SE(m)±		-	-	-	1001	1052	1026	655	749	702	0.01	0.02	0.02
C.D. (P = 0.05)		-	-	-	3006	3153	3079	1959	2242	2101	0.04	0.06	0.05

5. Conclusion

Applying of water at active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS along with 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) and Pusa Hydrogel @ 7.5 kg ha^{-1} recorded higher crop growth, yield attributes and yield of barley. Highest economic returns were fetched with the application of three irrigation at active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS along with 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) and Pusa Hydrogel @ 7.5 kg ha^{-1}. However, the maximum net B: C ratio was fetched with the application of three irrigation at active tillering at 30-35 DAS, flag leaf at 60-65 DAS and milking at 80-85 DAS along with 100% RDN (60 kg N + 30 kg P_2O_5 + 20 kg K_2O) and Pusa Hydrogel @ 5.0 kg ha^{-1}.

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