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# Effect of irrigation scheduling and hydrogel level on growth and yield of wheat (*Triticum aestivum* L.)

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## Abstract
A field experiment was conducted to evaluate the performance of different irrigation schedule and hydrogel levels on the growth and yield of wheat (*Triticum aestivum* L.) at Ayodhya, Uttar Pradesh, during *Rabi* season of 2018-19. The different irrigation schedule and hydrogel levels were taken in wheat crop. The study comprised of 12 treatment combinations in split design with 3 replications. Among various irrigation schedules, I3 (CRI + jointing + milking + dough) being at par with I4 (Irrigation at 0.6 IW/CPE) recorded highest plant height, number of tillers $m^{-2}$, leaf area index, dry matter accumulation, number of spikes $m^{-2}$, length of spike, grains $spike^{-1}$, yield attributes and yield. The similar trend was observed with the application of hydrogel @ 5.0 kg $ha^{-1}$ compared to 2.5 kg $ha^{-1}$ and control.

**Keywords:** Irrigation, hydrogel, wheat, yield

## Introduction
Indian mustard (*Brassica juncea* L.) is an important *Rabi* oilseed crop extensively grown as rainfed crop in India. Mustard oil meets the one third of edible oil requirement of the country, to meet these needs the country highly depends on imports of vegetable oil. Import of vegetable oils during July 2019 is up by 26% to 14.12 lakh tones as compared to 11.19 lakh tones in July 2018, according to data compiled by the Solvent Extractors' Association of India (SEA). There is a need to decrease the Import of vegetable oils by expanding the area under oil seed crops. It is important to increase the yields of mustard crop by improving the available germplasm lines, for that we need to know various yield contributing characters and the relationship among them and with the seed yield. In this experiment, we studied correlation or mutual association among different yield contributing characters and the direct and indirect effects also estimated through path coefficient analysis. The inter-relationship between the yield components will be helpful to a breeder to assess the nature, extent and direction of selection pressure on characters.

## Material and Methods
Wheat (*Triticum aestivum* L.) belonging to the family poaceae is the single most important cereal crop, that has been considered as integral component of the food security system of several nations. In India, wheat occupies second place after rice. As per Indian Council of Agricultural Research, the demand for wheat in the country will reach 140 million tonnes by 2050. Efficient input management along with varietal improvement are the two basic element that can help in achieving the target. Irrigation water is the most crucial input for agricultural production.

It enables a higher productive potential from the land, and significant production response from associated use of high yielding varieties, fertilizer, and other (Kukal *et al.*, 2014) [6]. Therefore, the issue of water management in crop production has assumed paramount importance in India as well as in the world. The sharp fall in ground water level so wing to excessive removal for agricultural and other uses coupled with the high costs of fuel and electrical energy used in drawing ground water, and poor water use efficiency due to wasteful practices are affecting the economics of water use in all spheres of human activity. Several technologies and agronomic practices have been developed and recommended to improve water productivity in crops. However, a holistic approach to evolve integrated solutions for multiple problems has been elusive.

Among the several recognized criteria of irrigation scheduling in wheat, the critical stage approach is very familiar among the farmers as it needs no technical knowledge, skill and instruments. The impact of limited irrigation on crop yield and WUE depends on the growth stage and most sensitive stage vary region to region due to regional variability in environment and agronomic practices (Singh *et al.,* 1991) [11].

Hydrogel 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 time sits original volume (Bowman *et al.*, 1991) [2] while on weight basis it can absorb as high as 400 times its original weight (Kalhapure *et al.*, 2016) [5]. Grain yield, nutrient uptake and water use efficiency improved in winter wheat when hydrogel was applied at the rate of 5kg/ha in sandy loam soil (Tyagi *et al.*, 2015) [12]. Hydrogel reduces the leaching of herbicide, fertilizer and requirements of irrigation for crops. Though, not much research in India has been undertaken on the use of hydrogel in agriculture, many researchers over world have extensively worked for increasing water use efficiency and enhancing crop yield (Dabhi *et al.*, 2013) [3]. Keeping above points in view, the present investigation was undertaken to study the effect of irrigation scheduling and hydrogel on growth and yield of wheat crop.

An experiment was conducted at Research Farm of the Acharya Narendra Deva University of Agriculture &Technology, Kumarganj, Ayodhya, Uttar Pradesh ($26^0$47' N latitude, $82^0$12' E longitude and 113 meters above mean sea level) in *Rabi* seasonof2018-19 with wheat (K 7903 - HALNA) as a test crop. The experiment was laid out in split plot design (SPD) with three replications. Total 12 treatment combinations comprised of four irrigation schedules in main plot and three hydrogel levels in sub plot were tested. The wheat was hand sown with a seed rate of 125kg/ha. Sowing was done in rows 20 cm apart and 4-5 cm deep in furrows opened by Kudali. The field was fertilized with N: $P_2O_5$: $K_2O$ @ 120:60:40 Kg $ha^{-1}$in the form of urea, di-ammonium phosphate and muriate of potash, respectively. Full dose of phosphorus and potassium and half dose of nitrogen were applied at the time of sowing and rest half dose of nitrogen was applied after first irrigation. Crop was irrigated as per irrigation schedule. Hydrogel was applied as per treatment in the field by mixing with dry soil in a ratio of 1: 10 for uniform distribution in the field. After application it was mixed in the upper soil layer (0–15cm). The weeds of the experimental field were removed manually with the help of Khurpi at 30 days after sowing. The data recorded on different growth parameters, yield attributes and yield during the course of investigation were subjected to statistical analysis using analysis of variance (ANOVA) technique for SPD as prescribed by (Gomez and Gomez, 1984) [4]. Standard error of mean in each cases was calculated at 5% levels of probability.

Growth Characters: The effect of irrigation scheduling and hydrogel level on growth parameters of wheat was studied (Table 1). The maximum plant height (79.15 cm) was recorded under the effect of treatment $I_3$ (four irrigation at CRI, jointing, milking and dough stage) being on par with $I_4$ (irrigation at 0.6 IW/CPE) butsignificantlysuperioroverI$_2$ (two irrigation at CRI and Jointing stage) and $I_1$ (one irrigation at CRI). Application of hydrogel @ 5.0 kg/ha recorded significantly highest plant height (78.43 cm) compared to its lower dosages. Increase in plant height at higher moisture regime in presence of higher level of hydrogel might be possible due to maintenance of constant water supply to the plants, which maintained various metabolic processes (Kumar *et al.*, 2019) [9]. Highest number of tillers $m^{-2}$ was recorded under the influence of $I_3$ (four irrigation at CRI, jointing, milking and dough stage) which was significantly superior over $I_2$ (two irrigation at CRI and Jointing stage) and $I_1$ (one irrigation at CRI) while at par with $I_4$ (irrigation at 0.6IW/CPE). At the same time application of hydrogel @5.0 kgha$^{-1}$ recorded significantly highest number of tillers $m^{-2}$ (448.03) compared to hydrogel application @ 2.5 kg/ha (427.53) and control (hydrogel application). The higher number of tillers associated withI$_3$ (four irrigation at CRI, jointing, milking and dough stage) might be due to timely supply of water at the critical stages (*Ali et al.*, 2012). Treatment $I_3$ (four irrigation at CRI, jointing, milking and dough stage) recorded significantly highest LAI (4.59) than $I_1$ (one irrigation at CRI) being at par with $I_4$ (irrigation at 0.6 IW/CPE) and $I_2$ (two irrigation at CRI and Jointing stage). Application of hydrogel @ 5.0 kg $ha^{-1}$ produced significantly higher LAI (4.52) compared to rest of the hydrogel levels. The increase in leaf area index might be due to the fact that sufficient availability of moisture increased the absorption of nutrients and resulted into fully turgid and higher number of green leaves with enlarged size which led to higher leaf area index (Singh 2015) [12]. Dry matter production is a result of collective combination of various growth parameters like plant height, number of tillers, leaf area index and yield of other vegetative parts. It is the sum of metabolic processes occurring in the plants and consequently affecting the yield. Highest dry matter accumulation (873.02 g $m^{-2}$) was recorded in the treatment $I_3$ (four irrigation at CRI, jointing, milking and dough stage) being on par with $I_4$ (irrigationat0.6IW/CPE) and $I_2$ (two irrigation at CRI and Jointing stage). Whereas, hydrogel application @ 5.0 kg $ha^{-1}$ recorded significantly highest dry matter accumulation (875.44gm$^{-2}$) compared to hydrogel application @ 2.5 kgha$^{-1}$ (800.70 g $m^{-2}$) and control (741.12 g $m^{-2}$). The increase in dry matter accumulation might be due to increased plant height, tiller production, leaf area index and uptake of nutrients through adequate moisture supply (Kumar *et al.* 2019) [9].

**Table 1:** Plant height, number of tillers, leaf area index and dry matter accumulation as influenced by irrigation schedules and hydrogel levels

| Treatment | | Plant Height (cm) | Number of tillers ($m^{-2}$) | Leaf area index (90 Das) | Dry matter accumulation (g $m^{-2}$) |
|---|---|---|---|---|---|
| **(A) Irrigation scheduling** | | | | | |
| $I_1$ | One irrigation at CRI | 70.84 | 337.19 | 3.81 | 708.53 |
| $I_2$ | Two irrigation at CRI and Jointing stage | 75.49 | 445.73 | 4.30 | 788.09 |
| $I_3$ | Four irrigation at CRI, jointing, milking and dough stage | 79.15 | 466.76 | 4.59 | 873.02 |
| $I_4$ | Irrigationat0.6 IW/CPE | 77.91 | 458.10 | 4.12 | 853.44 |
| | S.Em± | 0.92 | 5.90 | 0.13 | 22.18 |
| | CD(P=0.05) | 3.24 | 20.81 | 0.48 | 78.25 |

| | | | | | |
|---|---|---|---|---|---|
| (B) Hydrogel levels(kg ha$^{-1}$) | | | | | |
| $H_0$ | 0 | 73.14 | 405.26 | 3.91 | 741.12 |
| $H_1$ | 2.5 | 75.96 | 427.53 | 4.19 | 800.70 |
| $H_2$ | 5.0 | 78.43 | 448.03 | 4.52 | 875.44 |
| | S.Em± | 0.75 | 7.69 | 0.10 | 10.89 |
| | CD(P=0.05) | 2.26 | 2.54 | 0.30 | 32.92 |

Yield attributing characters and yield: A perusal of data summarized in table 2 revealed that the maximum number of spikes per square meter (266.16) was recorded in $I_3$ (four irrigation at CRI, jointing, milking and dough stage) which was significantly superior to $I_2$ (two irrigation at CRI and Jointing stage) and$I_1$ (one irrigation at CRI) but on par (259.05) with $I_4$ (irrigation at 0.6 IW/CPE). Similarly, hydrogel application @ 5.0 kg ha$^{-1}$ recorded significantly highest number of spikes per square meter (257.90) compared to hydrogel application @ 2.5 kg ha$^{-1}$ (246.07) and control (235.67). It is also evident from the data that higher length of spike (9.11 cm) was found in $I_3$ (four irrigation at CRI, jointing, milking and dough stage) closely followed by $I_4$ (irrigation at 0.6 IW/CPE) while significantly over than rest of irrigation schedules. Increasing levels of hydrogel application gave additive response to length of spike. Longest spike (8.92cm) was noted with the application of hydrogel @ 5.0 kg ha$^{-1}$ which was significantly higher than control (8.02cm) but was at par with hydrogel application @ 2.5 kg ha$^{-1}$. The maximum number of grains spike$^{-1}$ (31.59) was found with $I_3$ (four irrigation at CRI, jointing, milking and dough stage) closely followed by $I_4$ (irrigation at 0.6 IW/CPE) but significantly better when compared to rest irrigation schedules. Hydrogel when applied @ 5.0 kg ha$^{-1}$ produced significantly higher number of grains spike$^{-1}$ than control (no hydrogel application) but was at par to hydrogel application @ 2.5 kg ha$^{-1}$. The maximum 1000-grain weight (g) was recorded with$I_3$ (four irrigation at CRI, jointing, milking and dough stage) followed by $I_4$ (irrigation at 0.6 IW/CPE) but significantly higher to rest irrigation schedules. Whereas, $I_2$ (two irrigation at CRI and Jointing stage) was significantly superior to $I_1$ (one irrigation at CRI). In case of hydrogel application, significantly highest 1000-grain weight (36.42 g) was recorded under the influence of application of hydrogel @ 5.0 kgha$^{-1}$. Under adequate moisture availability, plant height, tillers m$^{-2}$, leaf area and dry matter production were improved and translocation of photosynthates from source to sink also enhanced with better partitioning of photosynthates to sink. The increase in grains spike$^{-1}$ is the result of fertilized spikes which is determined by moisture levels which influence nutrient uptake and amount of carbohydrate produced at the time of spikelet differentiation (Tyagi *et al.*, 2015) [12].

**Table 2:** Yield attributes and yields of wheat as influenced by irrigation schedules and hid

| Treatment | | Number of spikes (m$^{-2}$) | Length of spike (cm) | Number of grains spike$^{-1}$ | 1000 grain weight (g) | Biological yield (q ha$^{-1}$) | Grain yield (q ha$^{-1}$) | Straw yield (qha$^{-1}$) | Harvest index (%) |
|---|---|---|---|---|---|---|---|---|---|
| (A) Irrigation scheduling | | | | | | | | | |
| $I_1$ | One irrigation at CRI | 214.28 | 7.22 | 27.18 | 34.37 | 64.18 | 26.06 | 38.12 | 40.55 |
| $I_2$ | Two irrigation at CRI and Jointing stage | 246.70 | 8.09 | 28.79 | 35.70 | 70.65 | 29.96 | 40.69 | 42.39 |
| $I_3$ | Four irrigation at CRI, jointing, milking and dough stage | 266.16 | 9.11 | 31.59 | 37.10 | 80.52 | 34.20 | 46.32 | 42.45 |
| $I_4$ | Irrigation at 0.6 IW/CPE | 259.05 | 9.10 | 31.39 | 36.76 | 79.60 | 33.82 | 45.78 | 42.46 |
| | S.Em± | 5.15 | 0.27 | 0.76 | 0.12 | 0.94 | 0.77 | 0.29 | 0.50 |
| | CD (P=0.05) | 18.18 | 0.96 | 2.67 | 0.41 | 3.32 | 2.72 | 1.02 | NS |
| (B) Hydrogel levels (kg ha$^{-1}$) | | | | | | | | | |
| $H_0$ | 0 | 235.67 | 8.02 | 28.46 | 35.58 | 70.21 | 29.19 | 41.02 | 41.46 |
| $H_1$ | 2.5 | 246.07 | 8.20 | 30.24 | 35.95 | 73.33 | 30.92 | 42.41 | 42.13 |
| $H_2$ | 5.0 | 257.90 | 8.92 | 30.51 | 36.42 | 77.67 | 32.92 | 44.76 | 42.30 |
| | S.Em± | 1.88 | 0.24 | 0.57 | 0.06 | 0.46 | 0.45 | 0.28 | 0.40 |
| | CD (P=0.05) | 5.67 | 0.73 | 1.71 | 0.18 | 1.40 | 1.35 | 0.84 | NS |

Yield is the resultant of coordinated interplay of growth and yield contributing characters whereas, yield attributes are the function of vegetative development. Biological, grain and straw yield was significantly influenced by different irrigation schedules and hydrogel levels. The highest biological yield (80.52 q ha$^{-1}$), grain yield (34.20 q ha$^{-1}$) and straw yield (46.32 q ha$^{-1}$) was recorded with $I_3$ (four irrigation at CRI, jointing, milking and dough stage) being on par with $I_4$ (irrigation at 0.6IW/CPE) but significantly higher to rest irrigation schedules. Similarly, application of hydrogel @ 5.0 kg ha$^{-1}$ recorded significantly highest biological yield (77.67qha$^{-1}$), grain yield (32.92 q ha$^{-1}$) and straw yield (44.76 q ha$^{-1}$) compared to rest levels.The better growth and development of crop along with increased yield attributes in presence of sufficient moisture supply resulted into higher yield (Roy *et al.*, (2019) [9]. Though the effect of irrigation schedules and various levels of hydrogel on harvest index of wheat were found to be non-significant but numerically it increased with increasing number of irrigation and level of hydrogel.

## Summary

The study was undertaken to devise an efficient irrigation schedule along with use of hydrogel to enhance the crop productivity per unit available water, particularly in moisture stress condition. Among various treatment combinations, highest yield was obtained from treatment combination $I_3H_2$ (four irrigation at CRI, jointing, milking and dough stage along withhydrogel5.0 kgha$^{-1}$). Hence, treatment $I_3H_2$ (four irrigation at CRI, jointing, milking and dough stage along with hydrogel 5.0 kgha$^{-1}$) can be an effective measure for higher productivity of wheat under limited water condition and therefore, may be recommended.

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