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*Research Article*

# Influence of hydrogel, irrigation and nutrient levels on wheat productivity

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## Abstract

**An investigation was conducted for two consecutive *Rabi* seasons of 2011-12 and 2012-13 at Research Farm of Indian Institute of Wheat & Barley Research, Karnal (Haryana) to study the effect of hydrogel (synthetic Poly Acryl Amid) on *in situ* moisture conservation under different nutrient and irrigation levels. The experiment was conducted in split plot design with three main plot treatments (no irrigation, two irrigations and four irrigations) and six sub-plot treatments (100% NPK without hydrogel, 100% NPK with 2.5 kg/ha hydrogel, 100% NPK with 5 kg/ha hydrogel, 70% NPK without hydrogel, 70% NPK with 2.5 kg/ha hydrogel, 70% NPK with 5 kg/ha hydrogel). Progressive increase in wheat grain yield was recorded with every increment in irrigation level and 4 irrigations brought about significantly higher grain yield (44.82 q/ha) over no irrigation (32.37 q/ha) and two irrigations (42.03 q/ha). No yield improvement was observed with hydrogel application. The difference among various hydrogel treatments were found statistically at par. Grain yield was the highest under 100 % of recommended dose of NPK with (40.26 q/ha) and without (41.14 q/ha) hydrogel. On pooled basis 70% NPK application with and without hydrogel recorded significantly lower yield than 100% NPK application.**

**Key words:** Hydrogel, irrigation, nutrients, wheat yield.

## 1. Introduction

Wheat (*Triticum aestivum* L.) is the most important staple food crop grown globally on an area of about 215.5 million hectare with production of 670.9 million tonnes (FAO STAT, 2012). Besides staple food for human beings, wheat straw also serves as an important dry matter source of feed for animals (Sarwar *et al.*, 2006). Water availability is one of the most important inputs which contribute to the growth and productivity of the crop. For high wheat yields, water requirement (ET) of wheat crop is 450 to 650 mm depending upon soil, type climatic conditions and length of growing period. In North Western Plains Zone (NWPZ) of India, about 4-6 irrigations are required for wheat. On the clay loam vertisols of Central India, however, 80 % depletion of available water in 15-20 cm soil layer could be allowed and this required about 4 irrigations (Motiramani, 1968). Light aridisols of Rajasthan needs more number of irrigations since only 20-25 % depletion of available moisture up to a depth of 30 cm surface soil layer was found optimum on these sandy soils (Rathore and Singh, 1973) and this required about 8 irrigations. Water is the major component of any plant and plays an important role in nutrient absorption and transportation, plant growth and plant response to abiotic stresses. Carbohydrates, the products of photosynthesis, are transported through water solution to storage organs. A major portion of the water absorbed by the plant evaporates through the stomata as transpiration and it is essential for absorbing oxygen for photosynthesis. In addition, water absorbs heat, cools the plant and prevents plant injury from high temperatures. Water is also lost directly from the soil surface as evaporation. Available fresh water resources are subjected to an ever-increasing pressure due to extensive demand for agricultural, industrial and domestic usage. Long-term perspective in paucity of fresh water resources, especially in arid and semi-arid area, highlights an urgent solution for innovative strategy of moisture conservation and agricultural water management. As the competition for the limited water resources on earth increases due to growth in population and affluence, agriculture is facing intensified pressure to improve the efficiency of water used for food production. Irrigated agriculture is the main user of the available water resources. About 70 % of the total water withdrawals and 60-80 % of total consumptive water use are consumed in irrigation (Huffaker and Hamilton, 2007). Therefore, water resources should be used with a higher efficiency and to achieve this goal, improvement in agricultural water management is a key factor. Thus, there is a sufficient scope to carry out the validation of available information with recently invented technologies. Hydrogel is one of the products developed by Indian Agricultural Research Institute, New Delhi, which is believed to increase infiltration rate in field besides increasing water holding capacity of the soil. Leaching losses of water, nutrients and other inputs with irrigation water is completely associated with irrigation water management. Though it is not possible to eliminate leaching losses completely, proper irrigation scheduling can help restrict the leaching losses to a minimum level (Kumar *et al.*, 1995). Crop production technologies that optimize yield aims at reducing leaching losses and improving water use efficiency, which is a prerequisite for sustainable agriculture. The use of hydrophilic polymers, for improving water holding capacity of soil and nutrient retention properties is attracting considerable interest. Keeping this in view, the present investigation was undertaken with an objective to study the influence of hydrogel on growth and yield of wheat under different moisture and fertility levels.

## 2. Materials and methods

The experiment was conducted in split plot design for two consecutive *Rabi* season of 2011-12 and 2012-13 comprising three main plot treatments (no irrigation, two irrigations and four irrigations) and six sub plot treatments (recommended dose of NPK i.e. 100% NPK) without hydrogel, 100% NPK with hydrogel @ 2.5 kg/ha, 100% NPK with hydrogel @ 5 kg/ha, 70% NPK without hydrogel, 70% NPK with hydrogel @ 2.5 kg/ha hydrogel, 70% NPK with hydrogel @ 5 kg/ha) with three replications at Indian Institute of Wheat & Barley Research, Karnal (29°43'N, 76°58'E and 245 M AMSL). The region is characterized by sub tropical and semi arid climate with a hot dry summer (March-June), wet monsoon season (late June – mid September) and a cool dry winter (November-February). The crop season had received 36.3 mm and 203.0 mm rainfall during 2011-12 and 2012-13, respectively. Soil of experimental field was sandy clay loam with pH of 7.9 (1:2.5 soil:water). The soil of experimental field had 0.40 % organic carbon, 190 kg/ha available N, 17.8 kg/ha available P and 165 kg/ha available K at beginning of the experiment. Nutrients were applied as per treatments taking 100 % recommended dose of fertilizer as150:60:30 kg of N, $P_2O_5$ and $K_2O$/ha and 70 % of recommended dose of fertilizer as 105:42:21 kg of N, $P_2O_5$ and $K_2O$/ha as part of nutrient management. Full dose of P and K and 1/3 dose of N through N:P:K: mixture (12:32:16) was applied at sowing and remaining N was applied in two equal splits at first and second irrigation through urea. Full dose of N, P and K was applied as basal in no irrigation treatment. Hydrogel was applied as per treatments by mixing in sand and applied by hands in lines before placing seed. Hydrogel products constitute a group of polymeric materials, the hydrophilic structure of which renders them capable of holding large amounts of water in their three-dimensional networks. Irrigation treatments were imposed as per treatments viz. no irrigation, two irrigations (crown root initiation stage and late jointing stage), four irrigations (crown root initiation, late jointing, flowering and milking stages) and 60 mm of water was applied in each irrigation. Wheat variety DBW 17 was used for the experimentation and seeds were sown 20 cm apart in rows with a seed rate of 100 kg/ha. Other package of practices were adopted as per recommendations for the crop under irrigated conditions. Number of effective tillers per square meter from the centre of plot was measured in each plot at maturity. A net plot of 9.8 $m^2$ (7m x 1.4 m) was harvested manually for biomass and yield data. Grain samples were randomly selected from grain yield of each sub plot and 1000-grains were counted with Contador seed counter and weighed to record 1000-grain weight. SAS (Statistical Analysis Software) version 10.3 was utilized to analyze the observations and differences among means.

## 3. Results and discussion

Yield and yield attributes viz. number of earhead/$m^2$, 1000-grain weight (g), biomass yield and grain yield (q/ha) were significantly influenced by irrigation treatments. On pooled basis, application of two (42.03 q/ha) and four (44.82 q/ha) irrigations resulted in significantly higher grain yield than no irrigation (32.37 q/ha). During 2012-13, the experiment site received 203.0 mm of rainfall, whereas, it was only 36.3 mm during 2011-12 and because of this rainfall comparatively very high yield was obtained during 2012-13 (37.19 q/ha) than 2011-12 (27.54 q/ha) under no irrigation treatment. Among fertilization treatments, the highest yield was recorded where 100 % NPK without hydrogel was applied during both the years of study. On pooled basis also, the highest yield was recorded for the treatment 100% NPK without hydrogel (41.14 q/ha) followed by 100% NPK with hydrogel @ 2.5 kg/ha (40.26 q/ha) which were at par among themselves (Table 1). The harvest index was at par in irrigation levels treatments as well as in hydrogel and nutrient treatments (Table 1). Fairly good amount of rainfall (203.0 mm) and irregular distributions which had created water logged conditions during 15-21 January, 5-11 February, 19-25 February might be the reason of yield reduction during year 2012-13 in 2 and 4 irrigation treatments. There seems to be highly inconsistent effect of hydrogel on grain yield and its attributing characteristics. Progressive increase in

**Table 1.** Effect of hydrogel on yield and yield attributing characters of wheat under different irrigation and nutrient levels

| Treatment | Yield q/ha | | | Biological Yield q/ha | | | Earhead/M$^2$ | | | 1000 Grain weight, g | | | Harvest Index | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2011-12 | 2012-13 | Pooled | 2011-12 | 2012-13 | Pooled | 2011-12 | 2012-13 | Pooled | 2011-12 | 2012-13 | Pooled | 2011-12 | 2012-13 | Pooled |
| Irrigation Levels | | | | | | | | | | | | | | | |
| No Irrigation | 27.54 | 37.19 | 32.37 | 55.42 | 77.58 | 66.50 | 325 | 358 | 342 | 33.71 | 34.67 | 34.18 | 0.51 | 0.48 | 0.50 |
| 2 Irrigation | 44.70 | 39.35 | 42.03 | 93.33 | 80.03 | 86.68 | 348 | 375 | 362 | 33.98 | 36.51 | 35.26 | 0.48 | 0.50 | 0.49 |
| 4 Irrigation | 47.63 | 42.00 | 44.82 | 99.59 | 87.63 | 93.61 | 409 | 417 | 413 | 34.87 | 37.19 | 36.02 | 0.48 | 0.48 | 0.48 |
| S.E.m± | 0.43 | 0.66 | 0.503 | 3.41 | 12.89 | 7.96 | 8.89 | 7.74 | 5.24 | 0.42 | 0.34 | 0.33 | 0.01 | 0.01 | 0.03 |
| CD=0.05 | 1.68 | 2.65 | 2.03 | 13.76 | NS | NS | 35.81 | 31.17 | 21.13 | NS | 1.37 | 1.32 | NS | NS | NS |
| Hydrogel and nutrient Levels | | | | | | | | | | | | | | | |
| 100% NPK without Hydrogel | 41.15 | 41.13 | 41.14 | 87.74 | 83.86 | 85.80 | 367 | 407 | 387 | 33.72 | 35.90 | 34.82 | 0.48 | 0.49 | 0.48 |
| 100% NPK with 2.5 kg/ha hydrogel | 40.75 | 39.77 | 40.26 | 84.06 | 82.54 | 83.30 | 375 | 377 | 376 | 34.34 | 36.14 | 35.22 | 0.50 | 0.48 | 0.49 |
| 100% NPK with 5 kg/ha hydrogel | 40.79 | 38.39 | 39.59 | 83.84 | 81.09 | 82.46 | 341 | 364 | 353 | 34.00 | 35.66 | 34.83 | 0.49 | 0.48 | 0.48 |
| 70% NPK without Hydrogel | 38.86 | 39.36 | 39.11 | 78.02 | 80.95 | 79.49 | 358 | 408 | 383 | 32.27 | 36.66 | 35.46 | 0.51 | 0.49 | 0.50 |
| 70% NPK with 2.5 kg/ha hydrogel | 39.19 | 39.04 | 39.12 | 79.72 | 80.95 | 80.34 | 364 | 332 | 348 | 34.29 | 36.33 | 35.31 | 0.49 | 0.48 | 0.48 |
| 70% NPK with 5 kg/ha hydrogel | 39.02 | 39.40 | 39.21 | 83.29 | 81.08 | 82.19 | 359 | 412 | 384 | 34.49 | 36.04 | 35.28 | 0.47 | 0.49 | 0.48 |
| CD=0.05 | 2.07 | 1.12 | 1.23 | 5.83 | NS | 4.00 | NS | 6.31 | NS | NS | NS | NS | NS | NS | NS |

wheat grain yield with every increment in irrigation levels was observed and four irrigations resulted in significantly higher grain yield might be due to favourable soil moisture conditions under higher irrigation levels. Similarly, Shiraz et al. (2014) reported that irrigation regimes have significant effect on yield and growth parameters of wheat. The treatment with 70 % NPK with hydrogel was statistically at par with 100 % NPK during first year (2011-12) indicating some positive effect of hydrogel under drier years.

From this study it can be concluded that under limited availability of irrigation water, 70 % of recommended NPK may be optimum without having any yield penalty of wheat crop. The results indicate that there is no significant impact of hydrogel application on wheat yield and yield attributing characters. Being meagre quantity of hydrogel (2.5 to 5.0 kg/ha) its application along with seed of wheat in lines by drilling is also a difficult task. The difference in rate of application of hydrogel (2.5-5.0 kg/ha) in comparison to wheat seed rate (100 kg/ha) makes it difficult to be applied together using seed drill. On the other hand, its application as a mixture with sand also leads to blockage of seed drill. Further studies are required on exploring the possibility of seed priming or coating seed with hydrogel (Lather, 2015) which can make easy to apply it uniformly to address the problem of sub-optimal moisture availability to crop in rainfed agro-ecology.

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