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Hydrogels: An Innovative Polymer for Water Conservation in Wheat (*Triticum aestivum L*)

Abha Saxena*, Tarun Upadhyay, Deepti Rai & Anup Kalra

Ayurvet Research Foundation; 28-5Km Panipat - Gohana rod NH-71H, Village Chidana, Tehsil: Gohana, Sonipat Haryana 123301

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***Corresponding author:** Abha Saxena, Ayurvet Research Foundation; 28-5Km Panipat - Gohana rod NH-71H, Village Chidana, Tehsil: Gohana, Sonipat Haryana 123301 and Tel- 0120-7100201. Email: abha.saxena@arfmail.in

Abstract

Effect of hydrogel (hydrophilic polymer) on irrigation frequency, growth & yield parameters of Wheat crop was evaluated. It was hypothesized that the use of hydrogelwill increase efficient water use, decreases irrigation cost per hectare, encourages safe release of fertilizers and increases per hectare yield. Ayurvet Research Foundation with the support of NABARD had conducted a comparative study at 24 farmer's Wheat crop fields of different villages of Sonipat district of Haryana (India). There were two broad treatments wheat crop grown with Hydrogel (T_1) and without Hydrogel (T_o). Hydrogel was applied at the rate of 2.5kg ha^{-1} (Vishwa hydrogels). Observations for growth and yield parameters were recorded and the data was analyzed at $P_{(0.01)}$. The Wheat grain yield increased from 49.9q $ha^{-1}$to 53.5q ha^{-1}. One irrigation per crop cycle was saved with the application of Hydrogel. There was an additional income of Rs. 7500/ ha because of yield gain of 12.5% and saving of one irrigation per ha.

Use of Hydrogel has significantly impacted the irrigation frequency, growth & yield parameters of Wheat crop. The improved performance of Wheat upon hydrogel application was evident in the field. The technology could be promising in terms of productivity improvement of rainfed crops and in combating the moisture stress in agriculture.

Keywords: Hydrogel; Hydrophilic Polymer; irrigation frequency; water conservation

Introduction

Wheat is the 2nd largest grown cereal crop in the world. However, many production constraints including sharp fall in groundwater levels, high costs of fuel and electrical energy used in drawing groundwater, poor water use efficiency have adversely affected the economics of wheat production (Suhag, 2016). One of the reasons of water crisis is theweather uncertainty and inadequate natural precipitation. In India Haryana state received 343.9 mm of rainfall against its average of 459.8 during monsoon 2017 (study was convened in 2017-18). Out of 21 districts in Haryana for which rainfall was reported during monsoon 2017 only 7 districts received normal rainfall. Sonipat district received 2% rainfall received and was categorized deficit (IMD, Haryana -2017).Besides, increasing demand of water due to ever-increasing population, the direct application of irrigation water allows the crop to utilize only 50% of the applied water, however rest is lost in runoff and by evaporation. Adoption of new appropriate viable water management technologies is the need of the hour (Mancousu *et al*., 2015).

Several agronomic practices have been recommended for improvement of water productivity in crops like the application of mulches, limited irrigation scheduling and application of super absorbent polymers (SAPs) which reduces irrigation frequency and increases the moisture retention capacity of soil (Singh,2017). Hydrogel has emerged as one of the feasible solutions for improving water productivity. Hydrogels are cross linking polymers which forms extensive hydrogen bonds between water/solvent and polymeric chains, thereby help them in forming three dimensional networks. They act as super absorbents which when mixed with soil absorb 500 to 1000 times water of its weight and releases as per requirement of crops based on water potential gradient which helps the crop in maintaining their moisture level and adds to soil quality fertility level(Shibayama and Tanaka, 1993). Hydrogels retain water and plant nutrients and release them in sustained inplant rhizosphere under water scarcity conditions. Water hydrogel composite treatment significantly enhances water volumetric content of soil when the surrounding soil dries; the stored water is released back slowly into the soil. The hydrogels increasethe efficiency of water consumption, decreases irrigation costs, increases irrigation intervals, improves water holding capacity and porosity of soil, so enhances soil moisture and nutrients, plant viability and root development thereby

increases crop yield. (Abobatta, 2018). The physical appearance of hydrogel is loose, granular, powdery formation with light yellowish color. Its application can reduce the number of irrigation required for the optimum crop growth without compromising the grain yield. (Trisha Roy *et.al*, 2019).The hydrogels could be promising in crop productivity improvement and in combating the soil moisture stress. The hydrogel use conserves soil moisture and plant nutrients to satisfy the crop needs and is considered one of the most efficient strategies (Shaikh *etal.*, 2020). Therefore, considering the benefits of hydrogel and the problems related to water availability in Haryana (India), a field study was undertaken on wheat cropto evaluate the effect of hydrogel-use on water requirement of wheat and on crop growth and yield.

Materials and Methods

A field experiment was conducted in *Rabi* (winter) season of year 2017 and 2018.Wheat crop was grown with 2 broad treatments i.e. T_1- with application of Hydrogel and T_2 – without application of hydrogel. Granular hydrogel was applied to the wheat crop fields @2.5kg ha^{-1} by broadcast method. Pusa hydrogel manufactured under the trade name- Varidha Pusa Hydrogel was procured for the trial from Vishwa hydrogels Pvt. Ltd. Gurugram, Haryana. The dose of hydrogel as suggested in the literature varies from 2.5 – 5 kg ha^{-1} depending on the soil texture and location.

Hydrogel was applied in field with water hydrogel composite which when mixed with seeds stick to its surface. For one hectare 100kg seed was coated with 2.5kg of Hydrogel powder along with adequate moisture (water), so that it sticks well to the surface of the seed. All of the management practices were uniformly practiced by the farmer in both the treatments. The trial was replicated at 24 farmer's field of different villages of district Sonipat. Wheat variety 'HD-2967' was sown in between 15-20th Nov, 2017 @ 100kg seed ha^{-1}.First irrigation was given at crown root initiation stage i.e., 20-25 days after sowing, followed by subsequent irrigation at late tillering, late jointing, milk and dough stages. Regular training sessions were organized for the farmers through which issues related to irrigation, agriculture practices and effectivelyof hydrogel were discussed with agriculture experts. Observations on growth characters and yield parameters like plant height (cm), number of grains per ear head, earhead length (cm), plants cm^{-2}, 1000 seed weight (g), yield (qt ha^{-1}) and number ofirrigations were recorded for both the treatments. The data was analyzed using single factor analysis. Analysis of variance (ANOVA) was performed using WASP (ICAR) statistical software at 1% level of significance to test the significance of difference among the treatment and control. For various parameters the critical difference (CD) among the treated and control plots were worked out. The agriculture expenses per hectare was recorded as per the actual expenses in both the treatments. The input cost was taken as per the local Haryana rates. The cost of irrigation ha^{-1} was taken @ Rs100/ hour operation of pump. For 1 hectare it took 10 hours, i.e., Rs.1000 per irrigation. Income from yield was calculated on the basis of the MSP of Wheat in the year of Study which was Rs.1625 /q. Cost of Hydrogel kg^{-1} was Rs. 1200 (Varidhar Pusa Hydrogel).

Results & Discussion

The results revealed statistically significant difference in hydrogel-treated and control fields in terms of growth and yield parameters (**Table 2**).

Growth parameters

Plant height was significantly increased with the application of hydrogel (**Table 1**). This can be due to the fact that Hydrogel retains more soil moisture, reduces the leaching losses of nutrients thereby enhances the crop growth. The results are similar to the findings of Ifhtikaretal. (2002).At the time of harvesting, Hydrogel (T_1) fields recorded the higher Plant height (97.06 cm) which was 7.66cm higher than that of control (T_o), 89.4 cm.(**Table 2**).

Village	Plant height (cm) at Harvesting Stage		Earhead length (cm)		Grains/Earhead		1000 seed wt (gm)		Yield (q/ha)		Number of irrigations	
	T_1	T_0	T_1	T_0	T_1	T_0	T_1	T_0	T_1	T_0	T_1	T_0
Chidana(F1)	98	89.4	11.6	9.2	55	50	38.5	39.5	44.5	43.2	3	4
Dhurana(F2)	96.6	91.2	11.4	9	48	44	40.2	39.8	51.4	51.4	4	4
Mundlana(F3)	97	84.6	11.4	8.8	56	50	42.2	35.5	52.1	46.4	3	4
Mundlana(F4)	94	84.6	11.6	8.6	57	52	33.9	32.8	52.4	49.4	3	4
Mundlana(F5)	94	87.4	11.4	8.4	56	50	41.1	38.5	49.4	39.5	3	4
Mundlana(F6)	97.2	89.8	11.6	8.6	55	49	40.6	38.4	44.5	40.8	4	4
Mundlana(F7)	99.6	86.6	11.4	9	57	51	41	39.8	53.4	50.4	4	4
Chidana(F8)	98	91	11.6	8.8	57	50	42	40	51.9	51.4	4	4
Badoti(F9)	102	91.8	11.4	8.6	57	51	41.9	37.6	59.3	51.9	4	4
Chidana(F10)	98.2	91.6	11.6	8.4	57	51	40.2	38.7	49.4	46.4	4	4
Chattera(F11)	95.8	91.6	11.4	8.8	57	50	42.3	40.2	59.3	55.6	4	5
Gangana(F12)	99.4	92.6	11.6	8.6	56	49	41.2	40	60.3	56.8	4	4
Gangana(F13)	98	87.2	11.4	8.8	57	44	39.1	39.2	54.3	51.9	3	4
Kalana(F14)	95	89	11.6	8.6	56	49	40.1	39	51.9	42.5	3	4
Ramgarh(F15)	94.4	86.4	11.4	8.4	57	50	41.8	39.7	58.3	45.4	3	3
Gamri(F16)	97	92.6	11.8	10	55	44	42.5	40.6	60.8	54.3	2	3
Gamri(F17)	98	90.8	11.4	9.2	57	50	42.3	39.8	56.8	51.9	2	3
Chidana(F18)	96.6	92	11.6	9.6	56	49	43.2	42.8	35.1	36.8	3	4
Gangashe(F19)	100	94	11.6	9.6	55	44	39.3	40	61.3	61.3	5	5
Jolly(F20)	95.2	82.2	11.4	9	57	50	39.7	38.2	44.5	39.5	2	3
Mundlana(F21)	95.2	90.2	11.4	9	56	49	42.5	42.1	59.3	59.3	3	4

Gangashe(F22)	94.2	88.6	11.6	8.8	48	44	41	42.2	59.3	59.3	4	4
Busana(F23)	97.6	88.8	11.6	9.6	55	44	40.8	40.1	56.8	56.8	3	4
Mundlana(F24)	98.2	93	11.6	9.6	57	52	41.6	40.2	59.3	54.3	4	4
Total	**2245**	**2147**	**276.4**	**215**	**1334**	**1166**	**979**	**945**	**1285.1**	**1196.5**	**81**	**94**
Average	**97.06**	**89.4**	**11.5**	**9**	**55**	**48**	**40.8**	**39.3**	**53.5**	**49.9**	**3**	**4**
S.D.	**2.04**	**3.02**	**1.3**	**0.4**	**2.4**	**2.8**	**1.9**	**2.05**	**6.6**	**6.9**	**0.7**	**0.5**
*T_1- Application of Hydrogel : T_0- Control (no hydrogel)												

Table 1: Comparative analysis for growth and yield parameters of Hydrogel applied Wheat and conventional Wheat by farmers in villages of Sonipat district.

The irrigations provided are based entirely on the land requirements which vary from land to land& village to village basis the quality of soil. The comparison should be made among the number of irrigations provided in T_1 and Control T_2 in the same experimental plot.

Yield Attributes

Application of Hydrogel significantly affected the above mentioned yield attributes all the yield attributes *viz.* earhead length, number of grains per earhead, test weight. The performance of Wheat where Hydrogel was applied was remarkably better than that of control system (**Table1**).

The mean values of 1000 seed weight with hydrogel application was 40.8 gm which was 1.5gm and 3% higher than (T_o) control (**Table 2**).

Earhead length in Hydrogel applied fields (T_1) was recorded to be 11.5 cm which was 2.5 cm and 25% higher than the control (T_o) fields. (**Table 1**).

Similarly, average number of grains per earhead were recorded to be 55 in fields where Hydrogelwas applied (T_1) which is 6 and 12% higher than control (48). (**Table 2**).

These higher values might be due to better growth and development where plant got good opportunity for nutrient uptake.

Parameters	**Plant height(cm) at maturity stage**	**Panicle length (cm)**	**Number of grains per panicle**	**Plants persquare meter**	**1000 seed wt (gm)**	**Yield (qt/ha)**	**Number of Irrigations**
Treatments							
Hydrogel (T_1)	97.06 ± 2.04	11.5 ± 1.3	55 ± 2.4	55 ± 1.08	40.8 ± 1.9	53.5±6.6	3 ± 0.7
Control(T_0)	89.4 ± 3.02	9 ± 0.4	48 ± 2.8	49 ± 2.12	39.3 ± 2.05	49.9±6.9	4 ± 0.5
C.D (1%)	1.53	0.23	0.3	1.25	0.96	0.88	0.293
CV	2.025	2.82	3.1	2.96	2.959	5.13	9.963

Table 2: Data for growth and yield parameters in wheat crop analyzed at 1% level of significance.

Yield

The application of hydrogel had significant effect on the yield of Wheat crop. Data showed that the grain yield of wheat increased significantly with the application of Hydrogel when analyzed at 1% level of significance (**Table 2**). The yield per hectare was recorded to be 53.5qt in Hydrogel applied fields which were7.2 % and 3.6 qt/ha higher than the control (T_o) fields. (**Table 2**). The probable reason behind higher yield might be higher number of grains per panicle and increased 1000 seed weight (gm). Hydrogels also reduces the leaching losses which might have contributed to higher yields.

Irrigation Frequency

The numbers of irrigations provided to the Wheat crop fields were reduced significantly with the application of Hydrogel (T_1). An average saving of one irrigation per crop cycle was recorded, which saves approximately 1.5 lakhs litres of water (Volume calculated on the basis of height andarea). The average number of irrigation provided in T_1 i.e., with the application of Hydrogel was 3 whereas in T_0 control 4 irrigations were provided. The reason behind this is that the water was retained in hydrogel which swells and imbibe water in their three dimensional space, leading to reduced loss of water due to surface runoff and evaporation. Significant difference in all the parameters indicates the success of the experiment to detect difference among the treatments (Application of Hydrogel and Control). It proves that the treatments are different because differences are detected between the parameters. The CV values of all the parameters indicate theprecision within the treatments (**Table 2**).

Cost Economics

With the application of Hydrogel the wheat grain yield increased from 49.9qt ha^{-1} to 53.3qt ha^{-1} leading to an additional income benefit of Rs 7500 ha^{-1}.

The results showed promising impact of hydrogel in improving the various yield parameters and the total yield of Wheat in T_1 as compared to control T_O. Since water scarcity is one of the major problems in agriculture, this hydrophilic polymer gel can be a boon to farmers. The inclusion of hydrogel will help in alleviating moisture stress of crop plants during prolonged dry period in the rainfed areas and where irrigation facilities are available this technology reduces the number of irrigations applied to the crops. One to Two irrigations in wheat can be saved by application of hydrogel without compromising the grain yield .Thus hydrogel can be real advantage in terms of water saving . The current study involved first time introduction of this polymer in the area and was well accepted by the farmers. This technology has the potential and could help in solving the water woes of the farming community.

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References

1. Abobatta W (2018) Impact of hydrogel polymer in agricultural sector. *Advance AgricultureEnvironment Science*, 1:59-64.
2. Iftikhar MH, Shamshad HS, Hussain S, Iqbal K (2002) Growth yield and qualityresponse of three wheat (triticumaestivum L.) varieties to different levels of N P, K. *International Journal Agri bio*;4:362-64.
3. Indian Meteorogical department, Ministry of Earth Sciences. 2017. *End of Season report*, Haryana.
4. Noemi Mancosu, Richard L Snyder, Gavriil Kyriakakis, Donatella Spano (2015) Water scarcity and future challenges for food production. *Water* .**7:**975-992.
5. Roopal Suhag (2016) Overview of Ground water in India. *PRS Publications*. 1:5-7.
6. Shaikh A, Rehman O, Rashid M, Alvi S, Raza A, et al. (2020) Potential of Hydrogel in Rainfed soil to conserve soil and moisture and fertility to maximize Wheat yield. *Soil Science Society of Pakistan*; 39:204-210.
7. Shibayama M, Tanaka T (1993) Phase transition and related phenomena of polymer gels. *Advances in polymer science*, 109:1-62.
8. SP Singh, RK Singh, Santosh Kumar (2017) Response of irrigation schedule, mulching and hydrogel on various growth analysis attributes and nutrient uptake of wheat (*Triticumaestivum*L.). *Journal of Pharmacognosy and Phytochemistry*; 6: 2569-2573.
9. WE rudzinki, AM Dave, UH Vaishnav, SG Kumbar, AR Kulkarni, et al. (2002) Hydrogels as controlled release devices in agriculture. Designed monomers and polymers, **5**:39-65.
10. Water in Agriculture. 2020. The World Bank IBRD, *IDA*.

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