



## Influence of irrigation and hydrogel application on yield and economics of pearl millet (*Pennisetum glaucum* L.) under Eastern UP condition

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ARTICLE INFO	ABSTRACT
<p>Received : 20 May 2021                      Revised : 05 July 2021                      Accepted : 11 July 2021</p> <p>Available online: 19 November 2021</p> <p><b>Key Words:</b>                      Economics                      Hydrogel                      Irrigation                      Pearl Millet                      Yield</p>	<p>An experiment was conducted at CRF (Crop Research Farm), Department of Agronomy, SHUATS, Prayagraj, (U.P.) during Zaid crop season 2020. The soil of site was sandy loam in texture with neutral PH. The experiment was carried out in split plot design having nine treatment consisted of main plot Irrigation viz., I1 (2 Irrigation during Emergence and Early Tillering), I2 (3 Irrigation during Emergence, Early Tillering and Boot stage) and I3 (4 Irrigation during Emergence, Early Tillering, Boot stage and Grain filling) and sub plot, Hydrogel viz., H0 (0 kg/ha), H1 (2 kg/ha) and H2 (4 kg/ha) which are replicated thrice and effect was observed on Manipuri variety of Bajra. The result indicated that increase in irrigation interval and hydrogel significantly improved yield attributes and yield. At, harvesting, 4 irrigation recorded maximum of Grain yield (1.88 t/ha), Stover yield (4.31 t/ha) and Harvest index (30.24 %) hydrogel also resulted significantly higher Grain yield (1.98 t/ha), Stover yield (4.44 t/ha) and Harvest index (30.79 %) Maximum Gross return (69222.96/ha), Net return (45066.76/ha) and Benefit to Cost ratio (2.87) were recorded by application of 4 kg/ha hydrogel with 4 irrigation.</p>

### Introduction

India is the largest producer of bajra, during 2020-21 about 65.15 lakh ha (160.99 lakh acres) area was covered under bajra. The states of Rajasthan 38.42 lakh ha (94.94 lakh acres), Uttar Pradesh 9.20 lakh ha (22.73 lakh acres), Maharashtra 6.14 lakh ha (15.17 lakh acres), Haryana 4.32 lakh ha (10.67 lakh acres), Madhya Pradesh 3.05 lakh ha (7.54 lakh acres), Karnataka 1.45 lakh ha (3.58 lakh acres) and Gujarat 1.81 lakh ha (4.47 lakh acres) are the major growers of bajra in India. According to the 3rd advance estimates for 2019-20 bajra production estimate was 10.31 million tonnes as against 8.66 million tonnes in 2018-19. (Department of Food and Public Distribution 2020-

21). Water through irrigation is already scarce and the world is researching on water efficient agriculture. Increasing food demand and declining water resources are challenges for food security (Cookson *et al.*, 2001). The issue of water management has assumed paramount importance and occupied the centre stage of politico-economic debates in the world. Scheduling irrigation on the basis of evaporative demand results not only in efficient utilization of water but also in considerable saving of water. New methods in soil science and water are using hydrogels as reservoirs, prevention from water wastage and increase of irrigation efficiency (Bedi *et al.*, 2004). Hydrogel is

a hydrophilic polymer which is a cross-link of networks capable of holding large amounts of water as well as biological fluids. When the soil is applied with hydrogel, water holding capacity of soil increases significantly and when nearby soil dries, the stored water is released slowly back to the soil. These synthetic polymers crystalline in form and that they are marketed as super absorbent, hydrogel, aquasorb etc. this products shows a swelling potentials of 300 time, mostly exceeding 500 times its weight. Swelling ratio increases with the increase in temperature up to 50°C with none adverse effect on the polymer matrix structure (Khodadadi *et al.*, 2016).

### Material and Methods

The research was conducted during Zaid crop season, 2020 at CRF (Crop Research Farm), Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Science (SHUATS), Prayagraj (Allahabad) (UP). The CRF is situated at 25.57° N latitude, 87.19° E longitude and at an altitude of 98m above mean sea level. It is situated on the right side of the river Yamuna and by the opposite side of Prayagraj City. The research was carried out in split plot design, replicated thrice. The treatment comprised of 3 Irrigation interval based on crop growth stages, ( during Emergence, Early Tillering, Boot stage and Grain filling ) and noted as I1 (2 Irrigation during Emergence and Early Tillering), I2 (3 Irrigation

during emergence, early tillering and boot stage) and I3 (4 Irrigation during Emergence, Early Tillering, Boot stage and Grain filling) assigned as main plot. Each main plot was further divided into 3 sub plots, i.e. Hydrogel levels H0 (0 kg/ha Hydrogel), H1 (2 kg/ha Hydrogel), H2 (4 kg/ha Hydrogel) through surface application and the possible combination is presented in Table 1 with details of pearl millet crop. During the growing season, the mean weekly maximum and minimum temperature, relative humidity and rainfall were 36.60 °C, 24.90 °C, 76.40 %, 48.48 % and 4.72 mm respectively.

Bajra was sown at a spacing of 40 X 10 cm at a seed rate of 6-8 kg/ha. The field was irrigated before one day of sowing and further irrigated based on treatment. The RDF i.e Nitrogen (60 kg/ha) was supplied through urea and DAP in two equal splits, first as basal and second at 45 DAS (days after sowing), whereas full dose of P<sub>2</sub>O<sub>5</sub> (40 kg/ha) and K<sub>2</sub>O (40 kg/ha) was applied through DAP and MOP. Hydrogels were applied in each plots according to the treatments before sowing of seed along with fertilizers during first split as basal. Observations on growth parameters, yield attributes and yield of Bajra, was recorded and significance was analysed by the variance ratio. (F-value) at 5% level (Gomez and Gomez, 1984). Relative economics was calculated as per the prevailing market prices of the inputs and produced during Zaid season.

**Table 1: Treatment combinations.**

Treatments	Treatment Combination
I1 H0	2 irrigation (6 DAS and 27 DAS) with 0 kg/ha of Hydrogel
I2 H0	3 irrigation (6 DAS, 27 DAS and 47 DAS) with 0 kg/ha of Hydrogel
I3 H0	4 irrigation (6 DAS, 27 DAS, 47 DAS and 62 DAS) with 0 kg/ha of Hydrogel
I1 H1	2 irrigation (6 DAS and 27 DAS) with 2 kg/ha of Hydrogel
I2 H1	3 irrigation (6 DAS, 27 DAS and 47 DAS) with 2 kg/ha of Hydrogel
I3 H1	4 irrigation (6 DAS, 27 DAS, 47 DAS and 62 DAS) with 2 kg/ha of Hydrogel
I1 H2	2 irrigation (6 DAS and 27 DAS) with 4 kg/ha of Hydrogel
I2 H2	3 irrigation (6 DAS, 27 DAS and 47 DAS) with 4 kg/ha of Hydrogel
I3 H2	4 irrigation (6 DAS, 27 DAS, 47 DAS and 62 DAS) with 4 kg/ha of Hydrogel

**Emergence–6 DAS, Early tillering–27 DAS, Boot stage–47 DAS, Grain filling–62 DAS**

### Results and Discussion

#### Growth parameter

Growth parameters of pearl millet, viz. Plant height (cm) and Dry weight (g) varied because of

different irrigation interval and hydrogel level are presented in Table 2. The treatment receiving 4 irrigation (I3) resulted in higher plant height (182.34 cm) and Dry weight (128.33 g). In the above treatment, I3, was recorded significantly

**Table 2: Effect of Hydrogel and Irrigation on Yield of pearl millet**

Levels	Plant Height (cm.)						Dry Weight (g/plant)						Yield		
	Days After Sowing (DAS)						Days After Sowing (DAS)						Grain Yield	Stover Yield	Harvest Index (%)
	15	30	45	60	75	90	15	30	45	60	75	90	(t/ha)	(t/ha)	
<b>IRRIGATION (No.)</b>															
<b>2 Irrigation</b>	3.2	12.21	60.57	120.86	153.38	161.41	1.03	3.64	23.55	48.44	76.86	111.83	1.59	4.07	28.02
<b>3 Irrigation</b>	3.28	13.3	55.69	125.37	160.92	169.15	1.04	4.83	26.88	53.49	87.43	120.89	1.71	4.13	29.11
<b>4 Irrigation</b>	3.14	10.53	51.72	135.49	173.89	182.34	0.81	3.36	33.66	54.39	93.9	128.33	1.88	4.31	30.24
<b>S.E (d)</b>	0.12	1.42	3.88	5.71	4.65	4.86	0.168	0.488	0.232	1.675	1.352	1.48	0.032	0.042	0.453
<b>C.D at 5%</b>	-	-	-	-	7.46	7.79	-	-	0.372	2.685	2.167	2.37	0.052	0.067	0.726
<b>HYDROGEL (kg/ha)</b>															
<b>Hydrogel 0 kg ha-1</b>	3.04	11.06	44.86	110.58	145.36	153.49	0.96	3.28	25.53	49.25	80.31	114.09	1.47	3.88	27.55
<b>Hydrogel 2 kg ha-1</b>	3.49	12.34	50.97	126.36	162.9	171.25	0.86	3.45	28.1	51.74	86.65	119.81	1.72	4.19	29.03
<b>Hydrogel 4 kg ha-1</b>	3.09	12.64	72.16	144.78	179.93	188.15	1.05	5.1	30.46	55.33	91.22	127.14	1.98	4.44	30.79
<b>S.E (d)</b>	0.14	0.26	4.99	7.26	5.67	5.78	0.126	0.432	0.534	0.786	1.868	2.04	0.041	0.041	0.375
<b>C.D at 5%</b>	0.3	0.57	10.87	15.81	12.36	12.59	-	0.941	1.164	1.712	4.071	4.45	0.09	0.09	0.817

**Table 3: Effect of Irrigation and hydrogel on Economics of pearl millet**

TREATMENT	ECONOMICS			
	COST OF CULTIVATION (INR)	GROSS RETURN (INR)	NET RETURN (INR)	B : C RATIO
<b>IRRIGATION (No.)</b>				
2 IRRIGATION	18556.2	51260	32703.8	1.76
3 IRRIGATION	19556.2	54140	34583.8	1.77
4 IRRIGATION	20556.2	58600	38043.8	1.85
<b>HYDROGEL (kg/ha)</b>				
HYDROGEL 0 kg ha-1	16556.2	47860	31303.8	1.89
HYDROGEL 2 kg ha-1	18356.2	54600	36243.8	1.97
HYDROGEL 4 kg ha-1	20556.2	61320	40763.8	1.98
<b>INTERACTION</b>				
2 IRRIGATION + HYDROGEL 0 kg/ha	18556.20	47821.04	29264.84	1.58
2 IRRIGATION + HYDROGEL 2 kg/ha	20356.20	51903.01	31546.81	1.55
2 IRRIGATION + HYDROGEL 4 kg/ha	22156.20	58692.96	36536.76	1.65
3 IRRIGATION + HYDROGEL 0 kg/ha	19556.20	48815.93	29259.73	1.50
3 IRRIGATION + HYDROGEL 2 kg/ha	21356.20	56342.74	34986.54	1.64
3 IRRIGATION + HYDROGEL 4 kg/ha	23156.20	62217.04	39060.84	1.69
4 IRRIGATION + HYDROGEL 0 kg/ha	20556.20	51608.00	31051.80	1.51
4 IRRIGATION + HYDROGEL 2 kg/ha	22356.20	60715.85	38359.65	1.72
4 IRRIGATION + HYDROGEL 4 kg/ha	24156.20	69222.96	45066.76	1.87

higher plant height (cm) and Dry weight (g). While increasing dose of Hydrogel (H2) also contributed significantly higher plant height (188.15 cm) and Dry weight (127.14 g). Pre soil analysis showed available N, P and K as 187 kg ha<sup>-1</sup>, 12.9 kg ha<sup>-1</sup> and 186 kg ha<sup>-1</sup> respectively whereas post soil analysis revealed available N, P and K as 203.7 kg ha<sup>-1</sup>, 17.2 kg ha<sup>-1</sup> and 208.8 kg ha<sup>-1</sup> respectively. The increase in the plant height and may be due to supply of soil moisture around the root zone, which provided suitable micro environment for uptake and translocation of the nutrients which finally resulted in plant growth and development. (Saini *et al.*, 2018). Dry matter production means production of dry matter over a certain period of time which is essential for supply of photosynthates to sink. Significantly higher dry matter production was recorded in soil treated with hydrogel at different stages of crop. This concludes that hydrogel resulted in more dry matter production. Hydrogel increases water holding capacity of soil and nutrient supplying capacity of soil which finally increases growth and dry matter production (Saini *et al.*, 2016)

### Yield

Grain as well as stover yield varied significantly because various irrigation interval and application of 4 irrigation (I3) recorded up to 18.2 % and 9.9% higher grain yield than that of 2 irrigation (I1) and 3 irrigation (I2) respectively. Stover yield significantly higher under 4 irrigation (I3) (4.31 t/ha). In case of hydrogel, 4 kg/ha hydrogel application recorded significantly higher grain yield which fetched 34.6% more over no hydrogel application. Similar findings recorded in Stover yield due to application of hydrogel 4 kg/ha (4.44 t/ha) produced more biomass significantly over other hydrogel application. The higher seed and stover yields could be attributed to increased soil moisture coupled with accelerated nutrients uptake, which helped the plant to put optimum growth. Increase in seed and stover yields with an application of irrigation was reported by Fallahi *et*

*al.* (2015). The harvest index of pearl millet was increased by irrigation and hydrogel levels. As a well-established fact harvest index is more or less governed by genetic makeup of a plant and is not influenced much more by input supply system if crop is raised under recommended practices (Saini *et al.*, 2020).

### Economics

Economics includes cost of cultivation (INR), Gross return (INR), Net return (INR), and B: C Ratio. Least cost of cultivation was observed in 2 irrigation and 0 hydrogel kg/ha but, highest Gross return (INR 69222.96/ha), Net return (INR 450066.76/ha) and B: C Ratio (1.87) was recorded in 4 irrigation and 4 hydrogel kg/ha in table 3. whereas B: C Ratio (1.67), Net return (INR 66011/ha) was observed in treatment applied with 5 kg of hydrogel per ha and I3 (1.2 IW: CPE) (Saini *et al.*, 2020). Economics of different treatments changes according to availability of irrigation and hydrogel and other resources to the farmer.

### Conclusion

Pearl millet is mostly grown in arid and semi-arid regions. Hydrogel application and irrigation intervals during different critical stage of crop provide better growth and yield. It was observed that application of hydrogel and irrigation at different critical stages resulted in better plant height, dry weight, grain and stover yield in comparison to control. All these factors finally lead to increase in gross and net return. Some further study can also be done on different crops along with different dose of hydrogel and different irrigation management.

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