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Response of irrigation schedule, mulching and hydrogel on various growth analysis attributes and nutrient uptake of wheat (*Triticum aestivum* L.)

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Abstract
A field experiment was carried out during *Rabi* season of 2012-13 and 2013-14 at Varanasi to investigate the effects of irrigation schedules and moisture conservation practices on wheat (*Triticum aestivum* L.). The treatment combination were three irrigation schedule *viz.,* no irrigation, one irrigation at CRI and two irrigation at tillering and flowering and six moisture conservation treatments *viz.,* no hydrogel, 4t/ha mulch, 6 t/ha mulch, 2.5 kg hydrogel ha^{-1}, 5.0 kg hydrogel ha^{-1} and 7.5 kg hydrogel ha^{-1} were compared with four irrigation at CRI, tillering, late jointing and milk stage as control. Application of two irrigations at tillering and flowering (I_2) resulted in significant increase in CGR (g/m^2/day), RGR (g/g/day), leaf area index and nutrient uptake by crop than I_0 (no irrigation) and I_1 (one irrigation) treatments during both the years. The maximum CGR (g/m^2/day), RGR (g/g/day), leaf area index and nutrient uptake by crop were recorded with M_6 (7.5 kg hydrogel/ha), which was significantly higher than remaining treatments at all stages but it was at par with M_3 (6 t mulch/ha) and M_5 (5 kg hydrogel/ha) at most of the growth stages among moisture conservation practices.

Keywords: CGR**,** Hydrogel, Irrigation schedule, Mulching, Nutrient uptake and RGR

Introduction

Wheat (*Triticum aestivum* L.) is largest grown cereal in the world and it supplements around 19 per cent of our total calories. It satiates the food security and wide adaptability in different agro-climatic conditions. India entered the shadow zone of physical and economic water scarcity. Under this situation, only with the rational and scientific management of production inputs. However, a holistic strategy to evolve integrated solutions for multiple problems has been elusive. The vertical effort practices *viz.,* limited irrigation scheduling, application of mulches, antitranspirant and hydrophilic polymer increase the duration of moisture availability with an increase in the amount of available moisture in the soil. Scheduling of irrigation based on phenological stages (crown root, tillering, booting, anthesis, soft dough and hard dough stage) in wheat has been practical approach to the farmers.

Wheat response to water stress from stem elongation to booting, followed by anthesis and grain- filling stages (Dushouyu *et al.*, 1995) [4]. (The maximum plant height, LAI and highest tillers numbers/m^2 and total dry matter with five irrigation than no irrigation, two irrigations, three irrigations, four irrigation (Ali *et al.* 2012) [1]. Thus, limited irrigation at tillering and flowering stage of wheat can produce higher yields and saves water compare to more irrigation schedules on wheat (Shirazi *et al.,* 2014) [16]. Pahlavan *et al.* reported that in 2011 significantly influence of irrigation schedule on N, P and K content in wheat grains. Higher N, P and K content was found with five irrigations as compare to three irrigations.

Mulching has been proved to be useful in conserving moisture and increasing productivity of wheat. Straw mulch also provides benefit in terms of increasing infiltration rate**,** lowers the temperature improves fertilizer availability and increase crop yield (Singh *et al*., 2011) [17]. Mulches enhanced soil water status and improved growth and yield, which subsequently reducing runoff and evaporation losses. Application of rice straw mulch @ 4 t/ha effect significantly on growth attributes of crop (Sarwar *et al.,* 2013) [14].

Hydrogel is a semi-synthetic super absorbent polymer has shown the potential to realize more yield per drop of water (Khokhar *et al.*, 2010) [8]. Application of 5 kg/ha of hydrogel produced significantly higher grain yield with all the levels of irrigation (viz. no irrigation, two and four irrigations). Also, the equivalent yield of four irrigations with no hydrogel was obtained with only two irrigations when 5 kg/ha of hydrogel was applied (Anonymous, 2013) [2].

Therefore, the present study was undertaken to evaluate the effect of adequate and limited irrigation scheduled at critical stages with moisture conservation practices viz., mulching and hydrogel on growth analysis attributes and nutrient uptake by wheat.

Material and Methods

The field experiment was conducted at agricultural research farm of Banaras Hindu University, Varanasi, U.P., India, during 2012-13 and 2013-14. The soil was sandy clay loam in texture with a pH of 7.2. It was moderately fertile being low in mean organic carbon (0.35%) and available N 206.60 kg/ha, phosphorous 17.67 kg/ha, potash 238.0 kg/ha. The experiment was laid out in randomized block design (factorial experiment) with three replications. Treatments combination comprised of three irrigation schedules *viz.*, no irrigation, one irrigation at CRI and two irrigation at tillering and flowering and six moisture conservation treatments *viz.*, no hydrogel, 4t/ha mulch, 6 t/ha mulch, 2.5 kg hydrogel ha^{-1}, 5.0 kg hydrogel ha^{-1} and 7.5 kg hydrogel ha^{-1} were compared with four irrigation at CRI, tillering, late jointing and milk stage as control. Wheat variety HD 2733 was line sown at a row spacing of 22.5 cm. The seed rate was 125 kg/ha. A uniform basal rate of 60 kg N ha^{-1}, 60 kg P_2O_5 ha^{-1} and 40 kg K_2O ha^{-1} was applied in all the treatments combinations, except no irrigation which received 120 kg N/ha as basal with P_2O_5 and K_2O. Remaining half nitrogen was applied at 30 days after sowing in rest of the treatments. Quantity of irrigation water was measured with parshall flume to a depth of 5.0 cm and applied as per irrigation schedule. Among moisture conservation practices hydrogel was mixed with soil and applied in the band of seed line at the time of sowing and mulch was applied in inter row at 3 days after sowing. CGR (g/m^2/day), RGR (g/g/day) were recorded at 30, 60, 90 DAS and at harvest stage, but leaf area were recorded at 30, 60 and 90 DAS. CGR was the rate of the dry matter production per unit ground area per unit time and it was computed by using formula suggested by Watson (1952) [19]. Relative growth rate (g/g/day) was estimated for different periods by using the following formula suggested by Hoffmann and Poorter (2002) [5]. Leaf area index was computed by dividing the leaf area per unit land area as given by Sestak *et al*. (1971) [15]. The nitrogen, phosphorus and potassium contents in grain and straw of wheat were estimated at maturity stage with standard laboratory methods.

Result and Discussion

Growth analysis attributes

Crop growth rate (g/m^2/day)

Crop growth rate gradually increased up to 90 DAS and decreased at harvest during both years. The maximum crop growth rate was recorded from I_2 (two irrigations) which was significantly superior to I_1 (one irrigation) and I_0 (no irrigation), except at 30 DAS. At 30 DAS, I_1 (one irrigation) was significantly superior to I_0 (no irrigation) and I_2 (two irrigations), but I_0 (no irrigation) and I_2 (two irrigations) had no significant variation to each other during both years.

The maximum crop growth rate was recorded in M_6 (7.5 kg hydrogel/ha) which was on par to M_3 (6 t mulch/ha) and M_5 (5 kg hydrogel/ha) at 30 DAS, 90 DAS during 2013-14 and 60 DAS during 2012-13 and at harvest during both years and significantly superior to rest of the treatments. Data further reveal that M_3 (6 t mulch/ha) and M_5 (5 kg hydrogel/ha) did not differed significantly at all stages during both years. Simultaneously, M_5 (5 kg hydrogel/ha) was on par to M_4 (2.5 kg hydrogel/ha) at 60 DAS. Treatment M_4 (2.5 kg hydrogel/ha) had also significant higher with rest of treatments during both the years at 90 DAS.

Application four irrigations schedules versus remaining treatments had significant variation in crop growth rate with irrigation and moisture conservation practices at all stages during both the years.

Relative growth rate (g/g/day)

Relative growth rate gradually decreased up to harvest stage. At 30 DAS, I_1 (one irrigation) was significantly superior over I_0 (No irrigation) and I_2 (two irrigations) and I_0 (no irrigation) was at par with I_2 (two irrigations) during both the years. Whereas, I_2 (two irrigations) was significantly superior to I_0 (no irrigation) and I_1 (one irrigation) at 60 DAS during both the years and with harvest stage during 2012-13. I_0 (no irrigation) proved significantly superior to I_1 (one irrigation) I_2 (two irrigations) at 90 DAS during both the years.

Moisture conservation practices influenced the relative growth rate during both the years. However, it had no significant variation in RGR at 60 DAS during 2012-13 and at harvest during 2013-14. At 30 and 60 DAS, hydrogel at7.5 kg/ha (M_6) was significantly superior RGR than rest of treatments, except M_3 (6 t mulch/ha). Similarly, M_5 (5 kg hydrogel/ha) was at par with M_3 (6 t mulch/ha) and M_4 (2.5 kg hydrogel/ha) during both the years. At, 90 DAS, M_4 was significantly superior to M_6 during 2013-14.Treatment M_2 (4 t mulch/ha) had significantly higher RGR than M_1 (no moisture conservation practice) at 30 DAS during both years, was at par with M_1at later stages.

With application four irrigations schedules (control) versus remaining treatments had no significant variation in relative growth rate with irrigation and moisture conservation practices at 60 DAS, 90 DAS and at harvest during both the years, except at 60 DAS during 2012-13.

Leaf area index

Maximum leaf area index was recorded in I_2 (two irrigations) and was significantly superior to I_1 (one irrigation) and I_0 (no irrigation) at all growth stages, except at 30 DAS where I_1 (one irrigation) was significantly superior over I_0 (no irrigation) but remained on par to I_2 (two irrigations) in this respect (Table 2).

The maximum leaf area was recorded with M_6 (7.5 kg hydrogel/ha) at all growth stages during both years. It was statistically on par with M_3 (6 t mulch/ha) and M_5 (5 kg hydrogel/ha), except at 60 DAS during 2013-14. Similarly, M_5 (5 kg hydrogel/ha) was statistically at par with M_3 (6 t mulch/ha) at all stages and with M_4 (2.5 kg hydrogel/ha) and M_2 (4 t mulch/ha) at all the stages except at 30 DAS during 2012-13. Four irrigations schedule was significantly superior to I_2 (two irrigations) at 30 DAS during both the years and at harvest stage during 2013-14.

Increase in growth parameters at higher moisture regime might be due to maintenance of adequate and continuous moisture to plant which maintained good establishment of roots and various metabolic processes (Dushouyu *et al.*, 1995 & Jalilian and Mohsennia, 2013) [4, 7]. The increase in CGR, RGR and leaf area index and leaf might be due to fact that sufficient availability of moisture increased the absorption of nutrients and resulted in fully turgid and higher number of green leaves with enlarged size which led to higher plant height, dry matter accumulation (Arnon, 1972) [3]. Similar result was recorded by Ali, 2012 [1] and Sarwar *et al.*, 2013 [14].

Table1: Effect of irrigation schedules and moisture conservation practices on CGR (g/m2/day) and RGR (g/g/day) at different stages of crop

Treatments	CGR (g/m^2/day)								RGR (g/g/day)							
	30 DAS		60 DAS		90 DAS		At harvest		30 DAS		60 DAS		90 DAS		At harvest	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Irrigation schedules																
I_0 (No irrigation)	0.98	1.08	1.92	1.93	2.14	2.57	1.20	1.19	0.049	0.050	0.015	0.015	0.008	0.009	0.003	0.003
I_1 (One irrigation)	1.14	1.32	2.04	2.17	2.22	2.66	1.48	1.36	0.051	0.053	0.016	0.015	0.008	0.008	0.004	0.003
I_2 (Two irrigations)	0.98	1.09	2.59	3.03	2.19	2.63	1.74	1.43	0.049	0.050	0.019	0.019	0.007	0.007	0.004	0.003
SEm±	0.00	0.01	0.02	0.01	0.03	0.02	0.02	0.02	0.00004	0.00011	0.00009	0.00011	0.00008	0.00004	0.0001	0
CD (0.05)	0.01	0.02	0.03	0.03	0.05	0.03	0.05	0.04	0.00008	0.00022	0.00018	0.00023	0.00017	0.00009	0.0001	NS
Moisture conservation practices																
M_1 (Nothing used)	0.97	1.07	2.07	2.25	2.05	2.57	1.47	1.25	0.049	0.050	0.017	0.017	0.008	0.008	0.004	0.003
M_2 (4 t mulch/ha)	1.03	1.17	2.16	2.36	2.24	2.67	1.47	1.31	0.050	0.051	0.016	0.016	0.008	0.008	0.004	0.003
M_3 (6 t mulch/ha)	1.06	1.22	2.24	2.42	2.14	2.57	1.47	1.35	0.050	0.052	0.016	0.016	0.007	0.008	0.004	0.003
M_4 (2.5 kg hydrogel/ha)	1.02	1.14	2.17	2.30	2.26	2.71	1.42	1.33	0.050	0.051	0.016	0.016	0.008	0.008	0.003	0.003
M_5 (5 kg hydrogel/ha)	1.04	1.18	2.23	2.40	2.19	2.63	1.47	1.38	0.050	0.051	0.017	0.016	0.007	0.008	0.003	0.003
M_6 (7.5 kg hydrogel/ha)	1.07	1.20	2.21	2.54	2.21	2.58	1.53	1.34	0.050	0.052	0.016	0.016	0.008	0.008	0.004	0.003
SEm±	0.01	0.02	0.03	0.03	0.05	0.03	0.05	0.04	0.00008	0.00021	0.00018	0.00022	0.00016	0.00009	0.0001	0.0001
CD (0.05)	0.02	0.04	0.06	0.06	0.10	0.07	0.09	0.07	0.00017	0.00043	NS	0.00045	0.00033	0.00018	0.0002	NS
I×M	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C (Four irrigations)	1.06	1.37	2.43	2.89	2.26	2.52	1.48	1.29	0.050	0.054	0.017	0.016	0.007	0.006	0.003	0.003
SEm±	0.03	0.07	0.12	0.10	0.19	0.13	0.17	0.13	0.0003	0.0008	0.0007	0.0009	0.0006	0.0003	0.0005	0.0003
CD (0.05)	0.06	0.14	0.23	0.21	0.38	0.25	0.35	0.27	0.00064	0.0016	0.0014	0.0017	0.0013	0.00067	0.0009	0.0006

Table 2: Effect of irrigation schedules and moisture conservation practices on LAI and nutrient content (%) at different stages of crop

Treatments	LAI (%)						Nutrient content											
	30 DAS		60 DAS		90 DAS		N in grain		P in grain		K in grain		N in straw		P in straw		K in straw	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013- 14	2012-13	2013-14	2012-13	2013-14
Irrigation schedules																		
I_0 (No irrigation)	1.56	1.64	1.88	1.91	2.25	2.27	1.87	1.86	0.33	0.32	0.58	0.58	0.47	0.55	0.07	0.07	1.15	1.19
I_1 (One irrigation)	1.73	1.8	2.18	2.14	2.92	2.84	1.86	1.86	0.34	0.35	0.55	0.57	0.47	0.52	0.07	0.07	1.10	1.10
I_2 (Two irrigations)	1.56	1.65	2.24	2.28	2.84	3.07	1.86	1.86	0.35	0.36	0.53	0.55	0.47	0.46	0.07	0.08	1.04	0.94
SEm±	0.010	0.01	0.01	0.01	0.02	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.0002	0.002	0.0002	0.0001	0.003	0.003
CD (0.05)	0.02	0.01	0.03	0.01	0.03	0.02	0.001	NS	0.002	0.002	0.002	0.002	0.0004	0.003	0.0004	0.0003	0.005	0.006
Moisture conservation practices																		
M_1 (Nothing used)	1.47	1.62	1.94	2.04	2.47	2.6	1.86	1.87	0.34	0.33	0.54	0.57	0.47	0.52	0.07	0.07	1.10	1.03
M_2 (4 t mulch/ha)	1.63	1.69	2.07	2.07	2.63	2.69	1.86	1.86	0.34	0.34	0.54	0.57	0.47	0.51	0.07	0.07	1.10	1.05
M_3 (6 t mulch/ha)	1.65	1.73	2.12	2.14	2.7	2.76	1.86	1.86	0.34	0.34	0.55	0.57	0.47	0.51	0.07	0.07	1.10	1.07
M_4 (2.5 kg hydrogel/ha)	1.62	1.7	2.14	2.12	2.72	2.76	1.86	1.86	0.34	0.34	0.55	0.57	0.47	0.51	0.07	0.07	1.10	1.08
M_5 (5 kg hydrogel/ha)	1.67	1.71	2.15	2.13	2.73	2.77	1.86	1.86	0.34	0.35	0.56	0.57	0.47	0.51	0.07	0.07	1.10	1.10
M_6 (7.5 kg hydrogel/ha)	1.67	1.73	2.18	2.17	2.77	2.76	1.86	1.87	0.35	0.35	0.56	0.57	0.47	0.52	0.07	0.07	1.09	1.12
SEm±	0.01	0.03	0.01	0.03	0.02	0.001	0.002	0.002	0.002	0.002	0.002	0.0004	0.003	0.0004	0.0003	0.005	0.006	0.010
CD (0.05)	0.030	0.050	0.030	0.070	0.050	0.003	0.004	0.004	0.004	0.004	NS	0.001	0.007	0.001	0.001	0.011	0.012	0.030
I×M	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C (Four irrigations)	1.8	1.77	2.28	2.24	2.97	3.07	1.86	1.86	0.35	0.35	0.53	0.55	0.47	0.50	0.07	0.08	1.04	0.91
SEm±	0.08	0.05	0.1	0.05	0.12	0.09	0.006	0.007	0.007	0.008	0.007	0.006	0.001	0.013	0.001	0.001	0.020	0.023
CD (0.05)	0.16	0.09	0.2	0.11	0.25	0.18	0.011	0.015	0.014	0.016	0.014	0.013	0.003	0.025	0.003	0.002	0.040	0.046

Table 3: Effect of irrigation schedules and moisture conservation practices on total nutrient uptake (kg/ha) at different stages of crop

Treatments	Total Nutrient uptake (kg/ha)					
	Nitrogen		Phosphorus		Potassium	
	2012 -13	2013 - 14	2012 -13	2013 – 14	2012 -13	2013 - 14
Irrigation schedules						
I_0 (No irrigation)	58.94	64.08	10.05	10.20	46.41	49.98
I_1 (One irrigation)	75.29	83.67	13.17	14.58	56.72	62.36
I_2 (Two irrigations)	90.24	97.43	16.23	18.13	64.46	66.26
SEm±	0.64	0.44	0.12	0.09	0.46	0.32
CD (0.05)	1.29	0.89	0.25	0.18	0.93	0.64
Moisture conservation practices						
M_1 (Nothing used)	65.67	74.09	11.42	12.61	48.63	52.88
M_2 (4 t mulch/ha)	75.06	80.79	13.21	13.98	56.18	58.17
M_3 (6 t mulch/ha)	76.89	83.72	13.52	14.59	57.42	60.60
M_4 (2.5 kg hydrogel/ha)	76.65	83.42	13.37	14.57	56.98	60.83
M_5 (5 kg hydrogel/ha)	76.98	84.43	13.61	15.02	57.80	62.00
M_6 (7.5 kg hydrogel/ha)	77.70	83.93	13.79	15.05	58.17	62.71
SEm±	1.28	0.87	0.24	0.18	0.92	0.63
CD (0.05)	2.59	1.77	0.50	0.36	1.87	1.28
I×M	NS	NS	NS	NS	NS	NS
C (Four irrigations)	91.33	97.08	16.39	17.69	65.27	65.53
SEm±	4.82	3.30	0.92	0.67	3.47	2.38
CD (0.05)	9.77	6.69	1.87	1.35	7.05	4.83

Effect on nutrient content (%)

Irrigation schedules impose a greater demand for nutrients content and their uptake. In present experiment the maximum nitrogen and potash content were recorded from no irrigation (I_0) which was significantly superior to I_1 (one irrigation) and I_2 (two irrigation) (Table 2). The maximum phosphorous content was recorded from I_2 (two irrigation), which was significantly superior to I_1 (one irrigation) and I_0 (no irrigation) during both the years (Table 2).

The maximum N and K content recorded in M_1 (No moisture conservation practice) compare to M_3 (6 t mulch/ha) and M_2 (4 t mulch/ha). However, phosphorous content was recorded significantly higher due to application of M_3 (6 t mulch/ha) than M_2 (4 t mulch/ha) and no mulch.

Rainfed crop of wheat had high nitrogen content of grain compare to irrigated crop (Rahman *et al*., 2001) [12]. Nitrogen and potash content in grain decreased with increasing frequency of irrigation as compared to no irrigation. This may be attributed to higher amount of dry matter production resulting in dilution under more irrigation (Mehta *et al*., 1982) [9]. Phosphorous absorption by plant directly depends on the concentration of the soil solution which in turn regulated by the liable pool. Similar results were also reported by Parihar and Tiwari (2003) [11].

Effect of irrigation schedules and moisture conservation practices nutrient uptake (kg/ha)

Total Nitrogen uptake (kg/ha)

The data on nitrogen uptake as influenced by different experimental variables are presented in Table 3. The maximum nitrogen uptake was recorded from I_2 (two irrigations), which was significantly superior to I_1 (one irrigation) andI_0 (no irrigation) during both years.

Hydrogel 7.5 kg/ha had significantly higher nitrogen uptake than M_1 and M_0, and was at par with M_5 (5 kg hydrogel/ha), M_4 (2.5 kg hydrogel/ha) and M_3 (6 t mulch/ha) during both the years. Similarly, no significant variation was recorded among M_5 (5 kg hydrogel/ha), M_4 (2.5 kg hydrogel/ha) and M_3 (6 t mulch/ha) during both the years but these were significantly superior to M_1 and M_2 during both years.

Data revealed that N uptake in control (four irrigations) was significantly higher than I_0 (no irrigation), I_1 (one irrigation) and on par to I_2. Further, it is clear from the data that none of the moisture conservation practices reached to the level of control in N uptake during both the years.

Total phosphorous uptake (kg/ha)

The maximum phosphorous uptake was recorded from I_2 (two irrigations), which was significantly superior to I_1 (one irrigation) and I_0 (no irrigation) during both the years. I_1 (one irrigation) was also significantly superior over I_0 (no irrigation) during both the years.

Moisture conservation practices exhibited significant variation in phosphorous uptake during both years. Treatment M_6 (7.5 kg hydrogel/ha) was significantly superior in phosphorous uptake over rest of treatments, exceptM_5 (5 kg hydrogel/ha) during both the years and was at par withM_4 (2.5 kg hydrogel/ha) and M_3 (6 t mulch/ha) during 2012-13. However, M_5 (5 kg hydrogel/ha), M_4 (2.5 kg hydrogel/ha) and M_3 (6 t mulch/ha) were on par to each other during 2012-13. However, four irrigations had significantly higher phosphorous uptake than no irrigation, one irrigation and also than M_1 (no moisture conservation practice), M_2 (4 t mulch/ha) M_3 (6 t mulch/ha) and M_4 (2.5 kg hydrogel/ha) and M_5 (7.5 kg hydrogel/ha) during both the years.

Total potassium uptake (kg/ha)

The maximum potash uptake was recorded from I_2 (two irrigations), which was significantly superior to I_1 (one irrigation) and I_0 (no irrigation) during both the years (Table 3).

Among various moisture conservation, application of M_6 (7.5 kg hydrogel/ha) had significantly higher potassium uptake than rest of treatments during 2013-14 except M_5 (5 kg hydrogel/ha) during both years, and M_3 (6 t mulch/ha) and M_4 (2.5 kg hydrogel/ha) during 2012-13. Similarly, M_5 (5 kg hydrogel/ha) was on par to M_3 (6 t mulch/ha) and M_4 (2.5 kg hydrogel/ha) during 2012-13. Comparison between control (four irrigations) versus rest of treatments indicate that four irrigation recorded significantly higher K uptake than no and one irrigation and M_1 (no moisture conservation practice) and M_2 (4 t mulch/ha) during both the years.

The maximum N, P and K uptake were recorded from I_2 (two irrigation), which was significantly superior to I_1 (one

irrigation) and I_0 (no irrigation) but four irrigation was superior (Table 3). It might be due to increase moisture supplying capacity of soil enhance the better root establishment, better absorption and translocation of nutrients from the soil, vigorous plant growth and higher grain and straw yield. Adequate moisture in the root zone of rhizosphere increased the movement of nutrient in soil solution and finally their absorption by growing plants. These results are similar to Dubey and Sharma findings (1996). It was easily absorbed and reduces the nitrogen losses to reduce evapo-transpiration. Thus, mulching enhance absorption that ultimately increased uptake (Singh and Yadav, 2006) [18].
Moisture conservation practices also produced significant variation in CGR, RGR, LAI, and nutrient uptake at different stages of observations during crop years. This might be due to more moisture storage after irrigation in the respective mulched plots and proper utilization of nutrients from soil (Singh & Yadav, 2011) [17]. Hydrogel improves physical properties of soil, seed germination, seedling emergence rate, root growth and density that help plants to prolonged moisture stress (Rostampour, 2013 and Huang *et al.*, 2005) [13, 6]. Hydrogel had positive correlation with nitrogen and it is needed for the formation of chlorophyll, phosphorus for the synthesis of nucleic acid and similarly potassium is important for the growth and elongation probably osmotic regulator which is responsible for growth and improve their uptake.

Conclusion
It is concluded from the present study that four irrigations are optimum for wheat. But, under limited water condition, two irrigation in combination with 7.5 kg hydrogel/ha can be better for growth attributes and higher nutrient uptake by crop. It is a viable option for water conservation in wheat cultivation.

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