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Efficacy of hydrogel on wheat (*Triticum aestivum* L.) growth and yield under different levels of irrigation

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Abstract
For efficient yield of any crop proper crop Irrigation is an important factor. Rainfall and irrigation are the two main sources of water in agriculture Current scenario of climate results in destructing rainfall pattern leading to different water stress. In some part of U.P, especially eastern U.P will face in temperature (3 to 5ºc up to 2050) as per SAPCC, due to increase in rate of transpiration that will rise demand. To cope up with coming situation the experiment was conducted at Central Agricultural field, Sam Higginbottom University of Agriculture, Technology & Sciences, U.P on wheat variety (HD-2967). Hydrogel and Chitosan were taken under different concentration to evaluate the Efficacy of Pusa Hydrogel on Wheat (*Triticum aestivum* L.) Growth and Yield Under Different Levels of Irrigation and Chitosan. Retaining the water in soil and by reducing the loss of water through stomata is the aspect to be considered to deal with such arriving future. Superabsorbent polymer can absorb large quantities of water and retain in soil and Antitranspirant may reduce the loss of water via transpiration. Hydrogel (75%) and Chitosan (100%, 75% and 50%) with twenty-five treatments and three replications along with control were laid out in randomized block design Result on crop growth and yield under water deficit condition was observed Treatment T_1 (100% HG and 100% CHT) showed best results, however T_2 was statistically at par with T_1, whereas comparing with control T_0 (100% IR 70 Lit +NO SAP +NO AT.

Keywords: hydrogel, chitosan, water scarcity, level of irrigation

Introduction

Water is most importantly used for irrigation in agriculture which is key component to produce food. Irrigation accounts for more than 70% of total water withdrawals on a global basis. Statistics exhibited that 25% of the world's agricultural land is now influenced by high levels of water stress (Alaei *et al.*, 2010) [2]. Water stress is connected with almost all aspects of biology and plant growth It should pointed out that drought is one of the major causes of crop loss worldwide, which commonly reduces average yield for many crop plants by more than 50% (Shao *et al.*, 2005) [19]. In some part of U.P, especially eastern U.P will face in temperature (3 to 5ºc up to 2050) as per SAPCC which directly affects on agriculture production. Food productivity is decreasing due to the effect of various abiotic stresses therefore minimizing these loses is a major area of concern for all nations to cope with the increasing food requirements.

Wheat is the leading crop of the temperate climates of the world and a unique world food grain and its grown on about 200 Million ha in a range of environments, with an annual production of more than 600 million metric tons (Plaut *et al.*, 2004) [17]. On the other hand, global wheat production must continue to increase 2% annually until 2020 to meet future demands of imposed population and prosperity growth (Karam *et al.*, 2009) [9]. There are various management practices through which water soil relationship can be maintained to make plant withstand water stress condition.

Hydrogel is one of the most popular, having also been used to reduce water runoff and increase infiltration rates in field agriculture, in addition to increasing water holding capacity for agricultural applications (Sharma, 2004) [20]. The use of hydrogels led to the significant decrease in the number of irrigations, especially for the soils with large-scale texture (Koupai and Sohrab, 2004) [1].

Antitranspirants are chemical compounds whose role is to train plants by gradually hardening them to stress as a method of reducing the impact of drought. There are different types of antitranspirants: film-forming which stops almost all transpiration; stomatic, which only affects the stomata; reflecting materials (Nasraui, 1993) [16]. Reducing transpiration can play a useful role in this respect by pre-venting the excessive loss of water to the atmosphere via stomata. The objective of this study was to understand the relationship of hydrogel applied to soil for better yield of wheat under different level of irrigation and chitosan.

Materials and Methods

Wheat variety (HD-2967), a local variety is taken as an experimental crop with different irrigation levels & chitosan. over all 25 treatments (Table 1) has been undertaken with soil application hydrogel (7kg/ha). Different growth and yield parameters have been recorded & stastically analysed during the course of study

Table 1: Treatment Details

Treatments	Treatment combination
T_0	100% IR 70 Lit +NO SAP +NO AT
T_1	80%IR (56 Lit) +100%AT (250ppm) +75%HG (1 gm)
T_2	80%IR (56 Lit) +100%AT (250ppm) +NO SAP
T_3	80%IR (56 Lit) +75%AT (187ppm) +75%HG (1 gm)
T_4	80%IR 56 Lit +75%AT (187ppm) + NO SAP
T_5	80%IR (56 Lit) +50%AT (125ppm) + 75%HG (1 gm)
T_6	80%IR (56 Lit) +50%AT (125ppm) + NO SAP
T_7	80%IR (56 Lit) +NOAT +75%HG (1 gm)
T_8	80%IR (56 Lit) + NOAT +NO SAP
T_9	60%IR (42 Lit) +100%AT (250ppm) +75%HG (1) gm
T_{10}	60%IR (42 Lit) +100%AT (250ppm) + NO SAP
T_{11}	60%IR (42 Lit) +75%AT (187ppm) +75%HG (1 gm)
T_{12}	60%IR (42 Lit) +75%AT (187ppm) + NO SAP
T_{13}	60%IR (42 Lit) +50%AT (125ppm) +75%HG (1. gm)
T_{14}	60%IR (42 Lit) +50%AT (125ppm) +NO SAP
T_{15}	60%IR (42 Lit) + NOAT+75%HG (1 gm)
T_{16}	60%IR (42 Lit) + NOAT+NO SAP
T_{17}	40%IR (28 Lit) +100%AT (250ppm) +75% SAP (1 gm)
T_{18}	40%IR (28 Lit) + 100%AT 250ppm + NOSAP
T_{19}	40%IR (28 Lit) +75%AT (187ppm) +75%HG (1 gm)
T_{20}	40%IR (28 Lit) +75%AT (187ppm) +NO SAP
T_{21}	40%IR (28 Lit) +50%AT (125ppm) +75%HG (1 gm)
T_{22}	40%IR (28 Lit) +50%AT (125ppm) +NO SAP
T_{23}	40%IR (28 Lit) +NOAT +75% SAP (1 gm)
T_{24}	40%IR (28 Lit) +NOAT+ NOSAP

Results and Discussion

For plant height which were treated with Hydrogel and Chitosan are showing better result in comparison to water deficit condition. when compared with Control (100% IR 70 Lit +NO SAP +NO AT) (37.9). Maximum plant height was observed in T_1 (82.6 cm) whereas, Minimum plant height was observed in T_{24} (54.8 cm) Table No:2 Hydrogel have been reported to increase the activity of cell division, cell expansion and cell elongation, ultimately leading to an increased plant height (Singh *et al.*, 2015) [21]. Similar results have been reported by (Sivalapan 2001) in soybean and (Kumaran *et al.*, 2001) [15] in tomato. For Number of Tillers (per hill) all the treatments under water deficit condition Over the stress treatments, stress imposed at vegetative caused decline of 19.11% in tillers as compared to nonstresses condition. When compared with Control (100% IR 70 Lit +NO SAP +NO AT) (8.48). Maximum Number of Tillers was observed in T_1 (10.02) whereas, Minimum Number of Tillers was observed in T_{24} (5.62 per/hill) Table No:2. Similar to present findings (Kimurto *et al*., 2003) [13] and (Baque *et al*., 2006) [3] have reported that water stress at tillering significantly affected the formation of tillers in wheat. For flag leaf length and flag leaf width all the treatments under water deficit condition. when compared with Control (100% IR 70 Lit +NO SAP +NO AT) (11.76) Maximum Flag Leaf Length was observed in T_1 (15.21 cm) whereas, Minimum Flag Leaf Length was observed in T_{24} (6.23 cm) Table No.1.2. compared with Control (100% IR 70 Lit +NO SAP +NO AT) (2.02) Maximum Flag Leaf Width was observed in T_1 (2.85 cm) whereas, Minimum Flag Leaf Width was observed in T_{24} (1.91 cm) Table No:2. The decreasing in grain number was linked with reduced leaf area and lower photosynthesis as outcome of drought stress (Fischer *et al.* 1980) [4].

For spike length per spike and number of spikelets per spike all the treatments which were treated with Hydrogel and Chitosan were showing better result in comparison to water deficit condition. when compared with Control (100% IR 70 Lit +NO SAP +NO AT) (7.24). Maximum Spike Length was observed in T_1 (17.31cm) whereas, Minimum Spike Length was observed in T_{24} (5.55 cm) Table No. 1.2. compared with Control (100% IR 70 Lit +NO SAP +NO AT) (14.26). Number of Spikelet's was observed in T_1 (20.20 per spike whereas, Minimum Number of Spikelet's was observed in T_{24} (8.20 per spike) Table No:3. The decrease in stem height and ear length due to water stress has been reported earlier in wheat (Iqbal *et al*., 1999) [8]. Water stress during vegetative and reproductive development had an equal suppressive effect on number of spikelet's per spike in four wheat varieties (Qadir *et al*., 1999) [18]. The results of this conform to the findings of (Karim *et al*., 2000) [10] and (Baque *et al.,* 2006) [3] who reported that water stress reduced grain yield by reducing productive tillers, fertile spikelet, number of grains per plant and individual grain weight. (Khanzada *et al*., 2001a) [12] found that pod length in guar genotypes decreased significantly with application of water stress when compared with control. (Qadir *et al*., 1999) [18] also found that water stress reduced the spikelet per spike in wheat. grain yield, harvest index all the treatments in which Hydrogel and chitosan is applied were showing better results in comparison to water deficit condition Maximum Grain yield was observed in T_1 (89.1 q/ha^{-1}) whereas, Minimum Grain Yield was observed in T_{24} (21.12 q/ha^{-1}). Maximum harvest index was observed in T_1 (211.99 %) whereas, Minimum Harvest index was observed in T_{24} (46.0). Table No: 3. Due to water shortage, the ability of absorbing nutrients, composing and transferring assimilate is decreased that leads to a reduction in biological yield (Kisman, 2003) [14]. The results of many researches show that drought stress at different stages of the growth wheat under different levels Irrigations and Chitosan. lead to a reduction in the yield of biomass, grain yield, harvest index and grain yield components wheat under different levels Irrigations and Chitosan. (Gooding *et al.*, 2003) [7], (Garcia *et al.*, 2003) [5], and (Zaharieva *et al*., 2001) [23]. The results of other researchers also show that harvest index will decrease in the treatments under drought stress due to the effect of drought stress on grain yield (Gebeyehu, 2006) [6]. 1000 grain weights of all the treatments which were treated with Hydrogel and Chitosan were showing better result in comparison to water deficit condition (60% IR with no HG and CHT). (Gooding *et al.*, 2003) [7] in their studies on intensity and duration of water stress on wheat reported that drought stress reduced grain yield and 1000-grain weight by shortening the grain formation period. (Khan *et al*., 2005) [11] and (Qadir *et al*., 1999) [18] who observed that 1000-grain weight wheat under different levels Irrigations and Chitosan. was reduced mainly due to increasing water stress.

Table 2: Efficacy of Pusa hydrogel on plant height (cm), number of tillers (per hill), flag leaf length (cm) and flag leaf width (cm) of wheat under different levels of irrigation and chitosan

Treatments	Plant height (cm)	No. of tillers per hill	Flag Leaf Length (cm)	Flag Leaf Width (cm)
T_0	69.3	8.26	11.76	2.02
T_1	82.6	10.95	15.21	2.85
T_2	76.9	9.46	14.67	2.47
T_3	74.9	9.38	14.31	2.45
T_4	74.1	8.95	13.63	2.28
T_5	71.0	8.63	13.61	2.22
T_6	70.6	8.55	13.37	2.21
T_7	69.3	8.45	12.15	2.05
T_8	69.2	8.15	11.55	1.99
T_9	67.5	8.02	10.23	1.99
T_{10}	67.2	7.77	10.19	1.98
T_{11}	65.4	7.73	9.83	1.97
T_{12}	65.3	7.42	9.81	1.86
T_{13}	65.2	7.33	9.65	1.80
T_{14}	64.8	7.09	9.53	1.77
T_{15}	64.7	6.96	9.13	1.76
T_{16}	64.1	6.9	9.11	1.75
T_{17}	64.0	6.76	8.55	1.74
T_{18}	63.8	6.74	8.13	1.73
T_{19}	61.9	6.52	7.85	1.68
T_{20}	61.6	6.21	7.39	1.47
T_{21}	61.2	6.14	7.37	1.43
T_{22}	60.4	6.02	6.91	1.40
T_{23}	57.3	5.83	6.77	1.39
T_{24}	54.8	5.62	6.23	1.21
Mean	66.68	7.59	10.26	1.91
C.D.	0.224	0.614	0.044	0.052
SE(m)	0.079	0.216	0.016	0.018
F-test	Significant	Significant	Significant	Significant

Table 3: Efficacy of hydrogel on Spike length (cm), Number of spikelet (per spike), grain yield(q/ha), harvest index(%) of wheat under different levels of irrigation and chitosan

Treatments	Spike length (cm)	Number of spikelet's/spikes	Grain yield (q/ha^{-1})	Harvest index (%)
T_0	7.24	14.26	32.68	171.46
T_1	17.31	20.20	89.19	211.99
T_2	14.41	18.20	65.97	206.35
T_3	10.61	15.93	47.77	202.16
T_4	8.53	15.80	40.17	170.43
T_5	8.45	15.60	39.97	175.08
T_6	8.13	15.40	39.47	206.97
T_7	7.53	15.20	33.87	177.98
T_8	7.19	13.80	32.37	177.56
T_9	7.11	13.60	31.67	205.25
T_{10}	6.95	12.60	31.43	214.25
T_{11}	6.91	11.73	31.28	219.82
T_{12}	6.85	11.60	30.27	214.23
T_{13}	6.61	11.53	28.28	201.00
T_{14}	6.47	11.20	27.93	199.93
T_{15}	6.45	11.00	27.87	199.50
T_{16}	6.39	10.93	27.4	207.58
T_{17}	6.31	10.80	27.33	211.86
T_{18}	6.23	10.60	25.86	201.56
T_{19}	5.87	10.53	25.43	208.96
T_{20}	5.81	9.93	23.91	199.75
T_{21}	5.79	9.73	23.74	201.70
T_{22}	5.77	9.00	23.33	202.17
T_{23}	5.69	8.73	22.33	195.36
T_{24}	5.55	8.20	21.12	188.40
Mean	7.61	12.64	33.99	198.85
C.D.	0.029	0.162	18.196	4.267
SE(m)	0.010	0.057	6.390	1.499
F-test	Significant	Significant	Significant	Significant

Conclusion

Under Agro climatic condition of Allahabad This study may conclude that T_1 is performing best for all the absorbed parameters with maximum yield **(**89.19 q/ha^{-1}) Minimum performance was showed by T_{24} yield **(**21.12q/ha^{-1}) Recommendation: T_1, T_2, T_3, T_4, T_5, T_6, T_7. from all treatments are performing well, according to requirement and retention capacity of the soil any of these treatments can be adopted by the farmer. On the basis of cost benefit analysis following treatments are performing better comparison to T_0, thus on the basis of soil condition and availability of water any of these can be adopted by the farmer.

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