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Efficacy of hydrogel and chitosan on wheat (*Triticum aestivum* L.) physio-biochemical and economical yield parameters under deficit irrigation level

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Abstract
In India natural sources of water for irrigation is rainfall or by using artificial resources. Apart from that now rainfall pattern leading to unpredictable changes due to climate change and global warming. Based on experimentation at New Delhi, India has reported that a 1ºc rise in temperature throughout the growing period will reduce wheat production by 5 million tonnes. Wheat is most sensitive to drought stress. Water stress at this stage is substantially impact on yield. 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 effect of hydrogel and chitosan on Physio-Biochemical, and Economical yield of wheat under water deficit irrigatipon level as hydrogel can retain large quantity of water and chitosan can reduce transpirational loss of water. Hydrogel (100%, 75%, 50% and 25%) and Chitosan (100%, 75% and 50%) with twenty-one treatments and three replications along with control were laid out in randomized block design. Physio-Biochemical and yield parameters were observed. Result on crop Physio-Biochemical and yield under water deficit condition was observed. Treatment T_9 (100% HG and 100% CHT) showed best results, however T_{10} was statistically at par with T_9, while T_{11} was found non-significant with T_0.

Keywords: Pusa hydrogel, chitosan, water scarcity, growth, yield

Introduction
Water is becoming increasingly scarce worldwide. Aridity and droughts are the natural causes for scarcity. Agriculture is therefore forced to find new approaches to cope with water scarcity but adopting sustainable water use issues (Allen, R.G., 1997). Climate impacts and adaptation strategies are increasingly becoming major areas of scientific concern, e.g. impacts on the production of crops such as maize, wheat and rice (Howden and Leary., 1997) [9].

Although population growth is generally expected to slow in the coming decades, median forecasts typically assume that the world population will grow close to another 50% above the recent milestone of 7 billion people (United Nations, 2008).

Drought is a normal recurrent feature of Climate & occurs in all climatic regiones and is usually characterized in terms of its spatial extension, intensity & duration (Rizwana *et al.*,) Drought is generally considered to be occurring when the principle monsoon, i.e. southwest monsoon & north cost monsoon, fail or are deficient or scanty. (GOI, 2000) [18].

Wheat (*Triticum aestivum* L) is the most extensively grown cereal crop in the world, covering about 237 million hectares annually, accounting for a total of 420 million tonnes (Olabanji *et al.*, 2004) and for at least one-fifth of man's calorie intake (Olabanji *et al.*, 2004).

The position of wheat is crucial in daily food consumption due to its absolute baking performance in contrast to all other cereals (Dewettinck *et al.*, 2008) [2] and is the best source for feeding humans (Mesbah, 2009) [16]. Due to water stress, wheat yield, as well as the quality of wheat, is affected (Moharram and Habib, 2011) [17]. So, the time has come to improve water availability on one hand, and on the other to evolve wheat varieties that can withstand water stress without compromising quality.

To cope with water scarcity two different technologies have been used like-water saving or water retention capacity and reducing transpiration through formation waxy coating layer on the leaf surface.

These problems require the use of an integrated approach that includes agronomic water-saving techniques, and appropriate management practices (Yu *et al.*, 2011) [26].

The use of water absorbing polymers (i.e., hydrogels) or superabsorbent polymers (SAPs) such as polyacrylates cross-linked with polyacrylamides (PAM) can effectively improve the top soil's ability to store water available for plant growth and production (Yu *et al.*, 2011) [26], and reduce seepage of water, and fertilizer and heavy metal leaching down the soil profile (Qu and Varennes, 2009) [21].

Hydrogel is a semi-synthetic, cross linked, derivatized cellulose-graft-anionic polyacrylate super absorbent polymer. (Success Story, 2012) [22]. Optimized absorption release ratio under load (AUL) Gradual biodegradability without formation of toxic products HG -neutrality after swelling in water. (Success Story, 2012) [22]

A balance between leaf HG photosynthesis and transpiration can be achieved by adjusting the stomatal behaviour to the optimal status using exogenous substances (antitranspirants), which lead to an increase in water use efficiency (WUE) at the leaf level. Application methods using antitranspirants have been proposed to reduce water loss and enhance the water status of plants. (Lipe and Wendt, 2008) [14].

Chitosan is an antitranspirant compound that has proved to be effective in many crops (Karimi *et al.*, 2012). Can help to preserve water resources use in agriculture (Bittelli *et al.*, 2001). Under chitosan application plant reacts to water deficit with a rapid, abscisic acid (ABA)-mediated closure of stomata bringing down rate of transpiration (Pospisilova *et al.*, 2003). They include both film-forming and stomata closing compounds, able to increase the leaf resistance to water vapor loss. (Tambussi and Bort, 2007) [23].

Materials and Methods

Present study was conducted in central agricultural field of SHUATS, located at 25.57^0 N latitude, 81.51^0 E longitude and 98 m altitude above the mean sea level. As per the purpose of study experiment was conducted based on surface irrigation to create water deficit condition for wheat variety HD-2967 we have taken different doses of Hydrogel (100%, 75%, 50%, and 25%) applied in soil initially before sowing and foliar spray of antitranspirant chitosan (100%, 75%, and 50%) at jointing and booting stage. Overall twenty-one treatments were laid under randomized block design with three replications.

Different vegetative growth (Plant height, No. of tillers/hill, flag leaf length, flag leaf width) and reproductive and yield parameter (Spike length/spike, No. of spikelet/spike, Days to 50% flowering, biological yield, grain yield, harvest index, and 1000 grain weight) are analyzed during the course of study. All the observation and analysis are conducted by standard procedure and statistical analysis are provided.

Treatment details: T_0 (100% IR without HG & CHT), T_1 (40% IR without HG & CHT), T_2 (40% IR with 100% HG), T_3 (40% IR with 75% HG), T_4 (40% IR with 50% HG), T_5 (40% IR with 25% HG), T_6 (40% IR with 100% CHT), T_7 (40% IR with 75% CHT), T_8 (40% IR with 50% CHT), T_9 (40% IR with 100% HG & 100% CHT), T_{10} (40% IR with 100% HG & 75% CHT), T_{11} (40% IR with 100% HG & 50% CHT), T_{12} (40% IR with 75% HG & 100% CHT), T_{13} (40% IR with 75% HG & 75% CHT), T_{14} (40% IR with 75% HG & 50% CHT), T_{15} (40% IR with 50% HG & 100% CHT), T_{16} (40% IR with 50% HG & 75% CHT), T_{17} (40% IR with 50% HG & 50% CHT), T_{18} (40% IR with 25% HG & 100% CHT), T_{19} (40% IR with 25% HG & 75% CHT), T_{20} (40% IR with 25% HG & 50% CHT). Where, HG is Hydrogel, CHT is chitosan and IR are irrigation.

Results and Discussion

For Chlorophyll the treatments which were treated with Hydrogel and Chitosan were showing better result in comparison to water deficit level (50% IR without HG and CHT). However, for chlorophyll 'a' when we are comparing our observation with normal irrigation we observed that treatment T_9 (1.77 mg/g fw) and T_{10} (1.56 mg/g fw) were showing better result while T_{11} (1.51 mg/g fw) was at par with T_0 (1.41 mg/g fw) (Table 4.9) while for chlorophyll b T_{11} (1.24 mg/g fw) was showing non-significant relationship with T_0 (1.04 mg/g fw) (Table, 4.10, 4.11 and 4.12). Water stress effects on biochemical component of plant like chlorophyll, carotenoid and total chlorophyll of plant. The decrease in chlorophyll content under drought is a commonly observed phenomenon (Nikolaeva *et al.*, 2010) [28]. The reduction in chlorophyll content under drought stress has been considered a typical indication of oxidative stress and may be the result of pigment photo-oxidation and chlorophyll degradation (Farooq *et al.*, 2009) [3].

For relative water content all the treatment in which Hydrogel and chitosan is applied showing better results in comparison to water deficit level T_1 (56.78) (50% IR without HG and CHT). However, when we are comparing our observations with normal irrigation we observed that treatment T_9 (69.94) and T_{10} (67.96) were showing better result. While, T_{11} (85.56) was non-significant with T_0 (67.62) (Table 4.13). Relative water content (RWC) of leaves has been reported as direct indicator of plant water contents under water deficit levels (Lugojan and Ciulca 2011) [15]. Increasing water stress caused a drastic decrease in leaf relative water content (%). Drought stress leads to reduction of water status during crop growth, soil water potential and plant osmotic potential for water and nutrient uptake which ultimately reduce leaf turgor pressure which results in upset of plant metabolic activities.

Antioxidant - Naturally there is a balance between antioxidant enzymes and reactive oxygen species (ROS) in a system. Any stress can disturb the balance which leads to an increase in the ROS amount, causing oxidative stress. Antioxidant enzyme levels increase to overcome ROS damage and bring cellular homeostasis back (Lee *et al.*, 2007) [13].

For antioxidant Proline and Superoxide dismutase (SOD) treatments under water stress are showing higher level Proline and superoxide dismutase level the highest level was found in T_1 (50% IR without HG and CHT). However, when we are comparing our observation with normal irrigation we observed that treatment T_9 (Proline 0.42; SOD 0.36) and T_{10} (Proline 0.39; SOD 0.37) are showing better result while T_{11} (Proline 0.39; SOD 0.42) is showing non-significant relationship with T_0 (Proline 0.50; SOD 1.41) (Table 2). There was an inverse relationship between drought severity and proline content, which create a defence mechanism in stressed in order to control osmotic pressure (Wang, 2003) [24]. Proline is well known to occur extensively in higher crop plants and accumulates in higher concentration in response to different abiotic environmental stresses specially drought stress (Kishore *et al*., 1995) [11].

Superoxide dismutase (SODs) are ubiquituous metalloenzymes that catalyze the dismutation of superoxide radical to H_2O_2 and O_2. The superoxide radical is a potential precursor of the highly oxidizing hydroxyl radical and, therefore, SODs are a critical defense of plants, other aerobic organisms, and some anaerobes against oxidative stress (Halliwell and Gutteridge, 1999) [7]. Plants under water deficit stress showed a significant increase in SOD, CAT and GPX activities of canola leaves compared with control plants.

For yield parameters biological yield, grain yield, harvest index and 1000 grain weight all the treatments in which hydrogel and chitosan is applied were showing better results in comparison to water deficit condition T_1 (GY 37.86; TGW 11.93) (50% IR without HG and CHT). However, when we are comparing our observation with normal irrigation T_0 (GY 49.87; TGW 35.49) we observed that treatment T_9 (GY 55.24; TGW 41.64) and T_{10}(GY 54.55; TGW 39.96) were showing better result (Table 2). 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) [12]. The results of many researches show that drought stress at different stages of the growth of wheat lead to a reduction in the yield of biomass, grain yield, harvest index and grain yield components of wheat (Gooding *et al.*, 2003) [6], (Garcia *et al.*, 2003) [4], and (Zaharieva *et al.*, 2001) [27]. 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) [5]. 1000 grain weights of all the treatments which were treated with hydrogel and chitosan were showing better result in comparison to water deficit condition (50% IR without HG and CHT). (Gooding *et al.,* 2003) [6] 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) [10] and (Qadir *et al*., 1999) [20] who observed that 1000-grain weight of wheat was reduced mainly due to increasing water stress.

Table 1: Efficacy of hydrogel and Chitosan on Chlorophyll 'a'(mg/g fw), Chlorophyll 'b'(mg/g fw), Carotenoids (mg/g fw), Relative Water Content (%) of wheat under different levels of irrigation and chitosan

Treatments	Chlorophyll 'a'(mg/g fw)	Chlorophyll 'b'(mg/g fw)	Carotenoids (mg/g fw)	Relative Water Content (%)
T_0	1.41	1.04	1.89	67.42
T_1	0.69	0.33	1.21	56.78
T_2	1.32	0.98	1.85	67.14
T_3	1.24	0.62	1.78	66.36
T_4	1.05	0.46	1.49	61.89
T_5	0.99	0.42	1.45	61.53
T_6	0.91	0.39	1.40	60.63
T_7	0.89	0.38	1.36	58.97
T_8	0.81	0.37	1.26	57.67
T_9	1.77	1.40	2.20	69.94
T_{10}	1.56	1.29	2.13	67.96
T_{11}	1.51	1.24	2.08	67.62
T_{12}	1.30	0.66	1.83	66.72
T_{13}	1.24	0.63	1.80	66.44
T_{14}	1.16	0.58	1.71	63.68
T_{15}	1.17	0.59	1.74	66.06
T_{16}	1.11	0.54	1.65	63.43
T_{17}	1.10	0.51	1.57	62.65
T_{18}	1.08	0.49	1.54	62.26
T_{19}	0.99	0.43	1.47	61.72
T_{20}	0.94	0.41	1.43	61.03
Mean	1.15	0.66	1.66	63.71
SE. d	0.095	0.197	0.205	-
C.D (5%)	0.191	0.395	0.411	-
C.V	10.299	36.947	15.276	15.077
F Test	S	S	S	N/S

Table 2: Efficacy of hydrogel Proline (mg/g fw), Superoxide dismutase (mg/g fw), Economical yield(q/ha^{-1}), Test Weight (gm) on of wheat under different levels of irrigation

Treatments	Proline (mg/g fw)	Superoxide dismutase (mg/g fw)	Economical yield(q/ha^{-1})	Test Weight (gm)
T_0	0.5	0.41	49.87	35.49
T_1	1.52	1.31	37.86	11.93
T_2	0.5	0.44	49.65	34.26
T_3	0.56	0.5	46.98	33.82
T_4	0.63	0.66	43.73	30.07
T_5	0.64	0.77	43.54	28.04
T_6	0.69	1.17	42.93	27.95
T_7	0.83	1.23	42.54	26.27
T_8	0.92	1.24	41.97	23.95
T_9	0.42	0.36	55.24	41.64
T_{10}	0.45	0.37	54.55	39.96
T_{11}	0.49	0.39	50.69	37.90
T_{12}	0.53	0.46	48.60	33.95
T_{13}	0.54	0.48	47.77	33.91
T_{14}	0.59	0.56	46.31	31.99
T_{15}	0.57	0.54	46.60	32.48
T_{16}	0.6	0.59	45.82	31.84
T_{17}	0.6	0.61	44.94	30.75
T_{18}	0.62	0.65	44.86	30.36
T_{19}	0.64	0.73	43.70	29.91
T_{20}	0.67	0.78	43.47	14.30
Mean	0.64	0.68	46.27	30.51

SE. d	0.092	0.130	0.207	0.580
C.D (5%)	0.184	0.261	0.414	1.161
C.V	17.459	23.430	0.541	2.310
F Test	S	S	S	S

Conclusion

This study may conclude that under water deficit condition all the treatments are showing better results in comparison to T_1 (50% IR without hydrogel and Chitosan) for growth and yield parameters. Although T_9 (50% IR with 100% hydrogel and 100% Chitosan) was showing best results for physio-biochemical, Yield and 1000 grain weight. In comparison to T_0 (100% IR without hydrogel and chitosan), T_9 and T_{10} were found better for all the parameters observed, analysed during the study although T_{11} states non-significant with T_0. whereas in Proline and Superoxide dismutase were showing maximum in T_1 and Minimum in T_9 due to water deficit condition and leads to increase in proline and superoxide dismutase.

References

1. Allen RG, Pereira LS, Raes D, Smith M. Crop evapotranspiration. Guidelines for computing crop water requirements. FAO, Irrig. Drain. Paper, FAO Rome. 1998; 56:300.
2. Dewettinck K, Van Bockstaele F, Kuhne B, Van de Walle D, Courtens TM, Gellynck X. Nutritional value of bread: Influence of processing, food interaction and consumer perception. J Cereal. Sci. 2008; 48:243-257.
3. Farooq M, Wahid A, Kobayashi N, Fujita D, Basra SMA. Plant drought stress: effects, mechanisms and management. Agron. Sustain. Dev. 2009; 29:185-212.
4. Garcia D, Moral LF, Rharrabt Y, Villegas D, Royo C Evaluation of grain yield and its components in durum wheat under Mediteranean condition, Agronomy Journal. 2003; 95:266-274.
5. Gebeyehu S. Physiological response to drought stress of common bean (*Phaseolus vulgaris* L.) genotypes differing in drought resistance, Ph.D. Thesis. University of Giessen. Germany, 2006.
6. Gooding MJ, Ellis RH, Shewry PR, Schofield JD. Effects of restricted water availability and increased temperature on grain formation, drying and quality of water wheat, Journal of cereal Sciences. 2003; 37:295-309.
7. Halliwell B, Gutteridge JMC. Free Radicals in Biology and Medicine. 3rd Ed. Oxford University Press, New York, 1999, 936.
8. Hamdani Rizwana MJ, Pathan MG. Drought –cuses & its impacts. National Seminar on Problem of Droughts & its remedies, ISBN 978-97-8367-23-3, 2016, 52-56.
9. Howden SM, Leary OGJ. Evaluating options to reduce greenhouse gas emissions from an Australian temperate wheat cropping system. Environ Modell Software. 1997; 12:169-76.
10. Khan AJ, Azam F, Ali A, Tariq M, Amin M. Inter-relationship and path co-efficient analysis for biometric traits in drought tolerant wheat (*Triticum aestivum* L.). Asian Journal of Plant Sciences. 2005; 4(5):540-543.
11. Kishor PBK, Hong ZL, Miao GH, Hu CAA, Verma DPS. Overexpression of delta-pyrroline-5-carboxylate synthetase increases proline production and confers osmotolerance in transgenic plants. Plant Physiology 1995; 108:1387-1394.
12. Kisman A. Effects of drought stress on growth and yield of soybean, Sci Phil. Term paper. Borgor Agric. Univ. (Institute Pertanian Borgor), 2003.
13. Lee KP, Kim C, Landgraf F, Apel K. EXECUTER1-and EXECUTER2-dependent transfer of stress-related signals from the plastid to the nucleus of Arabidopsis thaliana. Proc. Natl. Acad. Sci. U.S.A. 2007; 104:10270–10275. doi: 10.1073/pnas.0702061104.
14. Lipe WN, Wendt CW. Effects of antitranspirants on yield, grade distribution, and water use of potatoes. - Am. J of Potato Res. 2008; 55(4):203-209.
15. Lugojan C, Ciulca S. Evaluation of relative water content in winter wheat. Journal of Horticulture Forestry Biotechnology. 2011; 15:173-177.
16. Mesbah. Effect of irrigation regimes and foliar spraying of potassium on yield, yield components and water use efficiency of wheat (*Triticum aestivum* L.) in sandy soils. World J. Agric. Sci. 2009; 5(6):662-669.
17. Moharram J, Habib M. Evaluation of 10 wheat cultivars under water stress at Moghan (Iran) condition. African Journal of Biotechnology. 2011; 10(53):10900-10905.
18. NDMD Moha. GOI. Contingency plan –drought 2000, Department of Agriculture and co-operative. MoAg GOI, New Delhi, 2000.
19. Omeje MU, Mohammed I, Ndahi WB, Nkema I. Wheat. In Cereal Crops of Nigeria: Principles of Production and Utilization, xxii, 337 (Idem, N.U.A. and F.A. Showemimo edited), 2007, 230-249.
20. Qadir G, Mohammad S, Cheema MA. Effect of water stress on growth and yield performance of four wheat cultivars. Pak. Journal of Biological Sciences. 1999; 2(1):236-239.
21. Qu G, Varennes A. Use of hydrophilic insoluble polymers in the restoration of metal-contaminated soils, Appl. Environ. Soil Sci. 2009, 1-8. doi:10.1155/2009/790687
22. Success Story No. 14 lCN: 101/2012.
23. Tambussi EA, Bort J, Araus JL. Water use efficiency in C3 cereals under Mediterranean conditions: A review of physiological aspects. Ann. Appl. Biol. 2007; 150:307-321. doi: 10.1111/j.1744-7348.2007. 00143.
24. Wang W, Vinocur B, Altman A. Plant responses to drought, salinity and extreme temperatures: towards genetic engineering for stress tolerance. Planta 2003; 218:1-14. doi: 10.1007/s00425-003-1105-5.
25. Water in the United States. Circular 1344, US Department of the Interior, US Geological Survey, 2005, 52.
26. Yu J, Shainberg I, Yan YL, Shi JG, Levy GJ, Mamedov AI. Superabsorbents and semiarid soil properties affecting water absorption. Soil Sci. Soc. Am. J. 2011; 75:2305-2313.
27. Zaharieva M, Gaulin E, Havaux M, Acevedo E, Monneveux P. Drought and heat responses in the wild wheat relative *Aegilops geniculata* Roth, Crop Science. 2001; 14:1321-1329.
28. Nikolaeva MK, Maevskaya SN, Shugaev AG, Bukhov NG. Effect of drought on chlorophyll content and antioxidant enzyme activities in leaves of three wheat cultivars varying in productivity. Russ. J Plant Physiol. 2010; 57:87-95.