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Impact of Different Levels of Irrigation and Antitranspirant upon Wheat (*Triticum aestivum* L.) Physio-Biochemical and Economical Yield under Soil Application of Hydrogel

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A B S T R A C T

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.

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 (FAO, 2012a). Statistics exhibited that 25% of the world's agricultural land is now influenced by high levels of water stress (Alaei *et al.*, 2010). 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). 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 effects on agriculture production (SAPCC, 2014). 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 it has 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). 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). 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). 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).

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). 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 and chitosan. Over all 25 treatments (Table 1) has been undertaken with soil application hydrogel (7kg/ha). Different growth and yield parameters have been recorded and statistically analysed during the course of study

Results and Discussion

For Chlorophyll the treatments which were treated with Hydrogel and Chitosan were showing better result in comparison Control (100% IR 70 Lit +NO SAP +NO AT) (1.68) Maximum Chlorophyll 'a' was observed in T_1 (2.11) followed by T_2 (2.03), T_3 (1.96), T_4 (1.89), T_5 (1.86), T_6 (1.85), T_7 (1.73) these treatments are showing better. Whereas, Minimum Chlorophyll 'a' was observed in T_{24} (0.68) (Table 2). 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). 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). For relative water content all the treatment in which Hydrogel and chitosan is applied showing better results in comparison to water deficit condition. Control (100% IR 70 Lit +NO SAP +NO AT) (70.09), Maximum Relative Water Content was observed in T_1 (51.76 %) followed by T_2 (45.31 %), T_3 (43.51%), T_4 (42.62 %), T_5 (42.35 %), T_6 (40.79 %), T_7 (39.57 %) these treatments are showing better.

whereas, Minimum Relative water Content was observed in T_{24} (28.31 %) (Table 2). Relative water content (RWC) of leaves has been reported as direct indicator of plant water contents under water deficit conditions (Lugojan and Ciulca, 2011).

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). 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 in15 DAS (4^{th} Irrigation) Maximum Proline was observed in T_{24} (0.31 gm) followed by T_{23} (0.28 gm), T_{22} (0.26 gm), T_{21} (0.23 gm), T_{20} (0.21 gm), T_{19} (0.20 gm), whereas, Minimum Proline was observed in T_1 (0.08 gm) (Table 3).

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

Table.2 Impact of Different levels of Irrigation and Antitranspirant on Chlorophyll 'a' (mg/g fw), Chlorophyll 'b' (mg/g fw), Carotenoids (mg/g fw), Relative Water Content (%) upon Wheat (*Triticum aestivum* L.) Physio-biochemical and Economical Yield under Soil Application of Hydrogel

Treatments	Chlorophyll 'a'(mg/g fw)	Chlorophyll 'b' (mg/g fw)	Carotenoids (mg/g fw)	Relative Water Content (%)
T_0	1.68	1.59	2.11	38.47
T_1	**2.11**	**2.00**	2.76	**51.76**
T_2	2.03	1.94	2.34	45.31
T_3	1.96	1.86	2.32	43.51
T_4	1.89	1.79	2.17	42.62
T_5	1.86	1.76	2.15	42.35
T_6	1.85	1.69	2.13	40.79
T_7	1.73	1.63	2.13	39.57
T_8	1.66	1.56	2.12	37.73
T_9	1.64	1.54	2.11	36.24
T_{10}	1.37	1.27	2.07	35.33
T_{11}	1.36	1.26	2.06	33.48
T_{12}	1.33	1.23	2.03	33.36
T_{13}	1.30	1.20	2.03	32.73
T_{14}	1.30	1.20	1.97	32.67
T_{15}	1.27	1.17	1.94	32.54
T_{16}	1.26	1.16	1.92	32.51
T_{17}	1.22	1.12	1.85	32.43
T_{18}	1.20	1.10	1.81	32.42
T_{19}	1.14	1.03	1.68	31.76
T_{20}	1.13	1.03	1.67	30.71
T_{21}	1.11	1.01	1.63	30.36
T_{22}	1.10	1.00	1.62	29.78
T_{23}	0.87	0.77	1.15	29.51
T_{24}	0.68	**0.68**	0.96	**28.31**
Mean	**2.11**	1.59	**1.94**	**35.54**
C.D.	**0.189**	**0.209**	**0.002**	**1.362**
SE(m)	**0.066**	**0.73**	**0.001**	**0.478**
F-test	**Significant**	**Significant**	**Significant**	**Significant**

Table.3 Impact of Different levels of Irrigation and Antitranspirant on Proline (mg/g fw), Superoxide dismutase (mg/g fw), Economical yield (q/ha^{-1}), Test Weight (gm) upon Wheat (*Triticum aestivum* L.) Physio-biochemical and Economical Yield under Soil Application of Hydrogel

Treatments	Proline (mg/g fw)	Superoxide dismutase (mg/g fw)	Economical yield (q/ha^{-1})	Test weight (gm)
T_0	0.12	0.55	32.68	27.8
T_1	**0.08**	**0.28**	**89.19**	**43.3**
T_2	0.10	0.4	65.97	42.8
T_3	0.11	0.42	47.77	31.9
T_4	0.12	0.48	40.17	31.7
T_5	0.13	0.5	39.97	31.1
T_6	0.13	0.53	39.47	30.6
T_7	0.14	0.54	33.87	27.9
T_8	0.14	0.56	32.37	27.6
T_9	0.15	0.58	31.67	25.6
T_{10}	0.15	0.6	31.43	24.4
T_{11}	0.15	0.62	31.28	24.3
T_{12}	0.16	0.64	30.27	23.6
T_{13}	0.16	0.71	28.28	22.9
T_{14}	0.16	0.76	27.93	22.7
T_{15}	0.17	0.88	27.87	22.1
T_{16}	0.18	0.99	27.4	21.9
T_{17}	0.18	1.03	27.33	21.6
T_{18}	0.19	1.08	25.86	21.6
T_{19}	0.20	1.11	25.43	21.2
T_{20}	0.21	1.53	23.91	21.1
T_{21}	0.23	1.59	23.74	21.0
T_{22}	0.26	1.72	23.33	21.0
T_{23}	0.28	1.78	22.33	20.5
T_{24}	**0.31**	**1.85**	**21.12**	**20.1**
Mean	**0.1684**	**1.5004**	**33.99**	**26.01**
C.D.	**0.010**	**0.064**	**36.391**	**1.220**
SE(m)	**0.004**	**0.022**	**12.781**	**0.429**
F-test	**Significant**	**Significant**	**Significant**	**Significant**

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). 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.,* 2005). Superoxide dismutase (SODs) is ubiquitous metalloenzymes that catalyze the dismutation of superoxide radical to H2O2 and O_2. The superoxide radical is a potential precursor of the highly oxidizing hydroxyl radical and, therefore, SODs are a critical defence of plants, other aerobic organisms, and some anaerobes against oxidative stress (Halliwell and Gutteridge, 1999). Plants under water deficit stress showed a significant increase in SOD, CAT and GPX activities of canola leaves compared with control plants (Mohaddam *et al.*, 2009) 15 DAS (4^{th} Irrigation) Maximum Superoxide dismutase was observed in T_{24} (1.85) followed by T_{23} (1.78), T_{22} (1.72), T_{21} (1.59), T_{20} (1.53), T_{19} (1.11), T_{18} (1.08) whereas, Minimum Super-oxidedismutase was observed in T_1 (0.28) (Table 3) grain yield, all the treatments in which Hydrogel and chitosan is applied were showing better results in comparison to water deficit conditionMaximum 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}). 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). 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 Economic yield components wheat under different levels Irrigations and Chitosan (Gooding *et al.*, 2003; Garcia *et al.*, 2003 and Zaharieva *et al.*, 2001). 1000 grain weights of all the treatments which were treated with Hydrogel and Chitosan were showing better result in T_1 than comparison to Control (100% IR 70 Lit +NO SAP +NO AT) (Gooding *et al.*, 2003) 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) and Qadir *et al.*, (1999) observed that 1000-grain weight wheat under different levels Irrigations and Chitosan, was reduced mainly due to increasing water stress.

Under Agro climatic condition of Allahabad This study may conclude that $T_1$is performing best for all the absorbed parameters with Chlorophyll 'a', Chlorophyll 'b', Carotenoids, Relative Water Content, Yield and Test Weight maximum yield **(**89.19q/ha^{-1}) Minimum performance was showed by T_{24} yield **(**21.12q/ha^{-1}) Whereas in Proline, Superoxide dismutase under stress condition treatments are showing better in T_{24} than T_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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