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Using Hydrogel in Sandy Soil for Reducing Irrigation Quantity of Wheat under Drip Irrigation System

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Abstract: Field experiment was conducted at Researches and Production Station ofNational Research Centre (NRC), Al Emam Malek village, Al-Nubaria district, Al Behaira Governorate, Egypt. Sowing date was 15 November 2019 usingMisr 1 varietyin the seeding rate of 120 kg/Hectare under drip irrigation system, grains in holes under surface drip irrigation system SDIS. Treatments were five Irrigation quantities:-1- 100% Recommended Irrigation Quantity RIQ Without hydrogel (Control) – 2- 25% RIQ + hydrogel – 3- 50% RIQ + hydrogel – 4- 75% RIQ + hydrogel – 5- 100% RIQ + hydrogel. Results indicated the superiority of treatment 75% RIQ + hydrogel on all other treatments it produced tallest plants (104.65 cm); tallest spikes (10.67 cm); highest No. of spikes/m^2 (315.16); No. of spiklets/spike (20.67); biological yield/tiller (13.30 g); grain yield (3.327 ton/ha.); and highest biological yield (10.68 ton/ha.) but treatment of 50% RIQ + hydrogel produced the highest straw yield (7.368 ton/ha.) and treatment of 100% Recommended Irrigation Quantity RIQ Without hydrogel (Control) recorded the highest harvest index (36.43%).

Key words: Hydrogel · Water Irrigation Quantity WIQ · Drip Irrigation System

INTRODUCTION

Wheat is the most important and widely grown cereal crop worldwide for its various properties and uses of its grains and straw. Increasing cultivated area, reducing irrigation quantity with drought tolerance and high yielding capacity of wheat aremain objectives in agriculture under Egyptian conditions.

Evolution of wheat production in Egypt from 2.08 in 1983 to 8.80 million ton in 2017 was achieved by increasing cultivated area from 0.763 to 1.410 ha/year in the same period [1] and this led to increasing NPK fertilizers in the form of chemical, organic and bio-fertilizers as slow release source [2, [3]

Significant reduction in grain yield and its components of wheat as result of drought-stress effect at different periods of growth especially under sandy soil condition using sprinkler and/or drip irrigation system [4 -7].

One of promising approach to minimize drought stress that induces crop losses from moisture in root growth zone is hydrogel, which acts by absorbing and storing water hundreds of times their own weight, 400-1500 g water per one gram of dry hydrogel [8, 9]. Hydrogel is attended as a soil reservoir for maximizing the efficiency of plant water uptake [10-13] indicated that hydrogel amendments in sandy soil promoted seedlings survival and growth under arid conditions also, Viero *et al*. [14] found an increase in seedling growth only when hydrogel was applied in combination with irrigation. Hydrogel application in sandy soil promotes an increase in water retention capacity and plant water potential, [5-17] indicated that application of hydrogel can result in significant reduction in the required irrigation frequency particularly for coarse-textured soils.

Under Egyptian condition many researchers found the excellence of hydrogel in many crops [18]; on rice and barley; Waly *et al*. 2015b [19] pointed out that the best

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effect occurred on wheat and sunflowerwhile, [20] revealed dual effect of hydrogel in sugar beet by decreasing water irrigation quantity and decreasing nitrogen leaching from sandy soil; and [21] on sunflower in field trial. Hassan *et al*. [22] revealed positive effect of hydrogel on potato in reducing irrigation quantity, increasing the water-holding, water use efficiency, preventing nutrient leaching and fertilizers use efficiency also, decrease nutrients lost from rooting zone in sandy soil;also, [23] on double purpose (forage+seed) of mungbean (*Vigna radiata* L. Wilczek) and [24] cleared that hydrogel had best effect under in vitro study by increasing rooting and acclimatization of pine apple (*Ananas comosus* cv. Smooth cayenne) as alternated of agar. El karamany *et al*. [25] indicated the superiority of hydrogel in 75% from recommended irrigation quantity surpassed to other treatment also, interaction of variety Sids-12 x 75% water irrigation quantity produced the highest values in both important characters grain and straw yields per unit area with increase in rate 41.1% and 35.6% compared to control under sprinklers irrigation system.

Thus, the aim of this work is to study the role of hydrogel as super water absorbent on yield and yield components of wheat and reducing recommended water irrigation quantity under drip irrigation system.

MATERIALS ANDMETHODS

Field experiment was conducted at Researches and Production Station of National Research Centre NRC, Al Emam Malek village, Al-Nubaria district, Al Behaira Governorate, Egypt. Sowing date was 15 November 2019. Misr-1 wheat cultivar sown by broadcast method in the seeding rate of 144 kg/hectare under surface drip irrigation system DIS, diameter of the lateral line was 16 mm with dripper discharge of 4 L/h with 30 cm miters spacing. Distance between lines (sub line) was 0.5 m and between drippers was 0.30 m. Area irrigated by each valve contained 10 lines was 10 x 0.50 x 25 = 125 m^2. Mechanical and chemical analyses of experimental soil before addition of hydrogel are presented in Table (1), according to Chapman and Pratt (1978).

Table 1: Mechanical and chemical analysis of soil

Sand (%)	Silt (%)	Clay (%)	pH	O.M (%)	Ca Co^3	E.c mmhos/cm^3	N (ppm)	P (ppm)	K (ppm)
92.3	3.1	4.6	7.4	0.3	1.3	0.3	8.0	3.0	19.8

Experiment included 5 irrigation quantity treatments which were:

Recommended irrigation quantity (%)	25 % + hydrogel (4 g/m^2)	50 % + hydrogel (4 g/m^2)	75 % + hydrogel (4 g/m^2)	100 % + hydrogel (4 g/m^2)	100 % without hydrogel
Water amount (m^3) Valve read	15	30	45	60	60
Water amount per Hectare	1210	2419	3629	4838	4838

Irrigation automatically system IAS was used as show in Figure (2) it contains as follows:

- Main water pumping unit (20 hp).
- Main line 4 inch.
- Main line of IAS was 2 inch – 6 bar.
- Control head 1.5 inch .
- Motor 1.5 horses – 220 volt – Calbida NGM 32E.
- Electricity unit (5 control key 220 volt).
- Water meter).
- Sub main line (16 mm).
- Drippers discharge of 4 L/h with 30 cm emitters spacing.

In duple jacketed of a capacity 60 litter equipped with condenser, variable speed motor temperature controller adjusted at 30°C was reactor charged with 4 kg starch slurred in 40 litter water followed by addition of 2 g emulsifier after 10 minutes acrylonitrile (AN) 4 kg added during 20 minutes with continues stirring for three hours. The obtained product was saponified in isopropanol (40 litters) with continues stirring with the addition of 0.65 equivalent sodium hydroxyl tell the color of the product changed from deep brown to yellowish color. The obtained hydrogel was filtered, driedand milled. Materials used commercial product without purification-(Acrylonitrile (AN), Corn starch, sodium hydroxyl, emulsifier).

Harvest date was carried out 140 days after sowing DAS. Ten plants were harvested randomly from each treatment and the following characters were determined 1- plant height (cm) 2- spike length (cm) 3- No. of spikelet's/spike 4- biological yield/ tiller (g) 5- Grain yield /spike (g). One $meter^3$ harvested to determine 6- Grain yield /spike (g).

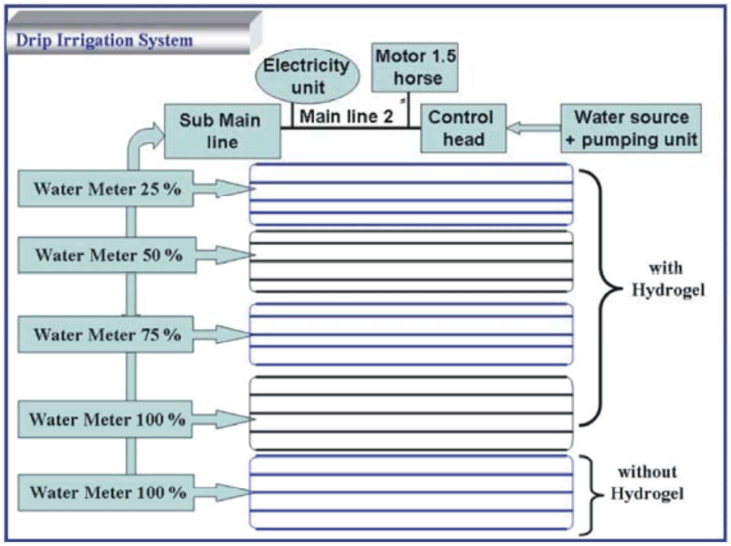

Fig. 1: Drip Irrigation System DIS

The whole area of each treatment was harvested to determine characters measured per hectare 7- biological yield/ hectare. 8-Grain yield/ hectare. 9- Straw yield/ hectareand harvest indexwas determined as a ratio of grain yield/biological yield.

RESULTS AND DISCUSSION

Data presented in Table (2) and figure (2) clearly indicate that treatment of 75% recommended irrigation quantity with hydrogel produced the tallest plants (104.65 cm); tallest spikes (10.67 cm); highest number of spikes/m^2 (315.16); highest grain yield/spike (5.20 g) and highest grain yield/ha (3.326 ton).

Treatment of 50% recommended irrigation quantity with hydrogel produced the highest no. of spikelet's/spike (21.67); highest bio-yield/tiller (15.30 g); highest bio-yield/hectare (10.37ton) and the highest straw yield/hectare (7.37ton). Control 100% recommended irrigation quantity RIQ recorded the highest harvest index (38.34%).

Results are considered logical due to superiority of treatment 75% irrigation quantity with hydrogel addition in characters of plant height; spike length; grain yield/spike beside highest number of spikes per unit area (meter) asan indicator to the best growth obtained from this treatment compared to other treatments. Consequently the superiority in these characters were reflected on grain yield and biological yield per hectare as important economic yields. It can be concluded that superiority may be due to the best effect of hydrogel in making balance between reducing recommended irrigation quantity to 75% and saving suitable amount of moisture in root growth zone for wheat plants which irrigated by drip irrigation method under sandy soil condition. Superiority of control 100% recommended irrigation quantity in harvest index% may be due to low biological yield/ha as denominator of harvest index which equal grain yield / biological yield %. The obtained resultsare in accordance with those obtained by [15, 16, 17], they indicated that application of hydrogel can result in significant reduction in the required irrigation frequency particularly for coarse-textured soils. Under Egyptian condition many researchers recorded results in accordance with the obtained results, they found the excellence of hydrogel in many crops [18]; on rice and barley;while [19] pointed out that the best effect on wheat and sunflower; revealed dual effect of hydrogel in sugar beet by decreasing water irrigation quantity and decreasing nitrogen leaching from sandy soil; also, [21] on sunflower in field trial; and [22] on potato revealed positive effect of hydrogel in reducing irrigation quantity, increasing the water-holding, water use efficiency, preventing nutrient leaching and fertilizers use efficiency also, decrease nutrients lost from rooting zone in sandy soil; [23] on double purpose (forage+seed) of mungbean (*Vigna radiat*a L. Wilczek) recorded that hydrogel had continuation after 7 seasons (4 summer and 3 winter seasons), [24] clear that hydrogel had best effect under *in vitro* study by increasing rooting and acclimatization of pine apple (*Ananas comosus* cv. Smooth cayenne) as alternated of agar the most important media utilize in tissue culture technique. Due to wheat trials under Egyptian condition using sprinkler irrigation system

Table 1: Effect of irrigation quantities on yield and yield components of wheat (Misr-1 cultivar) under sandy soil condition. (Winter season of 2014/2015)

Irrigation	Plant height (cm)	Spike length (cm)	No. spikes/m^2	No. spikelet's /spike	Bio-yield/ tiller (g)	Grain yield /spike (g)	Bio-yield (ton/ha)	Grain yield (ton/ha)	Straw yield (ton/ha)	Harvest Index %
Control Without Hydrogel	101.67	10.33	291.32	18.00	11.00	4.60	8.02	2.921	5.09	36.43
25% RIQ + hydrogel	86.00	9.83	235.55	15.33	10.50	3.70	6.43	2.276	4.18	35.17
50% RIQ + hydrogel	103.27	10.50	283.42	21.67	11.20	4.87	10.37	2.994	7.37	28.88
75% RIQ + hydrogel	104.65	10.67	315.16	20.67	13.30	5.20	10.68	3.326	7.34	31.15
100% RIQ + hydrogel	102.33	10.33	247.15	16.00	12.30	4.77	8.66	3.074	5.59	35.48
LSD	1.05	0.18	2.44	1.03	0.11	0.25	0.33	13.09	0.12	0.27

RIQ = Recommended Irrigation Quantity – Bio-yield = Biological yield

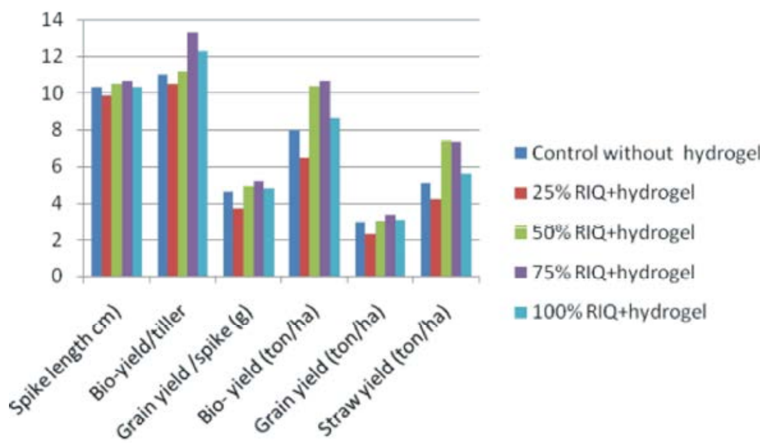

Fig. 2: Effect of reducing WIQ by using hydrogel on spike length, bio-yield/tiller, (grain, straw and bio-yields/ha)

El-karamany *et al*., [25] indicated the superiority of hydrogel in reducing RIQ to 75% from recommended irrigation quantity and surpassed other treatment also, interaction of variety Sids-12 x 75% water irrigation quantity produced the highest values in both important characters grain and straw yields per unit area with increase in rate 41.1% and 35.6% compared to control under sprinklers irrigation system.

CONCLUSION

It can be concluded that addition of hydrogel prepared under study at the rate of 4 (g)/m^2 was effective tool to reduce water irrigation quantity WIQ to 75% from recommended amount under drip irrigation system also, it can be applicable tool when sowing wheat on irrigation lines between small fruit trees by inter planting system to increase land use efficiency and irrigation but perfecting study is needed to confirmation these hypothesis.

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