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Some Correlative Studies of Wheat Yield Attributes under Different Drip Irrigation Regimes Using Hydrogel in Sandy Soil

[1]M.F. El-Karamany, [1]A.B. Bakry, [2]Hamed A.A. Omer, [1]T.A. Elewa and [3]A.I. Waly

[1]Field Crops Dept. Agricultural & Biological Institute,
33 El-Bohouth Street, P.O. Box: 12622, Dokki, Giza, Egypt
[2]Animal Production Dept., Agricultural & Biological Institute,
33 El-Bohouth Street, P.O. Box: 12622, Dokki, Giza, Egypt
[3]Preparation & Finishing of Cellulosic Fibers Dept., National Research Centre,
33 El-Bohouth Street, P.O. Box: 12622, Dokki, Giza, Egypt

Abstract: Field experiment was conducted at Experimental Farm of National Research Centre (NRC), Al Nubaria district, Al-Behaira Governorate. Misr-1 local wheat variety sown in mid November 2019 at a seeding rate of 120 kg/hectare under drip irrigation system, grains in holes under surface drip irrigation system (SDIS). Five irrigation treatments were 1- (Control) 100% recommended irrigation quantity (RIQ) (4838 m^3/ha.) without hydrogel. 2- 25% RIQ (1210 m^3/ha.)+ hydrogel. 3- 50% RIQ (2419 m^3/ha.)+ hydrogel. 4- 75% RIQ (3629 m^3/ha.) + hydrogel. 5- 100% recommended irrigation quantity (RIQ) (4838 m^3/ha.) + hydrogel. Results indicated the superiority of treatment of 75% RIQ+ hydrogel on all other treatments in most yield attributes (plant height (cm); spikes height (cm); no. of spikes/m^2; no. of spiklets/spike; biological yield/tiller (g); grain yield (ton/ha) and biological yield (ton/ha). Treatment of 50% RIQ + hydrogel produced the highest straw yield (ton/ha) and control recorded the highest harvest index%. Correlation study clears that due to important economic yield characters of wheat crop (grain yield, straw yield and biological yield per unit area ton/h.) detected that grain yield (ton/h.) had high significant correlation with grain yield/spike in gram (0.989); spike length cm. (0.964); biological yield ton/h. (0.961) and plant height cm. (0.960). Straw yield ton/h. had a high significant correlation with biological yield ton/h. (0.990); No. of spiklets/spike (0.916); spike length cm. (0.903) and grain yield ton/h. (0.797). Biological yield ton/h. had a high significant correlation with spike length cm. (0.951); grain yield/spike g. (0.928); No. of spiklets/spike (0.887) and plant height (0.847).

Key words: Drip irrigation regimes · Hydrogel · Correlation

INTRODUCTION

Wheat is considered the most important and widely cereal crop worldwide for its grains and straw uses. Increasing cultivated area in sandy soil with cultivars had high yielding, drought tolerance and reducing irrigation quantity was one of the main objectives under Egyptian conditions. Wheat cultivated area increased from 0.763 in 1983 to 1.370 million hectare in 2020 FAOSTAT [1]. Wheat plants are exposed to drought stress in desert lands under Egyptian condition at different periods of growth especially in sandy soil under sprinkler and/or drip irrigation system. Irrigation is used to maintain the soil moisture profile in the root zone to field capacity and satisfied evapotranspiration requirement of each crop on any area. Hussein [2]; Mousa and Abdel-Maksoud [3]; El-Afandy [4] and Fang *et al*. [5] found that subjecting wheat plants to drought-stress resulted in a significant reduction in grain yield and its components.

Hydrogel is one of the promising approaches to minimize drought stress that induces crop losses from moisture in root growth zone. Hydrogel is super absorbents that absorb and store water 400-1500g water per one dry gram of hydrogel Johnson [6]; Brwman and Evans [7]. Water held in the expanded hydrogel is

Corresponding Auther: M.F. El-Karamany, Field Crops Dept. Agricultural & Biological Institute,
33 El-Bohouth Street, P.O. Box: 12622, Dokki, Giza, Egypt.

intended as a reservoir for maximizing the efficiency of plant water uptake. Callaghan *et al*. [8] found that hydrogel amendments in sandy soils promoted seedlings survival and growth under arid conditions, while Viero *et al*. [9] under similar conditions found only an increase in seedling growth when hydrogel was applied in combination with irrigation. Related results to soil texture clear that hydrogel application in sandy soil promotes an increase in water retention capacity and plant water potential, Huttermann *et al*. [10]; Abedi-kaoupai and Sohrab [11] but in loamy and clay soils the effect may be negligible. Jahangir *et al*. [12], revealed that application of hydrogels can result in significant reduction in the required irrigation frequency particularly for coarse-textured soils. Hydrogel can be effective tool in decreasing nitrogen leaching from sandy soil by make N application as slow release fertilizer. Under Egyptian conditions many researchers pointed the excellent effect of hydrogel on many crops. Team of hydrogel project of (NRC) in Egypt clear the effect of hydrogel in decreasing water irrigation in sandy soil under both systems sprinklers and/or drip systems Waly *et al*. [13]on rice and barley; Waly *et al*. [14] on sunflower and wheat (2015) also, El-karamany *et al*. [15] on sugar beet; El-karamany *et al*. [16] on sunflower; Waly *et al*. [17] on potato; Elkaramany *et al*. [18] in long term effect study revealed positive effect of hydrogel in reducing irrigation quantity, increasing the water water-holding capacity, water use efficiency, preventing nutrient leaching and fertilizers use efficiency also, decrease nutrients lost from rooting zone in sandy soil; El-Karamany *et al*. [19] on two wheat varieties and [20] on two barley varieties irrigated by sprinkles system; Bakry *et al*. [21] on flax; Bakry *et al*. [22] on wheat under drip irrigation system; Elkaramany *et al*. [23] on cotton; Bakry [24] on barley under drip irrigation system; Hassan *et al*. [25, 26] revealed that hydrogel at different percentage can be replacement agar in tissue culture explants production.

Therefore the objective of this study was to determine effect of using hydrogel as soil addition in reducing water irrigation quantity under drip irrigation system without loss in grain and/or straw yield of wheat also, correlation between yield attributes.

MATERIALS AND METHODS

Field experiment was conducted at Experimental Farm of National Research Centre (NRC), Al Nubaria District, Al-Behaira Governorate. Misr-1 local wheat variety sown in mid November 2019 at seeding rate of 144 kg/hectare under drip irrigation system, grains in holes under surface drip irrigation system (SDIS), diameter of the lateral line was 16 mm with dripper discharge of 4 L/hour 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 10x0.50x25 = 125 m^2.

Mechanical and chemical analysis of experimental soil before addition of hydrogelwas: Sand (92.3%) - Silt (3.1%) – Clay (4.6%) – pH (7.4) – O.M (0.3%) – Ca Co3 (1.3) – Ec mmhos/cm^3 (0.3) – N (8.0 ppm) – P (3.0 ppm) – K (19.8 ppm) according to [27].

Preparing and finishing hydrogel: in double jacketed of a capacity 60 litre equipped with condense, variable speed motor temperature controller adjusted at 300 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 stirring for three hours. The obtained product was saponified in isopropanol (40 liters) 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, dried and milled. Materials used commercial product without purification – (Acrylonitrile AN, Corn starch, sodium hydroxyl, emulsifier). Recommended hydrogel addition amount was 4 g/m^2 from dry hydrogel.

Five irrigation treatments were 1- (Control) 100% recommended irrigation quantity (RIQ) (4838 m^3/ha.) without hydrogel. 2- 25% RIQ (1210 m^3/ha.)+ hydrogel. 3- 50% RIQ (2419 m^3/ha.)+ hydrogel. 4- 75% RIQ (3629 m^3/ha.)+ hydrogel. 5- 100% recommended irrigation quantity (RIQ) (4838 m^3/ha.) + hydrogel.

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 spikelets/spike 4- biological yield/tiller(g) 5- grain yield/spike (g). One meter was harvested to determine 6- grain yield/spike (g). The whole area of each treatment was harvested to determine characters measured per hectare 7- biological yield/H. 8- grain yield/h. 9- straw yield/H. 10- harvest index (%) determined as a ratio of grain yield/biological yield per hectare.

Correlation coefficient was done between all studied characters due to [28].

RESULTS AND DISCUSSION

Data presented in Table 1 clear the superiority of treatment of 75% RIQ+ hydrogel on all other treatments in most yield attributes (plant height (cm); spikes height

Table 1: Effect of irrigation quantities on yield and yield components of wheat (Misr-1 cultivar) under sandy soil condition. (Winter season of 2019/2020)

	Irrigation					
Characters	Control Without hydrogel	25% RIQ + hydrogel	50% RIQ + hydrogel	75% RIQ + hydrogel	100% RIQ + hydrogel	LSD at 0.05
Plant Height (cm)	101.67	86.00	103.27	104.65	102.33	1.05
Spike length cm)	10.33	9.83	10.50	10.67	10.33	0.18
No. spikes/m^2	291.32	235.55	283.42	315.16	247.15	2.44
No. of spiklets/spike	18.00	15.33	21.67	20.67	16.00	1.03
Bio- yield/ tiller(g)	11.00	10.50	11.20	13.30	12.30	0.11
Grain yield /spike (g)	4.60	3.70	4.87	5.20	4.77	0.25
Bio- yield (ton/ha)	8.02	6.43	10.37	10.68	8.66	0.33
Grain yield (ton/h)	2.92	2.28	2.99	3.33	3.07	0.01
Straw yield (ton/ha)	5.09	4.18	7.37	7.34	5.59	0.12
Harvest Index	36.43	35.17	28.88	31.15	35.48	0.27

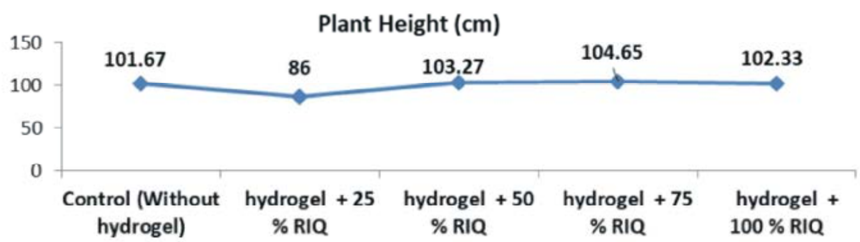

Fig. 1: Effect of different irrigation regimes and hydrogel on wheat plant height

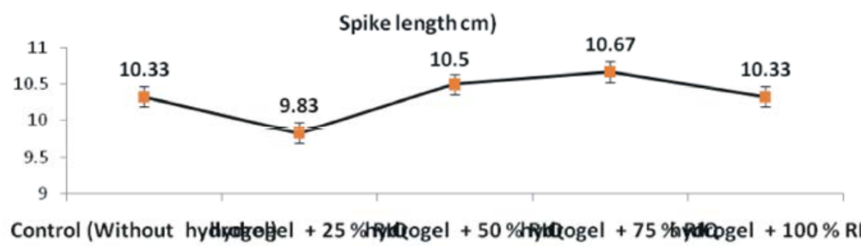

Fig. 2: Effect of different irrigation regimes and hydrogel on wheat spike length

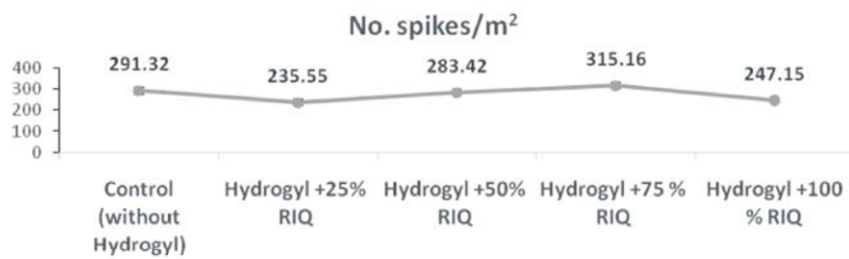

Fig. 3: Effect of different irrigation regimes and hydrogel on No. spikes/m^2

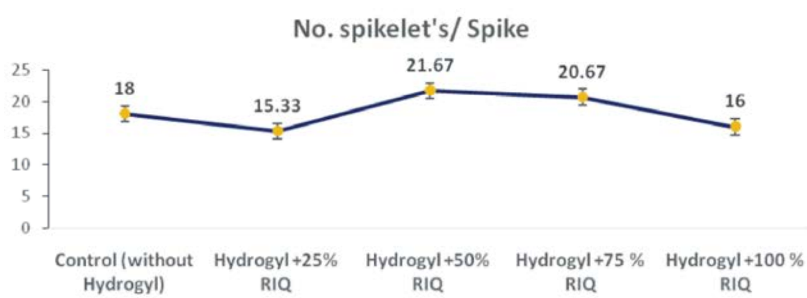

Fig. 4: Effect of different irrigation regimes and hydrogel on No. spikelets/spike

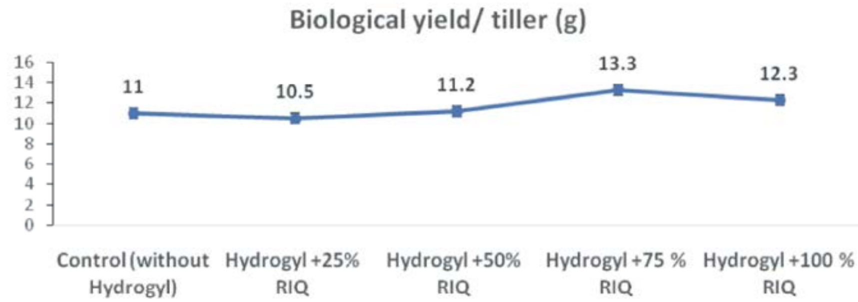

Fig. 5: Effect of different irrigation regimes and hydrogel on bio-yield/yiller(g)

(cm); no. of spikes/m^2; no. of spiklets/spike; biological yield/tiller (g); grain yield (ton/ha) and biological yield (ton/ha). Treatment of 50% RIQ + hydrogel produced highest straw yield (ton/ha) and control recorded the highest harvest index%.

Figure (1) show that treatment of 75% RIQ+ hydrogel produced tallest plants followed by 50% RIQ+ hydrogel and 100% RIQ+ hydrogel.

It's clear from Figure (2) that spike length (cm) due to recommended irrigation quantity and hydrogel arranged in descending order 75% RIQ+ hydrogel had tallest spikes followed by 50% RIQ+ hydrogel came in second order then 100% RIQ+hydrogel and control recorded the third order.

Data presented in Figure (3) show that No. of spikes/m^2 recorded the highest number per unit area in treatment of 75% RIQ+ hydrogel followed by control and 50% RIQ+ hydrogel was the third.

Data presented in Fig. (4) show that the highest No. of spiklets/spike produced by treatment of 50% RIQ+ hydrogel and 75% RIQ+ hydrogel came in the second order and control was third.

Treatment of 75% RIQ + hydrogel recorded the highest bio-yield/tiller (g) as shown in Fig. 5 then 100% RIQ+ hydrogel recorded second order followed by 50% RIQ+hydrogel in the third order, control in the fourth order and 25% RIQ+hydrogel produced the lowest bio-yield/tiller (g).

Data presented in Fig. 6 show the differences between treatments in grain yield/spike, 75% RIQ+hydrogel produced the heaviest grain yield/spike (g) followed by treatment of 50% RIQ+hydrogel and 100% RIQ was third , control was fourth and 25% RIQ+hydrogel produced the lowest grain yield/spike (g).

Data presented in Fig. (7) clear that the highest bio-yield (ton/h.) was produced by treatment of 75% RIQ+hydrogel (first order), then treatment of 50% RIQ+ hydrogel came in the second order followed by 100% RIQ+ hydrogel in the third order and control 100% RIQ without hydrogel was the fourth and 25% RIQ recorded the lowest in fifth order.

Figure (8) show the differences between all treatments in grain yield per unit area (ton/h.). It's clear from date that the highest grain yield (ton/h.) produced by treatment of 75% RIQ+hydrogel and recorded the first order , treatment of 100% RIQ+ hydrogel in the second order, 50% RIQ came in the third order, control was the fourth and 25% RIQ was fifth by lowest grain yield per unit area.

Due to straw yield (ton/h.) Fig. (9) show the superiority of treatment of 50% RIQ+ hydrogel followed by 75% RIQ+ hydrogel and the third was 100% RIQ+ hydrogel followed by ontrol in the fourth order and 25% RIQ+ hydrogel was the fifth.

Data presented in Fig. (10) clear that control (without hydrogel) recorded the highest harvest index followed by 100% RIQ+ hydrogel in second order and 25% RIQ+ hydrogel in the third order, 75% RIQ+ hydrogel was fourth and 50% RIQ+ hydrogel was fifth.

Results in Table (1) and figures from (1) to figure number (10) clear that there were significant differences between treatments in all studied characters. Treatment of 75% recommended irrigation quantities (RIQ) + hydrogel recorded the first order in 7 characters from the ten studied characters; it produced the tallest plants (104.65 cm); the tallest spike length (10.67 cm); the highest number of spikes/m^2 (315.16); the highest biological yield/ tiller (13.30 g); the highest grain yield/spike (5.20 g.); the highest biological yield per unit area (10.68 ton/h.); the highest grain yield per unit area (3.33 ton/h.) and the second order in two characters No. of spikelets/spike (20.67) and straw yield per unit area (7.34 ton/h.) and the fourth order in harvest index (31.15).

Treatment of 50% RIQ + hydrogel recorded the first order in number of spiklets/spike (21.67) and straw yield per unit area (7.37 ton/h.); the second order in plant height; spike length; grain yield / spike; gio-yield (ton/h.); grain yield (ton/h.) and the fifth order in harvest index).

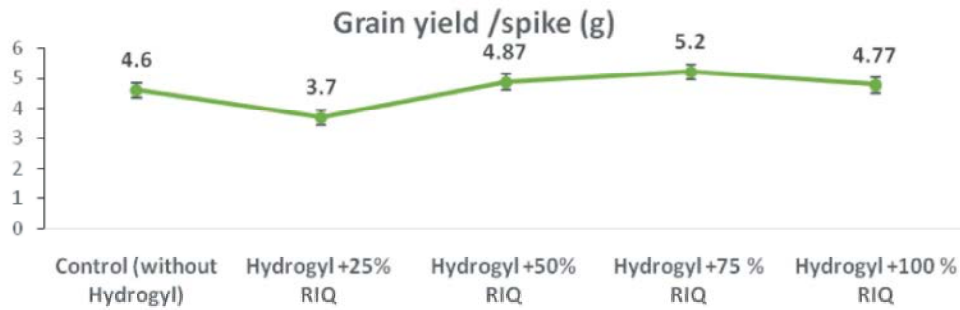

Fig. 6: Effect of different irrigation regimes and hydrogel on grain yield/spike (g)

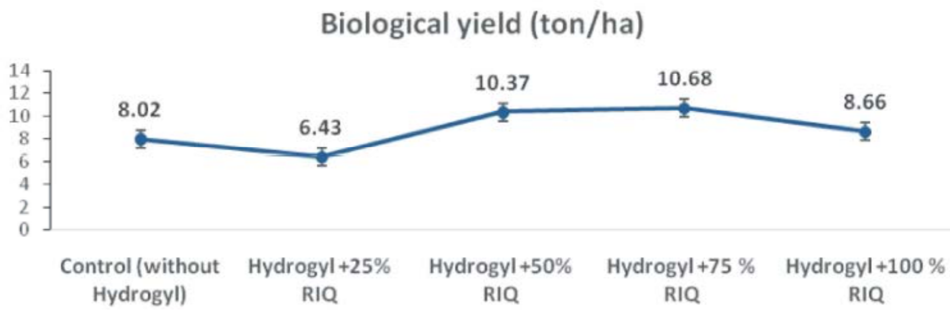

Fig. 7: Effect of different irrigation regimes and hydrogel onbio- yield (ton/h.)

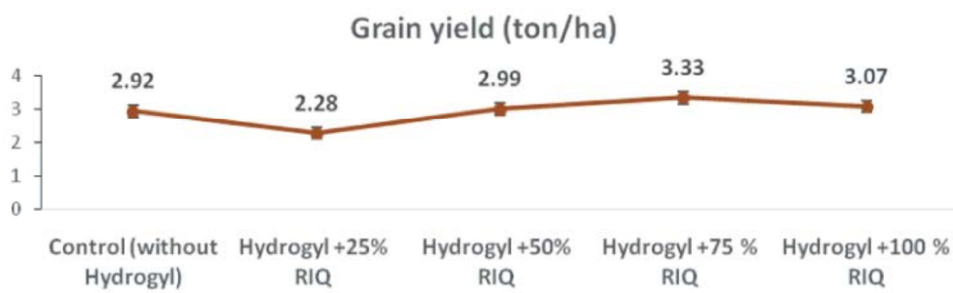

Fig. 8: Effect of different irrigation regimes and hydrogel on grain yield (ton/h.)

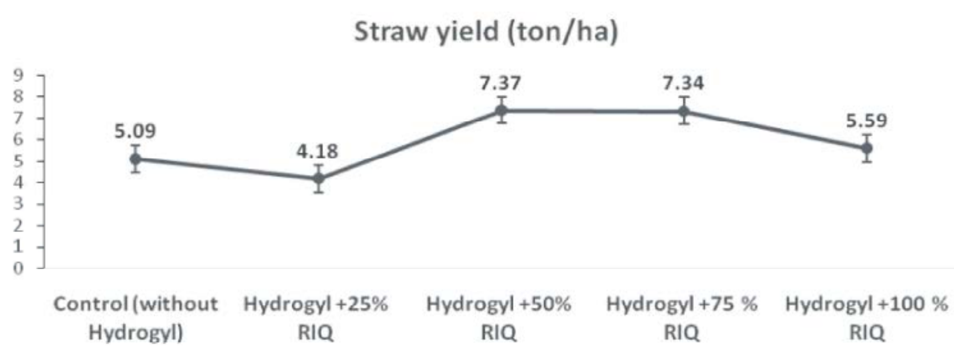

Fig. 9: Effect of different irrigation regimes and hydrogel onstraw yield (ton/h.)

It can be concluded that reducing recommended irrigation quantity to 75% RIQ or 50% RIQ beside utilize hydrogel with reducing RIQ produced the highest level of all studied characters except harvest index, thus it can be effective tool in reducing amount of irrigation quantity with utilization of 4 g/m^2 hydrogel, the obtained results may be due to the effect of hydrogel is one of the promising approaches to minimize drought stress that

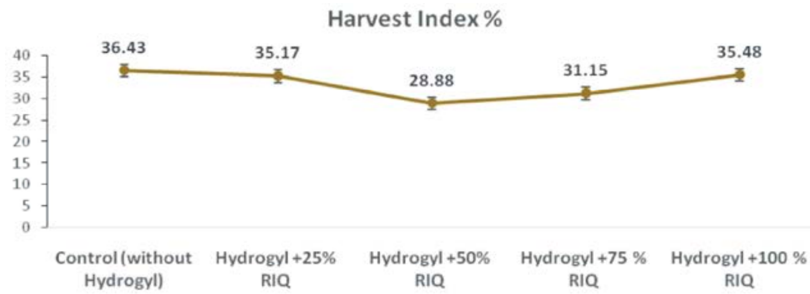

Fig. 10: Effect of different irrigation regimes and hydrogel on harvest index (%)

Table 2: Correlation between yield components of wheat Misr-1 variety under different recommended irrigation quantity and hydrogel

Characters	Spike length cm)	No. spikes/m^2	No. of spiklets/spike	Bio-yield /tiller (g)	Grain yield /spike (g)	Bio- yield (ton/ha)	Grain yield (ton/ha)	Straw yield (ton/ha)	Harvest Index
Plant Height (cm)	0.959*	0.724	0.674	0.656	0.967*	0.847	0.960*	0.775	-0.402
Spike length cm)		-0.658	0.578	0.747	0.989*	0.951*	0.964*	0.903*	-0.593
No. spikes/m^2			-0.902	0.536	0.776	0.757	0.745	0.723	-0.486
No. of spiklets/spike				0.357	0.784	0.887	0.635	0.916	-0.869*
Bio- yield/ tiller (g)					0.792	0.701	0.838	-0.681	-0.295
Grain yield /spike (g)						0.928*	0.989**	0.867	-0.521
Bio- yield (ton/ha)							0.961	0.990**	-0.800
Grain yield (ton/ha)								0.797	-0.407
Straw yield (ton/ha)									-0.867*

induces crop losses from moisture in root growth zone that absorb and store water 400-1500g water per one dry gram of hydrogel Johnson [29]; Brwman and Evans [7] also, water held in the expanded hydrogel is intended as a reservoir for maximizing the efficiency of plant water uptake. Callaghan *et al*. [8] reported that hydrogel amendments in sandy soils promoted seedlings survival and growth under arid conditions, while Viero *et al*. [9] found only an increase in seedling growth when hydrogel was applied in combination with irrigation. Related results to soil texture clear that hydrogel application in sandy soil promotes an increase in water retention capacity and plant water potential, Huttermann *et al*. [10] Abedi-kaoupai and Sohrab [11] but in loamy and clay soils the effect may be negligible. Jahangir *et al*. revealed that application of hydrogels can result in significant reduction in the required irrigation frequency particularly for coarse-textured soils. Under Egyptian conditions many researchers pointed the excellent effect of hydrogel on many crops and in decreasing water irrigation in sandy soil under both systems sprinklers and/or drip systems Waly *et al*. (2015) on rice and barley Waly *et al*. [13] on rice and barley; Waly *et al*. [14] on sunflower and wheat (2015) also, El-karamany *et al*. [15] on sugar beet; El-Karamany *et al*. [16] on sunflower; Waly *et al*. [17] on potato; El-Karamany *et al*. [18] in long term effect study revealed positive effect of hydrogel in reducing irrigation quantity, increasing the water water-holding capacity, water use efficiency, preventing nutrient leaching and fertilizers use efficiency also, decrease nutrients lost from rooting zone in sandy soil; El-Karamany *et al*. [19] on two wheat varieties and [20] on two barley varieties irrigated by sprinkles system; Bakry *et al*. [21] on flax; Bakry *et al*. [22] on wheat under drip irrigation system; El-Karamany *et al*. [23]on cotton; Bakry [24] on barley under drip irrigation system.

Correlation study: behavior of plants may be affected due to drought stress in treatments of study. Thus, a correlation study was done to test relations between yield characters of wheat plants under reducing recommended irrigation quantities with utilizing of 4 g/m^2 hydrogel as soil addition under soil surface irrigated by drip irrigation system in sandy soil.

Table (2) clear that due to important economic yield characters of wheat crop (grain yield, straw yield and biological yield per unit area ton/h.) detected that grain yield (ton/h.) had high significant correlation with grain yield/spike in gram (0.989); spike length cm. (0.964); biological yield ton/h. (0.961) and plant height cm. (0.960).

Straw yield ton/h. had high significant correlation with biological yield ton/h. (0.990); No. of spiklets/spike (0.916); spike length cm. (0.903) and grain yield ton/h. (0.797).

Biological yield ton/h. had high significant correlation with spike length cm. (0.951); grain yield/spike g. (0.928); No. of spiklets/spike (0.887) and plant height (0.847).

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