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# Effect of Hydrogel Doses on Yield Attributes of Cotton under Limited Irrigation Quantity in Sandy Soil

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**Abstract:** Two green house experiments were carried out during 2019 and 2020 summer seasons in Researches and Production Station of National Research Centre (NRC), Al-Nubaria District, Al Behaira Governorate, Egypt. Egyptian cotton cultivar Giza 86 (*Gossypium barbadense* L.) was used in the experiment. Hydrogel*as soil improver commercial product named (Barbary) was used at different rates. Data after harvested 2nd season revealed that hydrogel rates of 6 g/m$^2$ and 8 g/m$^2$ increased organic matter, also, N, P, K, Cu, I, Mn, Z and available water and decreased pH, $caco_3$ and EC after two seasons. Treatment of 6 g/m$^2$ had superiority in no. of leaves/plant, no. of bolls/plant and seed cotton weight/plant (g) but treatment of 8 g/m$^2$ surpassed other treatments in plant height (cm), no. of vegetative branches/plant and position of 1st vegetative node. It can be concluded that imported hydrogel named (Barbary) had positive effect either on reducing irrigation quantity to 75% from recommended or on soil properties and yield of seed cotton as summer crop had long season in sandy soil under Egyptian condition.

**Key words:** Hydrogel · Cotton · Seed yield · Soil properties

## INTRODUCTION

One of the promising approaches to minimize drought stress is hydrogel that induces crop losses from moisture in root growth zone [1]. Bowman and Evans [2] reported that hydrogel act by absorb and store water hundreds of their own weight water per one gram of dry hydrogel. Save *et al*., [3]; Specht and Harvey Jones [4] revealed that hydrogel is attended as one of the soil reservoir for maximizing the efficiency of plant water uptake, also, [5, 6] indicated that hydrogel amendments in sandy soil promoted seedlings survival and growth under arid conditions. Viero *et al*. [7] found an increase in seedling growth when hydrogel was applied in combination with irrigation. Hydrogel application in sandy soil promotes an increase in water retention capacity and plant water potential, [8, 9, 10] indicated that application of hydrogel can result in significant reduction in the required irrigation frequency particularly for coarse-textured soils. Tohidi-Moghadam *et al*. [11] clear that drought stress and absence of super absorbent lead to a decrease in all agronomic parameters. Cotton is considered one of important summer crops with long season 180 to 200 days so, it required high amount of irrigation quantity in sandy soil under Egyptian condition (4000 m$^3$)/feddan (4200m$^2$) per season.

Cotton is considered to be one of the most important summer crops with long season 180 to 200 days so, it required high amount of irrigation quantity in sandy soil under Egyptian condition (4000 m$^3$)/feddan (4200m$^2$) per season.

The excellence of hydrogel for reducing water irrigation up to 50 and/or 75% from recommended quantity in sandy soil reported in many crops under Egyptian condition by researchers team of National Research Centre (NRC), [12] on rice and barley; [13] pointed increase effect on yield of wheat and sunflower; [14] revealed the dual effect of hydrogel in sugar beet by

*Imported from France, registered from Agriculture Ministry in France under number (9010133) also, registered by Agricultural Research Centre, Ministry of Agriculture, Egypt, its components were hydro polymer (42%), source acryl amide + total Nitrogen (6.5%), source ammonium nitrate and potassium nitrate + Phosphorus $P_2O_5$ (4.8%), source phosphoric acid + Potassium $P_2O$ (8.2%), source potassium nitrate.

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decreasing water irrigation quantity and decreasing nitrogen leaching from sandy soil; [15] revealed best effect on yield and yield attributes of sunflower in field trial; [16] on potato revealed positive effect of hydrogel in increasing the water-holding, water use efficiency in sandy soil; same results recorded by [17] on double purpose (forage+seed) of mungbean (*Vigna radiat*a L. Wilczek) and [18] 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. El karamany *et al*. [19] indicated the superiority of hydrogel under 75% from recommended irrigation quantity on wheat varieties grown in sandy soil 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.

The aim of this study was to complete plan of researchers team of National Research Centre (NRC), to investigate the role of hydrogel as super water absorbent on yield and yield components of cotton as summer crop required high rate of irrigation especially under sandy soil condition to reach a goal of reducing recommended water irrigation quantity to 75% under sprinkler irrigation system so, researchers team of NRC selected cotton crop to study its response to hydrogel different doses under sandy soil condition.

## MATERIALS AND METHODS

Two greenhouse experiments were carried out during summer seasons of 2019 and 2020 in Researches and Production Station of National Research Centre, NRC, Al-nubaria Disrict, Al Behaira Governorate, Egypt. Location and climate of experimental site was (latitude 30°30'1.4"N and longitude 30°19'10.9"E and mean altitude 21 m above sea level. The data of temperature and relative humidity were obtained from (Local Weather Station inside the farm), Summer is hot with no rain.

The experimental soil before added hydrogel, commercial product under name (Barbary) treatments was analyzed according to [20]. Soil texture was sandy and its mechanical and chemical characteristics are shown in Table 1 and after harvested the 2$^{nd}$ season in Tables 2, 3. Sandy soil from virgin area in NRC station was used in the experiment. Sowing date was 25 Mars in both seasons. Earthenware pots 50 cm diameter and 40 cm in depth each one filled with 12 kg sandy soil then, treatment was done in 10 pots (replicates) by broadcasting of dose of hydrogel then covered with thin layer of soil and 2 seeds of cotton variety Giza 86 were sownin each pot.

Nitrogen fertilizer was added after sowing at a rate of 60 kg N/fed. (3.67 g/pot) as ammonium nitrate (33.5%N) in 3 equal doses at 21 days where 2$^{nd}$ and 3$^{ed}$ at 4 weeks intervals. Phosphprus dose of 24 kg./fed. $p_2o_5$ (2.53 g/pot) in the form of calcium superphosphate 15.5% $p_2o_5$ during seed bed preparation. Potassium was added at rate of 24 kg/fed. (0.85 g/pot) in the form of potassium sulphate 48% $k_2o$.Recommended water irrigation quantity (RIQ) was 4000 $m^3$/feddan so, 75% of RIQ was 3000 $m^3$/fed. which were (0.030 $m^3$/pot). Normal cultural practices of growing cotton were done according to the recommendations of this district except treatments of study.

**Experimental Treatments:**

**Four Treatments Were Implemented:**

- Control 75% from recommended irrigation quantity RIQ(0.030 $m^3$/pot) without hydrogel, identified 3000 $m^3$/feddan.
- 75% RIQ (0.030 $m^3$/pot) +hydrogel 4g/$m^2$.
- 75% RIQ (0.030 $m^3$/pot) +hydrogel 6g/$m^2$.
- 75% RIQ (0.030 m3/pot) +hydrogel 8g/$m^2$.

Hydrogel is soil improver commercial product (Barbary) imported from France, registered from Agriculture Ministry in France under number (9010133) also, registered by Agricultural Research Centre, Ministry of Agriculture, Egypt, its components were hydro polymer (42%), source acryl amide + total Nitrogen (6.5%), source ammonium nitrate and potassium nitrate + Phosphorus $P_2O_5$ (4.8%), source phosphoric acid + Potassium $P_2O$ (8.2%), source potassium nitrate.

The experimental design was Complete Randomized Block design with ten replications, to investigate the effect of hydrogel on Egyptian cotton cultivar Giza 86.

At harvest date the two plants of each pot were taken to determine the following traits:

- Plant height (cm).
- No. of vegetative branches/plant.
- Number of leaves/ plant.
- Position of 1$^{st}$ vegetative node.
- No. of bolls/plant.
- Boll weight (g)
- Seed cotton weight/plant (g).

**Statistical Analysis:** The analysis of variance procedure of complete randomize block design according to [21], combined analysis of two seasons 2019 and 2020 was done, treatments means were compared using at 5% of probability.

Table 1: Mechanical and chemical analysis of experimental soil before sowing

| Sand % | Silt % | Clay % | pH | OM % | $CaCo_3$ | EC ds/m | Soluble N (ppm) | Av. P (ppm) | Ex. K (ppm) |
|---|---|---|---|---|---|---|---|---|---|
| 92.0 | 3.9 | 4.1 | 8.3 | 0.2 | 4.8 | 4.3 | 8.1 | 0.2 | 10.2 |

## RESULTS AND DISCUSSION

Data presented at Table 2 show mechanical and chemical analysis of experimental soil after harvest of second season of cotton crop after addition of hydrogel treatments. It is clear that percentage of sand; clay; pH; $CaCo_3$ and E.C were decreased in descending order due to increased hydrogel dose from 4 – 6 – 8 g/m$^2$. On the other hand percentage of silt and organic matter were slightly increased, these result may be due to effect of hydrogel by absorb water by many hundreds of its weight combined with nutrients N, P and K in contents of hydrogel which act as slow release fertilizers reflect in reducing leaching nutrients from root growth zone, these result was in accordance with obtained by [1, 2, 14, 17].

It can be discussed from data in Table 3 that the effect of increasing hydrogel from 4 to 6 to 8 g/m$^2$ in experimental soil resulted increasing available water and macro and micro nutrients N; P; K; Cu; I; Mn; and Z in ascending order meaning that 8 g/m$^2$ surpassed control without hydrogel by 37% in N, 80% in P, 23% K, 76% in Cu, 35% in I, 60% in Mn, 37% in Z and 18% in available water also, 8 g/m$^2$ hydrogel had superiority in the same arranged nutrients determined by percentages of (75%, 150%, 61%, 88%, 71%, 66%, 68% and 39% in available water so, it can be concluded that treatments of 6 g/m$^2$ and 8 g/m$^2$ had positive effect in absorb all measured nutrients and decrease nutrients leaching from soil after two seasons.

Table 2: Mechanical and chemical analysis of experimental soil after harvest of 2nd season

| | Characters | | | | | | |
|---|---|---|---|---|---|---|---|
| Treatments | Sand % | Silt % | Clay % | pH | OM % | $CaCo_3$ % | E.C. dS/m |
| Control 75% RIQ without hydrogel | 91.90 | 3.90 | 4.20 | 8.2 | 0.30 | 1.4 | 1.7 |
| 75% RIQ +hydrogel 4g/m$^2$ | 91.90 | 3.98 | 4.12 | 8.2 | 0.40 | 1.3 | 1.6 |
| 75% RIQ +hydrogel 6g/m$^2$ | 91.40 | 4.60 | 4.00 | 8.0 | 0.50 | 1.3 | 1.4 |
| 75% RIQ +hydrogel 8g/m$^2$ | 91.40 | 4.70 | 3.90 | 7.9 | 0.50 | 1.3 | 1.4 |

OM% = Organic matter%

Table 3: Macro, micro nutrients and available water of experimental soil after harvest the 2nd season

| | Characters | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Treatments | N ppm | Av. P ppm | EX. K, ppm | Cu ppm | Fe ppm | Mn ppm | Z ppm | A.W % |
| Control 75% RIQ without hydrogel | 48 | 10 | 42 | 0.34 | 2.10 | 0.30 | 1.90 | 10.2 |
| 75% RIQ +hydrogel 4g/m$^2$ | 54 | 15 | 45 | 0.48 | 2.40 | 0.45 | 2.10 | 10.8 |
| 75% RIQ +hydrogel 6g/m2 | 66 | 18 | 52 | 0.60 | 2.84 | 0.48 | 2.60 | 12.0 |
| 75% RIQ +hydrogel 8g/m2 | 84 | 25 | 68 | 0.64 | 3.60 | 0.50 | 3.20 | 14.2 |

EX = Exchangeable - AW = Available Water

Table 4: Effect of hydrogel rates on yield and some yield attributes on variety Giza 86 of cotton crop under 75% of RIQ in sandy soil (combined of 2019 and 2020 seasons)

| | Characters | | | | | | |
|---|---|---|---|---|---|---|---|
| Treatments | Plant height (cm) | No. of vegetative branches/plant | No. of leaves/plant | Position of 1st vegetative node | No. of bolls/plant | Boll weight(g) | Seed cotton weight/plant (g) |
| Control 75% RIQ | 125 | 3.80 | 10.20 | 17.80 | 19.70 | 1.97 | 32.60 |
| 75% RIQ +hydrogel 4g/m$^2$ | 151 | 3.00 | 10.90 | 20.50 | 21.50 | 2.40 | 38.20 |
| 75% RIQ +hydrogel 6g/m2 | 161 | 3.80 | 14.10 | 22.90 | 25.30 | 2.50 | 57.00 |
| 75% RIQ +hydrogel 8g/m2 | 168 | 4.40 | 11.30 | 23.80 | 19.50 | 1.98 | 49.80 |
| LSD at 0.05 | 0.35 | 0.08 | 0.22 | 0.17 | 0.34 | 0.05 | 0.35 |

RIQ = Recommended Irrigation Quantity


Fig. 1: Effect of hydrogel rates on yield and some yield attributes on variety Giza 86 of cottoncrop under 75% of RIQ in sandy soil (combined mean of two seasons)

Data presented in Table 4 clear that there were significant differences among treatments in all studied characters . Treatment of 75% RIQ + 8 g/m$^2$ produced the tallest plants 168 cm., plant height decreased with lower dose of hydrogel to 6 g/m$^2$ (161 cm), 4 g/m$^2$(151 cm) and the shortest plants recorded by control without hydrogel addition (125 cm.).

Treatment of 75% RIQ + 8 g/m$^2$ produced the highest No. of vegetative branches/plant (4.40) followed by 75% RIQ + 6 g/m$^2$ and control (3.80) and the lowest was 75% RIQ + 4 g/m$^2$ (3.00).

The same trend recorded in plant height and no. of vegetative branches/plant was true in position of 1$^{st}$ vegetative node75% RIQ + 8 g/m$^2$ recorded (23.80 cm.) then reduced with reducing dose of hydrogel to 22.90 cm to 20.50 cm and the shortest was control (17.80 cm), it can be concluded that increasing values of these characters by increasing dose of hydrogel may be due to its effect of application in sandy soil promotes an increase in water retention capacity and plant water potential, results near reported by [8, 9, 10] indicated that application of hydrogel can result in significant reduction in the required irrigation frequency particularly for coarse-textured soils [11]. clear that drought stress and absence of super absorbent lead to a decrease in all agronomic parameters.

It is clear from data in (Table 4 and Fig. 1) that treatment of 75% RIQ + 6 g/$m^2$ had superiority in most important characters, it produced highest no. of leaves/plant (14.10), highest no. of bolls/plant (25.30), boll weight (2.5. g.) and heaviest seed cotton weight/plant (57.00 g.), treatment of 75% RIQ + 8 g/$m^2$ recorded the second order in no. of leaves/plant and seed cotton weight/plant, treatment of 75% RIQ + 4 g/$m^2$ was third.

Due to most important economic characters in cotton crop under study (seed cotton weight g/plant and boll weight in gram) it can be concluded that addition of hydrogel in dose of 6 g/$m^2$ or 8 g/ $m^2$ was effective tool in increasing both economic characters thus, we can recommend by 6 g/ $m^2$ increase economic crop beside reducing recommended irrigation quantity to 75% under sandy soil condition. Near results were reported by many researchers under same conditions [12]; on rice and barley [13] on wheat and sunflower [14] revealed the dual effect of hydrogel in sugar beet by decreasing water irrigation quantity and decreasing nitrogen leaching from sandy soil; [15] on sunflower in field trial; [16] on potato revealed positive effect of hydrogel in increasing the water-holding, water use efficiency in sandy soil; [17] on double purpose (forage+seed) of mungbean (*Vigna radiat*a L. Wilczek) and [18] 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. El karamany *et al*. [19] indicated the superiority of hydrogel under 75% from recommended irrigation quantity on wheat in field trial.

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