International Journal of Water Resources and Environmental Sciences 11(3): 40-51, 2022
ISSN 2311-2492

DOI: 10.5829/idosi.ijwres.2022.11.3.11133

Productivity of Some Canola Varieties under Water Deficit Conditions and Hydrogel Application in Sandy Soil

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Abstract: *Background*: There're severe shortage in edible oils production in Egypt which imports more than 95 of oil consumption. Rich crops in oil content like canola is needed and candidate for growing in the new lands. However, the new lands are characterized with water shortage but recently. The use of hydrophilic matter in plant production could help to mitigate the negative effects of water scarcity. This is due to the fact that hydrophilic matter has a larger capacity to absorb a huge amount of water, reducing the impact of environmental stress on plants. Therefore, field experiment were conducted in sandy soil over two seasons, 2018/2019 and 2019/2020 at the Research and Production Station, National Research Centre, El-Nubaria Province, El-Behera Governorate, Egypt (located about 150 km from the National Research Centre and about 13 km east of Cairo/Alexandria desert road (30° 91 N latitude, 29° 96 E longitude and almost at an altitude of 14 m above the sea)., The objective of the study was to evaluate the impact of hydrogel treatments at a rate of 16 kg/ha (with and without) on some biochemical aspects, yield, yield components and chemical components of three canola varieties (Pactol, Serw 4 and Serw 6) under water stress by using 50%of the recommended irrigation amount. *Results*: Hydrogel increases accessible water as well as macro N, Pand K, in the experimental soil. The obtained results showed that Serw 6 variety surpassed the other varieties in plant height, branches no., pods no., seed weight per plant, 1000 seeds weight, biological yield ton/ha while, Serw 4 came in the 1st order in seed, oil yield ton/ha. and photosynthetic pigments. Pactol recorded the highest harvest index%. On the other hand, hydrogel treatment proved to be effective photosynthetic pigments and yield parameters of normal irrigated plants as well as drought stressed plants. Furthermore, hydrogel treatment resulted in considerable increases in seed yield, oil, carbohydrate and protein content in the produced seeds. Interaction of Serw 6 x hydrogel produced highest values for all studied parameters in yield. While the interaction between serw 4 X hydrogel produced the highest levels of photosynthetic pigments, seed yield, oil yield (ton/ha) and seed yield quality. *Conclusions*: The current study found that using 16 kg of hydrogel per hectare enhanced the yield of canola cultivars planted on sandy soil. As a result, hydrogel 16 kg/ha and Serw 4 advise farmers to employ hydrogel because it provides a promising seed yield on reclaimed sandy soil.

Key words: Canola varieties · limited irrigation · Hydrogel

INTRODUCTION

Rapeseed (*Brassica napus* L.) is a major oil crop that is produced all over the world. Despite the vast variety of locations appropriate for its cultivation [1], significant efforts are undertaken to define optimal agricultural methods, create innovative formulations of nutrient solutions and techniques to approach the genetic potential of cultivars seed and oil yield.The oil content varies widely. These variations are more influenced by the environment and production systems than by diversity [2, 3]. Canola crops have a bright future and help bridge the gap between edible oil production and consumption in Egyptian conditions. Cultivation of canola oil in low fertility and/or water scarce irrigated soils can be successful if relatively high economic yields can be achieved with low inputs' [4] under saline stressed conditions using Pactol, Serw-4, Serw6 and Evita varieties [5, 6] indicated superiority of Serw-4 in yield and its components compared to AD201, Silvo, Topas, Serw-6

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and Pactol but Serw-6 produced the highest oil % in seeds. [7] reported that Chinese genotypes gave highest germination, seed yield and oil % compare to local variety Serw-4. One of the promising approaches to minimizing drought stress, which leads to crop loss due to moisture in the root growth zone, was hydrogels. The consequence is that the dried hydrogel absorbs and stores hundreds of times its own weight in water. Hydrogel is attended as one of the soil reservoirs for maximizing the efficiency of plant water uptake indicated that hydrogel additions in sandy soil increased seedling survival and development under dry circumstances, according to the findings. When hydrogel was used in conjunction with watering, seedling development increased [8]. The use of hydrogels in sandy soil improves water retention and plant water potential [9] also, [10] demonstrated that the use of hydrogel might result in a considerable reduction in the needed irrigation frequency, particularly for coarse-textured soils [11]. It is obvious that drought stress and the lack of super absorbent cause a decline in all agronomic indices. Under Egyptian condition many researchers found the excellence of hydrogel for reducing water irrigation to 50 or 75% from recommended quantity in many crops; on rice and barley; [12] pointed best effect on wheat and sunflower; [13] revealed dual reduced water irrigation has an influence on the hydrogel in sugar beets quantity and decreasing nitrogen leaching from sandy soil; [14] on sunflower in field trial; [15] on potato demonstrated a favourable impact of hydrogelin reducing irrigation quantity, increasing the water-holding, water use efficiency, preventing nutrient leaching and fertilizers are also efficient, reducing nutrient loss rooting zone in sandy soil; same results recorded by [16] on double purpose (forage+seed) of mungbean (*Vignaradiat*a L. Wilczek) and [17] clear that in vitro investigation, increasing the concentration of hydrogel had the greatest impact rooting and acclimatization of pine apple (*Ananascomosus*cv. Smooth cayenne) as alternated of agar. [18] indicated the superiority of hydrogel in 75% from recommended irrigation quantity surpassed all other treatments also in comparison to the control under sprinkler irrigation system, the interaction of variety Sids-12 x 75 %water irrigation amount provided the greatest values in both significant features grain and straw yields per unit area, with increases of 41.1 %and 35.6%. The aim of study was to investigate the role of hydrogel as super water absorbent on yield of canola varieties for reducing recommended water irrigation quantity to 50% under sprinkler irrigation system.

MATERIALS AND METHODS

Two field trials were conducted out at the National Research Centre's Research and Production Station in Al-Emam Malek Village, Nubaria District, Al-Behaira Governorate, Egypt(located about 150 km from the National Research Centre and about 13 km east of Cairo/Alexandria desert road (30° 91 N latitude, 29° 96 E longitude and almost at an altitude of 14 m above the sea), during the two successive winter seasons 2018/2019 and 2019/2020 to study the effect of hydrogel on three canola (*Brassica napus* L.) varieties under 50% of recommended irrigation quantity.

Mechanical and chemical analysis of the soil site is presented in Table (1) according to (19). After planting, 60 kg N/fed of nitrogen fertilizer was applied. At 21 and 35 days after seeding, as ammonium nitrate (33.5 %N) in two equal dosages. Normal cultural practices of growing canola were done according to the recommendations of this district except two factors of study.

Experimental Treatments

Rapeseed Varieties: The three rapeseed varieties investigated are:

- Pactol variety from the Oil Crop Council of the Ministry of Agriculture in Egypt, Giza, Dokki.
- Serw (4) produced by another culture Vido variety (Sweeden), El- Serw Experimental Station, Damietta Governorate, Agriculture Research Center, Ministry of Agriculture, Egypt.
- Serw (6) is a haploid plant selected from the Primere (Germany) varieties of the El Serw Experimental Station. Damietta Governorate, Egyptian Ministry of Agriculture Agricultural Research Center.

Hydrogel: The review of literature indicated that the proper hydrogel rate in sandy soil of the experimental site was 16 kg /ha according to [20, 21]. So two treatments of hydrogel application were tested: (16kg/hectare and without hydrogel).

Water requirements for canola under the conditions of the experimental site was calculated according to [22]. They calculated the seasonal irrigation water applied for canola, according to [23]. The calculated seasonal irrigation water applied was 3600 and 2900 m^3 ha^{-1} $season^{-1}$ for sprinkler irrigation. So the water deity applied as 50 % was 1800 and 1450 m^3ha^1 respectively in both seasons.

Table 1: Pre-treatment mechanical and chemical parameters of the soil experimental

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	0.3	8.1	0.2	10.2

Hydrogel is a commercial soil conditioner (Barbary) imported from France, registered under the number (9010133) by the French Ministry of Agriculture and registered by the Agricultural Research Center of the Egyptian Ministry of Agriculture. Its composition was hydropolymer (42%)., Source acrylamide + Total Nitrogen (6.5%), Source 3444 Ammonium Nitrate and Potassium Nitrate + Phosphorus P2O5 (4.8%), Source Phosphorus + Potassium P2O (8.2%), Source Potassium Nitrate.

The experimental design was Complete Randomized Block design with three replications and 6 treatments included the combinations among two hydrogel levels and three canola varieties. The experimental unit consisted of ten rows and covered 10.5 square meters (1/400 fed). (3.5 m long and 30 cm. between rows).Seeds were sown at a rate of 3.00 kg/ fed (one fed = 4200m^2) in November 20th in 2018/2019 and 2019/2020 growing seasons. The preceding crop was maize in the two growing seasons. Plant samples were taken during the vegetative stage (60 days after seeding) for measurements of plant height and fresh weight. Fresh leaves were taken to study (photosynthetic pigments, A random sample of 10 plants from each plot was taken at harvest to ascertain the following traits: plant height (cm), number of branches/plant, number of pods / plant, seed yield / plant (g) and1000-seed weight (g). Plants of one square meter from the middle part of each plot were harvested. These plants were dried under sunshine for one week and seeds were cleaned after being separated from the pods and the following traits were estimated: Seed yield (ton/hectare), biological yield (ton/hectare), harvest index (%) = seed yield / biological yield (%), oil yield (ton/hectare) = oil percent x seed yield (ton/hectare), oil% protein % and carbohydrates%.

Chemical Analysis: Photosynthetic pigments (Chlorophyll a, chlorophyll b, carotenoids and total pigments) were estimated using the method of [24].

Total soluble sugars were determined according to [25]. Proline was extracted as describes by [26] and assayed according to [27]. Total soluble protein concentration was determined according to the method described by [28].

Seed Quality: The amount of seed oil was determined using the Soxhlet equipment and petroleum ether (40-60°C) according to the manufacturer's instructions. [29]. The protein content was determined by microkjeldahl method according to [28]. Total carbohydrates were determined according to [29].

Statistical Analysis: The obtained data were subjected to the proper statistical analysis according to [31]. Since the trends were similar in both seasons, the homogeneity was carried out according to Bartlet's test and the combined analysis of the data was applied. Treatment means were compared using LSD test at 5% level.

Mechanical and chemical analysis of the soil site is presented in Table (1) according to [19].

RESULTS

Mechanical and chemical parameters of experimental soil following harvest of second season treatments are shown in Table (2) slight changes in pH, $CaCo_3$ and E.C were reported following two seasons of hydrogel application.

Canola Varieties: Data presented in Fig. (1 & 2) showed the differences among the tested canola varieties in Chle. a, Chle. b, total pigments, carotenoids, proline, TSS and soluble protein also, it seems that serw 6 variety surpassed the other two varieties in photosynthetic pigments, proline, TSS and soluble protein regardless the irrigation treatments.

Table (3) revealed that the varietal differences under study at combined of two seasons, results indicated that Serw 6 developed the tallest plants (127.50 cm.), the highest values of branches and podsnumber/plant (4.41 & 195.33) and the heaviest weight of 1000 seed & seed yield/plant (2.95 & 12.61g after that Serw 4 and Pactol. Seed and oil yield (ton/hectare).

Data in Table (3) pointed out that Serw-4 surpassed the other two varieties with marginal increases without significant differences, its production was (2.406 & 1.016 ton/ha.)with increase by 2.10% than Serw-6 (2.357ton/ha.) and 2.20% than Pactol (2.355 ton/ha.). From the same Table (3) it is clear that there were significant differences among the three varieties; Serw-6 produced the highest biological yield per unit area (18.739 ton/ha.) followed by Serw-4 (17.430 ton/ha.) by increase 7.60% and the third was Pactol (16.951 ton/ha.) by 10.60%, it can be indicated that Serw-4 and Serw-6 interchange their order 1st and 2nd in the most important characters seed and

Table 2: Shows the mechanical and chemical parameters of the experimental soil following the 2nd season's harvest

	Characters						
Treatments	pH	O.M %	$CaCO_3$	E.C.ds/m	Soluble N (ppm)	Av. P (ppm)	Ex. K (ppm)
Hydrogel	8.0	0.30	4.6	4.1	8.8	0.40	14.2
Without	8.2	0.30	4.70	4.2	8.2	0.30	10.4

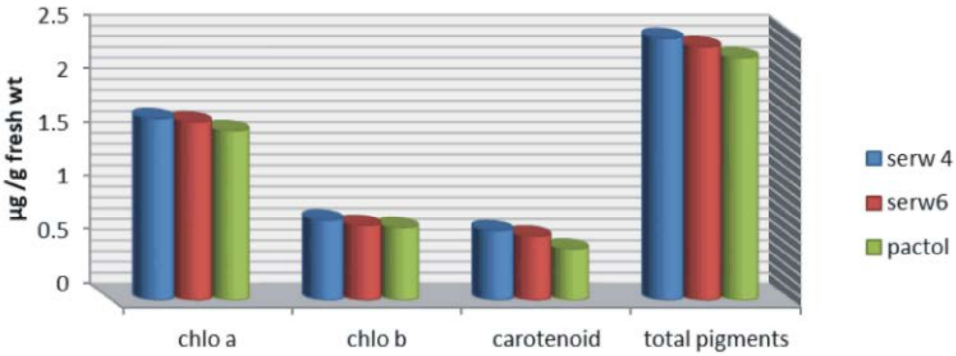

Fig. 1: Effect of varietal differences on photosynthetic pigment (µg /g fresh wt) of canola under 50% of recommended irrigation quantity in sandy soil Combined of two seasons

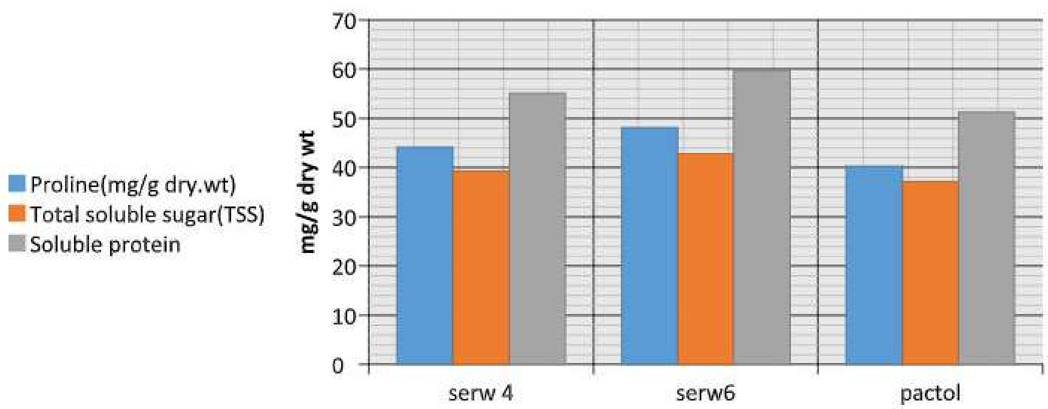

Fig. 2: Effect of varietal differences on proline (mg/g dry wt), total soluble sugar (mg/g dry wt) and soluble protein (mg/g dry wt) of canola under 50% of recommended irrigation quantity in sandy soil Combined of two seasons

Table 3: Effect of varietal differences on canola yield and yield components under 50% of recommended irrigation quantity in sandy soil. Combined means of two seasons

Varieties	Height of Plant (cm)	Number of Branches / plant	Pods number / plant	1000 Seed Weight (g)	Seed yield/ Plant (g)	Seed yield (ton/ha.)	Oil yield (ton/ha)	Bio-Yield (ton/ha.)	Harvest Index (%)
Pactol	120.83	4.18	183.66	2.78	11.32	2.355	0.985	16.951	13.93
Serw 4	124.83	4.18	191.33	2.86	12.25	2.406	1.016	17.430	13.83
Serw 6	127.50	4.41	195.33	2.95	12.61	2.357	0.986	18.739	12.85
LSD at 0.05%	2.55	N.S	3.71	0.14	1.61	N.S	N.S	0.152	0.82

bio-yields but Pactol was third constantly. Data of combined two seasons clear significant differences between tested varietiesin harvest index % but trend was opposite or all studied characters Pactol possessed the highest harvest index % (13.93 %) by increase of 0.80 % than Serw-4 (13.82 %) and 8.40 % than Serw-6 (12.85 %), it can be explain these results by the calculation method of harvest index as seed yield /biological yield % and lowest value of bio-yield (denominator) for Pactol by 10.80 % from Serw-6 and by 7.60 % from Serw-4 although the decrease of Pactol in seed yield as (nominator) was 2.10 % and 2.20 % from Serw-4 and Serw-6, soPactol recorded the highest harvest index %.

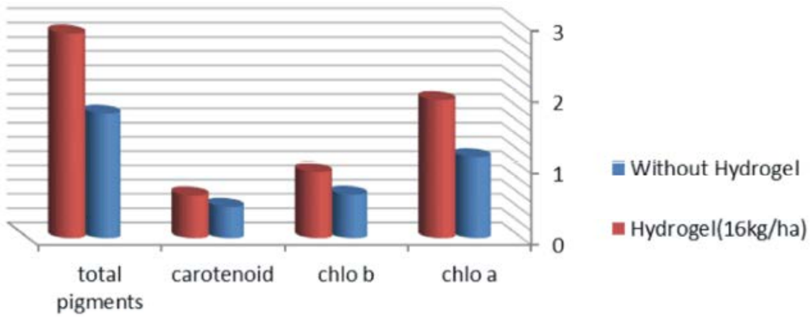

Fig. 3: Effect of hydrogel on photosynthetic pigment of canola under 50% of recommended irrigation quantity in sandy soil. Combination of two seasons in a sandy soil

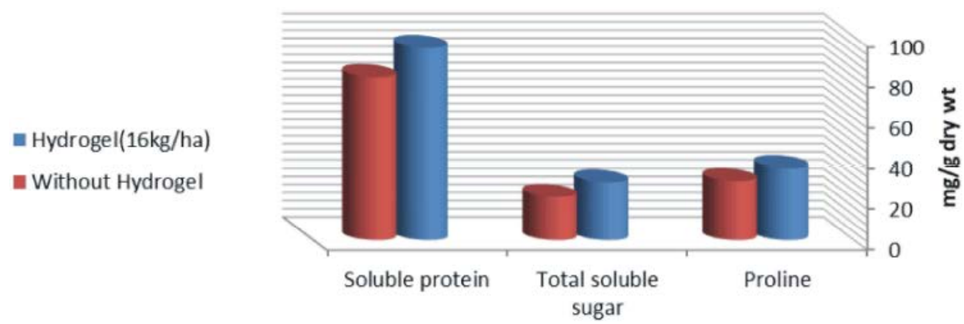

Fig. 4: Effect of hydrogel on proline (mg/g dry wt), total soluble sugar (mg/g dry wt) and soluble protein (mg/g dry wt) of canola under 50% of recommended irrigation quantity in sandy soil. Combination of two seasons in a sandy soil

Table 4: Effect of hydrogel on yield and yield components of canola under 50% of recommended irrigation quantity in sandy soil. Combination of two seasons in a sandy soil

Hydrogel	Height of Plant (cm)	Number of Branches / plant	Number of Pods / plant	1000 Seed Weight (g)	Seed yield / Plant (g)	Oil yield (ton/ha)	Seed yield (ton/ha.)	Bio-Yield (ton/ha.)	Harvest Index (%)
16kg/ha.	129.88	4.79	198.22	2.98	12.67	1.063	2.520	19.424	13.12
Without	118.88	3.73	182.00	2.74	11.44	0.930	2.225	15.989	13.96
LSD 0.05%	2.08	0.52	3.03	0.12	1.31	0.021	0.043	0.123	0.54

Hydrogel: The addition of hydrogel with the recommended dose (16 kg/fed) increased different photosynthetic pigments, proline, TSS and soluble protein constituents in comparison with those plants grown without hydrogel addition Fig. (3 & 4). Moreover, the results revealed that, addition of hydrogel to soil improved chlorophyll a, chlorophyll b, carotenoids, total pigments, proline, TSS and soluble protein.

Table 4 clearly shows the data of differences between treatments of hydrogel asoil addition and control (without addition) under limited irrigation (50 % from recommended quantity) in sandy soil. It is shown from table that the differences between hydrogel application and without addition were significant for all studied characters. Planttreated by hydrogel (129.88 cm) was taller than without treating (118.88 cm) by 9.30 % increase. Number of branches/plant were (4.79) in hydrogel treatment by increase rate 28.50 % than without (3.73). Plants treated by hydrogel produced (198.22) pods/plant but without produced (182.00) and the increase was 9.00 %. 1000 seed weight (g) of hydrogel treatment was (2.98 g), it was heavier than without (2.74 g) by 8.80 % increase. Seed yield/plant of hydrogel treatment was (12.67 g) with increase 10.80 % than 10.80 % than. Seed yield and oil yield /hectare clear that hydrogel treatment produced (2.520 &1.063 ton/ha) but without gave (2.225 & 0.930 ton/ha.) so, with increase 13.30 %. Biological yield ton/hashow the superiority of hydrogel treatment (19.424 ton/ha.) on without (15.989 ton/ha.) with increase rate 21.50 %, this result was recorded in allstudied attribute by different percentages.Harvest index % recorded the opposite trend thanall attributes without recorded (13.96) and hydrogel treatment was (13.12) decreased so; the percentage of decrease due to hydrogel was 6.40 %. It can be concluded from results of comparison between hydrogel treatment and without hydrogel.

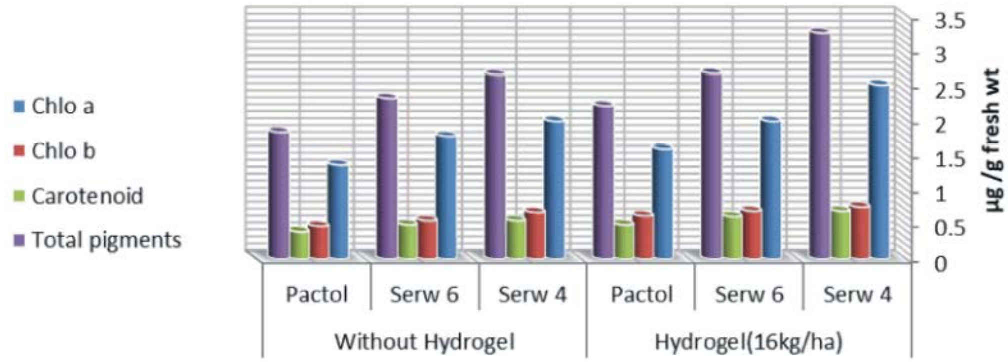

Fig. 5: Interaction of varieties and hydrogel on photosynthetic pigments (µg /g fresh wt) of canola under 50% of recommended irrigation quantity in sandy soil. Combination of two seasons in a sandy soil

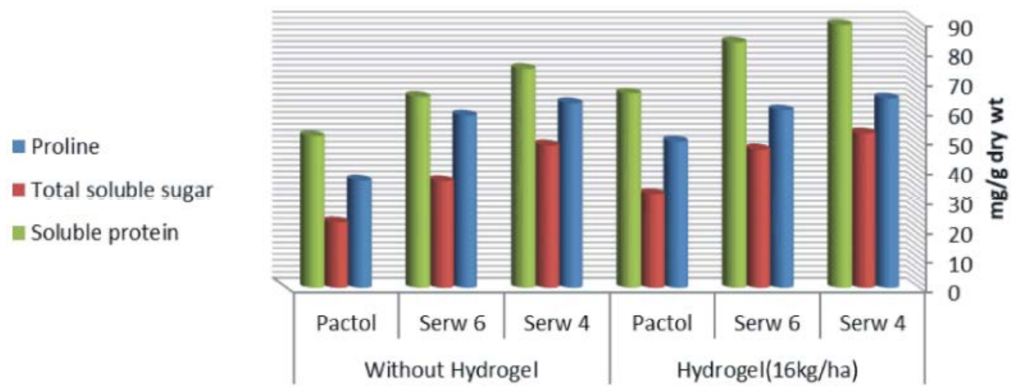

Fig. 6: Interaction of varieties and hydrogel on proline (mg/g dry wt), total soluble sugar (mg/g dry wt) and soluble protein (mg/g dry wt) of canola under 50% of recommended irrigation quantity in sandy soil. Combination of two seasons in a sandy soil

Table 5: Interaction of varieties and hydrogel on yield and yield components of canola under 50% of recommended irrigation quantity in sandy soil. Combination of two seasons in a sandy soil

	Characters								
Varity	Plant height (cm)	Branches number/ plant	Pods number /plant	1000 Seed weight (g)	Seed yield/ Plant (g)	Oil yield (ton/ha)	Seed yield (ton/ha.)	Bio-Yield (ton/ha.)	Harvest Index (%)
Hydrogel									
Pactol	123.00	4.63	187.66	2.87	11.49	1.052	2.532	17.794	14.30
Serw 4	130.67	4.86	199.33	2.99	12.92	1.108	2.573	18.723	13.77
Serw 6	136.00	4.86	207.67	3.09	13.59	1.059	2.453	21.756	11.30
Without									
Pactol	118.67	3.74	179.66	2.70	11.14	0.888	2.177	16.107	13.57
Serw 4	119.00	3.50	183.33	2.73	11.57	0.961	2.261	16.138	13.90
Serw 6	119.00	3.97	183.00	2.80	11.61	0.933	2.237	15.723	14.40
LSD at 0.05%	3.00	N.S	5.25	0.21	N.S	N.S	N.S	0.021	1.37

Interaction of Varieties and Hydrogel: Fig. (5 & 6) showed that the interaction between varietal differences in canola and hydrogel (with and without) on the photosynthetic pigments content, proline, TSS and soluble protein were significant. The highest values were recorded by (serw4) and hydrogel application followed by serw6 and pactol).

Table 5 show significant differences between interactions for most studied characters except for branches number/plant, seed yield per plant, per hectare and oil yield. Data revealed the superiority of interaction between canola variety Serw 6 x hydrogel treatment which, induced the tallest plants (136.00 cm.), highest branches number/plant (4.86), greatest pods number per

Table 6: Effect of hydrogel on nutritional value (oil %, seed protein% and carbohydrates %) of canola under 50% of recommended irrigation quantity in sandy soil. Combination of two seasons in a sandy soil

Treatment	Oil (%)	Seed Protein (%)	Carbohydrate (%)
Pactol	41.81	22.37	18.42
Serw 4	42.22	23.85	20.11
Serw 6	41.85	23.15	19.53
L.S.D at 5%	0.75	0.63	0.48
Hydrogel 16kg/ha	42.19	21.25	21.83
Without	41.82	20.76	20.22
L.S.D at 5%	0.52	0.33	0.37

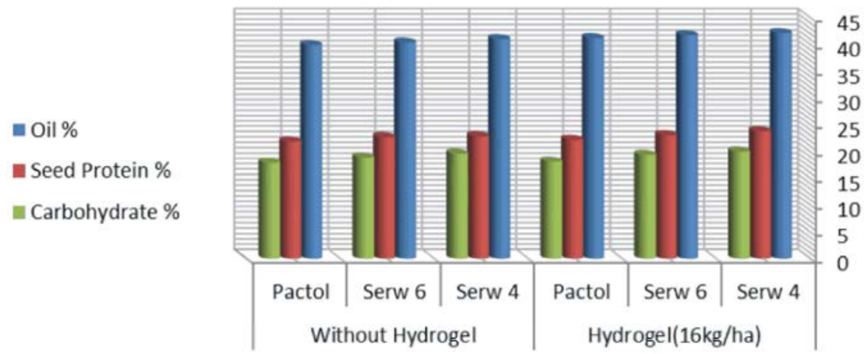

Fig. 7: Interaction of varieties and hydrogel on seed yield quality ofcanola under50% of recommended irrigation quantity in sandy soil. Combination of two seasons in a sandy soil

plant (207.67), heaviest 1000 seeds (3.09 g.), highest seed yield/plant (13.59 g) and highest biological yield per unit area (21.756 ton/ha.). Interaction of Serw 4 x hydrogel treatment recorded the highest seed yield and oil yield (2.573 & 1.108 ton/ha.)while the interaction between Serw 6 and without hydrogel recorded the best harvest index %.

Changes in Nutritional Value of Canola Plants: Data presented in Table 6 and Fig. (7) revealed the varietal differences under study as combined means of two seasons. The results indicated that Serw 4 produced the highest values (oil, seed protein and carbohydrate %) followed by Serw 6 and pactol. Meanwhile, addition of hydrogel to soil under 50% of recommended irrigation quantity significantly increased oil, carbohydrate and protein contents. In addition Fig. (4) show the interaction between Serw 4 and hydrogel recorded the best oil %, seed protein % and carbohydrate %.

DISCUSSION

Water scarcity and drought are one of the most important environmental stressors, using the hydrophilic matter in plant production could help to mitigate the negative effects of water scarcity. In this research, decreasing percentage of mechanical and chemical properties of experimental soil after harvest of second season treatments slightly changed (Table 2). Such effect may be due to effect of hydrogel which absorb high amount of water combined with nutrients N, P and K in contents of hydrogel which act as slow release fertilizers reflect in saving nutrients from leaching. The results were in accordance with obtained by [32], [33], [13] and [16]. Also, the effect of hydrogel addition in soil which increase available water, macro and micro nutrients N;P; K; Cu; I; Mn; and Z so, it can be concluded that hydrogel treatment had positive effect in saving all measured nutrients and decrease nutrients loss from soil after two seasons. The superiority serw 6 variety of in chlorophyll a, chlorophyll. b, total pigments, carotenoids and some osmolytes contents of canola plants (proline, total soluble sugars (TSS) and total soluble proteins Fig. (1 & 2) significantly increased plant biomass and this steady state was greater than the other two varieties. Drought –induced reductions in photosynthetic pigment contents might be due to the instability of pigment-protein complex and pigments destruction [34]. Furthermore, the reduction in leaf photosynthetic pigments may be attributed to a mechanism of preventing damage by reactive oxygen species (ROS). In addition to hydrogel role in water retention, it enhances soil aeration thus induces better photosynthetic pigments and plant growth consequently plant productivity. On the other handhydrogel addition to soil caused increases in plotline and more increases in the studied compatible osmolytes as compared with plants grown without hydrogel. In addition, proline has been considered as a carbon and nitrogen source for rapid recovery from stress [35] and acting as stabilizer for membranes and some macro molecules and also as a free radical scavenger. The accumulation of proline under drought stress and hydrogel treatment is consistent with the early findings of [36, 37]. One of the main benefits of hydrogel treatment is an increase in proline. From this point of view, no correlation with osmotic potential or RWC is surprising because the osmolytic properties of proline usually explain higher water potential in hydrogel-treated plants [38]. Regarding soluble sugars, it was found significant increases in soluble sugars due to moderate and severe drought stress (Fig. 4). Soluble sugars are accumulated in plants of many species that are subjected to water stress. [39] stated that water stress caused a remarkable increase in sugars content that might play a role in the osmotic adjustment. In addition, accumulations of soluble carbohydrates increase the resistance of plant to drought stress [40]. The primitive effect of hydrogel treatment on osmoprotectant content may be due to its effect as soil reservoir for maximizing the efficiency of plant water uptake, also, 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, superiority of Serw-4 inyield and yield components under 50% of recommended irrigation quantity in sandy soil comparing with other two varieties in Table (3) and Fig. (3 & 4) this result was near with those obtained by [5, 6] who reported interchange between Serw-4 and Serw-6 in yield and yield attributes under Egyptian conditions; [7] pointed out that imported Chinese genotypes surpassed Serw-4 in seed yield but study done in one season and genotypes did not adapted for Egyptian conditions on the other hand [41] pointed superiority of mutations produced after subjected to of gamma rays to seeds resulted higher yield and its components than their parents Serw-4, Serw-6 and Pactol. Biological yieldharvest index(%) took the same trend reported in all studied characters in this trail and by [6]. Data of combined two seasons clear significant differences between tested varieties in harvest index % but trend was opposite from all studied characters Pactol surpassed other two varieties. The effect of hydrogel addition on soil is consistent with other results. Because hydrogels are copolymers, they can absorb and retain large amounts of water and nutrients in the soil, ignoring water and nutrient deficiencies and making them available to plants, thereby photosynthesis and plant. Enhancing and strengthening vitality. In reality, hydrogels have a water capacity of 980 ml and absorb up to 150 times their own volume. In addition to hydrogel role in water retention, it enhances soil aeration thus induces better plant growth consequently plant productivity. The effectives of hydrogel on photosynthetic pigment under stress conditions are shown earlier on [42]. The differences between hydrogel and without addition were significant for all studied characters (Table 4), that superiority of hydrogel may be due to its effect by increasing water in soil contents for maximizing the efficiency of plant water uptake, also, increasing the water-holding, water use efficiency, preventing nutrient leaching and fertilizers use efficiency also, decrease nutrients lost from rooting zone in sandy soil. [11] reveal that drought stress and lack of hydrogel lead to a reduction in all agricultural parameters. The excellence of hydrogel for increasing yield and its attributes in many crops under Egyptian conditions was concluded by many researchers [12] tested rice crop in summer and barley crop in winter; [43] utilize wheat in winter and sunflower in summer; [14] on sunflower; [15] on potato; [16] in long term study on forage and seeds of mungbean; [18]; on wheat under sprinklers irrigation system; [20] on two barley varieties; [44] on flax; [21] on wheat under drip irrigation system; [45] on cotton; [46] on barley under drip irrigation system and [47] on wheat. Drought–induced reductions in photosynthetic pigment contents Fig. (7) might be due to the instability of pigment-protein complex and pigments destruction. Furthermore, the reduction in leaf photosynthetic pigments may be attributed to a mechanism of preventing damage by reactive oxygen species (ROS) as stated by [48]. Also, [49] showed thatall studied traits were affected by lack of irrigation water on faba bean. In contrast, addition of hydrogel soil amendments significantly enhanced photosynthetic pigments. These promoted effect of hydrogel on photosynthetic pigment under stress conditions are shown earlier on sunflower [50]. The interaction between canola cultivars and hydrogel treatments on yield and yield attributes was logic due to superiority of variety Serw 6 under 1st factor (varietal differences) except for seed yield/ha. And for harvest index % also, superiority of hydrogel treatment under 2nd factor of study (hydrogel treatment) in all studied attributes except for harvest index %, which reflected on result of interactions. The opposite trend recorded in harvest index % by superiority of interaction of Serw 6 x without hydrogel may be concluded to the lowest biological yield (which is the dominator of harvest index %). However, interaction between Serw 4 and hydrogel recorded the best oil %, seed protein % and carbohydrate %. Regarding increments in protein content under drought stress, [51] found that sunflower seed protein content was considerably greater when irrigation was absent during flowering. Hydrogel increased dry weight due to greater absorption of micro-and macronutrients, particularly nitrogen and potassium, similar to the findings of [52]. [53]. Increased levels of total proteins, photosynthetic pigments and Rubisco might be explained by a larger nutrition buildup. Carbohydrate alterations are particularly important because they are directly related to physiological functions like as photosynthesis, translocation and respiration. Water stress reduces the concentration of pigments in leaves, which inhibits photosynthetic activity. This results in reduced carbohydrate buildup in mature leaves, which may slow the rate of glucose transit from source to sink. (from leaves to developing seeds).

CONCLUSIONS

In general, current studies have shown that hydrogel application at16 kg / ha increases the amount of rapeseed varieties cultivated in sandy soil conditions. Therefore, Hydrogel 16kg / ha and Serw4 encourage growers to use Hydrogel to achieve promising seed yields under reclaimed sand.

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