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Biochemical Studies on some Soybean Cultivars under Water Stress Conditions

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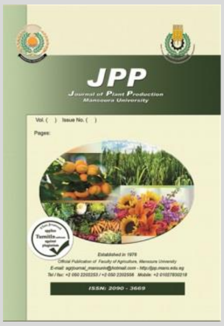

ABSTRACT

This study was carried out during 2018 and 2019 at the Research and Experiment Center, Fac. Agric., Benha Univ., Egypt. to analyses the impact of four different water regimes (two, four, six and eight irrigations supplies) on yield and biochemical compositions studies of four soybean varieties *i.e.* Crawford, Giza 111, Giza 35, and Giza 21 during both seasons. Four replications of a split-plot design were used to set up the treatments. In the main-plots, irrigation schedules were distributed at random, whereas soybean varieties were in the sub-plots. The 10.5 m^2 sub-plot was made up of 5 ridges that were each 3.5 m long and 60 cm wide. Results revealed that, as compared to the control plants, all of the different treatments clarified important significant changes in all traits. Increasing the number of irrigations considerably boosted seed production when compared to the seasons' lowest number of irrigations. Meanwhile, chemical analysis significantly decreased by increasing number of irrigations, except for oil content. Soybean varieties were significantly varied in seed yield for both seasons of chemical analysis which was significant in the leaves and phosphorus percentage of seeds only except for proline content of leaves. Therefore, it was not sufficiently substantial for irrigation regimes and soybean seed production to interact.

***Keywords*:** Chemical constituents, yield, Soybean, water stress.

INTRODUCTION

Improper irrigation schedule for soybean [*Glycine max* (L) Merr.] plant is crucial, since this may likely lead to either severe yield reduction or a waste of water resources, or both. In addition, this may negatively affect soybean seed chemical composition, leading to seed quality deterioration. In semiarid regions of the world (e.g., Egypt, 26.8206° N, 30.8025° E) this is especially true, where furrow irrigation is the main common watering management practice. In addition, to appropriately choose soybean cultivar(s), which have acceptable yield potentials at water stress conditions, and to understand considered essential crop management elements for reducing both seed yield and quality losses are the growth stages (GS) that are most susceptible to water stress.

Water stress is one abiotic environmental factor that has a detrimental effect on soybean yield and yield components. It causes reduction in both pod growth (Orlowski *et al.*, 2016) and seed number and size (Wijewardana *et al.*, 2018a); it, in addition, shortens seed filling period (Brevedan and Egli, 2003) and negatively affect seed quality attributes (Wijewardana *et al.*, 2018b). Jumrani and Bhatia (2018), Wijewardana *et al.* (2019), and Du *et al.* (2020) have reported that water stress negatively influences both soybean yield and chemical components of both leaves and seeds. These losses relatively depend upon the severity of water stress conditions exerted on the soybean plant during its various growth stages – vegetative and reproductive ones.

Furthermore, water stress affects plant biomass production via affecting relative growth rate and/or its duration. Under water stress, leaf expansion and radiation interception rate or conversion efficiency indirectly affect relative growth rate (Giunta et al, 1995). Ludlow *et al.* (1980) argued that the extent to which photosynthetic processes are affected when plants suffer from water deficit or following water stress release determines the relative dry matter and crop yield reductions. Day and legg (1983) assumed that reduction in CO_2 exchange between plant leaf and air and deficient energy supply for photosynthesis process during water stress, this leads to dry matter accumulation reduction.

In soybean, both plant GS and cultivars are quite influential factors in deciding irrigation schedule (Kranz and Specht, 2012). Plant growth stages (GS) are primarily separated into vegetative and reproductive phases. The reproductive stage (R1–8) begins with the blooming of the first flower on the plant, whereas the vegetative stage (VE–N) starts with the germination of seeds and the emergence of seedlings. The authors stated that the familiarity of these soybean development stages is quite crucial to apply the GS procedure to plan for irrigation schedule. Unnecessary extra amount of irrigation water during vegetative developmental stages is considered a waste unless water status in soil layers is quite low prior and/or following planting. Excess watering might enhance vegetative growth to limits that do not contribute much, as an effective photosynthate source, to targeted yield; it is also likely that plants subjected to lodging, and if it occurs during R_4 GS--end of pod elongation—this likely leads to severe yield loss. Hence, any water stress soybean plants are subjected to during R_3-R_4, *i.e.*, pod development and R_5-R_6, *i.e.*, seed filling is considered detrimental to seed yield and quality. This is due to the relatively highest evapotranspiration rate, ET (0.32 inch d^{-1}) that occurs during late flowering, R_2, and early pod, R_3 GSs,

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and approximately 65% of total water use occurs during $R_{1\text{-}6+}$ reproductive stages, as indicated by Kranz and Specht (2012). Moreover, they further added that selecting soybean cultivar which belongs to i) *indeterminate*, ii) *semi-determinate*, or iii) *determinate* growth pattern determines irrigation timing since these plant developmental patterns are related to soybean plant developmental stages. Mohamed and Latif (2017), Farboodi *et al.* (2018), and Du *et al.* (2020) have reported that soybean cultivars, in addition, vary in their seed yield and chemical components in both leaf and seed.

Therefore, this research aims at evaluating how soybean cultivars relatively respond to water stress via varying irrigation frequency during various plant growth stages for both seed yield and leaf and seed chemical constituents.

MATERIALS AND METHODS

To determine the impact of water stress at various growth stages, a study was conducted on four soybean varieties (Giza 21, Giza 35, Giza 111, and Crawford) at the Agricultural Experiment Center, Faculty of Agriculture, Moshtohor, Benha University, Kalubia Governorate, Egypt, over two growing seasons of 2018 and 2019.

Irrigation regime *i.e.* four treatments as follows;

1- Two irrigations were added after 40 and 80 days after sowing at vegetative growth and full flowering, respectively, each irrigation was add at rate of 300 m^3 fed^{-1}.

2- Four irrigations were added after 30 days (d.) at vegetative growth, 60 d at beginning of flowering, 90 d. at beginning of pod formation and 120 d at full pod formation, while, each irrigation was at rate of 250 m^3 fed^{-1}

3- Six irrigations were add after 30 d. (vegetative growth), 50 d. (beginning and full of flowering), 70 d. (end of flowering), 90 d (beginning of pod formation), 110 d (full pod formation) and 130 d. (full seed formation) while, each irrigation was at rate of 200 m^3 fed^{-1} .

4- Traditional irrigation (8 regular subsequently irrigations) once every 15 days at all vegetative and reproductive stages.

Utilizing triangle-shaped weirs, irrigation was regulated (V notch). Water flow had a set height of 30 cm. According to the equation of Hansen *et al.* (1980), water discharge was measured as follows; Q is equal to 0.0138 x h2.5 x 3.6, where Q is the water discharge in m3 hr-1, 0.0138 and 3.6 are constant values, and 3.6 was added to get Q in m3 hr-1 (cm). According to Hansen *et al.* (1980), water usage efficiency (WUE) was calculated as follows:

WUE equals the seed yield kg/total water input m^3. Water saved in m^3 fed^{-1} and the percentage of seed yield loss were calculated for each irrigation technique as compared to flooding irrigation throughout the course of the whole growing season.

Four Soybean varieties was as follows; Giza 21, Giza 35, Giza 111 and Crawford. Seeds were provided by the legume department, Agriculture Research Center, Ministry of Agriculture, Giza, Egypt.

The design was a split plot (4 replicates) with irrigation as main plots and varieties as subplots. The area of sub-plot was 10.5 m^2 (3X3.5m).

The soil was clay of pH 7.8. Four replications of a split plot design were employed. The four irrigation methods were assigned to the main plots, and the four soybean cultivars were distributed among the sub-plots at random. N was administered in two equal portions at planting and before the first watering, at a rate of 20 kg N fed^{-1} (as urea 46.5%N). During soil preparation, P was provided at a rate of 10 kg P fed^{-1} (as Ca-superphosphate 6.8% P), and the soil had a sufficient K content. In five ridges that were each 3.5 meters long and 60 cm broad, seeds were manually drilled. Planting took place on May 23, 2018, and May 28, 2019, respectively. The Climates Research Station, Agriculture Research Center, provided the trials with climatic information for the two growth seasons (Table 1).

Table 1. The Kalubia Governorate's predominant ambient environmental conditions for each of the two growing seasons (2018 and 2019).

Seasons	**Climatic factors during summer 2018 growing season**							
Climatic factors	**Temperature (°C)**		**Humidity (%)**		**Pressure (mbar)**		**Dew point**	**Wind**
Month	**Min.**	**Max**	**Max.**	**Min.**	**Max.**	**Min.**	**(°C)**	**km/h**
May 2018	31.8	32.5	94	7	1017	1001	11	14
June 2018	34.7	26.9	94	9	1016	1003	15	13
July 2018	35.8	27.8	89	17	1012	1003	17	12
Aug. 2018	34.3	27.5	94	21	1012	1006	19	12
Sep.2018	32.9	25.9	94	19	1017	1006	19	13
Climatic data during summer 2019 growing season								
May 2019	31.7	21.9	83	5	1018	1004	12	15
June 2019	34.3	26.8	88	15	1020	1005	16	14
July 2019	34.8	27.6	84	11	1013	1002	19	12
Aug. 2019	34.5	27.6	89	10	1013	1004	20	12
Sep. 2019	32.0	24.6	88	24	1019	1006	18	12

Studied parameters:

Data recorded: In the 2019 season (the second growing season), fresh shoots were collected at 80 days of plant age to analyses their chemical composition and chemical analysis**.** Proline concentration was determined calculated on a dry weight basis based on the technique of Bates *et al.* (1973) follows:

$$\textbf{Proline content (mg/g)} = \frac{(X)\ \text{ppm x ml Extract volume}}{2\ \text{x Sample dry weight x}100}$$

Enzyme Extraction and Activity: Enzymes of catalase, peroxidase enzymes in leaves:

- **Peroxidase activity (POD, EC 1.11.1.7):** Peroxidase activity was extracted and determined in leaves according to the methods of (Zhang, 2004).

Calculating formula:

$$\textbf{POD}\ (\mathbf{U.g^{-1}.FW.min^{-1}}) = \frac{\Delta A470 \times Vt}{W \times Vs \times 0.01 \times t}$$

Formula: ΔA470: change of absorbance in reaction time; Vt: total volume of extracting enzyme solution, mL; Vs: volume of enzyme liquid, mL; W: fresh weight of sample, g; t: reaction time, min.

-The CAT enzyme activity (EC, 1.11.1.6): The CAT enzyme activity was extracted and determined in leaves according to the methods of (Zhang, 2004).

Calculating formula:

$$\text{CAT (U.g}^{-1}\text{ .FW.min}^{-1}\text{)} = \frac{\Delta A240 \times Vt}{0.1 \times V1 \times t \times FW}$$

Formula: ΔA240: difference of absorbance between sample tube and boiled tube; Vt: total volume of extracting enzyme solution, mL; V1: volume of enzyme liquid, mL; W: fresh weight of sample, g; t: reaction time, min.

B- Substances found in soybean seeds to identify their chemical composition, seeds from the 2019 season (the second growing season) were collected at harvest time.

-Total nitrogen and crude protein content (%): Total nitrogen content was determined in seeds at harvest time by using wet digestion according to the methods of Piper (1947). Using microkjeldahil as described by using (Horneck and Miller, 1998), then calculated as percentage of dry weight. Then crude protein was calculated according to the following equation:

Crude protein= total nitrogen x 6.25 by (A.O.A.C. ,1990).

-Phosphorus content (%): Total phosphorus was determined calorimetrically according to the method reported by (Sandell, 1950) and calculated as a percentage.

-Potassium content (%): Potassium was determined by the flame photometer model Carl-Zeiss according to the described method of (Horneck and Hanson, 1998) and calculated as a percentage.

- Total carbohydrates content (%): The amount of total carbohydrates in seeds was estimated (%) using the phenol-sulphoric acid technique described by Dubois *et al.* (1956) at the time of harvest in the second growing season.

-Total oil content (%): Using the Soxlet apparatus using petroleum ether as a solvent, the oil % content was calculated (A.O.A.C. ,1990).

-Statistical analysis: Data from each of the two growth seasons were subjected to a variance analysis using the following formula: (Steel and Torrie ,1981). In order to compare means, the L.S.D. test at the 5% level was applied.

RESULTS AND DISCUSSION

-Effect of water regimes, soybean varieties and their interactions on:

I-Seed yield:

Results from Table 2 demonstrate the impact of water regimes on different soybean varieties and how they interact with seed production during two growing summer seasons. By increasing the number of irrigations up till conventional irrigation, the average seed yield improved. Highest yields were 1537.25 and 1186.16 kg fed^{-1} obtained by normal irrigation in the first and second seasons respectively. Lowest values were 703.33 and 1012.66 kg fed^{-1}. It is generally noticed that, the traditional irrigation gave the highest seed yield followed by the 6-irrigation treatment then the 4-irrigation one the 2-irrigation one. There was no significant difference between the traditional and the 6-irrigation one with. ***** These results agree with those by Desclaux *et al.* (2000); Gaballah *et al.* (2008), Ouda *et al.*, (2008) and Masoumi *et al.* (2011-a).

Giza 21 gave the highest seed yield (1611.67 and 1355.0 kg fed^{-1} in seasons 1 and 2 respectively, followed by Giza 35 variety (1557.33 and 1330.00 kg fed^{-1}) then Giza 111 variety (1536.67 and 1270.00 kg fed^{-1}) followed by Crawford yield variety (443.33and 789.66 kg fed^{-1}). Crawford variety gave the lowest seed yield of 625.0 and 896.66 kg fed^{-1} respectively. Differences may be due to their individual specific genetic make up (Farboodi *et al.*, 2018; He *et al.*, 2017).

Table 2. Impact of water regimes on soybean varieties for seed yield (kg fed^{-1}) at each seasons of 2018 and 2019.

Water regime (W)	**2018 season**				
	Soybean Variety (V)				
	Giza 21	**Giza 35**	**Giza 111**	**Crawford**	**Means**
Two irrigations at (V.G.S. and F.F.S)	775.0	743.3	670.0	625.0	703.3
Four irrigations at (V.G.S., B.F.S., B.P.S. and F.P.F.S)	1186.7	1088.3	961.7	880.0	1029.2
Six irrigations at all vegetative and reproductive stages	1540.0	1510.0	1400.0	1383.3	1458.3
Traditional	1611.7	1557.3	1536.7	1443.3	1537.3
Means	1278.3	1224.7	1142.1	1082.9	1182.0
L.S.D. at 5% :	W = 31.58, V = 14.50 WV = 29.0				
Water regime (W)	2019 season				
	Soybean Variety (V)				
	Giza 21	Giza 35	Giza 111	Crawford	Means
Two irrigations at (V.G.S. and F.F.S)	1105.0	1061.7	987.3	896.7	1012.7
Four irrigations at (V.G.S., B.F.S., B.P.S. and F.P.F.S)	1226.0	1203.3	1100.0	1030.0	1139.8
Six irrigations at all vegetative and reproductive stages	1324.0	1275.0	1160.0	1087.3	1211.6
Traditional	1355.0	1330.0	1270.0	789.7	1186.2
Means	1252.5	1217.5	1129.3	950.9	1137.5
L.S.D. at 5% for:	W= N.S, V= 86.5 and WV= N.S				

Giza 21 variety when irrigated with the traditional way produced the highest seed yield Lowest was by the Crawford variety when irrigated of two irrigations. Ranking order in respect to the applied irrigation water regimes: two irrigations, then four irrigations, followed by the six irrigations. Giza 21 was more productive variety as compared with the other three varieties (Giza 35, Giza 111 and Crawford). Results are in agreement with those by Chowdhury *et al.*, (2016-b) and Anda *et al.* (2020).

- Proline content:

Proline content was determined in plants of the second season only (Table3). Results show lowest of 281.0 mg g^{-1} in the traditional irrigation Giza 21. The highest was 416.0 given by Crawford of 4 irrigations. Ranks of averages for irrigations show two irrigations (413.16) > four irrigations (405.33) > six irrigations (387.50) > traditional (315.25).Averages for varieties ranked. Ranks of averages by varieties are Crawford (391.0) > Giza 111 (387.6)> Giza 35(375.8)> Giza 21(366.8). These results agree with those by Bates *et al.* (1973), Trinchant *et al.* (2004), Lobato *et al.*, (2008), Hossain et al (2014), Mokter *et al.* (2014) Sheshbahre (2017), Wijewardana *et al.* (2019) and Sarkar *et al.* (2015)..Differences reflect individual specific genetical make up . The obtained findings agree with those of the reported by Masoumi *et al.*, (2011-b) and Devi *et al.* (2015).

Table 3. Impact of water regimes on soybean varieties for proline content (mg g^{-1}) at 2019 season.

Water regime (W)	2019 season				
	Soybean Variety (V)				
	Giza 21	Giza 35	Giza 111	Crawford	Means
Two irrigations at (V.G.S. and F.F.S)	420.3	408.0	416.0	408.3	413.2
Four irrigations at (V.G.S., B.F.S., B.P.S. and F.P.F.S)	396.3	399.0	410.0	416.0	405.3
Six irrigations at all vegetative and reproductive stages	369.7	402.7	383.3	394.3	387.5
Traditional	281.0	293.7	341.0	345.3	315.3
Means	366.8	375.8	387.6	391.0	380.3
L.S.D. at 5% for: W= 21.70, V= N.S and WV= N.S					

-The Peroxidase enzyme activity ($U.g^{-1}$.$FW.min^{-1}$):

Results for the second growing summer of 2019 are shown in Table 4 and indicate the effects of water regime for soybean varieties and their interaction on peroxidase enzyme activity (U.g 1.FW.min 1) in soybean leaves (4).

Table shows the average values of peroxidase enzyme activity in soybean leaves as influenced by water regimes (4). The second season's leaves' considerable peroxidase enzyme activity effect was made clear by the irrigation strategy. The second season's highest mean value of peroxidase activity was 6.06 with six irrigation treatments, after which 6.37 with four irrigation treatments. When regular watering (control) was used in the second season, the lowest mean value of peroxidase activity in leaves was 4.43 were noted during the second season of routine irrigation (control).

The four irrigations and the two irrigations that were applied appear to have nothing in the way of noticeable distinctions. The current findings support those made by (Naya *et al.*, 2007; Masoumi *et al.*, 2011-a).

It is abundantly evident that the observed variations in peroxidase activity in leaves for each of the produced soybean varieties may be attributed to their unique genetic make-up and the distinct particular patterns of the environmental circumstances at the time. These results matched those published by Devi *et al.* (2015) and Moloi *et al.* (2016).

Table 4. Impact of water regimes on soybean varieties for POD enzyme activity at 2019 season.

Water regime (W)	2019 season				
	Soybean Variety (V)				
	Giza 21	Giza 35	Giza 111	Crawford	Means
Two irrigations at (V.G.S. and F.F.S)	6.49	6.60	6.63	6.67	6.06
Four irrigations at (V.G.S., B.F.S., B.P.S. and F.P.F.S)	5.97	6.53	6.58	6.39	6.37
Six irrigations at all vegetative and reproductive stages	5.28	5.82	6.10	6.79	5.99
Traditional	4.42	4.35	4.33	4.62	4.43
Means	5.54	5.82	5.19	6.12	5.71
L.S.D. at 5% for:	W= 2.09, V = 0.16 and WV= 0.33				

-The Catalase enzyme activity ($U.g^{-1}$. $FW.min^{-1}$) in soybean leaves:

Results for the second growing summer season's effects of soybean varieties' water regimes and their interactions on CAT enzyme activity (U.g 1.FW.min 1) in leaves are shown in Table (5).

Table (5) shows the mean value of CAT enzyme activity in soybean leaves as influenced by water regimes. For the second season, the CAT enzyme activity in leaves varied significantly depending on irrigation scheme. The greatest mean value of CAT enzyme activity in leaves was commonly seen to be 123.43 when employing two irrigation treatments, followed in the second season by 101.35 when using four irrigation treatments, respectively. While the second season's administration of standard irrigation treatment resulted in the lowest mean value of CAT enzyme in leaves of 95.71. As can be shown in Table 5, drought stress caused POD activity in leaves at the V.G.S. and F.F.S. (two irrigations); the rate of increase accelerated as the stress level increased. ***** Such obtained result are along the same line with those of (Zhang and Kirkham, 1995; Apel and Hirt, 2004 ; Sharma and Dubey, 2005; Moller *et al.*, 2007; Naya *et al.*, 2007 ; Masoumi *et al.*,2011-a).

Table 5. Impact of water regimes on soybean varieties for the CAT enzyme activity at 2019 season.

Water regime (W)	2019 season				
	Soybean Variety (V)				
	Giza 21	Giza 35	Giza 111	Crawford	Means
Two irrigations at (V.G.S. and F.F.S)	114.13	118.23	131.83	129.53	123.43
Four irrigations at (V.G.S., B.F.S., B.P.S. and F.P.F.S)	99.52	98.61	101.20	106.06	101.35
Six irrigations at all vegetative and reproductive stages	94.53	100.79	104.03	96.13	98.87
Traditional	94.43	93.82	99.39	95.22	95.71
Means	100.65	102.86	109.11	106.73	104.84
L.S.D. at 5% for:	W= 3.23,	V= 1.55	and WV= 3.11		

CAT enzyme levels in second-season leaves differed substantially across the soybean cultivars under investigation (Table 5). In the second season, the Giza 111 variety had the highest levels of CAT enzyme in leaves (131.83), followed by the Crawford variety (129.53), and the Giza 35 variety (with the lowest levels of CAT enzyme activity) (118.23). The Giza 21 variety, using the two irrigations in the second season, recorded the lowest value (114.13). However, findings suggested that the four soybean types may be grouped as follows in declining order of their leaf CAT enzyme activity: There are notable distinctions between the Giza 111 variety, Crawford variety, Giza 35 variety, and Giza 21 variety. It is abundantly evident that the observed variations in CAT enzyme in soybean leaves for each variety planted may be related to their unique genetic makeup and how it interacts with the relevant environmental factors in distinct particular ways. These results concur with those mentioned by (Masoumi *et al.*, 2011-b; Devi *et al.*, 2015 ; Moloi *et al.*, 2016).

The interplay between water regimes and varieties in the second season had a considerable impact on the CAT enzyme in soybean leaves (Table 5). The second season's application of two irrigations for the Giza 111 variety, followed by irrigations for the Crawford variety, the Giza 35 variety, and the Giza 111 variety with no discernible difference between them, may have produced the highest CAT activity in leaves of 131.83, whereas the second season's application of a standard irrigation treatment at the flowering stage for the Giza 21 variety produced the lowest value of CAT enzyme activity in leaves of 94.43.

B- Chemical properties of soybean seeds:

-Nitrogen content (%):

Results on the effect of water regimes for soybean varieties and their interaction on nitrogen content (%) in soybean seeds during the second growing summer (2019) are displayed in Table (6).

Table (6) gives the mean value of the nitrogen content of soybean seeds as impacted by water regimes. In the second season, the nitrogen concentration (%) in seeds varied significantly depending on irrigation practises. The maximum mean nitrogen content (%) in seeds was found when two irrigation treatments were applied, at 5.54%, and the lowest value was 4.80% when four irrigation treatments were applied in the second seasons. While the administration of the six irrigation treatments in the second seasons resulted in the lowest mean value of nitrogen content in seeds (4.28%). Similar results were reported by (Purcell and King, 1996 ; Streeter, 2003; Naya *et al.*,2007 ; Wijewardana *et al.*, 2019).

According to Table 6's findings, there were no appreciable changes in the four types' total nitrogen concentration in seeds during the second growing season.

In the second season (2019), the Giza 35 variety recorded the greatest N content (%) in seeds (5.70%) by applying two irrigations, while the Giza 21 variety recorded the lowest amount (4.03%) by applying six irrigations. The remaining two varieties were in the middle as a single group. It was determined that the Giza 35 variety and the Crawford variety had higher N content (%) in their seeds when the two irrigation treatments were used. It is evident that the observed variances in nitrogen content (%) for each variety of growing soybeans were, of course, the result of the genetic makeup of each variety, which interacted uniquely and differently with the environmental variables under investigation in a variety of distinct patterns.

Table 6. Impact of water regimes on soybean varieties for the nitrogen content (%) at 2019 season.

Water regime (W)	2019 season				
	Soybean Variety (V)				
	Giza 21	Giza 35	Giza 111	Crawford	Means
Two irrigations at (V.G.S. and F.F.S)	5.29	5.70	5.60	5.57	5.54
Four irrigations at (V.G.S., B.F.S., B.P.S. and F.P.F.S)	4.73	4.90	4.76	4.81	4.80
Six irrigations at all vegetative and reproductive stages	4.03	4.04	4.51	4.55	4.28
Traditional	4.58	4.75	4.68	4.46	4.62
Means	4.65	4.85	4.89	4.85	4.81
L.S.D. at 5%:	W= 0.17, V= N.S and WV = N.S				

-Protein content (%):

Table shows the findings regarding the impact of soybean variety water regimes and their interactions on the protein % in seeds during the second growing summer seasons (7). The table below provides the mean value of the protein content (%) in soybean seeds as influenced by water regimes (7). The second season's irrigation program revealed notable variations in the protein content of seeds. The administration of two irrigation treatments during the blooming stage resulted in the greatest mean value of protein content in seeds (34.63%), which was followed by the application of four irrigation treatments during the second season, which produced a value of (30.01%). The second season's administration of the six irrigation treatments resulted in the lowest mean value of protein content in seeds (26.78%). Similar results were also obtained by (Streeter, 2003; Naya *et al.*,2007; Wijewardana *et al.*, 2019).

Table7. Impact of water regimes on soybean varieties for protein content (%) at 2019 season.

Water regime (W)	2019 season				
	Soybean Variety (V)				
	Giza 21	Giza 35	Giza 111	Crawford	Means
Two irrigations at (V.G.S. and F.F.S)	33.08	35.64	34.99	34.82	34.63
Four irrigations at (V.G.S., B.F.S., B.P.S. and F.P.F.S)	29.56	30.64	29.76	30.08	30.01
Six irrigations at all vegetative and reproductive stages	25.20	25.28	28.20	28.45	26.78
Traditional	28.62	29.70	29.26	27.91	28.87
Means	29.11	30.31	30.55	30.31	30.07
L.S.D. at 5% for:	W= 1.1, V = N.S and WV = N.S				

The four varieties under study were not significant in their protein content in seeds in the second season (Table 7). The greatest protein content which was (29.25%) for Giza 21 variety followed by Giza 35 (35.64%) then Giza 111 variety (34.99%). The lowest value was recorded by Giza 21 variety 33.08%, when application of two irrigation treatment. The differences among the varieties were almost significant. Moreover, in the second season. It is also clear that there was a slight difference between the four varieties were observed as follows: Giza 35 variety was of the top with highest protein content, followed by Giza 111 variety then Crawford variety with significant superiority of Giza 35 and Giza 21 varieties were of the last in this arrangement with lowest protein content for the application of the two irrigation treatments.

It could be concluded that Giza 35 and Giza 111 varieties were superior in assimilating protein percentage content in soybean seeds as compared with the Crawford and Giza 111 varieties. It is crystal evident that the observed variances in protein content for each of the growing soybean varieties may have resulted from their unique genetic makeup and how that made them interact with the varied environmental variables under consideration.

-Phosphorus content (%):

Results are shown in Table 8 for the impact of soybean variety water regimes and their interactions on phosphorus content in seeds during the second growing summer season (2019). As a function of water regime, the mean values of phosphorus content (%) in soybean seeds are shown in Table (8).

In the second season, the phosphorus content (%) of seeds was significantly impacted by irrigation practices. The use of two irrigation treatments produced the greatest mean value of phosphorus content in seeds (1.42%), which was followed by the administration of four irrigation treatments, which produced a value of 1.20% in the second season. The second season's typical irrigation treatments produced the lowest mean value of phosphorus content in seeds, which was 0.49 percent. These outcomes were corroborated by those mentioned in (Wijewardana *et al.*, 2019).

The recorded results in Table (8) made it abundantly evident that there were no appreciable changes in the second-season phosphorus content (%) of seeds among the examined soybean types. When the two irrigation treatments were applied in the second season, Crawford and Giza 111 types reported the highest values (1.70 and 1.49%), followed by Giza 35 and Giza 21 kinds (1.36 and 1.14%). While the lowest values were of those Crawford variety in the second season. It was evidently clear that the observed variations in phosphorus content for each of the four produced soybean varieties may have resulted from those varieties' unique genetic makeups, which interact in diverse specific ways with the environmental variables under study.

Table 8. Impact of water regimes on soybean varieties for phosphorus content (%) at 2019 season.

Water regime (W)	2019 season				
	Soybean Variety (V)				
	Giza 21	Giza 35	Giza 111	Crawford	Means
Two irrigations at (V.G.S. and F.F.S)	1.14	1.36	1.49	1.70	1.42
Four irrigations at (V.G.S., B.F.S., B.P.S. and F.P.F.S)	1.12	1.28	1.28	1.13	1.20
Six irrigations at all vegetative and reproductive stages	1.15	1.14	1.14	1.11	1.13
Traditional	0.84	0.26	0.55	0.30	0.49
Means	1.06	1.01	1.11	1.06	1.06
L.S.D. at 5% for :	W= 0.14, V= N.S and WV = 0.20				

-Potassium content (%):

Table gives information on how water irrigation affects different soybean varieties' potassium content in seeds during the second growing summer (9).

Table gives the mean values of the potassium content in soybean seeds as influenced by the water regime (9). The potassium content of seedlings varied significantly between irrigation regimes in the second season. The application of the six irrigation treatments produced the greatest mean value of potassium content in seeds of 3.40%, while the administration of the standard irrigation treatments produced the second-highest value of 3.36%. The two irrigation treatments in the second season had the lowest mean potassium level in seeds, which was 2.68%. The outcomes were in line with what was discovered by (Wijewardana *et al.*, 2019).

Table 9. Impact of water regimes on soybean varieties for potassium content (%) at 2019 season.

Water regime (W)	2019 season				
	Soybean Variety (V)				
	Giza 21	Giza 35	Giza 111	Crawford	Means
Two irrigations at (V.G.S. and F.F.S)	2.72	2.25	2.95	2.79	2.68
Four irrigations at (V.G.S., B.F.S., B.P.S. and F.P.F.S)	3.20	3.14	3.13	2.84	3.08
Six irrigations at all vegetative and reproductive stages	3.21	3.38	3.36	3.65	3.40
Traditional	3.34	3.58	3.08	3.46	3.36
Means	3.11	3.09	3.13	3.19	3.13
L.S.D. at 5% for:	W= 0.10, V= N.S and WV= 0.24				

The potassium content of the seeds for the four varieties under study did not differ significantly in the second season (Table 9), with Crawford variety having the highest potassium content (3.65%) after applying the six irrigation treatments, and Giza 35 variety having the lowest potassium content (3.58%) after using regular irrigation. The Giza 35 variety received the lowest value (2.25%) when the two irrigation treatments were used. It is evident that there were small, but noticeable, changes between the kinds. When the arrangement of the four kinds was studied for the second season, Crawford variety had the highest potassium content, followed by Giza 35 variety and Giza 111 variety, with Crawford variety clearly outperforming the others. The Giza 21 variety came up at number four in terms of potassium content. It is abundantly evident that the observed variations in potassium content for the various soybean cultivars may be related to their unique genetic makeups, which interact with the relevant environmental factors under study in a variety of distinct ways.

-Total Carbohydrates content (%):

Results on the influence of water regimes of soybean varieties and their interaction on total carbohydrates content in soybean seeds for the second growing summer (2019) are provided in Table (10).

The table showed the average amount of total carbohydrates in soybean seeds and how it was affected by the water regime (10). Depending on irrigation techniques, the total amount of carbohydrates in seeds from the second growing season varied greatly.

The administration of a normal irrigation treatment in the second season (32.49%) was followed by six irrigation treatments, which produced the highest mean value of the total carbohydrates contained in seeds (34.38%). The lowest mean value of the total carbohydrate content in seeds (26.65%) was produced by the application of two irrigation treatments in the second season. Similar studies were conducted by (Dehnavi and Sheshbahre, 2017 ; Wijewardana *et al.*, 2019; Du *et al.*, 2020).

The amount of total carbohydrates in the second season's seeds of the four studied soybean types did not differ substantially from one another (Table 10). It is more likely the case that, after applying six irrigation treatments, the Giza 21 variety had the highest total carbohydrate content (36.07%), followed by the Giza 35 variety (35.51%). Two irrigation treatments were used, and the Crawford variety's lowest figure (25.69%) was noted. In the second season, the variations' differences hardly made a difference. The best arrangement of the four kinds was evident, and the Giza 21 variety ranked first in terms of total carbohydrates% (27.85%), followed by the Giza 35 variety (26.90%) and the Giza 111 variant (26.16%), with a clear advantage for the Giza 21 variety. With a 25.69% carbohydrate content after two irrigation treatments, Crawford variety was the fourth and final in this combination. It is abundantly evident that the observed variations in total carbohydrate content for the various soybean cultivars may be related to their unique genetic makeups, which interact with the relevant environmental factors under study in varied particular ways. These outcomes matched those that were reported by (Du *et al.*,2020).

Table 10. Impact of water regimes on soybean varieties for total carbohydrates content (%) at 2019 season.

Water regime (W)	2019 season				
	Soybean Variety (V)				
	Giza 21	Giza 35	Giza 111	Crawford	Means
Two irrigations at (V.G.S. and F.F.S)	28.9	27.9	27.2	26.7	27.7
Four irrigations at (V.G.S., B.F.S., B.P.S. and F.P.F.S)	32.7	30.3	30.2	31.4	31.1
Six irrigations at all vegetative and reproductive stages	37.1	36.5	34.6	33.4	35.4
Traditional	34.1	33.2	32.6	34.1	33.5
Means	33.2	32.0	31.1	31.4	31.9
L.S.D. at 5% for:	W= 1.7 , V= N.S and WV= N.S				

-Total Oil content (%):

Table (11), which presents results for the second growing summer (2019), illustrates the effects of water regime, soybean varieties, and their interactions on the total oil content in soybean seeds (11). The average values of the total oil content in soybean seeds as affected by water regimes are shown in the table (11). Irrigation practices during the second season had no observable effects on the total oil content of seeds.

The greatest mean value of total oil content (31.86%) was obtained with the use of four irrigation treatments, which was followed by 31.12% with the use of two irrigation treatments in the second season. The lowest mean value of total oil content in seeds—30.64%—was produced in the second seasons by the application of frequent watering treatments. Mohamed and Latif discovered comparable results (2017).

The results in Table 11 demonstrated that there were no discernible differences in the total oil content (%) of seeds across the four soybean kinds in the second season. The Giza 111 variety had the highest total oil content in seeds with 33.01% after four irrigation treatments in the second season, followed by the Giza 35 variety with (32.01%), with no obvious distinction across soybean kinds. In the second season, there were no observable differences among the soybean varieties, with the Giza 35 variety generating the lowest figure for the total oil content in seeds (30.08%). These results corresponded to those that were stated by (Mohamed and Latif , 2017).

Table 11. Impact of water regimes on soybean varieties for total oil content (%) at 2019 season.

Water regime (W)	2019 season				
	Soybean Variety (V)				
	Giza 21	Giza 35	Giza 111	Crawford	Means
Two irrigations at (V.G.S. and F.F.S)	32.1	32.1	31.8	32.5	32.1
Four irrigations at (V.G.S., B.F.S., B.P.S. and F.P.F.S)	31.9	33.0	34.0	32.5	32.9
Six irrigations at all vegetative and reproductive stages	31.7	32.2	31.2	32.2	31.8
Traditional	31.3	31.1	32.1	32.1	31.6
Means	31.8	32.1	32.3	32.3	32.1
L.S.D. at 5% for:	W= N.S, V= N.S and WV= N.S				

REFERENCES

A.O.A.C. 1990. Association of Official Analytical Chemists. Official Methods of Analysis, 15th Ed., Washington, D.C., U.S.A.

Anda, A.; G. Soós ; L. Menyhárt; T. Kucserka and B. Simon (2020). Yield features of two soybean varieties under different water supplies and field conditions. Field Crops Research, 245, 107673.

Apel, K. and H. Hirt (2004). Reactive oxygen species: metabolism, oxidative stress, and signal transduction. Annual Review of Plant Biology, 55:373-399.

Bates, L.S.; R.P. Waldren and I.D. Teare (1973). Rapid determination of free proline for water stress studies. Plant and Soil, 39: 205-207.

Bellaloui, N.; A. Mengistu, D.K. Fisher and C.A. Abel (2012). Soybean seed composition constituents as affected by drought and phomopsis in phomopsis susceptible and resistant genotypes. Journal of Crop Improvement, 26(3):428-453.

Brevedan, R. and D.B. Egli (2003). Short periods of water stress during seed filling,leaf senescence, and yield of soybean. Crop Sci. 43:2083-2088.

Chowdhury, J. A.; M. Karim; Q. Khaliq; A. Solaiman and J. Ahmed (2016-b). Screening of soybean (*Glycine max L.*) genotypes under water stress condition. Bangladesh Journal of Agricultural Research, 41, 441. doi:10. 3329/bjar. v41i3. 29716.

Dehnavi, M. M. and M. J. Sheshbahre (2017). Soybean leaf physiological responses to drought stress improved via enhanced seed zinc and iron concentrations. Journal of Plant Process and Function, 5(18).

Desclaux, D.; T. T. Huynh and P. Roumet (2000). Identification of soybean plant characteristics that indicate the timing of drought stress. Crop science, 40(3), 716-722.

Devi, M. A., and P. Giridhar (2015). Variations in physiological response, lipid peroxidation, antioxidant enzyme activities, proline and isoflavones content in soybean varieties subjected to drought stress. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences, 85(1): 35-44.

Dongxiao Li ; H. Liu; Y. Qiao; Y. Wang, Z. Cai; B. Dong; C. Shi; Y. Liu; X. Li and M. Liu (2013). Effects of elevated CO_2 on the growth, seed yield, and water use efficiency of soybean (*Glycine max (L.) Merr.*) under drought stress. Agricultural Water Management, 129:105-112.

Du, Y.; Q. Zhao; L. Chen; X. Yao; W. Zhang; B. Zhang and F. Xie (2020). Effect of drought stress on sugar metabolism in leaves and roots of soybean seedlings. Plant Physiology and Biochemistry, 146: 1-12.

Dubois, M.; K.A. Gilles; J. K. Hamilton; P.A. Rebens and F. Smith (1956).Colorimetric methods for determination sugars and related substances. Annals. Chem. Soc, 46:1662-1669.

Farboodi, M.; M. Rostamzadeh and K. Khaksar (2018). Drought stress effects on growth and yield of three soybean genotypes in second cropping of moghan plain of iran. aper presented at the Euro-Mediterranean conference for environmental integration: 869-870.

Fridovich, I. (1986). Biological effects of the superoxide radical. Archives of Biochemistry and Biophysics. 247:1-11.

Gaballah, M.; S. Ouda and F. Khalil (2008). Effect of water stress on the yield of soybean and maize grown under different Intercropping patterns. Aust J Basic Appl Sci, 1.

Hansen, V.E.; O.W. Israelsen and G.E. Stringham (1980). Irrigation principles and practices. 4th ed. John Willey & Sons Inc. USA.Hare.

He, J.; Y.L. Du; T. Wang; N.C. Turner; R.P. Yang; Y. Jin; Y. Xi; C. Zhang; T. Cui; X.W. Fang and F.M. Li (2017). Conserved water use improves the yield performance of soybean (*Glycine max (L.) Merr.*) under drought. Agricultural Water Management, 179: 236-245.

Horneck, D. A. and R. O. Miller (1998). Determination of total nitrogen in plant tissue. In Handbook of Reference Methods for Plant Analysis.Karla Y.P.(Ed.): 75-83.

Horneck, D. A. and D. Hanson (1998). Determination of potassium and sodium by Flame Emission Spectrophotometry. In Handbook of Reference Methods for Plant Analysis, 153-155.

Hossain, M. M.; X. Liu; X. Qi; H. M. Lam and J. Zhang (2014).Differences between soybean genotypes in physiological response to sequential soil dryingandrewetting.The Crop Journal,2(6):366-380.

Hussain, M.; M.A. Malik; M. Farooq; M.Y. Ashraf and M.A. Cheema (2008).Improving drought tolerance by exogenous application of glycinebetaine and salicylic acid in sunflower. Journal of Agronomy and Crop Science, 194(3):193-199.

Jumrani, K. and V.S. Bhatia (2018). Impact of combined stress of high temperature and water deficit on growth and seed yield of soybean. Physiology and Molecular biology of Plants, 24(1):37-50.

Kranz, W.L., and J. E. Specht. 2012. Irrigating soybean. University of Nebraska – Lincoln Extension, Institute of Agriculture and Natural Resources, IANR. *https://extensionpublications.unl.edu/assets/pdf/g1367.pdf*

Liu, F.; M.N. Andersen and C.R. Jensen (2004). Drought stress effect on carbohydrate concentration in soybean leaves and pods during early reproductive development: its implication in altering pod set. Field Crops Research 86 (2004): 1–13

Liu, K. (1997). Chemistry and nutritional value of soybean components. In Soybeans (25-113). Springer, Boston, MA.

Lobato, da S.; A. K. de Oliveira; C. F. Neto, dos Santos Filho; B. G. Da Costa; R. Cruz; F. J. R. H. Neves and M. J. dos Santos Lopes (2008). Physiological and biochemical behavior in soybean (*Glycine max cv. Sambaiba*) plants under water deficit. Aust. J. Crop Sci, 2(1): 25-32.

Manavalan, L.P.; S.K. Guttikonda; L.S. Phan Tran and H.T. Nguyen (2009). Physiological and molecular approaches to improve drought resistance in soybean. Plant and Cell Physiology, 50(7):1260-1276.

Masoumi, H.; F. Darvish; J. Daneshian; G. Nourmohammadi and D. Habibi (2011-b). Chemical and Biochemical Responses of Soybean (*'Glycine max'L.*) Cultivars to Water Deficit Stress. Australian Journal of Crop Science, 5(5):544-553.

Masoumi, H.; F. Darvish; J. Daneshian; G. Normohammadi and D. Habibi (2011-a). Effects of water deficit stress on seed yield and antioxidants content in soybean (*Glycine max L.*) cultivars. African Journal of Agricultural Research, 6(5):1209-1218.

Mohamed, H.I. and H.H. Latif (2017). Improvement of drought tolerance of soybean plants by using methyl jasmonate. Physiology and Molecular Biology of Plants, 23(3):545-556.

Mokter, G.; R. K.Todorova; Tasheva and M. Dimitrova (2014). Screening of soybean against water stress mediated through polyethylene glycol. Turk. J. Ag. Nat. Sci. 1:895-899.

Møller, I.M.; P.E. Jensen and A. Hansson (2007). Oxidative modifications to cellular components in plants. Annual Review of Plant Biology., 58:459-481.

Moloi, M.J.; O. J. Mwenye and R. Van der Merwe (2016). Differential involvement of ascorbate and guaiacol peroxidases in soybean drought resistance. South African Journal of Science, 112(9-10):1-4.

Nagasuga, K.; M. Kadowaki; S. Uchida; H. Kaji; A. Fuunaga and T. Umezaki (2014). Effects of water condition on soybean (*Glycine max L.*) plant growth after flowering. Environmental Control in Biology, 52(4):221-225.

Naya, L.; R. Ladrera; J. Ramos; E.M. González; C. Arrese-Igor; F.R. Minchin and M. Becana (2007). The response of carbon metabolism and antioxidant defenses of alfalfa nodules to drought stress and to the subsequent recovery of plants. Plant Physiology, 144(2):1104-1114.

Orlowski, J. M.; G. L. Gregg and C. D. Lee (2016). Early-season lactofen application has limited effect on soybean branch and mainstem yield components. Crop Sci.56:1-7.

Ouda, S.A.; F.A. Khalil; M.R.K. Ashrhy and K.M. Yousef (2008). Effect of water stress on soybean yield and water relations. In 12th International Conference of Water Technology. Egypt.

Purcell, L.C. and C.A. King (1996). Drought and nitrogen source effects on nitrogen nutrition, seed growth, and yield in soybean. Journal of Plant Nutrition, 19(6):969-993.

Sandell, R. (1950). Colorimetric determination of traces of metal. 2nd Ed. Inter. science Publishers., Inc. New York.

Sarkar, K.; M. Mannan; M. Haque and J. Ahmed (2015). Physiological basis of water stress tolerance in soybean. Bangladesh Agronomy Journal, 18(2), 71-78.

Saucedo, M.C.C.; A.D. Alvarado; L.C. Téllez; V.G. Hernández; E. Tapia-Campos; A.S. Varela; M.G.V. Carrillo and G. García-De Los Santos (2012). Changes in carbohydrate concentration in leaves, pods and seeds of dry bean plants under drought stress. Interciencia, 37(3):168-175.

Sharma, P. and R.S. Dubey (2005). Drought induces oxidative stress and enhances the activities of antioxidant enzymes in growing rice seedlings. Plant growth regulation, 46(3):209-221.

Shigeoka, S.; T. Ishikawa; M. Tamoi; Y. Miyagawa; T. Takeda; Y. Yabuta and K., Yoshimura (2002). Regulation and function of ascorbate peroxidase isoenzymes. Journal of experimental botany, 53(372):1305-1319.

Steel, R.G.D. and J.H. Torrie (1981). Principles and procedures of statistics, a biometrical approach. Second ed. Mc Graw-Hill, Company.

Streeter, J. (2003). Effects of drought on nitrogen fixation in soybean root nodules. Plant, Cell & Environment, 26(8), 1199-1204.

Trinchant, J.C; A. Boscari; G. Spennato; G.V. Sype and D. Rudulier (2004). Proline Betaine Accumulation and Metabolism in Alfalfa plants under Sodium Chloride Stress. Exploring its Compartmentalization in Nodules. Plant Physiology.135:1583-1594.

Wijewardana, C.; K.R. Reddy; M. W. Shankle; S. Meyers and W. Gao (2019). Low and high temperature effects on sweetpotato storage root initiation and early transplant establishment. Sci. Hortic. 240:38-48.

Wijewardana, C.; K.R. Reddy; F.A. Alsajri; J.T. Irby; J. Krutz and B. Golden (2018-a). Quantifying soil moisture deficit effects on soybean yield and yield component distribution patterns. Irrigation Science, 36(4-5):241-255.

Wijewardana, C.; K.R. Reddy and N. Bellaloui (2018-b). Soybean seed physiology, quality, and chemical composition under soil moisture stress. J. Food Chem. Revision submitted.

Zhang, F.; Y. Yang, W. He; F. Sun and L. Zhang (2004). Changes of antioxidant enzymes in wheat subjected to water deficit and rewatering. Acta Botanica Boreali-Occidentalia Sinica 24 (2): 205–209.

دراسات كيميائية حيوية على بعض أصناف فول الصويا تحت ظروف الإجهاد المائى

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الملخص

أقيمت تجربتان حقليتان بمركز التجارب و البحوث الزراعيه بكلية الزراعة بمشتهر جامعة بنها - محافظة القليوبية- مصر خلال موسمى صيف 2018و2019 م لدراسة تأثير اربع معاملات ري (ثمانى ريات وست ريات وأربع ريات وريتان) في مراحل مختلفة من حياة النبات وهي (ريتان واحدة بعد 40و80 يوم من الزراعة ، أربع ريات بعد 30 و و60 و90و120 يوم من الزراعة ، ست ريات بعد 30و50 و 70و 90و110و130 يوم من الزراعة ، رى عادي علي المحصول والصفات الكيميائية لأربع أصناف من فول الصويا وهي (جيزة 21 و جيزة 35 وجيزة 111 وكلوفورد) . وكان تصميم التجربة قطع منشقة في اربع مكررات حيث وضعت معاملات الري في القطع الرئيسية والأصناف في القطع الشقية. وكانت مساحة القطعة التجريبية 10,5 م^2 (3 متر عرض في 3,5 طول). وكانت أهم النتائج: - اثرت معاملات الري تأثير معنوى فى جميع الصفات المدروسة لمحصول البذور والمكونات الكيماوية لأصناف فول الصويا فى فى كلا الموسمين. - كانت هناك اختلافات معنوية بين التراكيب الوراثية لفول الصويا فى كلا موسمى الزراعة. - أدى التفاعل بين معاملات الرى والتراكيب الوراثية لفول الصويا الى ظهور فروق معنوية واضحة فى كلا الموسمين فى محصول البذور والتركيب الكيماوى. التوصية: لذا فإنه يوصى بتطبيق نظام الست ريات خلال أطوار ومراحل نمو النبات المختلفة حبذا مع الصنف جيزة 21 لعدم وجود فروق معنوية واضحة بين نظام الرى العادى (ثمان ريات) ونظام الإجهاد المائى (ست ريات).