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Evaluation of Some Soybean Varieties (*Glycine max* L. Merrill) Under Water Stress

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Abstract: Two field experiments were conducted at the Research and Experiment Center, Fac. Agric., Moshtohor, Benha Univ., KalubiaGovernorate, Egypt, during (2018 and 2019) summer seasons, to study the effect of four water regimes i.e, two irrigationsat flowering and pod formation stages (40 and 80) day after planting (DAP), four irrigation at vegetative growth, beginning of flowering, beginning of pod formation and full pod formation stages (30, 60, 90 and 120 DAP, respectively), six irrigations at vegetative growth, beginning and full pod formation, full pod formation and full seed formation stages (30, 50, 70, 90, 110 and 130 DAP, respectively) and normal irrigations (8 regular subsequent irrigations as a control) as well as biochemical studies on some Soybean (*Glycine max* L. Merrill) varieties (Giza 21, Giza 35, Giza 111 and Crawford) on yield, yield components and chemical compositions of soybean varieties in both seasons. The treatments were arranged in a split-plot design with four replications. Irrigation regimes were distributed at random in the main plots while, soybean varieties occupied the sub-plots. The sub-plot area was 10.5 m^2 consisted of 5 ridges of 3.5 m long and 60 cm width. Data exerted that all various treatments clarified a significant differences with these traits compared with control plants.It could be summarized as follows: All vegetative growth characteristics under study were significantly increased by increasing number of irrigations as compared with the lowest number of irrigation in both seasons respectively, on the other hand (N-P-K) and oil content decreased.

- Soybean varieties were significantly different in most of the studied traits in both seasons except total chlorophyll content, carbohydrate content and oil content in soybean in the first season.
- Generally, results were exerted insignificant effect of the interaction between irrigation regimes and soybean varieties for most traits of yield components and chemical composition of soybean leaves and seeds in both seasons, respectively.

Key words: Soybean varieties · Water stress · Yield Components · Chemical Constituents

INTRODUCTION

Soybean [*Glycine max* (L.) Merr.] is a globally important annual crop that provides oil and protein for both human and animal food. Compared to other crops, soybean produces more protein and oil per unit of land. The average composition of today's soybean is 40% protein, 21% oil, 34% carbohydrate, 5% crude fiber and 5% ash. In addition, seeds contain both macro- and micro-nutrients such as N, P, K, Ca, Mg, Fe, Cu, Mn, Zn, Co and several other components, including vitamins B1, B2 and B6, as well as bioactive compounds like is of lavones [1].

Soybean oil contains about 16% saturated fatty acids, 23% monounsaturated fatty acids and 58% polyunsaturated fatty acids. Major saturated fatty acids include palmitic (10 to 12%) and stearic (2.2 to 7.2%) and major unsaturated fatty acids include oleic (24%), linolenic (8%) and linoleic (54%) acid [2]. Its oil and meal, as well as its beneficial leguminous characteristics have led to the successful integration of soybean as a production crop. Drought is the primary environmental factor contributing to soybean yield loss worldwide. It decreases soybean pod growth [3], seed number and size [4], the length of the seed fill period [5] and seed quality [2,6]. All of these processes are either directly or indirectly related to

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soybean yield; however, the sensitivity of these processes vary depending on the severity of the drought stress and growth stage of the plant.

Soybean varieties show diverse physiological responses to drought, but specificphysiological traits that can be used to as a selection criterion for selecting drought tolerant genotypes.

Many investigators have reported the effect of water stress on soybean for biological, seed and straw yield as well as chemical constituents for leaves and seeds [7-18].

Many investigators have reported high variability among soybean varieties for biological, seed and straw yield as well as chemical constituents for leaves and seeds were reported by [15, 16, 18-23].

The main target of this studyto evaluate the effect of water stress on some soybean varieties on biological, seed and straw yield as well as chemical constituents for leaves and seeds.

MATERIALS AND METHODS

This investigation was carried out at the Agricultural Research and Experimental Center, Faculty of Agriculture, Moshtohor, Benha University, Kalubia Governorate, Egypt, during two growing summer seasons (2018 and 2019) to investigate the effect of water stress at different growth stages yield and as well as chemical constituents of some soybean varieties.

Factors under Study Were as Follows
Irrigation Regimes:

- Two irrigations (300 m^3 fed^{-1} for each irrigation) after 40 and 80 day after planting (DAP) at vegetative growth (V.G) and Full Flowering (F.F).
- Four irrigations (250 m^3 fed^{-1} for each irrigation) after 30, 60, 90 and 120 at V.G, beginning of flowering (B.F.), beginning of Pods formation (B.P.) and full Pods formation (F.P.F.).
- Six irrigations (200 m^3 fed^{-1} for each irrigation) after (30, 50, 70, 90, 110 and 130 D.A.P) during V.G., Beginning and full of Flowering (B.F.F.), F.P.F. and full seed formation (F.S.F.).
- Traditional irrigations (8 regular subsequent irrigations as a control) once every 15 days at all vegetative and reproductive stages.

Irrigation discharge was adjusted by using triangular weirs (V notch). The height of flowing water was fixed at 30 cm. Water discharge was counted according to the equation of [24] as follows:

$Q = 0.0138 \times h^{2.5} \times 3.6$ where: Q = Water discharge, m^3 hr^{-1}.

0.0138 and 3.6 = constant values, where 3.6 was added for obtaining Q in m^3 hr^{-1}.

h= Water height or pressure head (cm).

Water use efficiency (WUE) was determined according to [24] as follows:

WUE = seed yield kg/total water input m^3. Water saved m^3 fed^{-1} and seed yield reduction percentage were calculated for each irrigation treatment compared with flooding irrigation for all season.

Four Soybean Varieties:

Giza 21. 2- Giza 35.3- Giza 111. 4- Crawford.

Seeds of each of the four soybean varieties were provided from the seeds legume department, Agriculture Research Center, Ministry of Agriculture at Giza, Egypt.Before planting of soybean soil samples were taken from plots for soil analysis. Surface soil samples (0-30 cm) from the experimental sites were collected, air dried ground and sieved through a 2 mm mesh sieve then subjected to mechanical and some chemical analyses. The preceding crop was Egyptian clover in both seasons.

Experimental Design: A split plot design with four replications was used. The four irrigation treatments were allocated to the main plots and the four soybean varieties were randomly arranged in the sub plots. The area of sub-plot was 10.5 m^2 (3X3.5m).

Cultural Practices: Phosphorus fertilizer was applied in form of calcium super phosphate (15.5% P_2O_5) at a rate of 150 kg/feddan during the appropriate soil preparation and before sowing. Soybean varietieswere hand drilled in ridges and the experimental unit content 5 ridges of 3.5 m long and 60 cm wide. Planting was carried out on 23rd May in 2018 season and on 28th May in 2019 season.Starter dose of Nitrogen fertilizer at a rate of 20 kg N fed^{-1} was splitted into two equal doses applied at planting and before the first irrigation in the two seasons.The starter dose was urea (46.5% N).

Studied Parameters: Climatic factors during each of the two growing seasons of the experiments (Table 1) were supplied from the Climates Research Station, Agriculture Research Center.

Table 1: Prevailing ambient Climatic factors at Kalubia Governorate during each of the two growing seasons.

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

*The source of this data is Ministry of Agriculture and Land Reclamation, Agricultural Research Center (ARC), Central Lab. for Agricultural Climate (CLAC).

Table 2: Physical and chemical properties of the experimental soil units at Moshtohor agric. Exp. Station during each of the two growing seasons

	Seasons	
Properties	2018	2019
Mechanical analysis		
Course sand (%)	6.92	5.49
Find sand (%)	18.65	17.08
Silt (%)	29.15	30.03
Clay (%)	45.28	47.40
Texture grade	Clay	Clay
Chemical analysis		
pH (1: 2.5)	7.8	8.0
E.C. (ds/m) (1:20)	0.18	0.22
$CaCO_3$ (%)	3.15	2.1
HCO_3 (meq/L)	1.25	1.25
Cl^- (meq/L)	0.55	0.57
Ca^{++} (meq/L)	0.9	0.7
Na^+ (meq/L)	0.79	0.83
K^+ (meq/L)	0.25	0.18
Mg^{++} (meq/L)	0.3	0.2
N available (mg/kg)	265	185
P available (mg/kg)	12.0	7.0
K available (mg/kg)	1280	1030

The soil type of the experimental unit is clay with pH 7.8. The physical and chemical properties of the experimental soil units of Moshtohor Exp. Station are recorded in Table (2) in each of the two growing summer seasons.

Data Recorded

Vegetative Growth Characteristics: Ten plants were randomly selected from each experimental unit in each of the two growing seasons for studying the following parameters:

- Plant height (cm).
- No. of shoots plant^{-1}.
- Total chlorophyll content:Totalchlorophyll content measured by chlorophyll meter (SPDS) Model SPAD 402 according to [25].

Chemical Analysis

Chemical Components of Soybean Leaves: Fresh shoots at 80 days of plant age in 2019 season (the second growing season) were taken to determine their chemical constituents.

Total Nitrogen Content (%): Total nitrogen content (%) was determined in leaves by using wet digestion according to the methods of [26]. Using microkjeldahil as described by using [27], then calculated as % of dry weight.

Phosphorus Content (%): Total phosphorus was determined calorimetrically according to the method of [28]and calculated as a percentage (%).

Potassium Content (%): Potassium was determined by the flame photometer model Carl-Zeiss according to the method described by [29] and calculated as a percentage (%).

Chemical Components of Soybean Seeds: Seeds at harvest time in 2019 season (the second growing season) were taken to determine their chemical constituents.

Total Carbohydrates Content (%) in Seeds: Total carbohydratescontent was determined in the shoots at 60, 80 days after sowing and in seeds at harvest time in the second growing season by using phenol-sulphoric acid method according to [30] and calculated as a percentage (%).

Total Oil Content (%) in Seeds: Oil percentagecontent was determined by using soxlet apparatus using petroleum ether as a solvent according to [31].

Statistical Analysis: The analysis of variance for data of each of the two growing seasons was carried out according to [32]. The L.S.D. test at the 5% level was used in means comparison.

RESULTS AND DISCUSSION

Effect of Water Regimes, Soybean Varieties and Their Interactions On

Vegetative Growth Characteristics

Plant Height (cm): Results in Table (3) show the effects of water regime, soybean varieties and their interactions on plant height of soybean plants during two growing summer seasons.

Water regimes treatments exerted significant differences in plant heights in the first and second seasons are presented in Table (3). Two irrigation treatment decreased significantly plant height compared with other irrigation treatments in both seasons. Normal irrigation treatment produced the tallest plants (117.50 and 110.08 cm) in the first and second seasons respectively, followed by six irrigation (112.92 and 102.60 cm) and four irrigations treatments (106.17 and 101.33 cm). Therefore, water regimes treatments could be ranked in descending order in respect to plant height in the 1st season as follow: Control (117.50)> six irrigations (112.92)> four irrigations (106.17)> two irrigations (100.66), with significant differences among the subsequent order. Similar trend was observed during two growing summer seasons with various magnitudes with significant differences. Such obtained results indicate that water regimes affectplant height during two summer seasons. In general, it looks to be true that there is no significant differences between normal irrigation (control) and applied six irrigation with slight various magnitudes. Similar results were also reported by [10, 13, 16], [33-37].

Data in Table (3) indicate clearly that, there were significant differences between the studied soybean varieties in plant height in the first and second seasons. Giza 111 variety recorded the tallest plant (117.83 cm) in the first season and Giza 21 variety was the tallest in the second season (106.20 cm). While the shortest plants were those of Crawford variety in the first and second seasons (94.33 and 92.33 cm) respectively. Such obtained results indicate that Giza 21 variety is more stimulated variety during two summer seasons but Crawford variety is the much affected ones.

Regarding the comparison between the varieties of the 1st season, the respective heights could be presented in the following descending order: Giza 111 followed by Giza 21 then Giza 35 followed by Crawford variety corresponding, Giza 21 then Giza 35 followed by Giza 111 then Crawford in the 2nd season. It is clear that the obtained differences in plant height for each of the grown soybean varieties was due to the water deficit under some treatments especially at the severe shortage regimes (two irrigations) which resulted in shorter plantsand the prevailing environmental conditions under this study in various specific patterns. These results confirm what were reported by [20, 23], [34, 38, 39].

The effect of the interaction between water regime and soybean varieties was significant on plant heights of soybean in the first and second seasons (Table 3). The tallest soybean plants (118.66 and 113.66 cm) were obtained by normal irrigation with Giza 21 variety in the first and second seasons respectively. Meanwhile, the shortest plants of soybean (94.33 and 92.33 cm) resultedfrom application of two irrigations with Crawford variety in the first and second seasons respectively. The obtained results were in agreement with those obtained by [34].

No. of Shoots Plant^{-1}: Results in Table (4) clarify the effects of water regimes, soybean varieties and their interactions on No. of shoots plant^{-1} of soybean plants during two growing summer seasons.

The mean value of No. of shoots plant^{-1} as affected by water regimes are presented in Table (4). Irrigation regime showed significant differences in No. of shoots plant^{-1} in the first and second seasons. The highest value of the studied trait (3.16 shoots plant^{-1}) was recorded when normal irrigation treatment was applied, followed by (2.95 shoots plant^{-1}) was recorded at six irrigation treatment in the first season. Moreover, the highest mean value of the studied trait (3.13 shoots plant^{-1}) was recorded when normal irrigation treatment, followed by (2.95 shoots plant^{-1}) was recorded when six irrigation treatment in the second season. While, the lowest value of the studied trait (2.54 and 2.60 shoots plant^{-1}) were recorded when two irrigation treatments in the first and second seasons, respectively. In general, it looks to be true that there is no significant differences between normal irrigation (control) and applied six irrigation with slight various magnitudes. Similar results were also obtained by [16, 35, 40, 41].

Table 3: Effect of water regimes on plant height (cm) of soybean varieties during each of two growing summer seasons (2018 and 2019)

	2018 season				
	Soybean Varieties (V)				
Water regimes (W)	Giza 21	Giza 35	Giza 111	Choloford	Means
Two	104.00	103.33	101.00	94.33	100.66
Four	107.00	107.30	107.66	102.66	106.17
Six	110.33	110.00	127.66	103.66	112.92
Control	118.66	111.33	135.00	105.00	117.50
Means	110.0	108.0	117.83	101.42	109.31

L.S.D. at 5% for water = 4.4 , for Varieties = 2.64 and for interaction = 5.27

	2019 season				
	Soybean Varieties (V)				
Water regimes (W)	Giza 21	Giza 35	Giza 111	Choloford	Means
Two	100.00	97.66	99.00	92.33	97.24
Four	107.66	104.00	100.00	93.66	101.33
Six	103.33	107.00	104.00	96.00	102.60
Control	113.66	112.00	114.00	100.66	110.08
Means	106.20	105.20	104.30	95.66	164.50

L.S.D. at 5% for water = 3.45 , for Varieties = 1.12 and for interaction = 2.23

Two = Two irrigation at V.G.S. and F.F.S.

Four = Four irrigation at V.G.S., B.F.S., B.P.S. and F.P.F.S.

Six = Six irrigation at V.G.S., B.F.F.S., F.P.F.S., F.S.F.S.

Control = Normal irrigation (Eight irrigation as a control). At all vegetative and reproductive stages.

Data in Table (4) show clearly that in the second season Giza 21 variety was significantly highest in No. of branches plant^{-1} (3.50 shoots plant^{-1}) compared with the three other varieties. Also, the same variety Giza 21 gave the highest value of No. of branches plant^{-1} (3.00 shoots plant^{-1}) in the first season with significant differences between soybean varieties. Whereas, Crawford variety gave the lowest value of No. of shoots plant^{-1} (2.40 and 2.43 shoots plant^{-1}) in the first and second seasons, respectively with significant differences between soybean varieties in both seasons. In other words, Giza 21 proved to be the best in No. of shoots plant^{-1}compared with Crawford variety. It is obviously clear that the obtained differences in No. of branches for each of the grown soybean varieties was off course due to their individual specific genetical make up that interact differently with the prevailing environmental conditions under this study in various specific patterns. The present results confirmswith those obtained by [16, 21-23, 36, 38-39].

Table 4: Effect of water regimes on No. of shoots plant^{-1} of soybean varieties during each of two growing summer seasons (2018 and 2019)

	2018 season				
	Soybean Varieties (V)				
Water regimes (W)	Giza 21	Giza 35	Giza 111	Crawford	Means
Two	2.70	2.56	2.50	2.40	2.54
Four	2.93	2.83	2.73	2.66	2.79
Six	3.03	2.96	2.93	2.90	2.95
Control	3.36	3.26	3.03	2.96	3.16
Means	3.005	2.908	2.800	2.733	2.86

L.S.D. at 5% for water = 0.12, for Varieties = 0.07 and for interaction = N.S

	2019 season				
	Soybean Varieties (V)				
Water regimes (W)	Giza 21	Giza 35	Giza 111	Crawford	Means
Two	2.71	2.60	2.55	2.43	2.60
Four	2.90	2.87	2.79	2.80	2.84
Six	3.03	3.00	2.97	2.96	2.95
Control	3.50	3.02	3.00	3.01	3.13
Means	3.01	2.91	2.81	2.73	2.88

L.S.D. at 5% for water = 0.12, for Varieties = 0.073 and for interaction = N.S

Two = Two irrigation at V.G.S. and F.F.S.

Four = Four irrigation at V.G.S., B.F.S., B.P.S. and F.P.F.S.

Six = Six irrigation at V.G.S., B.F.F.S., F.P.F.S., F.S.F.S.

Control = Normal irrigation (Eight irrigation as a control). At all vegetative and reproductive stages.

Total Chlorophyll Content: Results in Table (5) represent the effect of water regimes, soybean varieties and their interactions of total chlorophyll content in leaves during two growing summer seasons.

The mean value of total chlorophyll content in leaves of soybean varieties as affected by water regime is presented in Table (5). Water regimes showed that there was not a significant difference in total chlorophyll content in leaves in the first season. The highest mean value of total chlorophyll content in leaves (41.66 and 37.50) were recorded by normal irrigation treatment, followed by (40.0 and 36.36) were recorded by application of six irrigations treatment in the first and second seasons, respectively. While, the lowest mean value of total chlorophyll content in leaves (36.70 and 34.73) were recorded when application of two irrigation treatment in the first and second seasons, respectively.

It is well noticed from such ranking order that normal irrigation treatmentwere the highest mean value duringthe first and second seasonswhile two irrigation treatmentswerethe lowest mean value. In general, it looks to be true that there is no significant differences between normal irrigation (control) and applied six irrigation with slight various magnitudes. Such results agree with those reported by [9, 41-45].

Soybean varieties under study were significantly varied in chlorophyll content in leaves in the second season (Table 5). In the first season, the greatest value of total chlorophyll content was (43.27) recorded by Giza 21 variety, followed by Crawford variety (42.0) then Giza 111 (41.43) followed by Giza 35 (39.97) varieties in the first season. While, In the second season, The 4 soybean varieties could be arranged in a descending order in their total chlorophyll content in leaves as follows: Giza 21(44.43)> Giza 35 (37.93)> Giza 111 (34.53)> Crawford (33.13), with the same significant differences among the subsequent order. The currently presented results of the behaviour of soybean varieties in their total chlorophyll content in leaves were more or less similar those reported by [15 , 38, 39].

Table 5: Effect of water regimes on total chlorophyll content of soybean varieties during each of two growing summer seasons (2018 and 2019)

	2018 season				
	Soybean Varieties (V)				
Water regimes (W)	Giza 21	Giza 35	Giza 111	Choloford	Means
Two	36.77	38.13	34.93	37.03	36.70
Four	36.63	38.40	36.06	37.83	37.23
Six	39.03	39.67	40.03	41.20	40.00
Control	43.27	39.97	41.43	42.00	41.66
Means	38.92	39.04	38.11	39.51	38.89
L.S.D. at 5% for water = N.S, for Varieties = N.S and for interaction = N.S					
	2019 season				
	Soybean Varieties (V)				
Water regimes (W)	Giza 21	Giza 35	Giza 111	Choloford	Means
Two	39.10	35.83	32.20	31.80	34.73
Four	39.70	36.43	33.06	32.26	35.36
Six	40.73	37.16	35.06	32.50	36.36
Control	44.43	37.93	34.53	33.13	37.50
Means	40.99	36.84	33.71	32.42	35.98
L.S.D. at 5% for water = 0.73, for Varieties = 0.63 and for interaction =1.25					

Two = Two irrigation at V.G.S. and F.F.S.

Four = Four irrigation at V.G.S., B.F.S., B.P.S. and F.P.F.S.

Six = Six irrigation at V.G.S., B.F.F.S., F.P.F.S., F.S.F.S.

Control = Normal irrigation (Eight irrigation as a control). At all vegetative and reproductive stages

Total chlorophyll content in soybean leaves was not significantly affected by the interaction between water regimes and soybean varieties in the first season (Table 5). The highest total chlorophyll content in leaves was (41.66 and 37.50) were obtained by application of eight irrigations (control) treatment with Giza 21 variety in the first and second seasons, Meanwhile, the lowest value of total chlorophyll content of (36.70 and 34.73) was recorded by application of two irrigation at flowering stage treatment with Crawford variety in the first and second seasons respectively. Similar comparative studies were conducted by [35, 45].

Effect of Water Regimes, Soybean Varieties and Their Interactions On:

- First: Chemical properties of soybean leaves:
- Nitrogen content (%) in soybeanleaves:

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

The mean value of nitrogen content (%) in leaves of soybean as affected by water regimes is presented in Table (6). Irrigation regimes showed significant differences in nitrogen % in leaves in the secondgrowing season. The highest mean value of nitrogen % in leaves 4.62% were recorded when application of two irrigation treatment, followed by 4.32% were recorded when application of four irrigation treatment in the second seasons. While, the lowest mean value of nitrogen content in leaves of 3.39% were recorded when normal irrigation treatment in the secondgrowing season. Similar results were also reported by [8, 17, 46, 47].

Results in Table (6) showed that there was a significant difference in total nitrogen content (%) in leaves among the four varieties in the second season.

In the second (2019) season, the highest N% in leaves was 5.23% which was recorded by Giza 21variety, when application of two irrigation treatment and the lowest content was 3.0% recorded by Giza 111variety when normal irrigation treatment and the rest two varieties were in between as one group. It could be concluded that Giza 21variety as well as Giza 35variety, were superior in N% in leaves. It is obviously clear that the obtained differences in nitrogen content for each of the grown soybean varieties was off course due to their individual specific genetical make up that interact differently with the prevailing environmental conditions under this study in various specific patterns.

Table 6: Effect of water regimes on nitrogen content (%) of soybeanvarieties leaves during the second summer growing season (2019)

	2019 seasons				
	Soybean Varieties (V)				
Water regimes (W)	Giza 21	Giza 35	Giza 111	Choloford	Means
Two	5.23	5.10	4.43	3.73	4.62
Four	4.86	4.40	4.30	3.73	4.32
Six	3.83	3.70	3.36	3.13	3.50
Control	3.63	3.56	3.00	3.36	3.39
Means	4.39	4.19	3.77	3.49	3.95

L.S.D. at 5% for water = 0.13, for Varieties = 0.16 and for interaction = 0.33

Two = Two irrigation at V.G.S. and F.F.S.
Four = Four irrigation at V.G.S., B.F.S., B.P.S. and F.P.F.S.
Six = Six irrigation at V.G.S., B.F.F.S., F.P.F.S., F.S.F.S.
Control = Normal irrigation (Eight irrigation as a control).

However, results generally indicate that N% content in soybean leaves was significantly affected by the interaction between water regimes and soybean varieties in the second growing season Table (6). The highest N% contents 5.23%were obtained by application of two irrigation at vegetativeandfull flowering stages treatment with Giza 21variety in the second season.whereas, the lowest values of N content (%) 3.0% were recorded by application of eight irrigation (control) treatment underGiza 111 variety in the second season.Similar results were obtained.

It is worthy to note that under the low irrigations regime (two irrigations) N content was greater than the other treatments especially the normal practice (8 irrigations). Such effect could be explained due to the dilution effect where the N content is distributed in leaves on ales dry matter formed therefore the concentration of N was greater than the normal practice.

Phosphorus Content (%) in Soybeanleaves: Results for the effect of water regimes, soybean varieties and their interaction on phosphorus content (%) in leaves during second growing summer season (2019) are presented in Table (7).

The mean values of phosphorus content (%) in leaves of soybean as affected by water regime are presented in Table (7). Irrigation regimes showed significant effect on phosphorus content (%) in leaves in the second growing seasons. The highest mean values of phosphorus content in leaves of 0.41% were recorded by four and six irrigation treatments, followed by 0.38%were recorded by application of two irrigation treatment in the second growing season. While, the lowest mean value of phosphorus content (%) in leaves of 0.26% were recorded by application of normal irrigation treatment in the second growing season. These results confirm what were reported by [17].

The results recorded in Table (7) indicate clearly that, there were significant differences among the studied soybean varieties in phosphorus content (%) in leaves in the second growing season. The trend of the studied soybean varieties confirm what Giza 21variety recorded the highest values of 0.51% by application of two irrigation treatment followed by Crawfordvariety of 0.48% by application of four irrigation treatment then Giza 111 variety of 0.46% by application of six irrigation treatment in the second growing seasons respectively.

While the lowest values were those of Giza 21 variety in the second growing season. It is obviously clear that the obtained differences in Phosphorus content (%) for each of the grown soybean varieties was off course due to their individual specific genetical make up that interact differently with the prevailing environmental conditions under this study in various specific patterns.

Phosphorus content in soybean leaves was significantly affected by the interaction between water regimes and varieties as cleared in Table (7).

It looks to be true that the highest phosphorus contents (%) of 0.51% were obtained by application of two irrigation with Giza 21 then Crawfordvariety 0.48% by application of four irrigation treatment in the second season, whereas, the lowest values of phosphorus content (%) 0.16% were recorded by application of normal (control) irrigation at flowering stage treatment under Giza 21 variety and in the second season.

Potassium Content (%) in Soybeanleaves: Results for the effect of water regimes, soybean varieties and their interaction on Potassium content(%) in leaves during second growing summer season (2019) are presented in Table (8).

The mean values of potassium content (%) in leaves of soybean as affected by water regime are presented in Table (8). Irrigation regimes showed significant differences in potassium content (%) in leaves in the second growing season. The highest mean values of potassium content (%) in leaves of 2.10% were recorded by application of two irrigation treatment, followed by 2.08% were recorded by application of four irrigations treatment in the second seasons. While, the lowest mean value of potassium content (%) in leaves of 1.34% were recorded by normal irrigation treatment in the second growing season. Such obtained results are along the same line as those of [17].

Table 7: Effect of water regimes on phosphorus content (%) of soybeanvarieties leaves during the second summer growing season (2019)

	2019 seasons				
	Soybean Varieties (V)				
Water regimes (W)	Giza 21	Giza 35	Giza 111	Crawford	Means
Two	0.51	0.36	0.32	0.36	0.38
Four	0.39	0.36	0.42	0.48	0.41
Six	0.42	0.45	0.46	0.45	0.41
Control	0.16	0.22	0.36	0.30	0.26
Means	0.37	0.35	0.39	0.40	0.36

L.S.D. at 5% for water = 0.01, for Varieties = 0.06 and for interaction = 0.04

Two = Two irrigation at V.G.S. and F.F.S.
Four = Four irrigation at V.G.S., B.F.S., B.P.S. and F.P.F.S.
Six = Six irrigation at V.G.S., B.F.F.S., F.P.F.S., F.S.F.S.
Control = Normal irrigation (Eight irrigation as a control).

Table 8: Effect of water regimes on potassium content (%) of soybeanvarieties leaves during the second summer growing season (2019)

	2019 seasons				
	Soybean Varieties (V)				
Water regimes (W)	Giza 21	Giza 35	Giza 111	Crawford	Means
Two	2.00	2.16	2.20	2.06	2.10
Four	1.86	2.16	2.16	2.13	2.08
Six	1.53	1.63	1.70	1.80	1.66
Control	1.20	1.33	1.30	1.53	1.34
Means	1.65	1.82	1.84	1.88	1.79

L.S.D. at 5% for water = 0.15, for Varieties = 0.11 and for interaction = N.S

Two = Two irrigation at V.G.S. and F.F.S.
Four = Four irrigation at V.G.S., B.F.S., B.P.S. and F.P.F.S.
Six = Six irrigation at V.G.S., B.F.F.S., F.P.F.S., F.S.F.S.
Control = Normal irrigation (Eight irrigation as a control)

The four varieties under study were significantly varied in potassium content (%) of leaves in the second season. In Table (8), it could be generally concluded that the greatest potassium was 2.20% recorded by Giza 111variety, followed by Giza 35 variety 2.16% then Crawford variety 2.06%.Application of two irrigation treatment. Meanwhile, the lowest values were recorded by Giza 21variety 1.20%by application of normal irrigation treatment. The differences among the varieties were almost significant.

It is obviously clear that the obtained differences in potassium content (%) for each of the grown soybean varieties was off course due to their individual specific genetical make up that interact differently with the prevailing environmental conditions under this study in various specific patterns.

Table 9: Effect of water regimes ontotal carbohydrates content (%) of soybean varieties seeds during the second summer growing season (2019)

	2019 seasons				
	Soybean Varieties (V)				
Water regimes (W)	Giza 21	Giza 35	Giza 111	Choloford	Means
Two	27.85	26.90	26.16	25.69	26.65
Four	31.70	29.34	29.22	30.43	30.1
Six	36.07	35.51	33.55	32.39	34.38
Control	33.07	32.21	31.59	33.10	32.49
Means	32.17	30.99	30.13	30.40	30.90

L.S.D. at 5% for water = 1.70 , for Varieties = N.S and for interaction = N.S

Two = Two irrigation at V.G.S. and F.F.S.
Four = Four irrigation at V.G.S., B.F.S., B.P.S. and F.P.F.S.
Six = Six irrigation at V.G.S., B.F.F.S., F.P.F.S., F.S.F.S.
Control = Normal irrigation (Eight irrigation as a control).

Potassium content in soybean leaves was not significantly affected by the interaction between water regimes and varieties in the second season, Table (8).

The highest potassium content of 2.20% were obtained by application of two irrigation treatment with Giza 111variety then Giza 35variety in the second season, whereas, the lowest values of potassiumcontent of 2.0% were recorded by application of two irrigation treatments under Giza 21variety in the second seasons.

Second: Chemical Properties of Soybean Seeds

Total Carbohydrates Content (%) in Soybean Seeds: Results for the effect of water regimes, soybean varieties and their interaction on total carbohydrates content (%) in seeds during second growing summer season (2019) are presented in Table (9).

The mean value of total carbohydrates content (%) in seeds of soybean as affected by water regime is presented in Table (9) Irrigation regime showed significant differences in total carbohydrates content (%) in seeds in the second season. The highest mean value of total carbohydrates content (%) in seeds 34.38% were recorded by six irrigation treatment, followed by 32.49% were recorded by application of normal irrigation treatment in the second season, respectively. While, the lowest mean value of total carbohydrates content in seeds 26.65% were recorded by application of two irrigation treatment in the second season. Similar comparative studies were conducted by [14, 17, 18, 47, 48].

The four varieties under study were not significantly varied in total carbohydrates content in seeds in second season Table (9) In (2019) season, It could be more likely true that the greatest total carbohydrates content was 36.07% recorded by Giza 21variety, followed by Giza 35variety by 35.51% by application of six irrigation treatment. The lowest values were recorded by Crawford variety 25.69% by application of two irrigation treatment. The differences among the varieties were almost not significant, in the second season. It is generally noticed that the ideal arrangement of the 4 varieties was observed and Giza 21variety was on the top with 27.85% total carbohydrates%, followed by Giza 35variety 26.90% and Giza 111variety 26.16% with significant superiority for Giza 21variety. Crawford varietywas the fourth and the last in this arrangement with 25.69% carbohydrates content by application of two irrigation treatment. It is obviously clear that the obtained differences in total carbohydrates content (%) for each of the grown soybean varieties was off course due to their individual specific genetical make up that interact differently with the prevailing environmental conditions under this study in various specific patterns. Such results agree with those reported by [18].

Total carbohydrates % in soybean seeds was not significantly affected by the interaction between water regimes and varieties in the second season Table (9). The highest total carbohydrates content 36.07%were obtained by application of six irrigation treatment with Giza 21variety in the second season, whereas, the lowest values of total carbohydrates content 25.69% were recorded by application of two irrigations treatment under Crawford variety in the second season, respectively. Similar results were also obtained by [49].

Total Oil Content (%) in Soybean Seeds: Results in Table (10) show the effects of water regime, soybean varieties and their interaction on total oil content (%) in seeds during second growing summer season (2019) are presented in Table (10).

The mean values of total oil content (%) in seeds of soybean as affected by water regimes are presented in Table (10). Irrigation regimes showed that there is no significant effect on total oil content in seeds in the second season. The highest mean value of total oil content of 31.86% were recorded with four irrigations treatment, followed by 31.12% were recorded with two irrigations treatment in the second season, respectively. While, the lowest mean value of total oil content in seeds were recorded when application of normal irrigations treatment with 30.64% in the second seasons. Similar results were also obtained by [15].

Results reported in Table (10) clearly indicated that, there were not significant differences between the different soybean varieties in total oil content (%) in seedsin the second season.

Table 10: Effect of water regimes on total oil content (%) of soybean varieties seeds during the second summer growing season (2019)

	2019 seasons				
	Soybean Varieties (V)				
Water regimes (W)	Giza 21	Giza 35	Giza 111	Choloford	Means
Two	31.06	31.11	30.84	31.48	31.12
Four	30.94	32.01	33.01	31.50	31.86
Six	30.72	31.20	30.24	31.15	30.83
Control	30.30	30.08	31.14	31.06	30.64
Means	30.76	31.10	31.30	31.30	31.11

L.S.D. at 5% for water = N.S , for Varieties N.S and for interaction = N.S

Two =Two irrigation at V.G.S. and F.F.S.
Four = Four irrigation at V.G.S., B.F.S., B.P.S. and F.P.F.S.
Six = Six irrigation at V.G.S., B.F.F.S., F.P.F.S., F.S.F.S.
Control = Normal irrigation (Eight irrigation as a control)

However, results generally indicate that the effect of the interaction between water regimes and soybean varieties on total oil content (%)in seeds was not significant in the second season Table (10). Similar results were also obtained by [50].

Giza 111 variety was the highest in seed total oil content with 33.01% followed by Giza 35variety by 32.01% when application of four irrigations treatment in the second season, without significant difference between soybean varieties. Whereas, Giza 35variety gave the lowest values of total oil content in seeds by 30.08% in the second season, without significant difference between soybean varieties in both seasons. Such results agree with those reported by [15].

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