Response of six genotypes of bread wheat *(Triticum aestivum* L.) to water stress under conditions of the central region of Iraq.

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Abstract

A field study was conducted at Al-Muradia Research Station, located southwest of the center of Babylon province, at latitude 30 32 North and longitude 39 44 East during the winter season 2019-2020 in a sedimentary soil with a silty loam texture to study the ability to withstand water stress in the vegetative and reproductive stages of six genotypes from Bread wheat (*Triticum aestivum* L.).This experiment was conducted with The Randomized Complete Block Design (RCBD), split-plot arrangement, and three replications. treatments (S1) control treatment without stress and (S2) the stress treatment in the vegetative stage and (S3) the stress treatment in the reproductive stage in the main plots , while the subplots included six genotypes of bread wheat, namely (Hawler 4, Abu Ghraib, Auras, Hewler 2, Nucal and SST843),The water was blocked by covering the experimental units to prevent the arrival of rain, as well as cutting off irrigation in the stages (between tillering and elongation) and (between flowering and grain filling),Regular irrigation of the experimental units was applied after depleting 50% of the available water in the soil, while the water stress factors were left without irrigation for one irrigation and depletion of 80%-75% of available water and depending on the moisture description curve of the experimental soil. It was found from the study that the genotypes affected by water stress in a different method from one genotype to another and that the best genotypes tolerant to water stress were the two genotypes SST843 and Nucal by giving them the lowest decrease in grain yield with an average of (4.18, 4.06) tons ha^{-1}respectively and the amount of decrease in this trait (grain yield) under the influence of stress in the reproductive phase is more than the vegetative stage, and these two structures were distinguished in the rest of the studied traits, such as the relative water content in which the Nucal genotype gave the highest average for the trait amounting to 91%. The proline content in which the SST843 genotype gave the highest average was 141.8 µg, and the two genotypes Nucal and SST843 gave the highest average total peroxide content of the flag leaf amounting to (1.59,1.69) µg, respectively and the highest average content of total soluble sugars in the flag leaf was (42.12,40.40) mg respectively.

Keywords: bread wheat, *Triticum aestivum* L, water stress

Introduction

Iraq, which is located in the arid and semi-arid region of the world, faces major environmental, security, political, and economic challenges. The agricultural sector in it consumes up to 85% of its renewable freshwater sources (Al-Ansari 2013).The expected

increase in the demand for water and climatic changes, which is characterized by successive droughts due to the increasing temperature (global warming) The lack of rainfall and the risks of decreasing water releases in the Tigris and Euphrates rivers, in addition to the increase in civil and industrial uses of water, the absence of strategic planning in the short and long term, the absence of a development plan for resource management, and a large loss of water in the distribution network and the old and dilapidated irrigation system in Iraq.Failure to apply modern irrigation technologies, all of this will pose a threat to the cultivation of crops, especially in the central and southern regions of Iraq, which depend on irrigated agriculture.Hence, wheat cultivation, especially in Iraq, and under conditions of water shortage, requires field practices that derive their applications from the results of scientific research in the fields of irrigation, physiology, plant breeding, climate, soil, and others. One of the most efficient methods to confront water shortage, which is characterized by low costs and ease of application, is the cultivation of genotypes tolerant of water stress through breeding and improvement programs and conducting screening tests on them under water stress conditions (Maleki 2013). Water stress can occur at any stage of plant growth depending on the environmental conditions prevailing in the crop growth area. The genotype varies in their performance according to the stage of growth, some of them are tolerant to water stress in the vegetative stage. sensitive in the reproductive stage or vice versa, or it is tolerant in the two stages, or sensitive in the two stages.(Reynolds et al. 2019,).Water stress tolerance is related to a set of measurable characteristics, especially physiological and biochemical (Sallam et al. 2019,). Grain yield varies from one genotype to another and according to the growth environment of the crop (Raman et al. 2012).Hence the importance of this study is to evaluate the performance of a group of genotypes of bread wheat under normal irrigation conditions and water stress in the vegetative and reproductive stages of plant life to determine the most sensitive stages of growth to water stress by studying its effect on a group of physiological traits. Biochemistry and its relationship to the plant's ability to withstand water stress and the possibility of using it in the indirect selection of tolerant genotypes and in the conditions of the central region of Iraq.

Materials and methods

Experiment location and soil properties

The field experiment was conducted for cultivating the wheat crop (Triticum aestivum L.) during the winter season 2019-2020 in the field experiments of Al-Muradia Agricultural Research Station dedicated to wheat research and affiliated to the Babylon Agriculture Directorate. Some physicochemical properties of soil were estimated according to standard methods (Black et al., 1967).

Soil water holding capacity was estimated by estimating the moisture content of samples taken from the same previous depths and on the basis of dry weight and according to standard methods (Richard, 1965) and at stress 0, 33, 100, 500, 1000 and 1500 kPa, which were graphically represented in the soil moisture description curve (Fig. 1).The soil available water content was calculated from the difference in moisture content at field capacity and wilting

point. Soil analyzes were conducted in the Central Laboratory for Soil, Water, and Plant Analysis of the College of Agricultural Engineering Sciences/University of Baghdad.

Table 1. Some physical and chemical properties of soil for depth 0-0.40 m

values	units	Traits	
		Soil Separators	
320	g.kg^{-1} soil	sand	
600	g.kg^{-1} soil	silt	
80	g.kg^{-1} soil	clay	
silty loam	-	texture	
1.51	Mg.m^{-3}.	bulk density	
4.79	DS.m^{-1}	Electrical conductivity (soil paste extractor)	
7.12	-	pH	
214.3	mg.kg^{-1}	availability Potassium (Ammonium Acetate)	
11.35	mg.kg^{-1}	availability phosphorous	
98.3	mg.kg^{-1}	availability Nitrogen	
29.77	kPa	33	moisture stress
29.2		100	
24.9		500	
17.89		1000	
13.2		1500	

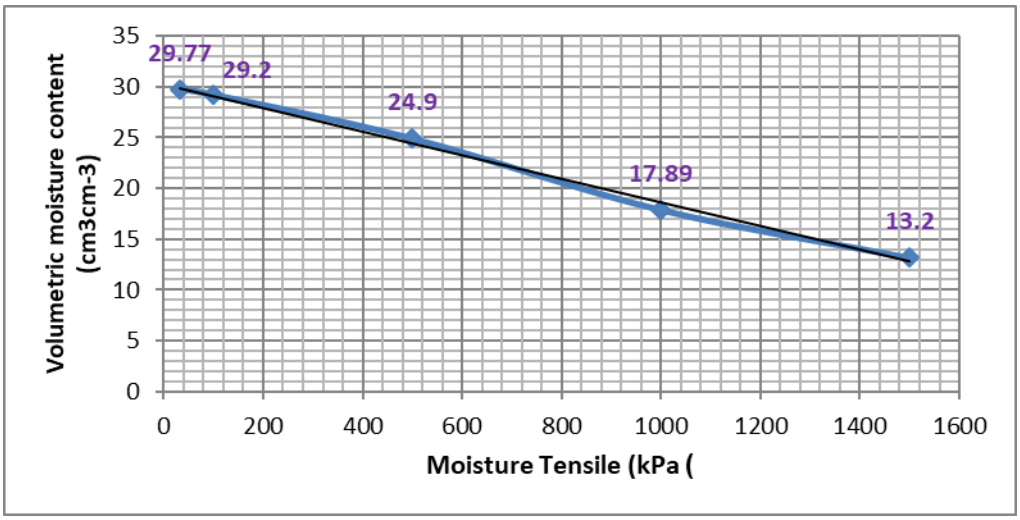

Figure (1) The moisture stress curve

3 - 2 Land preparation, experimental design, and treatments

The experimental land was tillage by two orthogonal tillage with a Moldboard plow and smoothed with disc harrows, and it was divided on the basis of the application of the Randomized Complete Block Design (RCBD) , in the arrangement of split-plot, and with three replications (Al-Rawi and Khalaf Allah, 1980).4 m intervals were left between the

replicates and 1 m intervals were left between the main units within the replicate and they were well aligned to limit the movement of water between the experimental units, and the experimental parameters were:

control treatment S0 (without stress) irrigation and re-irrigation after depleting (50%) of the available water and the two water stress treatments S1 Water blocking in the vegetative stage between branching and elongation (GSZ32-GSZ21) and S2 Water blocking in the reproductive stage between flowering and grain filling (GSZ79- GSZ61), where these treatments were applied to the main plot, while the sub plot included six genotypes of bread wheat, which are Hawler 4, Abu Ghraib, Auras, Hawler 2, Nucal, S384

3 - 3 . agricultural operations

The seeds of wheat cultivars were sown in sub plot , which included twelve lines for each plot of 3 m length and 0.25 m distance between one line and another on 12/12/2019 at a seeding rate of 140 kg/ha. Phosphorous fertilizer was added in an amount of 100 kg P per hectare of triple superphosphate fertilizer P2O5 45 when preparing the land,As for nitrogen, it was added in an amount of 200 kg N per hectare in the form of urea fertilizer (46%N) and in two equal batches, the first at planting and the second at the elongation stage (GSZ31). The bush was controlled manually as needed. The plants were harvested on May 4th, 2020.

Irrigation of experimental plot for treatments

control treatment

The irrigation process was conducted using Euphrates River water with an electrical conductivity of 2.7 ds.m-1 and using a water pump installed on its discharge pipe with a meter to measure the amounts of water added for each experimental unit and at each irrigation.After depleting 50% of the prepared water according to the equation in: (Kovda et al., 1973)

$$d = (\theta_{fc} - \theta_w)D \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:

d = depth of water added (mm(

θ_{fc} = = volumetric humidity at field capacity

θ_W =volumetric humidity before watering

D = depth of perfusion

The soil moisture content was continuously monitored using Soil Moisture Meter (model: PMS-714-Lutron Electronic Enterprise CO;LTD.) after calibration and by gravimetric method for measuring soil moisture.After the moisture percentage has been determined upon reaching a point where 50% of the ready water has been exhausted, the panels are re-irrigated

by adding water to each panel according to the quantity that is determined according to equations (1) and (2) to reach a moisture content close to the field capacity or use Kohnke's equation (1968.(

$$w = a \times \ell b \left[\frac{\%Pw^{f.c} - \%Pw^{w}}{100} \right] \times \frac{D}{100} \quad \text{..... (2)}$$

W = the volume of water to be added during irrigation (m3.(

a = irrigated area (m2)

= Bulk Density (Mg. m3)

Pwf.c = percentage of soil moisture based on weight at field capacity (after irrigation)

Pww = percentage of soil moisture based on weight before irrigation.

D = Depth of soil to be irrigated (m)

The soil moisture content was continuously monitored using Soil Moisture Meter (model: PMS-714-Lutron Electronic Enterprise CO;LTD.) after calibration and by gravimetric method for measuring soil moisture. After the moisture percentage has been determined upon reaching a point where 50% of the ready water has been exhausted, the plot is re-irrigated by adding water to each plot according to the quantity that is determined according to equations (1) and (2) to reach a moisture content close to the field capacity or use Kohnke's equation (1968).

studied traits

- Relative water content(RWC)

It was calculated according to the method (Barrs and Weatherley 1962) by taking ten full-fledged flag papers in the early morning hours (eight in the morning) from each experimental unit and making strips of each leaf (10 cm) long and (1 cm) wide.The slides were weighed with a sensitive scale and the arithmetic mean was extracted without delay to ensure no loss of moisture, and then soaked in distilled water for four hours in the dark at room temperature (25 °C) to extract the average full weight of them.

Then dried in the electric oven at a temperature of 80 degrees Celsius until the weight is stabilized to extract the average full weight for it, and then dried in an electric oven at (85°C) until its dry weight is established. The relative water content was calculated according to the following equation (Weatherley 1950):

$$RWC = \frac{fresh\ weight - dry\ weight}{\text{turgid}\ \ weight - dry\ weight} \times 100 \quad \text{..... (3)}$$

RWC== relative water content

Fresh weight(g)

dry weight(g)

turgid weight(g)

- The total peroxide content of the flag leaf µmol(gm. fresh weight^{-1})

The hydrogen peroxide content of H_2O2 was determined according to the method of Velikova et al. (2000), which is a modern, environmentally friendly method. As (0.07) g of leaf tissue was crushed in an ice bath with 5 ml of 1% (w/v) of trichloroacetic acid (TCA) to form a homogeneous solution. Centrifuge at 12000g for 15 minutes, then add 0.5 ml of the filtrate to 0.5 ml of 10 ml potassium phosphate (pH 7) and 1 ml of 1 M potassium iodide.The absorbance of the leachate was measured at 390 nm by a spectrophotometer (UV-9200 BIOTACH ENGINEERING MANAGEMENT CO. LTD U.K.) and the hydrogen peroxide content was calculated from the calibration curve that was extracted using different concentrations of H2O2.

Estimation of the total soluble sugars (carbohydrates) in the flag leaf mg (gm. fresh weight^{-1})

Total sugars were measured using the sulfuric acid-phenol method according to Wang et al. (2017), which is a colorimetric method.

Components: concentrated sulfuric acid, phenol (5%), sucrose standard solution

The work method :

50 µl of standard glucose and 50 µl of plant extract were added to a clean, sterile microplate, then 150 µl of concentrated sulfuric acid was added gradually and slowly, followed immediately by 100 µl of 5% phenol.The microplate was heated for 5 min at 90 °C. Then it was cooled to room temperature for 5 min, and the absorbance was then measured in a TS 800/TS microplate reader (USA) at a wavelength of A490 nm. Use distilled water added to the sugar determination reagents as an efficient solution (plank).

Total sugars concentration = (test-tube absorbance/measurement-tube absorbance) x standard-tube concentration

- flag leaf content of Proline µg (gm. fresh weight^{-1})

It is one of the environmentally friendly methods adopted according to the method of Carillo and Gibon (2011), which is based on the use of ninhydrin, where the reaction with proline produces a yellow-orange product at a moderate pH, which has the greatest absorption at 520 nm.

Components: Proline, ninhydrin, glacial acetic acid, ethanol (98%).

solutions:

1. Extraction: 0.5 g of plant tissue was taken and homogenized with ethanol-water solution (30:70) (vol/v) in a volume of 10 ml.

2. Proline Standard Solution: Proline solution shall be prepared to range from 0.04 to 1 mmol, in the same medium used for extraction.

3. Working solution (reaction reagent): ninhydrin 1% (w/v) in acetic acid 60% (v/v), ethanol 20% (v/v).

The method of work:

Extraction:

Proline is highly soluble and can be easily extracted by homogenizing the extracts for 20 minutes in pure ethanol or in water. Method of measuring proline using a spectrophotometer (spectrometer):

1. In 1.5 ml test tubes with a tight lid, 1000 µl of working solution (reaction reagent) was added.

2. Using a micropipette, 500 µl of ethanolic plant extract or 100 µl of standard proline were added to contain 0.2, 0.50, 1, 2.5 and 5 mmol of proline. The volume is supplemented to 400 µl using ethanol:water (40:60 volume/vol).

3. The tubes were closed, mixed and heated at 95°C in a water bath for 20 minutes.

4. Use a centrifuge (1 minute, 10,000 rpm) to remove the precipitate.

5. Transfer the filtrate to a 1.5 ml glass cell and read at a wavelength of 520 nm

The exact concentration of proline is calculated from the standard curve in Figure 3. Which shows the relationship between the amount of proline and the corresponding spectral absorption at 1-100 nm in a spectrophotometer. The following equation is used to calculate the amount of proline in the extracts:

Proline in nmol.mg^{-1} FW or in µmol.g^{-1} FW = (Abs extract – blank) / slope x Volextract/Volaliquo t*1/FW …….. (4)

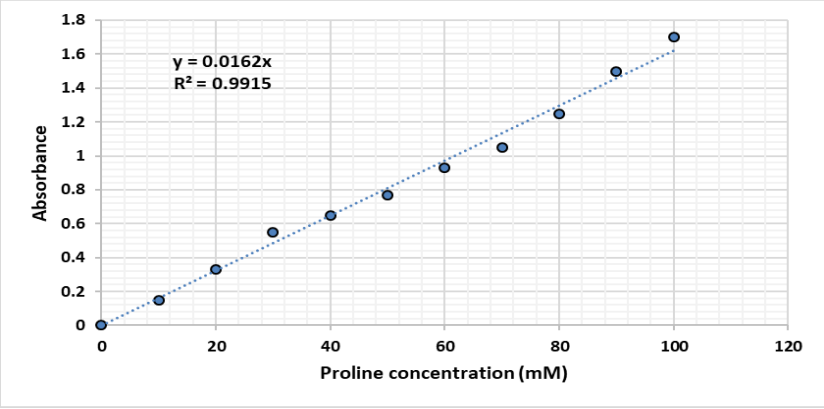

Figure 3. Standard Curve for Proline

Grain yield(ton.hs^{-1})

The weight of the grains per square meter was calculated and then converted to ton ha^{-1}.

Results

Relative Water Content of Flag leaf

(Table 1) shows that the water stress caused a decrease in the relative water content in the vegetative stage by a value of 87.22%, which is equivalent to a decrease of 3.74% compared to the control treatment, and caused a decrease in the reproductive stage by a value of 79.33%, which is equivalent to 12.38% compared to the control treatment. This agreed with the results reached by (2015) Muhammad which confirmed the decrease in the relative water content value when wheat plants were exposed to water stress and that the reproductive stage was more and more affected than the vegetative stage.(Table 2) shows that the highest arithmetic average of the relative water content was given by the genotype (Nukal), which reached 91.44%, while the lowest arithmetic average was what was recorded by the genotype (Hawler 2) by giving it the lowest average of the trait, which reached 83.33%, which did not differ significantly from the genotypes (Abu Ghraib) and (SST843) and (Auras). These results are in agreement with what was found by Yagmur and (2008) Kadan about the effect of the difference between the genotypes on the response of wheat plants differently in terms of the occurrence of physiological changes in the relative water content.

Table1. Effect of water stress and genotypes on the relative water content of flag leaf (%)

Arithmetic mean	water stress			genotypes
	S2	S1	S0	
87.33	**82.00**	**89.00**	**91.00**	Hawler 4
83.67	**76.33**	**84.67**	**90.00**	**Abu Ghraib**
84.67	**77.00**	**87.67**	**89.33**	**Auras**
83.33	**77.33**	**84.33**	**88.33**	**Hawler 2**
91.44	**85.33**	**93.00**	**96.00**	**Nucal**
84.00	**78.33**	**84.67**	**89.00**	**SST843**
	79.39	**87.22**	**90.61**	**Arithmetic mean**
		genotypes	**water stress**	
		1.46	**1.26**	**LSD 0.05**

- Total peroxide content of the flag leaf (gm. fresh weight^{-1})

(Table 2) indicates that the genotype (nucal) was the highest in the mean values and gave 1.69 µmol and did not differ significantly from the compositions (Abu Ghraib), (SST843) and (Houler4).While the genotype (Hawler2) gave the lowest content of total hydrogen peroxide, which was 1.38 µmol, and it did not differ significantly from the genotypes (Auras), (Hawler

4) and (SST843). These results are in agreement with the findings of Hu et al. (2009) regarding the difference in genotypes in hydrogen peroxide content in wheat.

Table2. Effect of water stress and genotypes on the total peroxide content of flag leaf µmol

Arithmetic mean	**water stress**			genotypes
	S2	**S1**	**S0**	
1.56	**1.70**	**1.37**	**1.61**	Hawler 4
1.65	**1.73**	**1.81**	**1.50**	Abu Ghraib
1.47	**1.40**	**1.68**	**1.33**	Auras
1.38	**1.28**	**1.45**	**1.40**	Hawler 2
1.69	**1.90**	**1.34**	**1.83**	Nucal
1.59	**1.45**	**1.80**	**1.51**	SST843
	1.58	**1.58**	**1.49**	Arithmetic mean
		genotypes	**water stress**	
		0.22	**n.s**	LSD 0.05

- Total soluble sugars in the flag leaf µmol

(Table 3) showed that the genotype (SST843) gave the highest average of the total soluble sugar content of 42.12 mg and it did not differ significantly from the genotypes (Nukal) and (Auras). While the genotype (Hawler 4) gave the lowest average for the trait, which was 32.52 mg, and it did not differ significantly from the genotype (Abu Ghraib) and (Hawler 2).These results are in agreement with the findings of Shabbir (2014) regarding the difference in the content of total soluble sugars and according to the difference in genotypes in wheat.

Table3. Effect of water stress and genotypes on total soluble sugars in flag leaf (gm fresh weight^{-1})

Arithmetic mean	**water stress**			genotypes
	S2	**S1**	**S0**	
32.52	**38.44**	**26.81**	**32.31**	Hawler 4
33.20	**30.89**	**40.71**	**28.00**	Abu Ghraib
39.91	**28.74**	**46.40**	**44.59**	Auras
36.20	**31.66**	**36.33**	**40.61**	Hawler 2
40.40	**29.79**	**45.67**	**45.75**	Nucal
42.12	**50.19**	**35.69**	**40.47**	SST843
	34.95	**38.60**	**38.62**	Arithmetic mean
		genotypes	**water stress**	
		5.40	**n.s**	LSD 0.05

- Proline content in the flag leaf µg (g. fresh weight $^{-1}$)

(Table 4) showed that the genotype (SST843) was the highest in the mean of the trait and gave 141.8 µg, which did not differ significantly from the genotype (Auras), while the genotype (Hawler 4) recorded the lowest average of the trait, reaching 113.6 µg.There were no significant differences between him and the two genotypes (Hawler 2) and (Abu Ghraib), and these results agreed with the findings of Mwadzingeni et al. (2016) regarding the difference in genotypes in their proline content in wheat plants.

Table4. Effect of water stress and genotypes on the content of proline in flag leaf µg(g. fresh weight $^{-1}$)

Arithmetic mean	**water stress**			genotypes
	S2	**S1**	**S0**	
113.6	**129.1**	**122.1**	**89.8**	Hawler 4
116.5	**131.8**	**126.6**	**91.1**	Abu Ghraib
136.6	**124.2**	**135.3**	**150.3**	Auras
115.5	**115.4**	**116.8**	**114.2**	Hawler 2
127.4	**170.7**	**102.3**	**109.0**	Nucal
141.8	**122.7**	**117.4**	**185.3**	SST843
	132.3	**120.1**	**123.3**	Arithmetic mean
		genotypes	**water stress**	
		13.31	**n.s**	LSD 0.05

Grain yield (tons.ha^{-1})

Table 5, it is evident that the water stress caused a decrease in the grain yield in the vegetative and reproductive stage, where it recorded a decrease in the vegetative stage, which amounted to 3.57 tons.ha^{-1}, corresponding to a percentage decrease of 11.33% compared to the comparison treatment. In the reproductive stage, the value was 3.16 tons ha-1, which is equivalent to a percentage decrease of 21.36% from the control treatment. The reproductive stage was more affected than the vegetative stage by water stress and was the most in the percentage decrease by 11.30%, compared to the rest of the genotypes, it was recorded The two genotypes (Nucal) and (SST843) had the lowest percentage decrease in yield under the influence of water stress for the vegetative stage, reaching (7.27%, 9.53%) respectively. They also recorded the lowest percentage decrease in the reproductive stage, which amounted to (16.36%, 12.41%) sequentially compared to the control treatment in the two growth stages. Which the plant is going through and that the effect was in the reproductive stages more than in the vegetative stages.It was noted from Table 5 that the genotype (SST843) was distinguished by giving it the highest average for the trait, which amounted to 4.18 tons ha^{-1} and there were no significant differences between it and the genotype (Nukal) while the genotype (Hawler 4) gave the lowest averages for the trait for this season of the study, reaching 3.14 tons ha^{-1} .There were no significant differences between him and the genotype

(Hawler 2). These results are in agreement with the findings of Hou et al. (2018) that grain yield in wheat plants is affected by the stability and stability of the genotype.

Table 5. Effect of water stress and genotypes on grain yield (ton ha^{-1})

Arithmetic mean	**water stress**			genotypes
	S2	**S1**	**S0**	
3.14	**2.56**	**3.07**	**3.81**	Hawler 4
3.35	**2.84**	**3.40**	**3.82**	Abu Ghraib
3.46	**3.04**	**3.46**	**3.90**	Auras
3.30	**2.90**	**3.31**	**3.69**	Hawler 2
4.06	**3.68**	**4.08**	**4.40**	Nucal
4.18	**3.95**	**4.08**	**4.51**	SST843
	3.16	**3.57**	**4.02**	Arithmetic mean
		genotypes	**water stress**	
		0.18	**0.20**	LSD 0.05

Discussion

The bearing capacity is often related to the amount of grain yield obtained under water stress conditions (Pour-Aboughadareh et al. 2019,).In this context, the genotypes (Nukal) and (SST843) showed the highest values for the average grain yield and recorded the lowest percentages of decrease in yield under the influence of water stress in the vegetative and reproductive stages compared to the rest of the genotypes (Table 5).Turgor Pressure is important for the permanence of cells' work, division, and expansion to achieve the desired. Inflation pressure is usually related to the relative water content of cells, where cells that maintain high levels of relative water content under water stress conditions can sustain their growth and thus the genotype is more tolerant to water stress because the relative water content is Reflects the amount of plant metabolic activity.It is one of the important physiological measures to determine the degree of moisture in cells and tissues necessary for the physiological and biochemical performance and growth processes. It is considered one of the important electoral criteria under water stress conditions. Rather, it is the best of these criteria when compared to others. In this study, the genotype (Nucal) showed the highest levels of relative water content (Table 1). Exposure of plants to abiotic stresses, including water stress, increases the content of these plants from hydrogen peroxide, and weak concentrations of it are often beneficial, as it can contribute to the process of plant acclimatization to resist internal and external stresses by increasing or regulating gene expression (Potters et al., 2007).It is considered the most stable and diffuse within cells compared to other reactive oxygen compounds, so it acts as a secondary signal molecule that is more acceptable than others and has a role in supporting many physiological processes such as photosynthesis, respiration, and movement of guard cells, so it was influential in the process of growth and development and increasing the tolerance of genotypes that were characterized by recording high values of total peroxide content, and this agreed with what

was found (Lv et al. 2011,). The results of this study showed the superiority of the two genotypes (Nucal) and (SST843) in the average values of total peroxide (Table 2). The water stress increases the level of total soluble sugars, where their values are higher in the stress moduli compared to the control treatment, and they are higher under the conditions of hard stress compared to the moderate stress. This is done by stimulating the activity of some degrading enzymes, whose activity leads to an increase in the content of soluble sugars, which increases the osmotic effort of the cell, which leads to an increase in its ability to absorb water. This is done by stimulating the activity of some degrading enzymes, whose activity leads to an increase in the content of soluble sugars, which increases the osmotic effort of the cell, which leads to an increase in its ability to absorb water. Enabling the plant to stress tolerance, and this is done through the functions of soluble sugars represented in maintaining the integrity of cellular membranes and providing the energy necessary to sustain the functions of the plant and its vital metabolism and contribute to scavenging free radicals and free radicals in the cell (Abid et al. 2018). This was demonstrated by this study (Table 3), which recorded high values of the two genotypes tolerant of water stress (SST843) and (Nukal) for the average total soluble sugars. Stress-tolerant genotypes, especially water stress, indicate an accumulation of proline in their plants, where it is an amino acid that accumulates under water stress conditions and is important for food metabolism, where it acts as a signal to stimulate a specific gene in addition to the great role it plays, which is to increase the plant's ability to cover. Overcoming the effects of water stress and regulating carbon and nitrogen reserves after the removal of water stress or its reduction through its functions in the plant, including its ability to modify, osmotic protection and root scavenging. Free radicals and protection of large molecules from deformation in addition to its most important functions of providing stability to membrane phospholipids and proteins, protecting them from degradation and reducing cell acidity, and this is agreed with (Hatami et al. 2017,). The results of this study (Table 4) showed the superiority of the genotype (SST843) by giving high values of proline content in the flag leaf. water stress tolerance in the vegetative and reproductive stages shown by the SST843 and Nucal genotypes is due to its ability to sustain growth through its exelled in the studied traits.

- Conclusions

The water stress caused a decrease in the grain yield of all the genotypes included in the study, and the percentage of decrease in the reproductive stage was higher than that of the vegetative stage compared to the control treatment. The two genotypes (Nucal) and (SST843) showed the most endurance by showing the lowest percentage of yield reduction under the influence of water stress and for the vegetative and reproductive growth stages.The susceptibility to water stress in the genotypes under study is related to the characteristics of the physiological and biochemical plants of the genotype.The most tolerant genotypes were the most superior in these traits, such as relative water content, total peroxide content, total sugars content, and proline content.

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